KARL
FRISTON
WHAT IS
LIFE?

1
00:00:03,030 --> 00:00:01,429
this is the longest interview i've ever

2
00:00:03,909 --> 00:00:03,040
done because there are such intriguing

3
00:00:05,670 --> 00:00:03,919
uh questions

4
00:00:07,110 --> 00:00:05,680
well yeah the fact i'm still here it's

5
00:00:10,950 --> 00:00:07,120
just but

6
00:00:14,070 --> 00:00:10,960
i've had a great time i don't go to

7
00:00:16,550 --> 00:00:14,080
our next next exchange

8
00:00:17,109 --> 00:00:16,560
carl fristen is considered by his peers

9
00:00:19,590 --> 00:00:17,119
to be

10
00:00:20,310 --> 00:00:19,600
the top neuroscientist that exists

11
00:00:23,189 --> 00:00:20,320
probably that

12
00:00:25,189 --> 00:00:23,199
ever existed now obviously he won't say

13
00:00:27,670 --> 00:00:25,199

that he'll rebuff that because he's a

14
00:00:30,070 --> 00:00:27,680
humble british chap who doesn't like to

15
00:00:31,509 --> 00:00:30,080
draw undue attention to himself but i

16
00:00:33,030 --> 00:00:31,519
give him that accolade he has a

17
00:00:34,709 --> 00:00:33,040
principle called the free energy

18
00:00:37,190 --> 00:00:34,719
principle which is

19
00:00:39,830 --> 00:00:37,200
infamously inscrutable but we try to

20
00:00:42,790 --> 00:00:39,840
make it as simple as possible

21
00:00:44,310 --> 00:00:42,800
please keep in mind that while there is

22
00:00:47,110 --> 00:00:44,320
plenty of technical jargon

23
00:00:48,470 --> 00:00:47,120
in this podcast it's important that you

24
00:00:49,670 --> 00:00:48,480
stay with it once you're at the end

25
00:00:51,029 --> 00:00:49,680
you'll probably have a better

26
00:00:52,389 --> 00:00:51,039
understanding as to how to interpret

27
00:00:54,630 --> 00:00:52,399
what he said at the beginning this is

28
00:00:56,150 --> 00:00:54,640
one of the longest conversations if not

29
00:00:57,590 --> 00:00:56,160
the longest conversation with carl

30
00:01:00,310 --> 00:00:57,600
firsten that exists

31
00:01:01,990 --> 00:01:00,320
and not that size matters but you can

32
00:01:03,349 --> 00:01:02,000
use the duration or the length of a

33
00:01:04,630 --> 00:01:03,359
podcast as a proxy

34
00:01:06,870 --> 00:01:04,640
for the interviewee's interest and

35
00:01:09,190 --> 00:01:06,880
that's great for me as an interviewer

36
00:01:10,550 --> 00:01:09,200
because hopefully the report comes

37
00:01:12,310 --> 00:01:10,560
across and

38
00:01:13,830 --> 00:01:12,320

influences whether or not you can absorb

39
00:01:15,429 --> 00:01:13,840
the information or influences the rate

40
00:01:16,789 --> 00:01:15,439
at which you can absorb it and possibly

41
00:01:17,749 --> 00:01:16,799
even the comfortableness that me and

42
00:01:21,510 --> 00:01:17,759
carl have with

43
00:01:23,190 --> 00:01:21,520
one another aids your understanding

44
00:01:25,030 --> 00:01:23,200
perhaps the integration of this

45
00:01:27,429 --> 00:01:25,040
information so that you can assemble

46
00:01:28,230 --> 00:01:27,439
your own veltan shawum that is your own

47
00:01:31,990 --> 00:01:28,240
theory

48
00:01:35,830 --> 00:01:34,230
these podcasts are extremely difficult

49
00:01:38,069 --> 00:01:35,840
to produce because they require

50
00:01:39,190 --> 00:01:38,079
quite a bit of preparation and if you're

51
00:01:40,789 --> 00:01:39,200
interested in supporting

52
00:01:43,109 --> 00:01:40,799
conversations like this or seeing more

53
00:01:44,469 --> 00:01:43,119
like this or you have other ideas as to

54
00:01:45,990 --> 00:01:44,479
who i should interview and you'd like to

55
00:01:46,630 --> 00:01:46,000
support this channel in some way shape

56
00:01:48,270 --> 00:01:46,640
or form

57
00:01:49,990 --> 00:01:48,280
then please do consider going to

58
00:01:52,469 --> 00:01:50,000
patreon.com

59
00:01:54,149 --> 00:01:52,479
kurtjimongo literally every dollar every

60
00:01:55,990 --> 00:01:54,159
donation every patron

61
00:01:57,910 --> 00:01:56,000
helps a tremendous amount not only

62
00:02:00,069 --> 00:01:57,920
financially but it also helps

63
00:02:01,590 --> 00:02:00,079

with encouragement it helps show me that

64
00:02:03,190 --> 00:02:01,600
this is something that people are

65
00:02:04,950 --> 00:02:03,200
people like and are willing to support

66
00:02:06,789 --> 00:02:04,960
voluntarily

67
00:02:08,389 --> 00:02:06,799
thank you to all the existing patrons

68
00:02:10,469 --> 00:02:08,399
and just so you know the best way to

69
00:02:12,390 --> 00:02:10,479
view this podcast in spite like i said

70
00:02:14,630 --> 00:02:12,400
its inscrutable nature as to what

71
00:02:16,229 --> 00:02:14,640
exactly the free energy principle is

72
00:02:18,869 --> 00:02:16,239
the best way to view this podcast or

73
00:02:20,070 --> 00:02:18,879
listen to it is by re-listening to it

74
00:02:21,750 --> 00:02:20,080
by the end of it you'll have a better

75
00:02:22,150 --> 00:02:21,760
understanding as to what carl firsten

76
00:02:23,990 --> 00:02:22,160
means

77
00:02:25,510 --> 00:02:24,000
when he says certain terminology and

78
00:02:27,270 --> 00:02:25,520
then when you re-watch

79
00:02:29,110 --> 00:02:27,280
or revisit certain parts you can look at

80
00:02:31,110 --> 00:02:29,120
the timestamps revisit and hopefully

81
00:02:32,869 --> 00:02:31,120
gain a better understanding for those

82
00:02:34,630 --> 00:02:32,879
listening and not watching

83
00:02:36,309 --> 00:02:34,640
there is also a youtube channel and for

84
00:02:39,830 --> 00:02:36,319
those who are watching and not listening

85
00:02:41,430 --> 00:02:39,840
there is a itunes spotify google play

86
00:02:42,710 --> 00:02:41,440
we're on pretty much every platform you

87
00:02:43,589 --> 00:02:42,720
can look at the description to get the

88
00:02:46,869 --> 00:02:43,599

links for that

89
00:02:47,990 --> 00:02:46,879
thank you so much and enjoy sir it's a

90
00:02:49,670 --> 00:02:48,000
pleasure

91
00:02:51,670 --> 00:02:49,680
i have been looking forward to this for

92
00:02:52,470 --> 00:02:51,680
quite some time as i started researching

93
00:02:55,509 --> 00:02:52,480
you

94
00:02:57,670 --> 00:02:55,519
the top

95
00:02:59,670 --> 00:02:57,680
neuroscientists that are living but you

96
00:03:02,710 --> 00:02:59,680
may be the greatest neuroscientist

97
00:03:03,990 --> 00:03:02,720
to ever exist i'm just going by the

98
00:03:06,149 --> 00:03:04,000
approbation from your own

99
00:03:07,270 --> 00:03:06,159
colleagues as well as your h index which

100
00:03:09,110 --> 00:03:07,280
is another

101
00:03:11,190 --> 00:03:09,120
reflection of colleagues approving of

102
00:03:14,309 --> 00:03:11,200
you and your citations which is

103
00:03:17,270 --> 00:03:14,319
in the six digits if i'm not mistaken

104
00:03:19,110 --> 00:03:17,280
so how about first we start off with

105
00:03:23,030 --> 00:03:19,120
just how is it that you balance work

106
00:03:24,149 --> 00:03:23,040
and life um very badly i i should say

107
00:03:26,550 --> 00:03:24,159
that i'm certainly not

108
00:03:27,350 --> 00:03:26,560
the greatest neuroscientist i think

109
00:03:29,910 --> 00:03:27,360
that's more of

110
00:03:32,710 --> 00:03:29,920
a reflection of the fact they invented

111
00:03:36,149 --> 00:03:32,720
the h index a few years ago so

112
00:03:40,149 --> 00:03:36,159
it gives me an unfair fair advantage um

113
00:03:43,509 --> 00:03:40,159

the balance is is um is very poor

114
00:03:46,550 --> 00:03:43,519
um so most of my life i spend

115
00:03:50,070 --> 00:03:46,560
um pursue academic

116
00:03:53,509 --> 00:03:50,080
uh commitments um in fact in the past

117
00:03:54,949 --> 00:03:53,519
in the past year also um commitments

118
00:03:56,070 --> 00:03:54,959
i've taken on in relation to the

119
00:03:59,670 --> 00:03:56,080
coronavirus

120
00:04:02,789 --> 00:03:59,680
outbreak in terms of modeling so um

121
00:04:04,949 --> 00:04:02,799
on the other hand i love what i do so

122
00:04:06,789 --> 00:04:04,959
for me life is a bit of a holiday anyway

123
00:04:10,149 --> 00:04:06,799
i think many people who suffer

124
00:04:10,470 --> 00:04:10,159
my family in terms of my improper work

125
00:04:13,910 --> 00:04:10,480
life

126
00:04:15,750 --> 00:04:13,920
balance does your family get upset that

127
00:04:16,949 --> 00:04:15,760
you're constantly thinking about work

128
00:04:18,150 --> 00:04:16,959
or are you distracted when you're

129
00:04:19,430 --> 00:04:18,160
spending time with them because

130
00:04:22,710 --> 00:04:19,440
something else is on your mind

131
00:04:24,550 --> 00:04:22,720
um i think they've got used to it and i

132
00:04:26,550 --> 00:04:24,560
have to say that they also have their

133
00:04:27,430 --> 00:04:26,560
preoccupations and their and their sort

134
00:04:30,070 --> 00:04:27,440
of uh

135
00:04:31,350 --> 00:04:30,080
those um the things that they invest in

136
00:04:34,310 --> 00:04:31,360
so i think they are

137
00:04:37,510 --> 00:04:34,320
um as guilty as i am in in not paying

138
00:04:39,749 --> 00:04:37,520

proper attention to

139
00:04:41,189 --> 00:04:39,759
the uh the life side of the work life

140
00:04:43,590 --> 00:04:41,199
balance

141
00:04:45,430 --> 00:04:43,600
do you have a daily ritual or do you

142
00:04:46,230 --> 00:04:45,440
meditate do you eat a certain type of

143
00:04:47,909 --> 00:04:46,240
meal

144
00:04:49,990 --> 00:04:47,919
go to sleep at a specific time wake up

145
00:04:52,870 --> 00:04:50,000
at a specific time what's the structure

146
00:04:54,629 --> 00:04:52,880
i i am certainly a creature of habit um

147
00:04:55,990 --> 00:04:54,639
and i guess we'll come back to why that

148
00:04:56,390 --> 00:04:56,000
is possibly the case i should be the

149
00:04:59,510 --> 00:04:56,400
case

150
00:05:02,629 --> 00:04:59,520
for most creatures um so

151
00:05:04,870 --> 00:05:02,639
um no i i i don't meditate but um it's a

152
00:05:08,710 --> 00:05:04,880
it's an interesting question because

153
00:05:11,590 --> 00:05:08,720
my daily routine does involve

154
00:05:12,550 --> 00:05:11,600
a long period of thinking in the morning

155
00:05:18,629 --> 00:05:12,560
so

156
00:05:20,310 --> 00:05:18,639
joke and perhaps not joke that i i don't

157
00:05:21,189 --> 00:05:20,320
like talking to other human beings

158
00:05:27,990 --> 00:05:21,199
before

159
00:05:30,950 --> 00:05:28,000
my day typically will start with

160
00:05:33,110 --> 00:05:30,960
at least an hour if not two hours

161
00:05:34,310 --> 00:05:33,120
sitting and contemplating on the problem

162
00:05:36,390 --> 00:05:34,320
at hand

163
00:05:38,150 --> 00:05:36,400

usually in my conservatory smoking my

164
00:05:40,629 --> 00:05:38,160
pipe just drilling down

165
00:05:41,830 --> 00:05:40,639
without any um aids without a computer

166
00:05:45,029 --> 00:05:41,840
or without any

167
00:05:47,029 --> 00:05:45,039
um pen and pencil just to boil down

168
00:05:49,270 --> 00:05:47,039
the simplicity of the problem at hand

169
00:05:51,430 --> 00:05:49,280
and try and see the architecture of

170
00:05:53,029 --> 00:05:51,440
of the solution and then it's a question

171
00:05:56,390 --> 00:05:53,039
of buckling down

172
00:05:58,790 --> 00:05:56,400
to emails or then uh doing

173
00:05:59,749 --> 00:05:58,800
coding or mathematical derivations or

174
00:06:01,670 --> 00:05:59,759
writing something up

175
00:06:03,430 --> 00:06:01,680
for the rest of the day and when i start

176
00:06:05,110 --> 00:06:03,440
talking to other people

177
00:06:07,029 --> 00:06:05,120
you sit without a pen and a paper and

178
00:06:09,909 --> 00:06:07,039
you just think with your eyes closed

179
00:06:11,510 --> 00:06:09,919
um well i actually enjoy looking at the

180
00:06:12,629 --> 00:06:11,520
garden whilst thinking but i do get

181
00:06:15,830 --> 00:06:12,639
distracted yeah

182
00:06:17,350 --> 00:06:15,840
yeah and if you see me close my eyes

183
00:06:18,950 --> 00:06:17,360
i'm often thinking deeply about what

184
00:06:20,390 --> 00:06:18,960
you're saying i don't want you to think

185
00:06:21,510 --> 00:06:20,400
i'm distracted or sleepy just so you

186
00:06:23,029 --> 00:06:21,520
know

187
00:06:24,629 --> 00:06:23,039
this it just sounds extremely british of

188
00:06:26,629 --> 00:06:24,639

you to have a pipe

189
00:06:28,870 --> 00:06:26,639
and do you drink tea are you sitting

190
00:06:31,590 --> 00:06:28,880
with biscuits do you have a breakfast

191
00:06:35,110 --> 00:06:31,600
well no um in the morning it's coffee

192
00:06:37,590 --> 00:06:35,120
and then tea would be for the afternoon

193
00:06:38,629 --> 00:06:37,600
without without biscuits but certainly

194
00:06:40,629 --> 00:06:38,639
coffee in the morning

195
00:06:42,629 --> 00:06:40,639
tea in the afternoon how do you choose

196
00:06:43,350 --> 00:06:42,639
which problems to tackle because i

197
00:06:45,909 --> 00:06:43,360
assume that

198
00:06:47,189 --> 00:06:45,919
maybe 80 percent of the reason for your

199
00:06:50,550 --> 00:06:47,199
high h index is

200
00:06:53,589 --> 00:06:50,560
the problem selection yeah absolutely

201
00:06:56,150 --> 00:06:53,599
um and you know i often

202
00:06:57,670 --> 00:06:56,160
um have heard it said that the the mark

203
00:07:01,350 --> 00:06:57,680
of a great scientist

204
00:07:02,950 --> 00:07:01,360
is not the the the answers that they

205
00:07:05,670 --> 00:07:02,960
offer it's really the questions that

206
00:07:08,150 --> 00:07:05,680
they ask and i have to say that um

207
00:07:09,110 --> 00:07:08,160
most the questions that i'm obliged to

208
00:07:12,230 --> 00:07:09,120
contend with

209
00:07:13,670 --> 00:07:12,240
are those that are proffered um either

210
00:07:16,309 --> 00:07:13,680
by colleagues internationally

211
00:07:17,510 --> 00:07:16,319
and most of the time by the uh by the

212
00:07:20,150 --> 00:07:17,520
younger people

213
00:07:22,469 --> 00:07:20,160

um that i work with or supervise so it's

214
00:07:23,189 --> 00:07:22,479
really i spend most my time in response

215
00:07:27,270 --> 00:07:23,199
mode

216
00:07:30,550 --> 00:07:27,280
just trying to formulate and resolve

217
00:07:33,749 --> 00:07:30,560
questions that uh my

218
00:07:35,110 --> 00:07:33,759
international usually younger team uh

219
00:07:37,990 --> 00:07:35,120
bring to the table

220
00:07:38,710 --> 00:07:38,000
so ninety percent of my work is just

221
00:07:41,589 --> 00:07:38,720
basically

222
00:07:41,960 --> 00:07:41,599
um helping other people solve problems

223
00:07:43,189 --> 00:07:41,970
um

224
00:07:45,510 --> 00:07:43,199
[Music]

225
00:07:47,430 --> 00:07:45,520
about 10 of it when i have time it's

226
00:07:50,469 --> 00:07:47,440
sort of focusing on you know

227
00:07:52,469 --> 00:07:50,479
on my um particular hobby which um

228
00:07:53,589 --> 00:07:52,479
in latter years has become the free

229
00:07:56,550 --> 00:07:53,599
energy principle

230
00:07:57,990 --> 00:07:56,560
but that's somewhat rare opportunity

231
00:07:59,670 --> 00:07:58,000
most of the time you're working

232
00:08:01,830 --> 00:07:59,680
on other slightly more practical

233
00:08:03,830 --> 00:08:01,840
problems how has learning

234
00:08:05,749 --> 00:08:03,840
mathematics new mathematics new physics

235
00:08:07,350 --> 00:08:05,759
whatever it may be how's that changed

236
00:08:11,510 --> 00:08:07,360
in your later years compared to younger

237
00:08:14,710 --> 00:08:13,589
it's um well practically an honest

238
00:08:18,550 --> 00:08:14,720

answer to that question

239
00:08:20,869 --> 00:08:18,560
um is it's much easier now um

240
00:08:22,710 --> 00:08:20,879
because of things like wikipedia and the

241
00:08:26,230 --> 00:08:22,720
electronic age

242
00:08:28,550 --> 00:08:26,240
i mean certainly i

243
00:08:30,150 --> 00:08:28,560
i had the conviction uh which i think is

244
00:08:32,790 --> 00:08:30,160
a proper conviction that to make

245
00:08:33,430 --> 00:08:32,800
um any real formal difference you you

246
00:08:35,269 --> 00:08:33,440
had to be

247
00:08:37,430 --> 00:08:35,279
able to articulate things mathematically

248
00:08:40,790 --> 00:08:37,440
so you made a particular point

249
00:08:41,670 --> 00:08:40,800
of um choosing an early career an

250
00:08:43,990 --> 00:08:41,680
education

251
00:08:45,590 --> 00:08:44,000
that covered physics and maths and

252
00:08:48,070 --> 00:08:45,600
probability theory and the like

253
00:08:49,829 --> 00:08:48,080
but probably not not dissimilar to your

254
00:08:52,790 --> 00:08:49,839
early career um

255
00:08:53,509 --> 00:08:52,800
structure um and then forgot it all

256
00:08:56,949 --> 00:08:53,519
until i

257
00:08:58,870 --> 00:08:56,959
um returned um after a studying as a

258
00:09:02,230 --> 00:08:58,880
doctor with a psychiatrist

259
00:09:05,509 --> 00:09:02,240
to uh maths via data analysis in

260
00:09:07,269 --> 00:09:05,519
imaging neuroscience um so

261
00:09:08,630 --> 00:09:07,279
it was extremely useful having had that

262
00:09:11,910 --> 00:09:08,640
early physics

263
00:09:13,750 --> 00:09:11,920

um sort of degree level education

264
00:09:15,590 --> 00:09:13,760
although i'd forgotten everything i at

265
00:09:17,269 --> 00:09:15,600
least had the confidence to relearn

266
00:09:19,030 --> 00:09:17,279
those bits that you need to know

267
00:09:21,350 --> 00:09:19,040
to make something work so it was very

268
00:09:23,910 --> 00:09:21,360
much on one of the situations of sort of

269
00:09:25,350 --> 00:09:23,920
c121 teach one where very quickly you

270
00:09:27,190 --> 00:09:25,360
need to solve a problem

271
00:09:28,550 --> 00:09:27,200
and then you went to um you know in

272
00:09:29,509 --> 00:09:28,560
latter days at least you went to

273
00:09:31,190 --> 00:09:29,519
wikipedia

274
00:09:33,590 --> 00:09:31,200
you got the right equations and you put

275
00:09:36,310 --> 00:09:33,600
them together implemented it in code

276
00:09:37,190 --> 00:09:36,320
and then proceed you know on to the next

277
00:09:41,030 --> 00:09:37,200
problem

278
00:09:44,550 --> 00:09:41,040
so um you know i have possibly

279
00:09:47,350 --> 00:09:44,560
an undue respect or reverence for

280
00:09:48,310 --> 00:09:47,360
the utility of maths not you know not

281
00:09:50,230 --> 00:09:48,320
just in

282
00:09:52,550 --> 00:09:50,240
relation to its unreasonable efficacy

283
00:09:55,269 --> 00:09:52,560
but also as a language for communication

284
00:09:56,150 --> 00:09:55,279
as a you know a calculus that every

285
00:09:59,590 --> 00:09:56,160
like-minded

286
00:10:02,790 --> 00:09:59,600
academic um or indeed industrial partner

287
00:10:04,710 --> 00:10:02,800
um will at some point subscribe to and

288
00:10:07,670 --> 00:10:04,720

drill down on and understand so

289
00:10:08,310 --> 00:10:07,680
i think it is the ultimate language um

290
00:10:11,509 --> 00:10:08,320
uh

291
00:10:15,269 --> 00:10:11,519
which you know effectively

292
00:10:18,870 --> 00:10:15,279
most of what i say in words or write

293
00:10:20,870 --> 00:10:18,880
textually um inherits from

294
00:10:22,630 --> 00:10:20,880
and is always guided by the underlying

295
00:10:23,990 --> 00:10:22,640
the underlying mathematics

296
00:10:25,350 --> 00:10:24,000
before we get to the free energy

297
00:10:26,949 --> 00:10:25,360
principle which i'm going to ask you to

298
00:10:28,470 --> 00:10:26,959
explain as simply as you can

299
00:10:29,990 --> 00:10:28,480
and then you can go as complex as you

300
00:10:31,670 --> 00:10:30,000
can later but

301
00:10:33,110 --> 00:10:31,680
before we get to that i found that there

302
00:10:34,790 --> 00:10:33,120
were a few

303
00:10:36,550 --> 00:10:34,800
words that you use in the different

304
00:10:38,230 --> 00:10:36,560
interviews that i've seen of you

305
00:10:39,509 --> 00:10:38,240
that i'm unsure as to what you mean

306
00:10:40,949 --> 00:10:39,519
precisely when you say them so

307
00:10:42,310 --> 00:10:40,959
deflationary is one

308
00:10:44,230 --> 00:10:42,320
uh-huh what do you mean when you say

309
00:10:46,470 --> 00:10:44,240
deflationary because i'm sure that will

310
00:10:47,990 --> 00:10:46,480
come up over and over here right yes

311
00:10:50,389 --> 00:10:48,000
you're right that's one of my favorite

312
00:10:53,110 --> 00:10:50,399
words at the moment um

313
00:10:54,870 --> 00:10:53,120

uh just taking uh if you want an honest

314
00:10:57,269 --> 00:10:54,880
answer i use it in the sense of

315
00:10:58,069 --> 00:10:57,279
just taking the hot air out of something

316
00:11:07,990 --> 00:10:58,079
um

317
00:11:08,470 --> 00:11:08,000
an over-interpretation of certain things

318
00:11:11,350 --> 00:11:08,480
so

319
00:11:11,990 --> 00:11:11,360
there is always a simpler explanation

320
00:11:14,630 --> 00:11:12,000
for

321
00:11:15,670 --> 00:11:14,640
various phenomena or behaviors or

322
00:11:19,030 --> 00:11:15,680
constructs

323
00:11:21,430 --> 00:11:19,040
um so for me a deflationary

324
00:11:22,870 --> 00:11:21,440
explanation is is a better thing in the

325
00:11:25,750 --> 00:11:22,880
sense that it provides

326
00:11:26,550 --> 00:11:25,760
a simpler more parsimonious account of

327
00:11:29,350 --> 00:11:26,560
something

328
00:11:29,829 --> 00:11:29,360
than was on offer before that simpler

329
00:11:32,870 --> 00:11:29,839
account

330
00:11:35,750 --> 00:11:32,880
came along so um

331
00:11:37,829 --> 00:11:35,760
philosophically um i think i'm using it

332
00:11:39,990 --> 00:11:37,839
in the sense of

333
00:11:41,030 --> 00:11:40,000
what my friend andy clark who's one of

334
00:11:42,949 --> 00:11:41,040
the

335
00:11:44,710 --> 00:11:42,959
world's more accomplished um

336
00:11:47,110 --> 00:11:44,720
philosophers refers to

337
00:11:48,710 --> 00:11:47,120
as a sort of queenian desert landscape

338
00:11:51,750 --> 00:11:48,720

so this inherits from

339
00:11:54,710 --> 00:11:51,760
quine who um you know

340
00:11:55,110 --> 00:11:54,720
conceived of a set of explanations that

341
00:11:58,949 --> 00:11:55,120
was

342
00:12:02,230 --> 00:11:58,959
the desert landscape

343
00:12:05,990 --> 00:12:02,240
and a lot of a lot of the aspirations

344
00:12:07,269 --> 00:12:06,000
of our theorizing um actually points in

345
00:12:09,030 --> 00:12:07,279
that direction

346
00:12:10,870 --> 00:12:09,040
a little bit like natural selection i

347
00:12:12,550 --> 00:12:10,880
mean the natural selection is such a

348
00:12:13,990 --> 00:12:12,560
wonderful idea probably the you know the

349
00:12:16,949 --> 00:12:14,000
greatest biological

350
00:12:18,069 --> 00:12:16,959
idea um certainly in the past few

351
00:12:20,949 --> 00:12:18,079
centuries

352
00:12:22,069 --> 00:12:20,959
and yet it is inherently tautological um

353
00:12:24,310 --> 00:12:22,079
you know it just

354
00:12:25,190 --> 00:12:24,320
almost goes away when you think about

355
00:12:27,990 --> 00:12:25,200
the the

356
00:12:28,629 --> 00:12:28,000
essential tautology of natural selection

357
00:12:30,389 --> 00:12:28,639
and

358
00:12:32,629 --> 00:12:30,399
so for me that's a beautiful idea that

359
00:12:35,670 --> 00:12:32,639
is deflationary it explains so much

360
00:12:37,110 --> 00:12:35,680
with hardly anything when you mean when

361
00:12:38,870 --> 00:12:37,120
you're saying that natural selection is

362
00:12:40,550 --> 00:12:38,880
tautological do you mean to say that

363
00:12:42,710 --> 00:12:40,560

survival of the fittest well you're

364
00:12:44,949 --> 00:12:42,720
defining fitness by survival anyway

365
00:12:46,470 --> 00:12:44,959
that's exactly right yep that's exactly

366
00:12:49,670 --> 00:12:46,480
what i mean yeah

367
00:12:52,949 --> 00:12:49,680
okay okay now self-evidencing

368
00:12:54,949 --> 00:12:52,959
self-evidencing is a philosophical term

369
00:12:55,990 --> 00:12:54,959
um which i think has been around for

370
00:12:58,949 --> 00:12:56,000
some time

371
00:12:59,990 --> 00:12:58,959
but i was introduced to it by my other

372
00:13:03,910 --> 00:13:00,000
philosophy friend

373
00:13:07,190 --> 00:13:03,920
yucca powy who's currently in melbourne

374
00:13:11,110 --> 00:13:07,200
as a nice perspective on

375
00:13:13,269 --> 00:13:11,120
the one take on what we do or what the

376
00:13:16,470 --> 00:13:13,279
imperatives existential imperatives

377
00:13:19,190 --> 00:13:16,480
um behind our behavior and our

378
00:13:20,710 --> 00:13:19,200
dynamics if you're a physicist which is

379
00:13:24,069 --> 00:13:20,720
to maximize the

380
00:13:27,910 --> 00:13:24,079
evidence for your models of of the world

381
00:13:31,190 --> 00:13:27,920
so in maximizing the evidence sometimes

382
00:13:33,350 --> 00:13:31,200
described perhaps poetically as

383
00:13:34,310 --> 00:13:33,360
acting to garner evidence for your own

384
00:13:37,190 --> 00:13:34,320
existence

385
00:13:38,069 --> 00:13:37,200
you can be said to be self-evidencing um

386
00:13:39,910 --> 00:13:38,079
i just say

387
00:13:41,269 --> 00:13:39,920
it's a slight play on words from the

388
00:13:44,470 --> 00:13:41,279

point of view of

389
00:13:48,790 --> 00:13:44,480
a mathematician because um

390
00:13:52,629 --> 00:13:48,800
nearly every interesting formulation um

391
00:13:54,949 --> 00:13:52,639
of self-organizing systems has itself in

392
00:13:55,910 --> 00:13:54,959
so you start off with self-organizing

393
00:13:58,230 --> 00:13:55,920
systems

394
00:13:59,949 --> 00:13:58,240
um of the sort you might see as a

395
00:14:03,030 --> 00:13:59,959
computational chemistry through

396
00:14:06,310 --> 00:14:03,040
self-assembly um sometimes in the

397
00:14:09,030 --> 00:14:06,320
biological uh sciences people refer to

398
00:14:10,069 --> 00:14:09,040
um autophagus which you know is again

399
00:14:13,189 --> 00:14:10,079
greek for

400
00:14:14,629 --> 00:14:13,199
for self-creation um you start off just

401
00:14:16,870 --> 00:14:14,639
thinking about the information

402
00:14:18,629 --> 00:14:16,880
theory that would underwrite that kind

403
00:14:20,870 --> 00:14:18,639
of self-organization the first thing you

404
00:14:24,230 --> 00:14:20,880
come across is self-information

405
00:14:27,269 --> 00:14:24,240
um you know following that through

406
00:14:31,829 --> 00:14:27,279
and you can sort of spin off um

407
00:14:33,430 --> 00:14:31,839
all sorts of other selfs in terms of um

408
00:14:35,110 --> 00:14:33,440
self-serving behaviors that you can

409
00:14:35,829 --> 00:14:35,120
write down in terms of information

410
00:14:38,949 --> 00:14:35,839
theory

411
00:14:40,389 --> 00:14:38,959
and for me the simplest and most um

412
00:14:42,470 --> 00:14:40,399
the prettiest is this notion of

413
00:14:44,710 --> 00:14:42,480

self-evidencing what about equilibrium

414
00:14:45,350 --> 00:14:44,720
state versus a non-equilibrium steady

415
00:14:47,670 --> 00:14:45,360
state

416
00:14:48,550 --> 00:14:47,680
so that one's not idiosyncratic to you

417
00:14:51,750 --> 00:14:48,560
right no

418
00:14:51,990 --> 00:14:51,760
no heavens though um and again remember

419
00:14:55,110 --> 00:14:52,000
i'm

420
00:14:57,110 --> 00:14:55,120
you're i

421
00:14:58,470 --> 00:14:57,120
trained as a physicist as a young man

422
00:15:02,550 --> 00:14:58,480
but haven't um haven't

423
00:15:03,910 --> 00:15:02,560
sort of um really been in that field

424
00:15:07,750 --> 00:15:03,920
throughout my career but

425
00:15:10,629 --> 00:15:07,760
my reading of um physics um

426
00:15:12,389 --> 00:15:10,639
as it applies to um the kinds of systems

427
00:15:15,750 --> 00:15:12,399
that we we have to deal with

428
00:15:16,310 --> 00:15:15,760
um can be read as sort of 20 century

429
00:15:19,269 --> 00:15:16,320
physics

430
00:15:19,509 --> 00:15:19,279
where you're dealing with closed systems

431
00:15:22,949 --> 00:15:19,519
at

432
00:15:24,710 --> 00:15:22,959
equilibrium and then the 21st century

433
00:15:27,269 --> 00:15:24,720
people got much more interested

434
00:15:30,790 --> 00:15:27,279
in the physics of open systems that are

435
00:15:33,990 --> 00:15:30,800
far from equilibrium or non-equilibrium

436
00:15:35,110 --> 00:15:34,000
and what can you do with these kinds of

437
00:15:37,910 --> 00:15:35,120
systems well you can

438
00:15:40,470 --> 00:15:37,920

you can write down their dynamics their

439
00:15:42,710 --> 00:15:40,480
density dynamics you can

440
00:15:44,150 --> 00:15:42,720
formalize the behavior of the

441
00:15:46,069 --> 00:15:44,160
probability distribution over the

442
00:15:49,509 --> 00:15:46,079
various states of these systems

443
00:15:52,230 --> 00:15:49,519
and how they would unfold from any given

444
00:15:53,350 --> 00:15:52,240
initial condition to some steady state

445
00:15:55,910 --> 00:15:53,360
distribution

446
00:15:57,030 --> 00:15:55,920
um for me though it is the steady state

447
00:15:58,350 --> 00:15:57,040
distribution which is interesting

448
00:15:59,590 --> 00:15:58,360
because that provides you with a

449
00:16:01,990 --> 00:15:59,600
well-defined

450
00:16:03,110 --> 00:16:02,000
probability distribution and once you've

451
00:16:04,870 --> 00:16:03,120
got that

452
00:16:06,150 --> 00:16:04,880
then you can go forward in terms of the

453
00:16:07,670 --> 00:16:06,160
information theory

454
00:16:09,990 --> 00:16:07,680
and spin off everything that you might

455
00:16:13,910 --> 00:16:10,000
want to in terms of inference and

456
00:16:16,470 --> 00:16:13,920
and the like so the non-equilibrium part

457
00:16:17,430 --> 00:16:16,480
is absolutely crucial in the sense that

458
00:16:21,269 --> 00:16:17,440
it defines

459
00:16:24,310 --> 00:16:21,279
a set of questions about systems

460
00:16:27,670 --> 00:16:24,320
that um are in exchange

461
00:16:28,710 --> 00:16:27,680
with a world out there so that there is

462
00:16:30,069 --> 00:16:28,720
you know from the

463
00:16:31,990 --> 00:16:30,079

uh thermodynamic point of view an

464
00:16:34,629 --> 00:16:32,000
exchange of energy and entropy

465
00:16:36,230 --> 00:16:34,639
between the system and of itself and the

466
00:16:39,030 --> 00:16:36,240
rest of the universe

467
00:16:41,030 --> 00:16:39,040
um from a mathematical point of view um

468
00:16:44,949 --> 00:16:41,040
the non-equilibrium aspect is

469
00:16:48,310 --> 00:16:44,959
is inherited from um the prevalence

470
00:16:51,509 --> 00:16:48,320
of um circular flows

471
00:16:53,189 --> 00:16:51,519
solenoidal flows the sort of flow which

472
00:16:55,110 --> 00:16:53,199
if you were in machine learning would

473
00:16:56,550 --> 00:16:55,120
destroy detailed balance and

474
00:16:58,710 --> 00:16:56,560
that would have a lot of technical

475
00:16:59,030 --> 00:16:58,720
implications but what i'm talking about

476
00:17:03,350 --> 00:16:59,040
is

477
00:17:06,549 --> 00:17:03,360
get

478
00:17:09,909 --> 00:17:06,559
um in classical mechanics like the

479
00:17:11,990 --> 00:17:09,919
orbits of heavenly bodies or the um

480
00:17:13,990 --> 00:17:12,000
the circular fluctuations you get in

481
00:17:15,990 --> 00:17:14,000
predator prey relationships or

482
00:17:17,990 --> 00:17:16,000
red queen dynamics wherever you look at

483
00:17:21,029 --> 00:17:18,000
sort of interesting systems

484
00:17:21,590 --> 00:17:21,039
that persevere over time you see this

485
00:17:24,789 --> 00:17:21,600
sort of

486
00:17:26,549 --> 00:17:24,799
solidal circular um oscillatory-like

487
00:17:29,590 --> 00:17:26,559
behavior

488
00:17:32,870 --> 00:17:29,600

and it is that which characterizes real

489
00:17:35,750 --> 00:17:32,880
dynamical systems that are

490
00:17:37,110 --> 00:17:35,760
you know i repeat not isolated from the

491
00:17:39,590 --> 00:17:37,120
rest of the universe or

492
00:17:40,630 --> 00:17:39,600
are not carefully and shrouded in a heat

493
00:17:42,950 --> 00:17:40,640
buff

494
00:17:44,070 --> 00:17:42,960
like an idealized gas but they actually

495
00:17:47,350 --> 00:17:44,080
have to contend

496
00:17:49,510 --> 00:17:47,360
with an exchange with the outside world

497
00:17:51,110 --> 00:17:49,520
so that's what's encapsulated by a

498
00:17:54,630 --> 00:17:51,120
non-equilibrium

499
00:17:56,310 --> 00:17:54,640
system um the steady state means that

500
00:17:57,669 --> 00:17:56,320
if you leave it alone for long enough it

501
00:18:01,270 --> 00:17:57,679
will self-organize

502
00:18:02,950 --> 00:18:01,280
into some recognizable configuration

503
00:18:05,669 --> 00:18:02,960
that you can describe probabilistically

504
00:18:06,390 --> 00:18:05,679
probabilistically with a probability

505
00:18:09,029 --> 00:18:06,400
density

506
00:18:11,029 --> 00:18:09,039
function uh or in terms of some

507
00:18:13,029 --> 00:18:11,039
attracting set a pullback attractor

508
00:18:14,470 --> 00:18:13,039
whatever your preferred kind of calculus

509
00:18:17,110 --> 00:18:14,480
our maths would be

510
00:18:18,870 --> 00:18:17,120
so steady state refers to it over time

511
00:18:20,630 --> 00:18:18,880
being somewhat stable but then the

512
00:18:22,150 --> 00:18:20,640
non-equilibrium means that it can ramify

513
00:18:24,150 --> 00:18:22,160

it can go between here and then it may

514
00:18:25,909 --> 00:18:24,160
jump here and then it may jump here but

515
00:18:27,430 --> 00:18:25,919
between three only instead of one would

516
00:18:28,950 --> 00:18:27,440
be equilibrium no i think that's a very

517
00:18:31,750 --> 00:18:28,960
nice description um

518
00:18:32,789 --> 00:18:31,760
so yes absolutely so the steady state um

519
00:18:36,630 --> 00:18:32,799
just means that

520
00:18:41,350 --> 00:18:36,640
you know the system has settled down um

521
00:18:43,669 --> 00:18:41,360
to some um attracting set of states

522
00:18:45,190 --> 00:18:43,679
but within those that set of states

523
00:18:46,310 --> 00:18:45,200
there is exactly what you were

524
00:18:48,230 --> 00:18:46,320
you were referring to there's an

525
00:18:51,190 --> 00:18:48,240
itinerancy there are different sort of

526
00:18:52,230 --> 00:18:51,200
you know regimes or sub-manifolds of an

527
00:18:53,750 --> 00:18:52,240
attracting set

528
00:18:55,669 --> 00:18:53,760
which gives it an itinerancy or a

529
00:18:57,350 --> 00:18:55,679
wandering so it moves around

530
00:18:59,029 --> 00:18:57,360
from one part of the attracting set to

531
00:19:01,669 --> 00:18:59,039
another part of the attracting set

532
00:19:02,630 --> 00:19:01,679
so the example i like to use when trying

533
00:19:05,669 --> 00:19:02,640
to

534
00:19:08,350 --> 00:19:05,679
get this notion in play is

535
00:19:09,510 --> 00:19:08,360
you know at every level of

536
00:19:11,750 --> 00:19:09,520
self-organization

537
00:19:14,390 --> 00:19:11,760
in me you see this phenomena whether

538
00:19:17,190 --> 00:19:14,400

it's very very fast fluctuations

539
00:19:18,390 --> 00:19:17,200
in electrophysiological potentials in

540
00:19:26,230 --> 00:19:18,400
one

541
00:19:28,630 --> 00:19:26,240
at say the gamma frequency

542
00:19:31,190 --> 00:19:28,640
or whether it's my heartbeat you know

543
00:19:32,950 --> 00:19:31,200
unfolding during the cardiac cycle

544
00:19:35,110 --> 00:19:32,960
or whether it's me getting up in the

545
00:19:37,510 --> 00:19:35,120
morning having a cup of coffee

546
00:19:38,230 --> 00:19:37,520
doing my emails or whether it's the

547
00:19:40,150 --> 00:19:38,240
annual

548
00:19:42,470 --> 00:19:40,160
cycles that we all enjoy sort of

549
00:19:45,750 --> 00:19:42,480
christmas easter summer holidays

550
00:19:49,430 --> 00:19:45,760
every one of these instances of

551
00:19:49,909 --> 00:19:49,440
um you know an open system at some kind

552
00:19:52,230 --> 00:19:49,919
of

553
00:19:54,789 --> 00:19:52,240
non-equilibrium steady state has in

554
00:19:57,029 --> 00:19:54,799
common the fact you keep revisiting

555
00:19:58,150 --> 00:19:57,039
certain states of being and it's that

556
00:20:01,350 --> 00:19:58,160
revisiting

557
00:20:04,870 --> 00:20:01,360
that defines this attracting set and

558
00:20:06,230 --> 00:20:04,880
um the your the steady state aspect so

559
00:20:07,270 --> 00:20:06,240
exactly as you are doing with your

560
00:20:09,830 --> 00:20:07,280
fingers you are

561
00:20:11,430 --> 00:20:09,840
you are moving around from sort of uh

562
00:20:12,630 --> 00:20:11,440
one part of the manifold to another part

563
00:20:15,750 --> 00:20:12,640

of the manifold

564
00:20:17,590 --> 00:20:15,760
you know if you're a physicist who did

565
00:20:19,590 --> 00:20:17,600
dynamical systems theory you might think

566
00:20:21,350 --> 00:20:19,600
of this in like a um

567
00:20:22,789 --> 00:20:21,360
a heteroclinic cycle where you're moving

568
00:20:23,750 --> 00:20:22,799
from one unstable point to the next

569
00:20:26,390 --> 00:20:23,760
unstable point

570
00:20:28,310 --> 00:20:26,400
but you're always ultimately coming back

571
00:20:31,430 --> 00:20:28,320
to the same attracting set

572
00:20:31,990 --> 00:20:31,440
of unstable points so it's it's that you

573
00:20:34,390 --> 00:20:32,000
know

574
00:20:36,710 --> 00:20:34,400
um non-equilibrium so we're not at a

575
00:20:39,029 --> 00:20:36,720
fixed point we're not all aspiring

576
00:20:40,070 --> 00:20:39,039
um you know to be at thermodynamic

577
00:20:41,909 --> 00:20:40,080
equilibrium

578
00:20:43,830 --> 00:20:41,919
um there's an itinerancy and a

579
00:20:47,190 --> 00:20:43,840
complexity and a richness

580
00:20:49,830 --> 00:20:47,200
to the behavior but on the other hand

581
00:20:50,870 --> 00:20:49,840
it's a behavior that evinces the same

582
00:20:52,950 --> 00:20:50,880
kinds of states

583
00:20:55,190 --> 00:20:52,960
the neighborhood of places in state

584
00:20:57,270 --> 00:20:55,200
space time and time and time again

585
00:20:59,669 --> 00:20:57,280
for the duration of the existence of of

586
00:21:01,590 --> 00:20:59,679
that particular system or particle or

587
00:21:03,750 --> 00:21:01,600
person in question

588
00:21:05,190 --> 00:21:03,760

why did you call it the free energy

589
00:21:07,029 --> 00:21:05,200
principle when i first heard

590
00:21:08,390 --> 00:21:07,039
well i heard about it quite a few times

591
00:21:09,029 --> 00:21:08,400
then i kept dismissing it because i

592
00:21:11,110 --> 00:21:09,039
thought it was

593
00:21:12,070 --> 00:21:11,120
referring to perpetual motion or the

594
00:21:15,110 --> 00:21:12,080
extraction of

595
00:21:18,470 --> 00:21:17,350
you're fluctuations right i understand

596
00:21:20,230 --> 00:21:18,480
that it has something to do with free

597
00:21:20,710 --> 00:21:20,240
energy in the physics term but what led

598
00:21:22,149 --> 00:21:20,720
you to

599
00:21:23,669 --> 00:21:22,159
calling it the free energy principle and

600
00:21:26,070 --> 00:21:23,679
have you had have you heard of other

601
00:21:29,669 --> 00:21:27,350
have you heard of the case of mistaken

602
00:21:30,390 --> 00:21:29,679
identity from other people this is just

603
00:21:34,870 --> 00:21:30,400
me

604
00:21:37,990 --> 00:21:37,029
but not so nicely articulated or gently

605
00:21:42,789 --> 00:21:38,000
articulated

606
00:21:45,590 --> 00:21:42,799
um so yeah for me in my world

607
00:21:46,549 --> 00:21:45,600
the free energy was the um the most

608
00:21:49,990 --> 00:21:46,559
natural and obvious

609
00:21:51,669 --> 00:21:50,000
uh thing um to call it because um

610
00:21:53,510 --> 00:21:51,679
the the kind of free energy that we're

611
00:21:57,110 --> 00:21:53,520
dealing with or when i say we

612
00:21:57,430 --> 00:21:57,120
um people in either base in statistics

613
00:21:59,270 --> 00:21:57,440

or

614
00:22:01,909 --> 00:21:59,280
laterally what would be known as as

615
00:22:06,310 --> 00:22:01,919
machine learning

616
00:22:09,190 --> 00:22:06,320
would would would always refer to this

617
00:22:12,070 --> 00:22:09,200
quantity this variational free energy

618
00:22:12,630 --> 00:22:12,080
as a computable objective function for

619
00:22:14,950 --> 00:22:12,640
any

620
00:22:16,470 --> 00:22:14,960
inference or estimation problem so

621
00:22:19,350 --> 00:22:16,480
whether you're doing sort of

622
00:22:21,029 --> 00:22:19,360
um classification with machine learning

623
00:22:22,630 --> 00:22:21,039
and you're using restricted builds of a

624
00:22:25,270 --> 00:22:22,640
machine and you're using

625
00:22:26,390 --> 00:22:25,280
or let's make it more current so you're

626
00:22:29,110 --> 00:22:26,400
doing um

627
00:22:30,710 --> 00:22:29,120
you using high-end deep learning using a

628
00:22:34,230 --> 00:22:30,720
variational auto encoder

629
00:22:35,270 --> 00:22:34,240
to try and recognize um some sequence of

630
00:22:38,310 --> 00:22:35,280
images

631
00:22:40,390 --> 00:22:38,320
then the weights that you are

632
00:22:41,830 --> 00:22:40,400
optimizing within that deep learning

633
00:22:43,350 --> 00:22:41,840
setting in that particular variation

634
00:22:46,230 --> 00:22:43,360
auto encoder setting

635
00:22:47,590 --> 00:22:46,240
um are optimized with respect to a

636
00:22:52,230 --> 00:22:47,600
variation free energy

637
00:22:55,430 --> 00:22:52,240
central role and has done for

638
00:22:59,430 --> 00:22:55,440

for um more than half a century now

639
00:23:01,590 --> 00:22:59,440
in optimization problems um

640
00:23:02,630 --> 00:23:01,600
its origins are actually really really

641
00:23:04,470 --> 00:23:02,640
quite interesting

642
00:23:07,110 --> 00:23:04,480
um historically again this is not really

643
00:23:09,909 --> 00:23:07,120
my field but from what i gather

644
00:23:10,549 --> 00:23:09,919
there are two ways that the free energy

645
00:23:13,909 --> 00:23:10,559
sort of

646
00:23:14,630 --> 00:23:13,919
came into play the the the american

647
00:23:16,950 --> 00:23:14,640
route

648
00:23:18,310 --> 00:23:16,960
and this starts with richard feynman as

649
00:23:22,870 --> 00:23:18,320
as with most things

650
00:23:24,440 --> 00:23:22,880
um so he had the problem of basically

651
00:23:25,909 --> 00:23:24,450
um wanting to

652
00:23:29,590 --> 00:23:25,919
[Music]

653
00:23:32,789 --> 00:23:29,600
you know express simply

654
00:23:35,590 --> 00:23:32,799
um evaluate the probability distribution

655
00:23:36,149 --> 00:23:35,600
over all the paths a an electron say

656
00:23:39,510 --> 00:23:36,159
could could

657
00:23:39,750 --> 00:23:39,520
could take and he realized that that was

658
00:23:44,470 --> 00:23:39,760
a

659
00:23:45,110 --> 00:23:44,480
problem he could he couldn't work out

660
00:23:46,950 --> 00:23:45,120
the sort of

661
00:23:48,470 --> 00:23:46,960
the normalization constant to make sure

662
00:23:51,430 --> 00:23:48,480
that probability distribution

663
00:23:52,630 --> 00:23:51,440

summed to one so he was faced with an

664
00:23:55,029 --> 00:23:52,640
intractable

665
00:23:56,710 --> 00:23:55,039
um effectively integration problem in

666
00:24:00,149 --> 00:23:56,720
quantum electrodynamics

667
00:24:02,149 --> 00:24:00,159
so he solved him by converting that

668
00:24:02,870 --> 00:24:02,159
integration problem into an optimization

669
00:24:05,510 --> 00:24:02,880
problem

670
00:24:07,029 --> 00:24:05,520
and the way he did it was to introduce a

671
00:24:09,830 --> 00:24:07,039
variational free energy

672
00:24:11,990 --> 00:24:09,840
that was always greater than the

673
00:24:12,950 --> 00:24:12,000
quantity that he wanted to minimize or

674
00:24:14,789 --> 00:24:12,960
was less than

675
00:24:16,470 --> 00:24:14,799
the quantity that he wanted to maximize

676
00:24:17,110 --> 00:24:16,480
which in this instance is just

677
00:24:20,390 --> 00:24:17,120
the marginal likelihood or the

678
00:24:23,990 --> 00:24:20,400
likelihood distribution of various paths

679
00:24:27,430 --> 00:24:24,000
say a small particle might take um so

680
00:24:30,310 --> 00:24:27,440
that's where i learned about free energy

681
00:24:31,110 --> 00:24:30,320
um essentially a feminine feminist free

682
00:24:34,310 --> 00:24:31,120
energy

683
00:24:36,549 --> 00:24:34,320
that was provided a bound approximation

684
00:24:38,310 --> 00:24:36,559
to something that you actually wanted to

685
00:24:41,430 --> 00:24:38,320
maximize or optimize

686
00:24:45,110 --> 00:24:41,440
um and in my world

687
00:24:47,269 --> 00:24:45,120
that that thing you want to maximize

688
00:24:48,149 --> 00:24:47,279

is the model evidence or the marginal

689
00:24:50,230 --> 00:24:48,159
likelihood

690
00:24:51,350 --> 00:24:50,240
because back to self-evidencing but also

691
00:24:52,950 --> 00:24:51,360
the marginal likelihood

692
00:24:55,750 --> 00:24:52,960
sort of indicating that this is a

693
00:24:59,430 --> 00:24:55,760
central notion in in physics

694
00:25:00,950 --> 00:24:59,440
in bayesian statistics as well

695
00:25:04,149 --> 00:25:00,960
and that quantity that variation free

696
00:25:06,789 --> 00:25:04,159
energy um has been in play now for

697
00:25:08,549 --> 00:25:06,799
for for you know not quite a century but

698
00:25:12,549 --> 00:25:08,559
certainly many many decades

699
00:25:14,950 --> 00:25:12,559
um currently known as an elbow elbow

700
00:25:16,149 --> 00:25:14,960
an evidence lower bound so that evidence

701
00:25:18,950 --> 00:25:16,159
lower bound

702
00:25:19,990 --> 00:25:18,960
underwrites you know all of high-end

703
00:25:23,430 --> 00:25:20,000
machine learning

704
00:25:25,590 --> 00:25:23,440
um and you know certain simply

705
00:25:26,789 --> 00:25:25,600
reduced cases of it i i would i would

706
00:25:29,430 --> 00:25:26,799
actually suggest probably

707
00:25:30,390 --> 00:25:29,440
all of machine learning at some point

708
00:25:34,070 --> 00:25:30,400
refer to

709
00:25:37,430 --> 00:25:34,080
or can be seen as a special case of this

710
00:25:38,870 --> 00:25:37,440
the other route um inherits more from

711
00:25:42,230 --> 00:25:38,880
the russian side

712
00:25:43,909 --> 00:25:42,240
and this is the notions of algorithmic

713
00:25:45,110 --> 00:25:43,919

complexity underlying universal

714
00:25:47,590 --> 00:25:45,120
computation

715
00:25:48,710 --> 00:25:47,600
via common growth complexity and sort of

716
00:25:51,990 --> 00:25:48,720
induction

717
00:25:56,149 --> 00:25:52,000
um so the big drive there

718
00:25:59,750 --> 00:25:56,159
is is again formulating

719
00:26:01,990 --> 00:25:59,760
universal computation as basically

720
00:26:03,990 --> 00:26:02,000
communicating or articulating or

721
00:26:06,470 --> 00:26:04,000
encoding

722
00:26:07,510 --> 00:26:06,480
some structure in the simplest way

723
00:26:10,710 --> 00:26:07,520
possible

724
00:26:13,990 --> 00:26:10,720
by introducing a bound

725
00:26:17,110 --> 00:26:14,000
on the thing that you want to you want

726
00:26:22,390 --> 00:26:17,120
to optimize or minimize or extremize

727
00:26:25,590 --> 00:26:22,400
so you can also find the free energy

728
00:26:28,710 --> 00:26:25,600
in the context of um sort of

729
00:26:31,269 --> 00:26:28,720
um a more shallow nest

730
00:26:32,230 --> 00:26:31,279
like uh take on on communication and

731
00:26:35,510 --> 00:26:32,240
optimization

732
00:26:38,470 --> 00:26:35,520
and david mckay sort of originally

733
00:26:39,430 --> 00:26:38,480
um brought that perspective to the table

734
00:26:42,470 --> 00:26:39,440
perspective

735
00:26:44,549 --> 00:26:42,480
that was was um well understood

736
00:26:45,750 --> 00:26:44,559
by people like uh wallace in uh

737
00:26:48,630 --> 00:26:45,760
melbourne

738
00:26:48,870 --> 00:26:48,640

who themselves had taken it from from

739
00:26:51,990 --> 00:26:48,880
the

740
00:26:54,630 --> 00:26:52,000
think he was

741
00:26:56,630 --> 00:26:54,640
he was an american but also uh you know

742
00:26:58,630 --> 00:26:56,640
taking this algorithmic complexity

743
00:27:00,070 --> 00:26:58,640
so it's a very long answer to to

744
00:27:00,789 --> 00:27:00,080
actually say that the free energy

745
00:27:04,070 --> 00:27:00,799
principle

746
00:27:07,430 --> 00:27:04,080
energy

747
00:27:09,029 --> 00:27:07,440
uh has underwritten um universal

748
00:27:11,110 --> 00:27:09,039
computation

749
00:27:12,230 --> 00:27:11,120
uh practical approaches to quantum

750
00:27:14,390 --> 00:27:12,240
electrodynamics

751
00:27:15,590 --> 00:27:14,400
and machine learning since since the

752
00:27:17,669 --> 00:27:15,600
1950s

753
00:27:19,029 --> 00:27:17,679
so it was you know that's what the free

754
00:27:21,830 --> 00:27:19,039
energy means it's not the

755
00:27:22,789 --> 00:27:21,840
the energy is costless it's it's it's

756
00:27:25,510 --> 00:27:22,799
just uh

757
00:27:26,389 --> 00:27:25,520
borrows from the formalism of the

758
00:27:28,950 --> 00:27:26,399
thermodynamic

759
00:27:31,110 --> 00:27:28,960
uh free energy either gibbs or helmholtz

760
00:27:32,630 --> 00:27:31,120
free energy

761
00:27:34,230 --> 00:27:32,640
okay this sounds like a great time to

762
00:27:35,590 --> 00:27:34,240
explain what the free energy principle

763
00:27:38,710 --> 00:27:35,600

is i know you touched on it but

764
00:27:42,389 --> 00:27:38,720
for the people who aren't aware

765
00:27:44,549 --> 00:27:42,399
right um so there are

766
00:27:45,669 --> 00:27:44,559
when asked to do this i i'll give you

767
00:27:47,590 --> 00:27:45,679
i'll give you a choice

768
00:27:48,950 --> 00:27:47,600
you can either take the high road or the

769
00:27:52,470 --> 00:27:48,960
low road

770
00:27:56,070 --> 00:27:52,480
so the high road

771
00:27:56,710 --> 00:27:56,080
would start with a consideration of what

772
00:28:00,149 --> 00:27:56,720
it is

773
00:28:03,990 --> 00:28:00,159
to exist to be something and

774
00:28:07,190 --> 00:28:04,000
then unpack that in terms of um

775
00:28:10,389 --> 00:28:07,200
physics um and then ultimately you get

776
00:28:12,389 --> 00:28:10,399
to a picture of things that exist

777
00:28:13,510 --> 00:28:12,399
as things that look as if they are

778
00:28:16,230 --> 00:28:13,520
trying to minimize

779
00:28:18,630 --> 00:28:16,240
their free energy and you can interpret

780
00:28:21,029 --> 00:28:18,640
that in terms of action and perception

781
00:28:22,310 --> 00:28:21,039
sentient behavior effectively a physics

782
00:28:25,590 --> 00:28:22,320
of sentience

783
00:28:27,750 --> 00:28:25,600
um where everything entailed by

784
00:28:29,510 --> 00:28:27,760
a particle that could be a sort of small

785
00:28:33,190 --> 00:28:29,520
particle or it could be a person

786
00:28:37,350 --> 00:28:33,200
or a plant anything that exists can be

787
00:28:41,269 --> 00:28:37,360
seen as or understood or characterized

788
00:28:43,190 --> 00:28:41,279

as trying to optimize or minimize

789
00:28:44,950 --> 00:28:43,200
a free energy through changes in

790
00:28:47,430 --> 00:28:44,960
internal states or through

791
00:28:48,789 --> 00:28:47,440
action upon the world that would be the

792
00:28:50,149 --> 00:28:48,799
high road and we can take that if you

793
00:28:52,950 --> 00:28:50,159
choose that option

794
00:28:53,430 --> 00:28:52,960
the low road would be sort of building

795
00:28:57,190 --> 00:28:53,440
up

796
00:28:58,149 --> 00:28:57,200
um a sense of there being just one

797
00:29:01,590 --> 00:28:58,159
imperative

798
00:29:03,990 --> 00:29:01,600
um from the the notions that

799
00:29:05,269 --> 00:29:04,000
probably um can be found in the students

800
00:29:07,510 --> 00:29:05,279
of plato

801
00:29:08,789 --> 00:29:07,520
throughout philosophy through canned

802
00:29:11,669 --> 00:29:08,799
through helmholtz

803
00:29:13,590 --> 00:29:11,679
through modern day psychology and

804
00:29:17,029 --> 00:29:13,600
subsequently machine learning

805
00:29:19,269 --> 00:29:17,039
um would appeal to a story

806
00:29:20,950 --> 00:29:19,279
a narrative about prediction and

807
00:29:24,710 --> 00:29:20,960
inference and that we are

808
00:29:28,870 --> 00:29:24,720
all effectively prediction machines

809
00:29:31,669 --> 00:29:28,880
um where in this setting the

810
00:29:32,470 --> 00:29:31,679
the existential imperative is basically

811
00:29:35,110 --> 00:29:32,480
to reduce

812
00:29:37,430 --> 00:29:35,120
prediction error so by particular i

813
00:29:41,029 --> 00:29:37,440

simply mean that

814
00:29:43,909 --> 00:29:41,039
we have in mind

815
00:29:45,110 --> 00:29:43,919
a model of the way that the world works

816
00:29:48,070 --> 00:29:45,120
and that

817
00:29:49,430 --> 00:29:48,080
we can leverage that model to produce

818
00:29:52,230 --> 00:29:49,440
predictions about

819
00:29:53,990 --> 00:29:52,240
the sensory evidence at hand and the

820
00:29:56,070 --> 00:29:54,000
disparity or the difference between

821
00:29:58,470 --> 00:29:56,080
our predictions and our actual sensory

822
00:30:00,630 --> 00:29:58,480
samples can be called prediction error

823
00:30:02,950 --> 00:30:00,640
and it turns out mathematically that the

824
00:30:06,149 --> 00:30:02,960
sort of the high road and the low road

825
00:30:09,350 --> 00:30:06,159
um converge because the prediction error

826
00:30:10,630 --> 00:30:09,360
is just the gradient of the free energy

827
00:30:13,269 --> 00:30:10,640
that you're trying to

828
00:30:14,470 --> 00:30:13,279
try to minimize so i'll come back to you

829
00:30:17,510 --> 00:30:14,480
which would you prefer the

830
00:30:20,310 --> 00:30:17,520
the high road or the low road okay first

831
00:30:22,310 --> 00:30:20,320
when you say sentient do you mean the

832
00:30:24,630 --> 00:30:22,320
capacity to feel pleasure or pain

833
00:30:26,310 --> 00:30:24,640
or how are you using that word yeah just

834
00:30:29,909 --> 00:30:26,320
a sense um just to

835
00:30:32,230 --> 00:30:29,919
um not not so much the affect aspect not

836
00:30:36,310 --> 00:30:32,240
the sort of the pleasure and the pain

837
00:30:39,830 --> 00:30:36,320
just being able to um to represent and

838
00:30:42,870 --> 00:30:39,840

infer so to have in mind um

839
00:30:45,110 --> 00:30:42,880
a notion of what caused your sensations

840
00:30:46,149 --> 00:30:45,120
so you know i'm using it in a

841
00:30:50,789 --> 00:30:46,159
deflationary way

842
00:30:53,990 --> 00:30:50,799
um so some systems um

843
00:30:54,710 --> 00:30:54,000
um may or may not have the kind of

844
00:30:56,950 --> 00:30:54,720
sentience

845
00:30:57,750 --> 00:30:56,960
that that you'd associate with with say

846
00:31:00,870 --> 00:30:57,760
a person

847
00:31:03,269 --> 00:31:00,880
or a you know a pet um

848
00:31:04,149 --> 00:31:03,279
say you know does a plant is a plant

849
00:31:06,310 --> 00:31:04,159
sentient

850
00:31:07,350 --> 00:31:06,320
um let me ask you do you think a plant

851
00:31:10,549 --> 00:31:07,360
is sentient does it

852
00:31:12,389 --> 00:31:10,559
does it have can it in an elemental way

853
00:31:14,389 --> 00:31:12,399
feel its way around the world or have

854
00:31:17,909 --> 00:31:14,399
some internal representation

855
00:31:19,909 --> 00:31:17,919
of um of the world that is that it

856
00:31:21,350 --> 00:31:19,919
inhabits

857
00:31:23,029 --> 00:31:21,360
i would say it's a scary thought to

858
00:31:24,070 --> 00:31:23,039
think of plants as extremely sentient

859
00:31:25,269 --> 00:31:24,080
because you crush them

860
00:31:27,750 --> 00:31:25,279
constantly and even if you're a

861
00:31:29,669 --> 00:31:27,760
vegetarian so i'm unsure if i think that

862
00:31:30,389 --> 00:31:29,679
they can feel pleasure pain it does seem

863
00:31:31,750 --> 00:31:30,399

like it's

864
00:31:32,950 --> 00:31:31,760
clear that they respond to the

865
00:31:34,149 --> 00:31:32,960
environment and that they take in

866
00:31:36,310 --> 00:31:34,159
sensory information

867
00:31:37,430 --> 00:31:36,320
and act on it yes yeah i think that's

868
00:31:39,430 --> 00:31:37,440
absolutely true

869
00:31:40,870 --> 00:31:39,440
in fact interestingly they they have the

870
00:31:43,830 --> 00:31:40,880
same sort of

871
00:31:45,669 --> 00:31:43,840
um electrochemical message passing that

872
00:31:47,909 --> 00:31:45,679
we have with our axons

873
00:31:49,590 --> 00:31:47,919
you know in the brain it unfolds at a

874
00:31:51,509 --> 00:31:49,600
much slower time scale

875
00:31:53,590 --> 00:31:51,519
but the you know the physics of the

876
00:31:55,669 --> 00:31:53,600
message passing the internal

877
00:31:57,110 --> 00:31:55,679
um the internal states of a plan to

878
00:31:59,669 --> 00:31:57,120
actually uh

879
00:32:01,269 --> 00:31:59,679
comply with very similar kinds of

880
00:32:03,110 --> 00:32:01,279
computational architectures that

881
00:32:04,789 --> 00:32:03,120
your bread and mind is i i would say a

882
00:32:07,830 --> 00:32:04,799
plant is sentient but

883
00:32:10,710 --> 00:32:07,840
not to the extent that it has no

884
00:32:12,149 --> 00:32:10,720
emotions or even a sense of self you

885
00:32:15,430 --> 00:32:12,159
know there are lots of

886
00:32:17,430 --> 00:32:15,440
graded um very you know sort of

887
00:32:19,430 --> 00:32:17,440
ladder there are lots of steps on the

888
00:32:21,430 --> 00:32:19,440

ladder of sentience right through to

889
00:32:23,750 --> 00:32:21,440
self-awareness and pleasure and pain

890
00:32:25,909 --> 00:32:23,760
um but i'm talking about a very

891
00:32:28,549 --> 00:32:25,919
elemental sort where

892
00:32:29,909 --> 00:32:28,559
there's something going on in the inside

893
00:32:34,230 --> 00:32:29,919
that

894
00:32:36,710 --> 00:32:34,240
going on on the outside

895
00:32:38,070 --> 00:32:36,720
um that you can read as a kind of

896
00:32:41,830 --> 00:32:38,080
representation

897
00:32:43,509 --> 00:32:41,840
or an inference um about the causes of

898
00:32:45,110 --> 00:32:43,519
sensations

899
00:32:46,549 --> 00:32:45,120
okay so when you ask this question as to

900
00:32:47,990 --> 00:32:46,559
which explanation would i prefer the

901
00:32:50,870 --> 00:32:48,000
high road or the low road

902
00:32:51,350 --> 00:32:50,880
i imagine that as top down versus bottom

903
00:32:53,110 --> 00:32:51,360
up

904
00:32:54,389 --> 00:32:53,120
and when i say that please let me know

905
00:32:55,669 --> 00:32:54,399
if i'm understanding it correctly when

906
00:32:57,190 --> 00:32:55,679
you say the bottom up it's something

907
00:32:58,070 --> 00:32:57,200
like looking at what exists and seeing

908
00:33:00,389 --> 00:32:58,080
that it does

909
00:33:01,990 --> 00:33:00,399
act such that it minimizes some quantity

910
00:33:03,990 --> 00:33:02,000
or it wants to minimize

911
00:33:05,029 --> 00:33:04,000
error in some way versus the top down

912
00:33:06,950 --> 00:33:05,039
which looks like

913
00:33:08,789 --> 00:33:06,960

if i was to sit in an armchair with my

914
00:33:11,830 --> 00:33:08,799
eyes closed and think

915
00:33:13,669 --> 00:33:11,840
what exists okay what would have to be

916
00:33:15,190 --> 00:33:13,679
the case if it were to exist what

917
00:33:17,590 --> 00:33:15,200
properties would it have to have

918
00:33:18,470 --> 00:33:17,600
so one is is that correct am i no that's

919
00:33:25,269 --> 00:33:18,480
am i obtuse

920
00:33:27,350 --> 00:33:25,279
no that's brilliant yeah okay

921
00:33:28,870 --> 00:33:27,360
let's start with the top down let's just

922
00:33:30,230 --> 00:33:28,880
do the top down because i we have quite

923
00:33:31,669 --> 00:33:30,240
a few questions so let's start from the

924
00:33:34,389 --> 00:33:31,679
arm chair

925
00:33:36,149 --> 00:33:34,399
excuse me so okay i'll do the top down

926
00:33:39,190 --> 00:33:36,159
with a little nod to the bottom up so we

927
00:33:41,269 --> 00:33:39,200
don't we don't miss out on anything so

928
00:33:43,110 --> 00:33:41,279
you've just said what you know um uh

929
00:33:46,389 --> 00:33:43,120
basically the strategy

930
00:33:49,590 --> 00:33:46,399
you start off okay i want to explain um

931
00:33:50,470 --> 00:33:49,600
anything a theory of everything yep so

932
00:33:51,990 --> 00:33:50,480
what's a thing

933
00:33:53,909 --> 00:33:52,000
well the first thing you have to contend

934
00:33:54,230 --> 00:33:53,919
with well how do i differentiate a thing

935
00:33:57,269 --> 00:33:54,240
from

936
00:33:58,549 --> 00:33:57,279
no thing or nothing or something else so

937
00:34:02,310 --> 00:33:58,559
that immediately

938
00:34:03,590 --> 00:34:02,320

implies that you're splitting or carving

939
00:34:06,950 --> 00:34:03,600
or partitioning

940
00:34:09,190 --> 00:34:06,960
the states of some universe into

941
00:34:11,190 --> 00:34:09,200
states that belong to the thing and

942
00:34:13,750 --> 00:34:11,200
states that don't belong to the thing

943
00:34:14,710 --> 00:34:13,760
and when you think about what that means

944
00:34:18,069 --> 00:34:14,720
you have to

945
00:34:21,109 --> 00:34:18,079
um well you're compelled then

946
00:34:24,230 --> 00:34:21,119
to consider the statistical

947
00:34:27,349 --> 00:34:24,240
dependencies that demarcate

948
00:34:30,149 --> 00:34:27,359
something from nothing and

949
00:34:31,349 --> 00:34:30,159
when one drills down on that um you come

950
00:34:34,310 --> 00:34:31,359
across this notion

951
00:34:35,750 --> 00:34:34,320
of a markov boundary or markov blanket

952
00:34:38,790 --> 00:34:35,760
which is effectively

953
00:34:39,510 --> 00:34:38,800
a set of states that separate or

954
00:34:41,829 --> 00:34:39,520
insulate

955
00:34:44,069 --> 00:34:41,839
internal states on the inside from

956
00:34:47,829 --> 00:34:44,079
external states on the outside

957
00:34:48,629 --> 00:34:47,839
so you have this picture of transactions

958
00:34:52,470 --> 00:34:48,639
mediated

959
00:34:53,030 --> 00:34:52,480
by standard dynamics by of the sort

960
00:34:56,069 --> 00:34:53,040
you'd see

961
00:34:59,430 --> 00:34:56,079
in physics with a launch van formulation

962
00:35:00,790 --> 00:34:59,440
um the kinds of equations of motions

963
00:35:03,030 --> 00:35:00,800

that everybody uses

964
00:35:04,710 --> 00:35:03,040
to you know to to to build their

965
00:35:07,349 --> 00:35:04,720
favorite physics whether it's sort of

966
00:35:08,150 --> 00:35:07,359
quantum mechanics or classical mechanics

967
00:35:10,790 --> 00:35:08,160
uh

968
00:35:11,589 --> 00:35:10,800
um cisco mechanics they all start with

969
00:35:15,030 --> 00:35:11,599
with the notion

970
00:35:17,270 --> 00:35:15,040
of there being some dynamics out there

971
00:35:18,870 --> 00:35:17,280
and the special kind of dynamics that

972
00:35:21,990 --> 00:35:18,880
you that we're interested in

973
00:35:25,109 --> 00:35:22,000
in terms of talking about anything um

974
00:35:28,790 --> 00:35:25,119
is um applies

975
00:35:30,790 --> 00:35:28,800
to systems that have this partition

976
00:35:31,990 --> 00:35:30,800
so as soon as you put this partition

977
00:35:34,950 --> 00:35:32,000
into play

978
00:35:36,310 --> 00:35:34,960
which is basically a partition where

979
00:35:39,589 --> 00:35:36,320
internal states

980
00:35:41,109 --> 00:35:39,599
influence external states this direction

981
00:35:43,750 --> 00:35:41,119
through the blanket states

982
00:35:45,829 --> 00:35:43,760
and then external states influence

983
00:35:47,430 --> 00:35:45,839
internal states in the other direction

984
00:35:48,950 --> 00:35:47,440
and vicariously through the markov

985
00:35:49,990 --> 00:35:48,960
blanket you have this notion of some

986
00:35:52,470 --> 00:35:50,000
generalized

987
00:35:55,030 --> 00:35:52,480
action and perception that you know the

988
00:35:57,430 --> 00:35:55,040

inside influences the outside so somehow

989
00:35:58,710 --> 00:35:57,440
the thing is acting upon the world but

990
00:36:01,910 --> 00:35:58,720
at the same time

991
00:36:04,230 --> 00:36:01,920
through the blanket states the outside

992
00:36:07,109 --> 00:36:04,240
is acting upon the inside

993
00:36:08,150 --> 00:36:07,119
you know and we normally divide the

994
00:36:09,510 --> 00:36:08,160
blanket states into

995
00:36:12,310 --> 00:36:09,520
sensory and active states so in this

996
00:36:14,550 --> 00:36:12,320
instance the outside external states it

997
00:36:16,630 --> 00:36:14,560
impress themselves upon the sensory

998
00:36:19,349 --> 00:36:16,640
states and then the sensory states

999
00:36:20,230 --> 00:36:19,359
influence the internal states and so

1000
00:36:23,510 --> 00:36:20,240
there's a sort of

1001
00:36:26,870 --> 00:36:23,520
circular causality implied

1002
00:36:29,349 --> 00:36:26,880
by this partition now all you do then

1003
00:36:31,190 --> 00:36:29,359
is say well look let's just look at the

1004
00:36:34,230 --> 00:36:31,200
long-term behavior

1005
00:36:37,910 --> 00:36:34,240
of any system um that

1006
00:36:40,870 --> 00:36:37,920
would that you can

1007
00:36:42,230 --> 00:36:40,880
describe in terms of the the dynamics or

1008
00:36:43,990 --> 00:36:42,240
the rate of change

1009
00:36:47,190 --> 00:36:44,000
of the probability distribution over

1010
00:36:50,390 --> 00:36:47,200
states or density of the states

1011
00:36:52,470 --> 00:36:50,400
and note that

1012
00:36:54,390 --> 00:36:52,480
because we are interested in systems

1013
00:36:55,510 --> 00:36:54,400

that have attained a non-equilibrium

1014
00:36:58,710 --> 00:36:55,520
steady state

1015
00:36:59,510 --> 00:36:58,720
that probability density is not itself

1016
00:37:01,990 --> 00:36:59,520
changing

1017
00:37:03,190 --> 00:37:02,000
and when one does that when one looks at

1018
00:37:06,390 --> 00:37:03,200
the solution

1019
00:37:07,670 --> 00:37:06,400
to the density dynamics in the context

1020
00:37:10,550 --> 00:37:07,680
of the markov blanket

1021
00:37:12,710 --> 00:37:10,560
you get a particular kind of mechanics

1022
00:37:12,950 --> 00:37:12,720
and that mechanics is exactly the same

1023
00:37:14,870 --> 00:37:12,960
as

1024
00:37:16,150 --> 00:37:14,880
quantum mechanics or statistical

1025
00:37:19,109 --> 00:37:16,160
mechanics

1026
00:37:19,750 --> 00:37:19,119
but with one key difference now it

1027
00:37:22,069 --> 00:37:19,760
applies

1028
00:37:23,910 --> 00:37:22,079
in the setting of a markov blanket and

1029
00:37:27,030 --> 00:37:23,920
it that that's where the

1030
00:37:29,030 --> 00:37:27,040
interpretation of um things

1031
00:37:30,150 --> 00:37:29,040
as self-evidencing comes from because

1032
00:37:33,910 --> 00:37:30,160
you can always

1033
00:37:37,349 --> 00:37:33,920
write down the flows that maintain

1034
00:37:40,710 --> 00:37:37,359
this steady state as um

1035
00:37:42,230 --> 00:37:40,720
effectively trying to trying to minimize

1036
00:37:44,150 --> 00:37:42,240
their prediction error

1037
00:37:46,870 --> 00:37:44,160
or minimize their self-information or

1038
00:37:48,790 --> 00:37:46,880

minimize their their

1039
00:37:50,310 --> 00:37:48,800
what's known as surprisal information

1040
00:37:51,829 --> 00:37:50,320
theory which

1041
00:37:53,349 --> 00:37:51,839
which mathematically is just the same

1042
00:37:56,150 --> 00:37:53,359
thing as uh

1043
00:37:57,510 --> 00:37:56,160
what statisticians like to call bayesian

1044
00:37:59,750 --> 00:37:57,520
model evidence or the log

1045
00:38:01,589 --> 00:37:59,760
of the probability of these sensory

1046
00:38:04,630 --> 00:38:01,599
states given my implicit

1047
00:38:08,230 --> 00:38:04,640
model encoded by

1048
00:38:08,710 --> 00:38:08,240
the internal states so what you end up

1049
00:38:12,150 --> 00:38:08,720
with

1050
00:38:15,190 --> 00:38:12,160
is a description of anything

1051
00:38:17,349 --> 00:38:15,200
defined stipulatively in terms of a

1052
00:38:19,670 --> 00:38:17,359
possessing a markov blanket

1053
00:38:21,670 --> 00:38:19,680
defined by its non-equilibrium steady

1054
00:38:25,430 --> 00:38:21,680
state density

1055
00:38:26,390 --> 00:38:25,440
whose dynamics or flows must have this

1056
00:38:29,829 --> 00:38:26,400
property

1057
00:38:32,310 --> 00:38:29,839
that the internal states and the

1058
00:38:35,190 --> 00:38:32,320
the active part of the blanket states

1059
00:38:38,390 --> 00:38:35,200
must be performing a gradient flow

1060
00:38:40,310 --> 00:38:38,400
on this self-information and then

1061
00:38:41,990 --> 00:38:40,320
you make a further move and say well

1062
00:38:43,990 --> 00:38:42,000
this self-information

1063
00:38:46,150 --> 00:38:44,000

can be written down as a free energy

1064
00:38:49,270 --> 00:38:46,160
functional well the free energy

1065
00:38:52,069 --> 00:38:49,280
if i interpret the internal states

1066
00:38:53,910 --> 00:38:52,079
as encoding bayesian beliefs or

1067
00:38:56,950 --> 00:38:53,920
probabilistic beliefs

1068
00:39:00,069 --> 00:38:56,960
about the external states so now you

1069
00:39:03,349 --> 00:39:00,079
have a mathematical image or a picture

1070
00:39:06,310 --> 00:39:03,359
of existential dynamics

1071
00:39:08,150 --> 00:39:06,320
that inherit from having a markov

1072
00:39:10,870 --> 00:39:08,160
blanket where you can say

1073
00:39:12,069 --> 00:39:10,880
that the dynamics of the internal states

1074
00:39:15,270 --> 00:39:12,079
look as if

1075
00:39:17,190 --> 00:39:15,280
they're trying to maximize their model

1076
00:39:19,910 --> 00:39:17,200
evidence or trying to minimize

1077
00:39:21,829 --> 00:39:19,920
uh their free energy or prediction error

1078
00:39:24,470 --> 00:39:21,839
and that's basically the story

1079
00:39:26,390 --> 00:39:24,480
so a story that rests really upon what

1080
00:39:26,790 --> 00:39:26,400
physicists will understand as dynamics

1081
00:39:29,270 --> 00:39:26,800
and

1082
00:39:30,550 --> 00:39:29,280
average flow at non-equilibrium steady

1083
00:39:33,750 --> 00:39:30,560
state

1084
00:39:35,990 --> 00:39:33,760
and in particular the gradient flows

1085
00:39:37,190 --> 00:39:36,000
so perhaps it would demystify this to

1086
00:39:39,030 --> 00:39:37,200
say that

1087
00:39:41,030 --> 00:39:39,040
and coming back to helmholtz it was a

1088
00:39:44,150 --> 00:39:41,040

key architecture these ideas on the

1089
00:39:47,349 --> 00:39:44,160
low road to describing um

1090
00:39:48,870 --> 00:39:47,359
so um what you're what

1091
00:39:50,390 --> 00:39:48,880
among the many things that helmholtz

1092
00:39:51,750 --> 00:39:50,400
brought to the table was you can always

1093
00:39:54,150 --> 00:39:51,760
decompose

1094
00:39:57,109 --> 00:39:54,160
the flow for example let's take the flow

1095
00:40:03,270 --> 00:40:00,150
into two parts there's one that's

1096
00:40:05,430 --> 00:40:03,280
flowing up or down

1097
00:40:06,950 --> 00:40:05,440
gradients say concentration gradients

1098
00:40:11,190 --> 00:40:06,960
and there's another

1099
00:40:13,750 --> 00:40:11,200
circular flow which flows around the iso

1100
00:40:14,470 --> 00:40:13,760
probability contours or the iso gradient

1101
00:40:17,589 --> 00:40:14,480
uh the

1102
00:40:18,550 --> 00:40:17,599
the iso contours of of any uh of any

1103
00:40:19,990 --> 00:40:18,560
function

1104
00:40:21,589 --> 00:40:20,000
so what we're talking about is the

1105
00:40:23,990 --> 00:40:21,599
gradient flow part of it

1106
00:40:26,390 --> 00:40:24,000
not the solenoidal which is the other

1107
00:40:27,750 --> 00:40:26,400
circular part of the flow that

1108
00:40:29,750 --> 00:40:27,760
we were previously talking about in

1109
00:40:31,510 --> 00:40:29,760
terms of um

1110
00:40:33,430 --> 00:40:31,520
defining non-equilibrium as opposed to

1111
00:40:37,430 --> 00:40:33,440
equilibrium systems

1112
00:40:41,430 --> 00:40:37,440
and you know that gradient flow then

1113
00:40:44,630 --> 00:40:41,440

can be now read as a gradient flow

1114
00:40:46,470 --> 00:40:44,640
on a variational free energy um

1115
00:40:48,630 --> 00:40:46,480
which is wonderful from the point of

1116
00:40:49,270 --> 00:40:48,640
view of people like me in neuroscience

1117
00:40:51,870 --> 00:40:49,280
because

1118
00:40:53,270 --> 00:40:51,880
now what you've got is a description of

1119
00:40:55,510 --> 00:40:53,280
neurodynamics

1120
00:40:56,550 --> 00:40:55,520
so you've got now a first principle

1121
00:41:00,710 --> 00:40:56,560
account

1122
00:41:02,870 --> 00:41:00,720
of how neuronal activity or states

1123
00:41:04,069 --> 00:41:02,880
change as a function of their state over

1124
00:41:05,589 --> 00:41:04,079
time and

1125
00:41:07,750 --> 00:41:05,599
you can write that down now as a

1126
00:41:10,390 --> 00:41:07,760
gradient flow on this one

1127
00:41:12,630 --> 00:41:10,400
quantity this variation free energy that

1128
00:41:16,309 --> 00:41:12,640
endows that gradient flow there's

1129
00:41:20,069 --> 00:41:16,319
that dynamics um with an interpretation

1130
00:41:23,510 --> 00:41:20,079
that they're trying to maximize

1131
00:41:27,670 --> 00:41:23,520
the evidence for their model internally

1132
00:41:31,510 --> 00:41:29,829
okay let's zoom out and we see in your

1133
00:41:32,950 --> 00:41:31,520
model most of the time when you're

1134
00:41:34,950 --> 00:41:32,960
presenting with the powerpoint slides i

1135
00:41:36,710 --> 00:41:34,960
see nodes and then they have arrows

1136
00:41:38,550 --> 00:41:36,720
and so the nodes are connected with

1137
00:41:40,870 --> 00:41:38,560
different arrows and then that's what

1138
00:41:42,390 --> 00:41:40,880

affords a markov blanket

1139
00:41:43,990 --> 00:41:42,400
i have a couple questions the arrows

1140
00:41:46,390 --> 00:41:44,000
represent influence

1141
00:41:48,550 --> 00:41:46,400
which to me is a synonym for causation

1142
00:41:49,510 --> 00:41:48,560
so i'm wondering is causation necessary

1143
00:41:51,510 --> 00:41:49,520
for

1144
00:41:52,950 --> 00:41:51,520
this model because some people argue

1145
00:41:55,670 --> 00:41:52,960
that causation is an illusion

1146
00:41:55,990 --> 00:41:55,680
so for example sean carroll may say that

1147
00:41:58,790 --> 00:41:56,000
and

1148
00:42:01,430 --> 00:41:58,800
i'm well first of all let's tackle that

1149
00:42:05,109 --> 00:42:01,440
does your model presuppose causation

1150
00:42:08,950 --> 00:42:05,119
um yeah in a deflationary sense yes

1151
00:42:12,069 --> 00:42:08,960
um so inflationary yes so

1152
00:42:14,309 --> 00:42:12,079
in in the sense uh you know

1153
00:42:15,990 --> 00:42:14,319
i i i'm not quite sure what sean has

1154
00:42:16,790 --> 00:42:16,000
said but i will i want to agree with it

1155
00:42:19,670 --> 00:42:16,800
with what what

1156
00:42:21,270 --> 00:42:19,680
whatever you said um so this is a very

1157
00:42:23,990 --> 00:42:21,280
trivial causation that

1158
00:42:25,910 --> 00:42:24,000
that is implicit when you write down any

1159
00:42:27,750 --> 00:42:25,920
random differential equation or

1160
00:42:29,430 --> 00:42:27,760
stochastic differential equation or

1161
00:42:32,710 --> 00:42:29,440
longevity expression

1162
00:42:35,430 --> 00:42:32,720
if you just write down a universe

1163
00:42:36,470 --> 00:42:35,440

in which there are states that change

1164
00:42:39,030 --> 00:42:36,480
with time

1165
00:42:41,030 --> 00:42:39,040
as a function of those states plus say

1166
00:42:41,910 --> 00:42:41,040
some random fluctuations to make it a

1167
00:42:44,309 --> 00:42:41,920
random

1168
00:42:45,510 --> 00:42:44,319
or a stochastic differential equation

1169
00:42:48,630 --> 00:42:45,520
then what you are saying

1170
00:42:50,790 --> 00:42:48,640
is that the flow of

1171
00:42:53,270 --> 00:42:50,800
those states the rate of change of those

1172
00:42:55,430 --> 00:42:53,280
states is caused by those states

1173
00:42:56,309 --> 00:42:55,440
that's the only causality that is in

1174
00:42:58,630 --> 00:42:56,319
play here

1175
00:42:59,589 --> 00:42:58,640
so it's its causality of a rather sort

1176
00:43:01,829 --> 00:42:59,599
of um

1177
00:43:03,829 --> 00:43:01,839
elemental and trivial sort that that i

1178
00:43:06,950 --> 00:43:03,839
have to refer to also i normally but

1179
00:43:08,790 --> 00:43:06,960
people often refer to as um uh causality

1180
00:43:09,430 --> 00:43:08,800
in a controlled theoretic sense that the

1181
00:43:11,430 --> 00:43:09,440
system

1182
00:43:13,510 --> 00:43:11,440
is causal in the sense that there is

1183
00:43:14,150 --> 00:43:13,520
just motion or dynamics that is caused

1184
00:43:19,190 --> 00:43:14,160
by

1185
00:43:20,550 --> 00:43:19,200
inherits just from writing down

1186
00:43:22,870 --> 00:43:20,560
differential equations

1187
00:43:25,510 --> 00:43:22,880
that interestingly are only expressed in

1188
00:43:25,990 --> 00:43:25,520

motion over time so there's a deep link

1189
00:43:29,349 --> 00:43:26,000
betw

1190
00:43:31,430 --> 00:43:29,359
behind this trivial causality and time

1191
00:43:32,630 --> 00:43:31,440
uh because you're just writing down a

1192
00:43:34,630 --> 00:43:32,640
differential equation

1193
00:43:35,910 --> 00:43:34,640
after that there's no causality there's

1194
00:43:39,270 --> 00:43:35,920
nothing else after that

1195
00:43:40,230 --> 00:43:39,280
um the the sort of the causal inference

1196
00:43:43,270 --> 00:43:40,240
that the

1197
00:43:47,030 --> 00:43:43,280
the sort of um that

1198
00:43:49,190 --> 00:43:47,040
um would be of the kind uh say that

1199
00:43:50,870 --> 00:43:49,200
people like pearl in his causal

1200
00:43:53,990 --> 00:43:50,880
mechanics talk about

1201
00:43:56,150 --> 00:43:54,000
um i think that's much more um a

1202
00:43:57,829 --> 00:43:56,160
product of inference but you'd have to

1203
00:43:59,990 --> 00:43:57,839
actually work right up through the free

1204
00:44:02,230 --> 00:44:00,000
energy principle with you know

1205
00:44:04,710 --> 00:44:02,240
you know to actually understand what it

1206
00:44:07,910 --> 00:44:04,720
means just to

1207
00:44:09,109 --> 00:44:07,920
measure things you know let alone have

1208
00:44:12,630 --> 00:44:09,119
ideas about

1209
00:44:13,910 --> 00:44:12,640
do did this a cause be you know you

1210
00:44:16,390 --> 00:44:13,920
first of all got to even

1211
00:44:18,470 --> 00:44:16,400
uh you know um work out how would you

1212
00:44:22,150 --> 00:44:18,480
measure how you infer the existence of

1213
00:44:24,309 --> 00:44:22,160

a out there and b out there so you know

1214
00:44:25,910 --> 00:44:24,319
the free energy principle starts at a

1215
00:44:28,470 --> 00:44:25,920
very very low level and then

1216
00:44:30,790 --> 00:44:28,480
the baby steps works up to higher order

1217
00:44:32,470 --> 00:44:30,800
notions of things like causality

1218
00:44:34,230 --> 00:44:32,480
does that answer your question about the

1219
00:44:35,750 --> 00:44:34,240
the other

1220
00:44:37,990 --> 00:44:35,760
yeah does time always have to be the

1221
00:44:40,630 --> 00:44:38,000
parameter or can it be something else

1222
00:44:42,069 --> 00:44:40,640
because then it presupposes time as well

1223
00:44:50,069 --> 00:44:42,079
yeah

1224
00:44:51,829 --> 00:44:50,079
because you can generalize that you know

1225
00:44:54,550 --> 00:44:51,839
just treat time as another another

1226
00:44:54,950 --> 00:44:54,560
another coordinate if if you wanted to i

1227
00:45:25,270 --> 00:44:54,960
i

1228
00:45:28,390 --> 00:45:25,280
you keep connected

1229
00:45:31,109 --> 00:45:28,400
to um

1230
00:45:32,790 --> 00:45:31,119
useful things of the sort that do rest

1231
00:45:36,230 --> 00:45:32,800
upon dynamics

1232
00:45:39,270 --> 00:45:36,240
um you know if you if you so don't keep

1233
00:45:40,230 --> 00:45:39,280
if you don't treat time as a special if

1234
00:45:43,829 --> 00:45:40,240
you like coordinate

1235
00:45:47,030 --> 00:45:43,839
or um aspect of some

1236
00:45:50,150 --> 00:45:47,040
of some space um then

1237
00:45:51,990 --> 00:45:50,160
you know um it it's

1238
00:45:53,990 --> 00:45:52,000

less easy in a straightforward way to

1239
00:45:54,790 --> 00:45:54,000
connect to things like entropy

1240
00:45:57,190 --> 00:45:54,800
production

1241
00:45:58,150 --> 00:45:57,200
or um even things like sort of

1242
00:46:01,510 --> 00:45:58,160
information entropy

1243
00:46:04,790 --> 00:46:01,520
information then in dynamical systems

1244
00:46:08,390 --> 00:46:04,800
so i personally do you know

1245
00:46:10,870 --> 00:46:08,400
time starts off with a privileged um

1246
00:46:12,630 --> 00:46:10,880
position in the formulation in the sense

1247
00:46:16,309 --> 00:46:12,640
that it underwrites

1248
00:46:18,069 --> 00:46:16,319
the meaning of a differential equation

1249
00:46:19,990 --> 00:46:18,079
do you see that as then meaning that the

1250
00:46:20,870 --> 00:46:20,000
free energy principle as it's currently

1251
00:46:22,870 --> 00:46:20,880
formulated

1252
00:46:24,550 --> 00:46:22,880
is incomplete in some manner given

1253
00:46:26,950 --> 00:46:24,560
special relativity let's say that or

1254
00:46:28,550 --> 00:46:26,960
any relativity says that time and space

1255
00:46:29,510 --> 00:46:28,560
must be on some equal footing and if

1256
00:46:31,430 --> 00:46:29,520
you're

1257
00:46:33,109 --> 00:46:31,440
saying that time has some privileged

1258
00:46:34,069 --> 00:46:33,119
position then well position needs to

1259
00:46:37,270 --> 00:46:34,079
have a

1260
00:46:41,510 --> 00:46:37,280
an equally privileged position right

1261
00:46:43,670 --> 00:46:41,520
yeah that question is above my pay grade

1262
00:46:50,230 --> 00:46:43,680
i personally don't know you can easily

1263
00:46:57,430 --> 00:46:53,829

dynamics or mechanics

1264
00:47:00,630 --> 00:46:57,440
out of a longevan formulation

1265
00:47:02,150 --> 00:47:00,640
that has time bait into the very core

1266
00:47:03,670 --> 00:47:02,160
of it you know at the beginning with

1267
00:47:05,190 --> 00:47:03,680
just right now the launch on you can

1268
00:47:08,230 --> 00:47:05,200
work the whole way thing

1269
00:47:10,150 --> 00:47:08,240
the whole density dynamics up um

1270
00:47:11,670 --> 00:47:10,160
and at non-equilibrium steady state you

1271
00:47:14,950 --> 00:47:11,680
can write down quite you know

1272
00:47:17,990 --> 00:47:14,960
a simple potential function that

1273
00:47:19,109 --> 00:47:18,000
describes general relativity um so i

1274
00:47:19,910 --> 00:47:19,119
don't think there's no i didn't know

1275
00:47:21,510 --> 00:47:19,920
that

1276
00:47:23,510 --> 00:47:21,520
okay because when i was looking at some

1277
00:47:24,230 --> 00:47:23,520
of your notes i know you call it the

1278
00:47:26,230 --> 00:47:24,240
launch van

1279
00:47:27,589 --> 00:47:26,240
equation i can never pronounce that so i

1280
00:47:29,109 --> 00:47:27,599
always called it the kalman

1281
00:47:30,790 --> 00:47:29,119
forward equation for some reason that's

1282
00:47:32,309 --> 00:47:30,800
easier for me but whatever

1283
00:47:34,549 --> 00:47:32,319
the launch man is that correct launch

1284
00:47:34,950 --> 00:47:34,559
fan yeah so that's how i say it anyway

1285
00:47:36,829 --> 00:47:34,960
yes

1286
00:47:38,390 --> 00:47:36,839
okay well let's just say like that for

1287
00:47:40,630 --> 00:47:38,400
now

1288
00:47:42,309 --> 00:47:40,640

yes right okay so the launch van

1289
00:47:45,030 --> 00:47:42,319
equation

1290
00:47:46,309 --> 00:47:45,040
it can it can imply newtonian mechanics

1291
00:47:47,589 --> 00:47:46,319
i saw that you were showing that in one

1292
00:47:48,470 --> 00:47:47,599
of your slides as well as quantum

1293
00:47:51,990 --> 00:47:48,480
mechanics

1294
00:47:53,750 --> 00:47:52,000
as well as some aspect of thermodynamics

1295
00:47:55,510 --> 00:47:53,760
and then i forgot the fourth one but

1296
00:47:57,109 --> 00:47:55,520
then i didn't see special relativity or

1297
00:47:58,390 --> 00:47:57,119
non-relativistic quantum mechanics

1298
00:47:59,430 --> 00:47:58,400
you're saying that you can tweak some of

1299
00:48:02,710 --> 00:47:59,440
the parameters to derive

1300
00:48:04,630 --> 00:48:02,720
general relativity yep um and it all

1301
00:48:05,990 --> 00:48:04,640
rests upon the way that you configure

1302
00:48:12,230 --> 00:48:06,000
the um

1303
00:48:14,069 --> 00:48:12,240
have the dissipative um the lender

1304
00:48:18,069 --> 00:48:14,079
system and dissipative aspect

1305
00:48:20,630 --> 00:48:18,079
um versus the um solenoidal flows the

1306
00:48:21,270 --> 00:48:20,640
that characterize more conservative

1307
00:48:23,190 --> 00:48:21,280
systems so

1308
00:48:25,270 --> 00:48:23,200
when we're talking about special sorry

1309
00:48:29,270 --> 00:48:25,280
general relativity for example

1310
00:48:30,790 --> 00:48:29,280
excuse me um we're almost um

1311
00:48:33,349 --> 00:48:30,800
considering the limiting case where the

1312
00:48:34,309 --> 00:48:33,359
random fluctuations are attenuated by

1313
00:48:35,349 --> 00:48:34,319

being averaged away

1314
00:48:37,670 --> 00:48:35,359
we're talking about sort of massive

1315
00:48:39,670 --> 00:48:37,680
bodies um moving around so

1316
00:48:41,589 --> 00:48:39,680
it's just a question of of looking at

1317
00:48:44,069 --> 00:48:41,599
the various functional forms

1318
00:48:46,470 --> 00:48:44,079
you would get out of the solution to the

1319
00:48:49,270 --> 00:48:46,480
common growth forward equation

1320
00:48:50,390 --> 00:48:49,280
under the limit that gamma is is is um

1321
00:48:52,230 --> 00:48:50,400
is very very sorry

1322
00:48:54,710 --> 00:48:52,240
the amplitude the random fluctuations is

1323
00:48:57,910 --> 00:48:54,720
very very small so the gradient flows

1324
00:48:59,349 --> 00:48:57,920
almost disappear um so then it's just a

1325
00:49:01,109 --> 00:48:59,359
question look at the functional forms

1326
00:49:02,790 --> 00:49:01,119
and with a few nonlinearities here and

1327
00:49:04,309 --> 00:49:02,800
there you can you can quite you can

1328
00:49:07,589 --> 00:49:04,319
quite you can quite easily

1329
00:49:10,549 --> 00:49:07,599
uh write down something that that the uh

1330
00:49:12,069 --> 00:49:10,559
general you know relativity we will be

1331
00:49:13,750 --> 00:49:12,079
quite comfortable with

1332
00:49:16,069 --> 00:49:13,760
there are some interesting twists here

1333
00:49:19,190 --> 00:49:16,079
but you know if you start putting back

1334
00:49:20,069 --> 00:49:19,200
the random fluctuations into the so

1335
00:49:23,829 --> 00:49:20,079
general

1336
00:49:26,549 --> 00:49:23,839
solution um to um

1337
00:49:27,190 --> 00:49:26,559
the um the focal point equation or the

1338
00:49:30,470 --> 00:49:27,200

uh

1339
00:49:31,910 --> 00:49:30,480
the kamalgr forward equation um and

1340
00:49:33,670 --> 00:49:31,920
sorry just for the people listening the

1341
00:49:35,589 --> 00:49:33,680
focker planck equation and then the

1342
00:49:38,710 --> 00:49:35,599
launch van equation and the kolmogorov

1343
00:49:41,270 --> 00:49:38,720
forward equation are all synonyms

1344
00:49:42,230 --> 00:49:41,280
yes or the special cases of one another

1345
00:49:44,630 --> 00:49:42,240
yeah well

1346
00:49:45,670 --> 00:49:44,640
the launchvan equation is is just the

1347
00:49:48,870 --> 00:49:45,680
the underlying

1348
00:49:50,950 --> 00:49:48,880
uh equation that describes the the

1349
00:49:52,309 --> 00:49:50,960
the flow of the system as a function of

1350
00:49:54,549 --> 00:49:52,319
the states

1351
00:49:56,710 --> 00:49:54,559
but if you if you know that and you know

1352
00:49:58,069 --> 00:49:56,720
the amplitude of any random fluctuations

1353
00:50:00,470 --> 00:49:58,079
on that flow

1354
00:50:01,270 --> 00:50:00,480
then you can do you can equivalently

1355
00:50:03,030 --> 00:50:01,280
write that down

1356
00:50:04,630 --> 00:50:03,040
as a focal planck equation or a whole

1357
00:50:06,870 --> 00:50:04,640
molecular forward equation

1358
00:50:08,230 --> 00:50:06,880
i should also say incidentally you can

1359
00:50:10,150 --> 00:50:08,240
also write it down

1360
00:50:11,349 --> 00:50:10,160
equivalently in terms of a path integral

1361
00:50:13,750 --> 00:50:11,359
formulation

1362
00:50:15,430 --> 00:50:13,760
all of these could be um thought of as

1363
00:50:16,390 --> 00:50:15,440

different ways of just articulating the

1364
00:50:19,349 --> 00:50:16,400
same thing

1365
00:50:21,349 --> 00:50:19,359
um so but the density dynamics most

1366
00:50:23,430 --> 00:50:21,359
transparently inherits from the

1367
00:50:24,790 --> 00:50:23,440
you know from the uh the focal plank or

1368
00:50:27,030 --> 00:50:24,800
the common graph

1369
00:50:28,309 --> 00:50:27,040
formulation which is explicitly about

1370
00:50:31,829 --> 00:50:28,319
how the probabilities

1371
00:50:33,990 --> 00:50:31,839
over the states um evolve over time

1372
00:50:35,190 --> 00:50:34,000
so one example of that would be this the

1373
00:50:37,750 --> 00:50:35,200
time independent

1374
00:50:38,309 --> 00:50:37,760
scrolling a wave equation um you know

1375
00:50:40,950 --> 00:50:38,319
which is

1376
00:50:42,390 --> 00:50:40,960
you know one version of a vodka plank

1377
00:50:45,190 --> 00:50:42,400
equation

1378
00:50:46,309 --> 00:50:45,200
what they have in common is describing

1379
00:50:49,829 --> 00:50:46,319
the dynamics

1380
00:50:52,790 --> 00:50:49,839
of um of systems um

1381
00:50:54,870 --> 00:50:52,800
uh in terms of uh the probability

1382
00:50:56,710 --> 00:50:54,880
density over the states

1383
00:50:58,309 --> 00:50:56,720
or if you need quantum mechanics over

1384
00:51:01,349 --> 00:50:58,319
the other sort of the

1385
00:51:02,309 --> 00:51:01,359
um i would say the wave function of

1386
00:51:06,230 --> 00:51:02,319
states

1387
00:51:08,230 --> 00:51:06,240
um so at steady state

1388
00:51:09,510 --> 00:51:08,240

um if i really need to go to steady

1389
00:51:13,030 --> 00:51:09,520
state but certainly

1390
00:51:16,150 --> 00:51:13,040
once you've written down um the

1391
00:51:18,870 --> 00:51:16,160
the foca planck equation um and

1392
00:51:20,790 --> 00:51:18,880
solved it for uh the flow and then use

1393
00:51:23,589 --> 00:51:20,800
the helmholtz decomposition

1394
00:51:25,030 --> 00:51:23,599
to split the contributions to flow into

1395
00:51:28,549 --> 00:51:25,040
the solenoidal and

1396
00:51:30,710 --> 00:51:28,559
gradient flow parts then that provides

1397
00:51:32,630 --> 00:51:30,720
sort of a nice way of looking at

1398
00:51:36,309 --> 00:51:32,640
limiting cases so

1399
00:51:39,109 --> 00:51:36,319
the the gradient flow is realized by

1400
00:51:39,510 --> 00:51:39,119
the random fluctuations so that you know

1401
00:51:44,309 --> 00:51:39,520
for

1402
00:51:47,109 --> 00:51:44,319
i often use the following analogy that

1403
00:51:47,829 --> 00:51:47,119
you know imagine that i placed a drop of

1404
00:51:51,030 --> 00:51:47,839
ink

1405
00:51:54,150 --> 00:51:51,040
in a cup of water um and

1406
00:51:57,349 --> 00:51:54,160
the ink for dissipative systems um

1407
00:51:59,270 --> 00:51:57,359
or your dissipative ink would disperse

1408
00:52:02,630 --> 00:51:59,280
itself throughout the solvent as a

1409
00:52:05,030 --> 00:52:02,640
random molecular uh fluctuations um

1410
00:52:06,470 --> 00:52:05,040
cause the ink molecules to diffuse down

1411
00:52:09,109 --> 00:52:06,480
concentration gradients

1412
00:52:09,910 --> 00:52:09,119
until you had you know a maximum entropy

1413
00:52:13,349 --> 00:52:09,920

dissipated

1414
00:52:15,670 --> 00:52:13,359
dissolved um um uh

1415
00:52:17,270 --> 00:52:15,680
uh sort of uh equilibrium within the

1416
00:52:19,349 --> 00:52:17,280
sort of the heat bath or

1417
00:52:20,390 --> 00:52:19,359
or the bound is supplied supplied by the

1418
00:52:22,069 --> 00:52:20,400
glass

1419
00:52:24,470 --> 00:52:22,079
that's not the kind of system that we're

1420
00:52:26,470 --> 00:52:24,480
interested in that's a 20th century

1421
00:52:28,790 --> 00:52:26,480
sort of equilibrium physics what we're

1422
00:52:30,549 --> 00:52:28,800
interested in is special kinds of ink

1423
00:52:32,950 --> 00:52:30,559
that seems to gather themselves up again

1424
00:52:36,870 --> 00:52:32,960
into a little globule

1425
00:52:37,270 --> 00:52:36,880
and that gathering up in the context of

1426
00:52:40,309 --> 00:52:37,280
sir

1427
00:52:41,750 --> 00:52:40,319
you stirring the uh stirring the the

1428
00:52:45,030 --> 00:52:41,760
glass of water

1429
00:52:45,990 --> 00:52:45,040
um can always be written down in accord

1430
00:52:48,870 --> 00:52:46,000
with the

1431
00:52:49,670 --> 00:52:48,880
helmholtz decomposition into two kinds

1432
00:52:54,069 --> 00:52:49,680
of flow

1433
00:52:56,069 --> 00:52:54,079
gradients

1434
00:52:57,750 --> 00:52:56,079
so it's this is the gradient flow i was

1435
00:52:59,109 --> 00:52:57,760
talking about so the molecules are

1436
00:53:01,670 --> 00:52:59,119
gathering themselves

1437
00:53:03,190 --> 00:53:01,680
together paradoxically if you like

1438
00:53:05,589 --> 00:53:03,200

looking as if they're flowing

1439
00:53:07,990 --> 00:53:05,599
towards each other or to the highest

1440
00:53:10,150 --> 00:53:08,000
concentration the highest

1441
00:53:11,670 --> 00:53:10,160
probabilities or log probabilities and

1442
00:53:16,069 --> 00:53:11,680
it's that it's that

1443
00:53:19,829 --> 00:53:16,079
gradient flow that is um responsible for

1444
00:53:22,309 --> 00:53:19,839
this self-assembly this sort of um

1445
00:53:22,870 --> 00:53:22,319
the uh the emergence of this attracting

1446
00:53:24,710 --> 00:53:22,880
set

1447
00:53:26,630 --> 00:53:24,720
of a small number of states that i i

1448
00:53:27,349 --> 00:53:26,640
keep visiting and then the solenoidal

1449
00:53:33,589 --> 00:53:27,359
flow

1450
00:53:35,510 --> 00:53:33,599
um around the ice the constant you know

1451
00:53:38,790 --> 00:53:35,520
in this instance the concentration

1452
00:53:41,829 --> 00:53:38,800
um profile the i

1453
00:53:44,710 --> 00:53:41,839
the iso concentration lines whereas the

1454
00:53:46,549 --> 00:53:44,720
gradient flow is is going to the

1455
00:53:49,030 --> 00:53:46,559
you know the maximum concentration or

1456
00:53:51,510 --> 00:53:49,040
the maximum probability density

1457
00:53:53,510 --> 00:53:51,520
so that's non-equilibrium steady state

1458
00:53:56,630 --> 00:53:53,520
crucially

1459
00:53:57,670 --> 00:53:56,640
that gradient flow is exactly balancing

1460
00:54:01,030 --> 00:53:57,680
the dispersion

1461
00:54:05,109 --> 00:54:01,040
due to the random fluctuations so

1462
00:54:07,349 --> 00:54:05,119
put that another way the gradient flow

1463
00:54:08,470 --> 00:54:07,359

that keeps things glued together as it

1464
00:54:10,790 --> 00:54:08,480
were that keeps things

1465
00:54:13,190 --> 00:54:10,800
pointing towards that attracting set

1466
00:54:15,270 --> 00:54:13,200
that pullback attractor that

1467
00:54:16,390 --> 00:54:15,280
states that have a high non-equilibrium

1468
00:54:20,150 --> 00:54:16,400
state

1469
00:54:22,470 --> 00:54:20,160
density is exactly offsetting the

1470
00:54:24,950 --> 00:54:22,480
dispersive dissipative

1471
00:54:26,790 --> 00:54:24,960
effects of the random fluctuations which

1472
00:54:28,790 --> 00:54:26,800
means that the random fluctuations

1473
00:54:31,670 --> 00:54:28,800
realize the gradient flow

1474
00:54:32,790 --> 00:54:31,680
so you have to have random fluctuations

1475
00:54:35,030 --> 00:54:32,800
before

1476
00:54:35,910 --> 00:54:35,040
you can have at non-equilibrium steady

1477
00:54:39,030 --> 00:54:35,920
state

1478
00:54:41,990 --> 00:54:39,040
the gradient flow so what would happen

1479
00:54:43,510 --> 00:54:42,000
if you took them away well what would

1480
00:54:44,150 --> 00:54:43,520
happen is there will be no gradient

1481
00:54:45,910 --> 00:54:44,160
flows

1482
00:54:47,430 --> 00:54:45,920
and things would just have solenoidal

1483
00:54:50,710 --> 00:54:47,440
orbits and then we have

1484
00:54:53,910 --> 00:54:50,720
basically lagrangian mechanics we have

1485
00:54:56,470 --> 00:54:53,920
you know a mechanics app for describing

1486
00:54:57,670 --> 00:54:56,480
large bodies heavenly bodies moons and

1487
00:54:59,910 --> 00:54:57,680
earths and the like

1488
00:55:00,870 --> 00:54:59,920

all they can do is move around in

1489
00:55:03,510 --> 00:55:00,880
circles

1490
00:55:04,470 --> 00:55:03,520
so they've just got solenoidal flow

1491
00:55:06,470 --> 00:55:04,480
that's because there

1492
00:55:08,069 --> 00:55:06,480
aren't all the random fluctuations are

1493
00:55:09,990 --> 00:55:08,079
averaged away so they're effectively

1494
00:55:12,309 --> 00:55:10,000
zero so they can't realize

1495
00:55:13,510 --> 00:55:12,319
the gradient flows so they don't fall

1496
00:55:15,670 --> 00:55:13,520
towards each other

1497
00:55:16,950 --> 00:55:15,680
you know with you know with a suitable

1498
00:55:19,990 --> 00:55:16,960
potential energy

1499
00:55:21,990 --> 00:55:20,000
um that would define the you know

1500
00:55:23,270 --> 00:55:22,000
the gradient flows or the form of that

1501
00:55:25,270 --> 00:55:23,280
non-equilibrium

1502
00:55:26,549 --> 00:55:25,280
density on the other hand you could say

1503
00:55:28,950 --> 00:55:26,559
well no i'm

1504
00:55:30,390 --> 00:55:28,960
more interested in systems um that are

1505
00:55:33,670 --> 00:55:30,400
hot and fast

1506
00:55:35,430 --> 00:55:33,680
really fast like so quantum fast

1507
00:55:37,589 --> 00:55:35,440
where the solenoidal pit can be ignored

1508
00:55:39,910 --> 00:55:37,599
i'm just going to focus in on the

1509
00:55:42,150 --> 00:55:39,920
on the random fluctuations or the the

1510
00:55:44,309 --> 00:55:42,160
impact of those on the density dynamics

1511
00:55:45,670 --> 00:55:44,319
and then you can ignore the solenoidal

1512
00:55:47,589 --> 00:55:45,680
flow we return

1513
00:55:49,349 --> 00:55:47,599

to systems that detail balance and we

1514
00:55:52,549 --> 00:55:49,359
can um

1515
00:55:55,829 --> 00:55:52,559
um write down certain you know all

1516
00:55:57,750 --> 00:55:55,839
all our favorite thermodynamic laws um

1517
00:55:59,750 --> 00:55:57,760
you know and derive all the integral

1518
00:56:00,950 --> 00:55:59,760
fluctuation theorems that underwrite

1519
00:56:04,309 --> 00:56:00,960
generalizations

1520
00:56:06,710 --> 00:56:04,319
of those laws so you know from that

1521
00:56:08,309 --> 00:56:06,720
perspective classical mechanics where

1522
00:56:10,150 --> 00:56:08,319
general relativity might live for

1523
00:56:12,390 --> 00:56:10,160
example um

1524
00:56:13,910 --> 00:56:12,400
lives at one end of the spectrum very

1525
00:56:16,470 --> 00:56:13,920
large cold

1526
00:56:17,750 --> 00:56:16,480
no random fluctuations and then quantum

1527
00:56:20,549 --> 00:56:17,760
mechanics lives

1528
00:56:20,950 --> 00:56:20,559
um at the other end where it's dominated

1529
00:56:22,950 --> 00:56:20,960
by

1530
00:56:24,630 --> 00:56:22,960
random fluctuations very fast gradient

1531
00:56:27,510 --> 00:56:24,640
flows and in the middle

1532
00:56:28,069 --> 00:56:27,520
is where we live where we've got both

1533
00:56:33,109 --> 00:56:28,079
the

1534
00:56:36,470 --> 00:56:33,119
disorbiting for eternally

1535
00:56:39,829 --> 00:56:36,480
um so uh uh we're you know um

1536
00:56:43,190 --> 00:56:39,839
orbiting um some

1537
00:56:46,789 --> 00:56:43,200
uh you know some center committed

1538
00:56:49,349 --> 00:56:46,799

to uh a periodic orbit um

1539
00:56:50,630 --> 00:56:49,359
for the rest of our lives nor do we

1540
00:56:53,589 --> 00:56:50,640
dissipate or behave

1541
00:56:55,510 --> 00:56:53,599
you know in a sort of in a quantum way

1542
00:56:57,270 --> 00:56:55,520
but we're sort of halfway between

1543
00:56:58,870 --> 00:56:57,280
um we're at that that right sort of

1544
00:57:00,630 --> 00:56:58,880
scale where

1545
00:57:02,630 --> 00:57:00,640
there's lots of solenoidal there's lots

1546
00:57:04,870 --> 00:57:02,640
of oscillations that you know

1547
00:57:06,789 --> 00:57:04,880
that we we are exposed to imposed from a

1548
00:57:08,549 --> 00:57:06,799
larger scale such as tides

1549
00:57:10,549 --> 00:57:08,559
that we generate ourselves such as

1550
00:57:12,230 --> 00:57:10,559
oscillations in our hearts and our

1551
00:57:14,950 --> 00:57:12,240
physiology and our brains

1552
00:57:17,109 --> 00:57:14,960
um but at the same time we do have to

1553
00:57:18,549 --> 00:57:17,119
contend with the random fluctuations so

1554
00:57:20,390 --> 00:57:18,559
you know we spend a lot of our time

1555
00:57:21,270 --> 00:57:20,400
doing our gradient flows gathering

1556
00:57:24,230 --> 00:57:21,280
ourselves up

1557
00:57:24,549 --> 00:57:24,240
planning homeostasis keeping ourselves

1558
00:57:37,030 --> 00:57:24,559
in

1559
00:57:39,510 --> 00:57:37,040
talked about when he said that life

1560
00:57:41,589 --> 00:57:39,520
resists entropy in some way yeah i think

1561
00:57:45,990 --> 00:57:41,599
that's absolutely right um

1562
00:57:50,309 --> 00:57:49,270
that's exactly right so you know in the

1563
00:57:53,349 --> 00:57:50,319

presence of these

1564
00:57:55,990 --> 00:57:53,359
um for

1565
00:57:57,030 --> 00:57:56,000
for at equilibrium uh for you know

1566
00:58:00,470 --> 00:57:57,040
certainly enclosed

1567
00:58:03,109 --> 00:58:00,480
systems um that don't have um

1568
00:58:04,150 --> 00:58:03,119
um sort of low entropy pullback

1569
00:58:06,950 --> 00:58:04,160
attractors

1570
00:58:08,710 --> 00:58:06,960
um then you will get the second law you

1571
00:58:10,950 --> 00:58:08,720
know in the usual way

1572
00:58:12,470 --> 00:58:10,960
where all the random fluctuations

1573
00:58:14,470 --> 00:58:12,480
eventually dissipate you and hence you

1574
00:58:17,750 --> 00:58:14,480
get dissipative systems and dissipative

1575
00:58:19,670 --> 00:58:17,760
dynamics and yet somehow we we

1576
00:58:21,430 --> 00:58:19,680
in our existence we're in existence

1577
00:58:22,230 --> 00:58:21,440
proof that that's a violation of that

1578
00:58:24,630 --> 00:58:22,240
kind of

1579
00:58:25,990 --> 00:58:24,640
behavior um and that's basically where

1580
00:58:26,470 --> 00:58:26,000
the free energy principle starts it just

1581
00:58:28,710 --> 00:58:26,480
says

1582
00:58:29,670 --> 00:58:28,720
there are things out there that have to

1583
00:58:33,670 --> 00:58:29,680
be explained

1584
00:58:35,750 --> 00:58:33,680
that seem to resist the second law so um

1585
00:58:37,030 --> 00:58:35,760
framed in terms of negative neg entropy

1586
00:58:40,630 --> 00:58:37,040
uh there's an aspiration

1587
00:58:40,870 --> 00:58:40,640
right uh you know to frame it in terms

1588
00:58:45,030 --> 00:58:40,880

of

1589
00:58:47,190 --> 00:58:45,040
dissipation

1590
00:58:49,030 --> 00:58:47,200
um by this gathering up behavior and it

1591
00:58:51,430 --> 00:58:49,040
is those gradient flows

1592
00:58:52,150 --> 00:58:51,440
that are responsible when you just write

1593
00:58:54,069 --> 00:58:52,160
down the

1594
00:58:55,430 --> 00:58:54,079
the dynamics in terms of the helmholtz

1595
00:58:57,430 --> 00:58:55,440
decomposition

1596
00:58:58,870 --> 00:58:57,440
for providing that balance between the

1597
00:59:00,910 --> 00:58:58,880
dissipative effects of

1598
00:59:03,750 --> 00:59:00,920
random fluctuations and the

1599
00:59:07,990 --> 00:59:03,760
self-organizing

1600
00:59:09,829 --> 00:59:08,000
dynamics that exactly balance those

1601
00:59:11,030 --> 00:59:09,839
those dissipative effects to give you

1602
00:59:15,990 --> 00:59:11,040
this

1603
00:59:17,510 --> 00:59:16,000
professor when i was first researching

1604
00:59:21,190 --> 00:59:17,520
the free energy principle

1605
00:59:24,309 --> 00:59:21,200
i kept coming up to cautions

1606
00:59:28,950 --> 00:59:26,789
intellectually formidable it is and if

1607
00:59:30,870 --> 00:59:28,960
one was to just go by the

1608
00:59:32,630 --> 00:59:30,880
just the warning signs one would think

1609
00:59:35,030 --> 00:59:32,640
that it was more

1610
00:59:36,549 --> 00:59:35,040
abstruse than particle physics or

1611
00:59:38,950 --> 00:59:36,559
general relativity

1612
00:59:40,150 --> 00:59:38,960
and i'm curious why do you think it has

1613
00:59:43,109 --> 00:59:40,160

this

1614
00:59:44,630 --> 00:59:43,119
reputation here's an example when you

1615
00:59:46,230 --> 00:59:44,640
search general relativity or particle

1616
00:59:47,990 --> 00:59:46,240
physics or quantum field theory stand or

1617
00:59:48,390 --> 00:59:48,000
the standard model or any grand unified

1618
00:59:50,470 --> 00:59:48,400
theory

1619
00:59:51,510 --> 00:59:50,480
i don't think i've ever read a single

1620
00:59:53,589 --> 00:59:51,520
sentence except

1621
00:59:55,030 --> 00:59:53,599
on quantum mechanics that says this is a

1622
00:59:56,630 --> 00:59:55,040
difficult theory to understand

1623
00:59:58,390 --> 00:59:56,640
however on the wikipedia page for the

1624
01:00:01,430 --> 00:59:58,400
free energy principle it says this is

1625
01:00:02,330 --> 01:00:01,440
notoriously difficult to understand

1626
01:00:05,430 --> 01:00:02,340
yeah um

1627
01:00:08,390 --> 01:00:06,549
so i'm just trying to think of other

1628
01:00:09,670 --> 01:00:08,400
examples that um i'm not saying that

1629
01:00:10,789 --> 01:00:09,680
it's easy to understand in the least

1630
01:00:12,789 --> 01:00:10,799
what i'm wondering is

1631
01:00:14,069 --> 01:00:12,799
why do you think it has this reputation

1632
01:00:17,190 --> 01:00:14,079
i see yes

1633
01:00:18,950 --> 01:00:17,200
um well i think it's largely because

1634
01:00:21,190 --> 01:00:18,960
somebody slipped in that wikipedia

1635
01:00:23,030 --> 01:00:21,200
that sentence in wikipedia to be quite

1636
01:00:28,150 --> 01:00:23,040
so becomes a self-fulfilling prophecy

1637
01:00:31,109 --> 01:00:28,160
absolutely and it's entertaining um it's

1638
01:00:33,030 --> 01:00:31,119

yeah and of course it it it's um i mean

1639
01:00:36,230 --> 01:00:33,040
i know it's not as hard as

1640
01:00:38,950 --> 01:00:36,240
uh quantum physics and um and

1641
01:00:40,549 --> 01:00:38,960
um thermodynamics because i used to do

1642
01:00:42,789 --> 01:00:40,559
those and i can tell you the free energy

1643
01:00:44,069 --> 01:00:42,799
principle the maths is much simpler than

1644
01:00:47,430 --> 01:00:44,079
than quantum physics or general

1645
01:00:49,430 --> 01:00:47,440
relativity um it is much simpler

1646
01:00:51,030 --> 01:00:49,440
but it is mathematical but if you're

1647
01:00:53,430 --> 01:00:51,040
you're you're in dialogue with

1648
01:00:55,349 --> 01:00:53,440
psychologists who um don't do

1649
01:00:55,990 --> 01:00:55,359
mathematics then then there can be this

1650
01:00:58,230 --> 01:00:56,000
sort of

1651
01:00:59,510 --> 01:00:58,240
inflationary ratification of the ideas

1652
01:01:01,829 --> 01:00:59,520
and then there's a mystery

1653
01:01:03,430 --> 01:01:01,839
because you you don't see the simplicity

1654
01:01:05,030 --> 01:01:03,440
that is inherent in the

1655
01:01:06,710 --> 01:01:05,040
in the mathematical formulas and the

1656
01:01:07,349 --> 01:01:06,720
functional forms that you're dealing

1657
01:01:09,349 --> 01:01:07,359
with

1658
01:01:12,069 --> 01:01:09,359
um but i i quite like that i think it's

1659
01:01:14,470 --> 01:01:12,079
quite funny really

1660
01:01:16,150 --> 01:01:14,480
keep that in the wikipedia page okay so

1661
01:01:17,750 --> 01:01:16,160
the free energy principle do you see it

1662
01:01:19,829 --> 01:01:17,760
as being a potential

1663
01:01:21,270 --> 01:01:19,839

theory of everything first of all you

1664
01:01:22,710 --> 01:01:21,280
have to decide what are the dissiderada

1665
01:01:25,510 --> 01:01:22,720
of a theory of everything

1666
01:01:27,030 --> 01:01:25,520
but the way that i one of the reasons

1667
01:01:27,589 --> 01:01:27,040
i'm interested was from seeing that

1668
01:01:29,030 --> 01:01:27,599
slide

1669
01:01:31,030 --> 01:01:29,040
about the launch van equation or the

1670
01:01:33,190 --> 01:01:31,040
kalmac or whatever that equation

1671
01:01:34,630 --> 01:01:33,200
and seeing that it when you tweak the

1672
01:01:36,069 --> 01:01:34,640
parameters you can either generate

1673
01:01:37,190 --> 01:01:36,079
newtonian mechanics or general

1674
01:01:38,710 --> 01:01:37,200
relativity at least you're saying that

1675
01:01:39,910 --> 01:01:38,720
now i haven't seen that and quantum

1676
01:01:41,670 --> 01:01:39,920
mechanics and so on

1677
01:01:43,430 --> 01:01:41,680
so then that to me means it's a more

1678
01:01:45,030 --> 01:01:43,440
fundamental principle than those which

1679
01:01:45,589 --> 01:01:45,040
makes it a candidate for a theory of

1680
01:01:47,109 --> 01:01:45,599
everything

1681
01:01:48,870 --> 01:01:47,119
but then i just heard you say well

1682
01:01:50,470 --> 01:01:48,880
there's the quantum mechanical world

1683
01:01:51,990 --> 01:01:50,480
let's say high fluctuations then there's

1684
01:01:54,230 --> 01:01:52,000
low fluctuations of general we

1685
01:01:56,150 --> 01:01:54,240
live in the middle so then is the free

1686
01:01:56,710 --> 01:01:56,160
energy principle simply a principle of

1687
01:01:58,870 --> 01:01:56,720
the middle

1688
01:02:00,470 --> 01:01:58,880

and not the one that generates all three

1689
01:02:01,829 --> 01:02:00,480
or do you see it as being a theory of

1690
01:02:05,430 --> 01:02:01,839
everything itself

1691
01:02:07,270 --> 01:02:05,440
so that's a very good question um

1692
01:02:08,549 --> 01:02:07,280
which deserves two completely different

1693
01:02:10,870 --> 01:02:08,559
um answers

1694
01:02:12,630 --> 01:02:10,880
um i i think the thing that the free

1695
01:02:16,390 --> 01:02:12,640
energy principle brings to the table

1696
01:02:20,789 --> 01:02:18,630
is only licensed by the presence of a

1697
01:02:22,950 --> 01:02:20,799
markov blanket so basically

1698
01:02:23,990 --> 01:02:22,960
um the way i look at this is it's just

1699
01:02:27,029 --> 01:02:24,000
applying

1700
01:02:29,589 --> 01:02:27,039
box standard um

1701
01:02:31,510 --> 01:02:29,599
variational calculus of the kind that

1702
01:02:34,069 --> 01:02:31,520
people have been using for centuries

1703
01:02:34,789 --> 01:02:34,079
well not centuries but so in certain

1704
01:02:37,990 --> 01:02:34,799
schools

1705
01:02:41,270 --> 01:02:38,000
at the most right um um to you know

1706
01:02:44,309 --> 01:02:41,280
to to get at um formal

1707
01:02:45,589 --> 01:02:44,319
formulations of of of um

1708
01:02:48,309 --> 01:02:45,599
classical mechanics and quantum

1709
01:02:50,390 --> 01:02:48,319
mechanics and cisco mechanics or

1710
01:02:51,990 --> 01:02:50,400
strictly speaking stochastic mechanics

1711
01:02:55,750 --> 01:02:52,000
uh thermodynamics

1712
01:02:57,990 --> 01:02:55,760
um so you know it uses exactly the same

1713
01:03:00,230 --> 01:02:58,000

maths the only thing that's special

1714
01:03:01,190 --> 01:03:00,240
about it is that it applies that math in

1715
01:03:04,230 --> 01:03:01,200
the context of

1716
01:03:05,029 --> 01:03:04,240
a marco a markov blanket or a particular

1717
01:03:07,670 --> 01:03:05,039
partition

1718
01:03:08,549 --> 01:03:07,680
into inside and outside and separated by

1719
01:03:10,150 --> 01:03:08,559
blanket states

1720
01:03:11,910 --> 01:03:10,160
that's the only thing that it brings to

1721
01:03:14,950 --> 01:03:11,920
the table and in

1722
01:03:18,150 --> 01:03:14,960
in that sense if you allow

1723
01:03:21,670 --> 01:03:18,160
me to interpret everything as

1724
01:03:23,029 --> 01:03:21,680
every space thing then thingness as

1725
01:03:25,109 --> 01:03:23,039
defined stipulatively

1726
01:03:26,309 --> 01:03:25,119
by a markov blanket that allows you to

1727
01:03:29,190 --> 01:03:26,319
demarcate

1728
01:03:30,069 --> 01:03:29,200
a thing from not thing it is certainly a

1729
01:03:32,470 --> 01:03:30,079
theory of everything

1730
01:03:33,190 --> 01:03:32,480
by definition but in a very deflationary

1731
01:03:34,870 --> 01:03:33,200
way

1732
01:03:36,710 --> 01:03:34,880
right right now when you say

1733
01:03:38,230 --> 01:03:36,720
deflationary see to me the way that you

1734
01:03:39,750 --> 01:03:38,240
use it

1735
01:03:41,349 --> 01:03:39,760
is different than how you described it

1736
01:03:43,190 --> 01:03:41,359
unless i'm misunderstanding it the way

1737
01:03:45,750 --> 01:03:43,200
that i hear you using the term is

1738
01:03:47,190 --> 01:03:45,760

like there are concepts that we have a

1739
01:03:47,910 --> 01:03:47,200
colloquial understanding is to its

1740
01:03:49,510 --> 01:03:47,920
connotations

1741
01:03:51,029 --> 01:03:49,520
but you use it in such an abstract

1742
01:03:52,870 --> 01:03:51,039
manner that it

1743
01:03:54,309 --> 01:03:52,880
coincides with the colloquial only

1744
01:03:55,910 --> 01:03:54,319
seldomly and so

1745
01:03:57,430 --> 01:03:55,920
we shouldn't take it too seriously for

1746
01:03:58,950 --> 01:03:57,440
example when someone says surprise

1747
01:04:00,710 --> 01:03:58,960
it doesn't or belief it doesn't mean

1748
01:04:01,990 --> 01:04:00,720
that that atom has a belief that's the

1749
01:04:03,829 --> 01:04:02,000
way that i understand deflation am i

1750
01:04:07,190 --> 01:04:03,839
misunderstanding deflationary no

1751
01:04:09,349 --> 01:04:07,200
well well not at all no you're certainly

1752
01:04:11,029 --> 01:04:09,359
understanding my use of the word but

1753
01:04:13,990 --> 01:04:11,039
it is quite likely that i'm using the

1754
01:04:14,309 --> 01:04:14,000
word uh i i'm abusing the word or at

1755
01:04:16,549 --> 01:04:14,319
least

1756
01:04:17,430 --> 01:04:16,559
misusing it but that's exactly what i

1757
01:04:19,990 --> 01:04:17,440
meant yes

1758
01:04:22,069 --> 01:04:20,000
yeah and so it is it's getting under the

1759
01:04:23,270 --> 01:04:22,079
hood and i'm not reifying and not

1760
01:04:26,069 --> 01:04:23,280
associating

1761
01:04:27,750 --> 01:04:26,079
all the psychological interpretations so

1762
01:04:29,109 --> 01:04:27,760
you know i i get that a lot i have to

1763
01:04:31,349 --> 01:04:29,119

suddenly pause and say

1764
01:04:33,109 --> 01:04:31,359
when i say amazing belief i of course do

1765
01:04:34,789 --> 01:04:33,119
not mean something you can talk about

1766
01:04:36,230 --> 01:04:34,799
that you have a conviction about

1767
01:04:37,829 --> 01:04:36,240
these these are just conditional

1768
01:04:40,710 --> 01:04:37,839
probability distributions

1769
01:04:41,750 --> 01:04:40,720
um so know you you always have to sort

1770
01:04:43,349 --> 01:04:41,760
of say look we're talking about

1771
01:04:45,589 --> 01:04:43,359
something much simpler here

1772
01:04:47,430 --> 01:04:45,599
than you might think um and i think that

1773
01:04:47,990 --> 01:04:47,440
may in part be an explanation as why

1774
01:04:49,670 --> 01:04:48,000
people

1775
01:04:51,430 --> 01:04:49,680
think that the free energy principle is

1776
01:04:53,349 --> 01:04:51,440
difficult to understand it's not

1777
01:04:54,789 --> 01:04:53,359
it's just they think it is because

1778
01:04:57,589 --> 01:04:54,799
they're um

1779
01:04:58,549 --> 01:04:57,599
they're reading it using um folk

1780
01:05:02,150 --> 01:04:58,559
psychological

1781
01:05:04,950 --> 01:05:02,160
or uh possibly from my point of view

1782
01:05:05,990 --> 01:05:04,960
over rarefying verifying refining the

1783
01:05:08,630 --> 01:05:06,000
mathematics

1784
01:05:10,069 --> 01:05:08,640
i see i see when i first started

1785
01:05:11,190 --> 01:05:10,079
learning free energy principle when i

1786
01:05:13,910 --> 01:05:11,200
first started learning it

1787
01:05:16,150 --> 01:05:13,920
what struck me was its connection to

1788
01:05:17,349 --> 01:05:16,160

disparate fields so biology physics

1789
01:05:18,230 --> 01:05:17,359
machine learning and so on and it

1790
01:05:20,069 --> 01:05:18,240
reminded me of

1791
01:05:21,670 --> 01:05:20,079
in mathematics there's modular forms

1792
01:05:24,309 --> 01:05:21,680
which keep coming up over and over

1793
01:05:25,829 --> 01:05:24,319
and there are problems which previously

1794
01:05:27,190 --> 01:05:25,839
were intractable that when you recast

1795
01:05:27,829 --> 01:05:27,200
them in terms of modular forms they

1796
01:05:29,910 --> 01:05:27,839
become

1797
01:05:31,349 --> 01:05:29,920
easier to solve do you mind listing some

1798
01:05:34,789 --> 01:05:31,359
of the

1799
01:05:37,670 --> 01:05:34,799
principle that

1800
01:05:38,630 --> 01:05:37,680
let's say reformulates previously

1801
01:05:42,150 --> 01:05:38,640
convoluted

1802
01:05:43,829 --> 01:05:42,160
complex problems into something more

1803
01:05:45,990 --> 01:05:43,839
simple and the different fields maybe i

1804
01:05:47,910 --> 01:05:46,000
can even when i'm editing this maybe

1805
01:05:49,829 --> 01:05:47,920
i'll even list like

1806
01:05:51,270 --> 01:05:49,839
physics and then here's how it helps

1807
01:05:52,630 --> 01:05:51,280
physics here's how it helps biology

1808
01:05:54,789 --> 01:05:52,640
here's how it helps machine learning so

1809
01:05:57,430 --> 01:05:54,799
do you mind going through a couple

1810
01:05:58,710 --> 01:05:57,440
examples you can go through this quickly

1811
01:05:59,270 --> 01:05:58,720
because i'm sure you've done this many

1812
01:06:01,750 --> 01:05:59,280
times

1813
01:06:03,270 --> 01:06:01,760

and i'm mainly interested in a list well

1814
01:06:06,549 --> 01:06:03,280
no that's a very interesting question no

1815
01:06:07,270 --> 01:06:06,559
no i haven't um so but you're absolutely

1816
01:06:09,990 --> 01:06:07,280
right so

1817
01:06:10,630 --> 01:06:10,000
you know the theory of everythingness

1818
01:06:12,710 --> 01:06:10,640
which is

1819
01:06:13,750 --> 01:06:12,720
you know i use in a rather cheaty way to

1820
01:06:15,670 --> 01:06:13,760
interpret every

1821
01:06:19,829 --> 01:06:15,680
thing and its thingness which is the

1822
01:06:22,950 --> 01:06:19,839
theory um

1823
01:06:24,950 --> 01:06:22,960
is also i think claimed by

1824
01:06:26,549 --> 01:06:24,960
this uh the free energy principle in the

1825
01:06:28,630 --> 01:06:26,559
sense you're you're

1826
01:06:31,430 --> 01:06:28,640
you're you're hinting out that it

1827
01:06:34,549 --> 01:06:31,440
provides an explanatory framework

1828
01:06:36,789 --> 01:06:34,559
although albeit deflationary for many

1829
01:06:40,069 --> 01:06:36,799
different disciplines

1830
01:06:43,670 --> 01:06:40,079
and you see that um in terms

1831
01:06:47,349 --> 01:06:43,680
of it really being the underlying maths

1832
01:06:50,470 --> 01:06:47,359
behind all kinds of explanations for

1833
01:06:54,230 --> 01:06:50,480
um behavior

1834
01:06:57,829 --> 01:06:54,240
of a purposeful or systematic sort so

1835
01:07:00,630 --> 01:06:57,839
for example you can interpret the um

1836
01:07:02,150 --> 01:07:00,640
this this quantity either cast as a

1837
01:07:03,910 --> 01:07:02,160
variation free energy

1838
01:07:05,990 --> 01:07:03,920

or the thing that it provides an

1839
01:07:06,549 --> 01:07:06,000
approximation to or abound on which is

1840
01:07:09,750 --> 01:07:06,559
the

1841
01:07:11,270 --> 01:07:09,760
attracting states

1842
01:07:13,109 --> 01:07:11,280
you can interpret that in many different

1843
01:07:15,510 --> 01:07:13,119
ways and you spin off

1844
01:07:18,069 --> 01:07:15,520
different kinds of approaches in the

1845
01:07:20,309 --> 01:07:18,079
life sciences and the physical sciences

1846
01:07:21,910 --> 01:07:20,319
that suddenly are seen as just different

1847
01:07:22,710 --> 01:07:21,920
ways of expressing the same underlying

1848
01:07:25,589 --> 01:07:22,720
mechanics

1849
01:07:26,950 --> 01:07:25,599
so a particular instance here would be

1850
01:07:30,150 --> 01:07:26,960
interpreting

1851
01:07:31,270 --> 01:07:30,160
the um the free energy as a value

1852
01:07:34,870 --> 01:07:31,280
function

1853
01:07:37,670 --> 01:07:34,880
you can write down

1854
01:07:38,230 --> 01:07:37,680
reinforcement learning uh you can write

1855
01:07:40,789 --> 01:07:38,240
down

1856
01:07:42,390 --> 01:07:40,799
expected utility theory in economics you

1857
01:07:44,870 --> 01:07:42,400
can write down

1858
01:07:46,870 --> 01:07:44,880
optimal control theory in engineering so

1859
01:07:49,430 --> 01:07:46,880
all of these things have in common

1860
01:07:50,150 --> 01:07:49,440
the notion that you want to have

1861
01:07:52,470 --> 01:07:50,160
controlled

1862
01:07:54,230 --> 01:07:52,480
dynamics that optimize some loss

1863
01:07:56,870 --> 01:07:54,240

function but if the loss function

1864
01:07:57,829 --> 01:07:56,880
is is just the negative evidence or the

1865
01:08:00,230 --> 01:07:57,839
free energy

1866
01:08:01,589 --> 01:08:00,240
you've now got an explanation as to why

1867
01:08:04,150 --> 01:08:01,599
all of these takes on

1868
01:08:06,549 --> 01:08:04,160
interesting behaviors of the kind that

1869
01:08:09,670 --> 01:08:06,559
economists and behavioral psychologists

1870
01:08:11,430 --> 01:08:09,680
and control theoreticians study have to

1871
01:08:13,270 --> 01:08:11,440
that they're looking at they're looking

1872
01:08:13,829 --> 01:08:13,280
at exactly the right kind of dynamics

1873
01:08:15,510 --> 01:08:13,839
because

1874
01:08:17,269 --> 01:08:15,520
all of these systems have to possess

1875
01:08:20,309 --> 01:08:17,279
this fundamental property

1876
01:08:22,789 --> 01:08:20,319
and then you can you're not only um

1877
01:08:24,630 --> 01:08:22,799
if you like provide a unifying framework

1878
01:08:26,229 --> 01:08:24,640
that you can now start to understand

1879
01:08:28,229 --> 01:08:26,239
yeah well where does the bellman

1880
01:08:30,550 --> 01:08:28,239
optimality principle come from

1881
01:08:31,829 --> 01:08:30,560
well you can actually cast it as a

1882
01:08:33,910 --> 01:08:31,839
limiting case

1883
01:08:35,189 --> 01:08:33,920
of a principle of station reaction

1884
01:08:35,910 --> 01:08:35,199
hamilton's principle of stationary

1885
01:08:37,910 --> 01:08:35,920
action

1886
01:08:39,510 --> 01:08:37,920
when applied to a markov blanket which

1887
01:08:41,749 --> 01:08:39,520
is just the free energy principle so

1888
01:08:43,269 --> 01:08:41,759

if you wanted me to say you know in in

1889
01:08:43,749 --> 01:08:43,279
one sentence what is the free energy

1890
01:08:45,669 --> 01:08:43,759
principle

1891
01:08:47,110 --> 01:08:45,679
it is the application of hamilton's

1892
01:08:50,309 --> 01:08:47,120
principle of stationary action

1893
01:08:51,430 --> 01:08:50,319
to a markov blanket that's interesting

1894
01:08:53,110 --> 01:08:51,440
that's interesting

1895
01:08:54,789 --> 01:08:53,120
so yeah where do you get the bellman

1896
01:08:56,870 --> 01:08:54,799
optionality principle from well

1897
01:08:58,309 --> 01:08:56,880
if you take away lots of uncertainty

1898
01:09:01,430 --> 01:08:58,319
around um you know from

1899
01:09:03,430 --> 01:09:01,440
from the probabilistic um uh treatment

1900
01:09:04,870 --> 01:09:03,440
on offer from the free energy principle

1901
01:09:06,229 --> 01:09:04,880
you end up with about an automatic

1902
01:09:07,910 --> 01:09:06,239
principle

1903
01:09:09,430 --> 01:09:07,920
so that you know that provides a

1904
01:09:11,990 --> 01:09:09,440
unifying take on

1905
01:09:13,030 --> 01:09:12,000
things like basin decision theory when

1906
01:09:15,430 --> 01:09:13,040
you put the

1907
01:09:16,070 --> 01:09:15,440
uncertainty back in again you get

1908
01:09:17,910 --> 01:09:16,080
something

1909
01:09:19,990 --> 01:09:17,920
which is now a mixture of bayesian

1910
01:09:20,789 --> 01:09:20,000
decision theory and optimal bayesian

1911
01:09:23,189 --> 01:09:20,799
design

1912
01:09:24,309 --> 01:09:23,199
sometimes known as active learning in

1913
01:09:26,709 --> 01:09:24,319

machine learning

1914
01:09:28,149 --> 01:09:26,719
so now you have a principal first

1915
01:09:30,789 --> 01:09:28,159
principle account

1916
01:09:32,309 --> 01:09:30,799
of the so-called exploration

1917
01:09:33,910 --> 01:09:32,319
exploitation trade-off

1918
01:09:35,590 --> 01:09:33,920
which just dissolves in the free energy

1919
01:09:36,789 --> 01:09:35,600
principle you know the free energy has

1920
01:09:39,990 --> 01:09:36,799
two bits to it

1921
01:09:41,829 --> 01:09:40,000
um i won't go into the details but in

1922
01:09:45,110 --> 01:09:41,839
the same way that

1923
01:09:48,149 --> 01:09:45,120
a good statistician is always trying to

1924
01:09:50,470 --> 01:09:48,159
optimize the the evidence

1925
01:09:51,749 --> 01:09:50,480
the marginal likelihood of or the

1926
01:09:53,269 --> 01:09:51,759
evidence for

1927
01:09:55,669 --> 01:09:53,279
or the variation of free energy

1928
01:09:57,110 --> 01:09:55,679
associated with their model

1929
01:09:58,709 --> 01:09:57,120
they're just trying to provide an

1930
01:10:01,430 --> 01:09:58,719
accurate account

1931
01:10:03,030 --> 01:10:01,440
of the data at hand that is as simple or

1932
01:10:04,310 --> 01:10:03,040
minimally complex as possible

1933
01:10:06,950 --> 01:10:04,320
so we come back to algorithmic

1934
01:10:08,709 --> 01:10:06,960
complexity uh under the hood here

1935
01:10:10,550 --> 01:10:08,719
so in the same way you got this these

1936
01:10:13,590 --> 01:10:10,560
dual aspects to the good

1937
01:10:14,149 --> 01:10:13,600
inference again complying with occam's

1938
01:10:17,750 --> 01:10:14,159

principle

1939
01:10:21,030 --> 01:10:17,760
maximum entropy

1940
01:10:23,510 --> 01:10:21,040
applied to belief structures or um

1941
01:10:24,870 --> 01:10:23,520
posterior beliefs amazing beliefs you

1942
01:10:28,950 --> 01:10:24,880
you you've got this sort of

1943
01:10:32,149 --> 01:10:31,430
to what is a good inference which has

1944
01:10:33,750 --> 01:10:32,159
this sort of

1945
01:10:35,510 --> 01:10:33,760
accuracy on the one hand and the

1946
01:10:37,510 --> 01:10:35,520
complexity of on the other hand

1947
01:10:38,550 --> 01:10:37,520
and when you apply this in an inactive

1948
01:10:40,550 --> 01:10:38,560
setting when you have to

1949
01:10:41,910 --> 01:10:40,560
have to make moves and decisions and

1950
01:10:44,870 --> 01:10:41,920
consider um

1951
01:10:45,990 --> 01:10:44,880
not just um you know me as a sentient

1952
01:10:48,229 --> 01:10:46,000
organ absorbing

1953
01:10:49,910 --> 01:10:48,239
sensory states but i actually also act

1954
01:10:51,590 --> 01:10:49,920
and choose where to look

1955
01:10:53,990 --> 01:10:51,600
you get this dual aspect which is

1956
01:10:55,669 --> 01:10:54,000
basically expiration exploitation

1957
01:10:57,830 --> 01:10:55,679
i want to minimize surprise or

1958
01:10:59,110 --> 01:10:57,840
prediction errors by sampling those

1959
01:11:01,110 --> 01:10:59,120
things that i predict

1960
01:11:02,870 --> 01:11:01,120
i should sample like being warm and

1961
01:11:05,430 --> 01:11:02,880
happy and befriended

1962
01:11:07,510 --> 01:11:05,440
but at the same time there's also

1963
01:11:08,310 --> 01:11:07,520

another aspect which is this epistemic

1964
01:11:11,990 --> 01:11:08,320
aspect this

1965
01:11:14,229 --> 01:11:12,000
resolving uncertainty so if surprise

1966
01:11:15,030 --> 01:11:14,239
and specifically self-information

1967
01:11:17,750 --> 01:11:15,040
surprisal

1968
01:11:19,430 --> 01:11:17,760
if expected self-information is entropy

1969
01:11:22,550 --> 01:11:19,440
then expected surprise

1970
01:11:23,990 --> 01:11:22,560
is uncertainty so in minimizing surprise

1971
01:11:26,550 --> 01:11:24,000
and a minimizing

1972
01:11:28,709 --> 01:11:26,560
prediction error in expectation on

1973
01:11:31,830 --> 01:11:28,719
average under particular decisions

1974
01:11:33,510 --> 01:11:31,840
or choices i make i'm also compelled to

1975
01:11:35,990 --> 01:11:33,520
minimize my uncertainty

1976
01:11:36,870 --> 01:11:36,000
about the world out there generating my

1977
01:11:39,189 --> 01:11:36,880
sensations

1978
01:11:40,310 --> 01:11:39,199
so there's this epistemic part that

1979
01:11:42,790 --> 01:11:40,320
comes into play

1980
01:11:44,709 --> 01:11:42,800
which you know in the same way that the

1981
01:11:47,830 --> 01:11:44,719
um the accuracy

1982
01:11:48,229 --> 01:11:47,840
and the complexity and together to give

1983
01:11:50,950 --> 01:11:48,239
you

1984
01:11:52,070 --> 01:11:50,960
the model evidence or the free energy

1985
01:11:54,550 --> 01:11:52,080
these two sort of

1986
01:11:55,510 --> 01:11:54,560
exploration exp exploitation things just

1987
01:11:58,390 --> 01:11:55,520
add together

1988
01:12:00,070 --> 01:11:58,400

to give you the expected free energy so

1989
01:12:03,669 --> 01:12:00,080
that to my mind provides a

1990
01:12:06,310 --> 01:12:03,679
you know another example of the unifying

1991
01:12:07,750 --> 01:12:06,320
aspect where you can from a first

1992
01:12:10,149 --> 01:12:07,760
principle account

1993
01:12:11,030 --> 01:12:10,159
put together two seemingly completely

1994
01:12:13,830 --> 01:12:11,040
separate

1995
01:12:14,709 --> 01:12:13,840
strands of bayesian theorizing on the

1996
01:12:16,790 --> 01:12:14,719
one hand

1997
01:12:18,390 --> 01:12:16,800
bayesian decision theory which is all

1998
01:12:18,790 --> 01:12:18,400
about making the right decisions under

1999
01:12:21,990 --> 01:12:18,800
some

2000
01:12:25,510 --> 01:12:22,000
other hand good

2001
01:12:27,270 --> 01:12:25,520
experimental design um that you know

2002
01:12:28,870 --> 01:12:27,280
could be read as a sort of preparing

2003
01:12:29,990 --> 01:12:28,880
approach to the scientific process or

2004
01:12:31,669 --> 01:12:30,000
possibly beyond

2005
01:12:34,630 --> 01:12:31,679
but they're just two sides of the same

2006
01:12:38,310 --> 01:12:34,640
coin so that's a nice unification

2007
01:12:40,470 --> 01:12:38,320
that i repeat dissolves um

2008
01:12:41,350 --> 01:12:40,480
things that i see as living in the 20th

2009
01:12:43,430 --> 01:12:41,360
century like the

2010
01:12:44,630 --> 01:12:43,440
the exploration exploitation dilemma

2011
01:12:46,310 --> 01:12:44,640
there is no dilemma

2012
01:12:49,669 --> 01:12:46,320
it's just how precise are your

2013
01:12:51,830 --> 01:12:49,679

preferences that drive that sort of um

2014
01:12:52,870 --> 01:12:51,840
that's technically what is actually a

2015
01:12:55,990 --> 01:12:52,880
risk so the

2016
01:12:57,110 --> 01:12:56,000
the complexity when you take the average

2017
01:12:59,910 --> 01:12:57,120
complexity

2018
01:13:01,669 --> 01:12:59,920
of the free energy um under some

2019
01:13:02,870 --> 01:13:01,679
expected outcomes before you've actually

2020
01:13:04,870 --> 01:13:02,880
made a move on the world

2021
01:13:06,950 --> 01:13:04,880
that becomes a chao divergence between

2022
01:13:08,790 --> 01:13:06,960
what you anticipate will happen

2023
01:13:11,510 --> 01:13:08,800
and what a priori you expect to happen

2024
01:13:15,830 --> 01:13:11,520
so that's risk in economics and in

2025
01:13:17,590 --> 01:13:15,840
um in engineering um sometimes as kl

2026
01:13:19,110 --> 01:13:17,600
what does kl stand for in the divergence

2027
01:13:22,149 --> 01:13:19,120
sorry

2028
01:13:25,270 --> 01:13:22,159
callback libra which um

2029
01:13:27,110 --> 01:13:25,280
so it's just a it's a particular well it

2030
01:13:30,070 --> 01:13:27,120
is just a relative entropy

2031
01:13:31,350 --> 01:13:30,080
it's just some a measure of um in fact

2032
01:13:34,470 --> 01:13:31,360
it's not a measure

2033
01:13:37,510 --> 01:13:34,480
i should it's uh a way of

2034
01:13:39,669 --> 01:13:37,520
quantifying the divergence between two

2035
01:13:42,070 --> 01:13:39,679
uh probability distributions or it's a

2036
01:13:44,870 --> 01:13:42,080
measure in the deflationary sense

2037
01:13:45,510 --> 01:13:44,880
well actually no no that's that's very

2038
01:13:47,270 --> 01:13:45,520

clever

2039
01:13:48,630 --> 01:13:47,280
but technically wrong now the reason i

2040
01:13:52,070 --> 01:13:48,640
caught myself was

2041
01:13:54,070 --> 01:13:52,080
um the kl divergence between a

2042
01:13:56,470 --> 01:13:54,080
and b is not the same as between b and a

2043
01:13:56,950 --> 01:13:56,480
so it's not a metric measure which is

2044
01:13:59,270 --> 01:13:56,960
why

2045
01:14:01,030 --> 01:13:59,280
technically that's correct right um so

2046
01:14:01,510 --> 01:14:01,040
everything it's not a measure but it's

2047
01:14:04,550 --> 01:14:01,520
like

2048
01:14:05,990 --> 01:14:04,560
divergence so

2049
01:14:09,030 --> 01:14:06,000
okay it's just a relative entropy this

2050
01:14:11,430 --> 01:14:09,040
is a way of of quantifying

2051
01:14:13,669 --> 01:14:11,440
how much you you know if you read a

2052
01:14:16,390 --> 01:14:13,679
bayesian belief as a state of mind

2053
01:14:16,950 --> 01:14:16,400
how much have you changed your mind and

2054
01:14:20,550 --> 01:14:16,960
the key

2055
01:14:22,550 --> 01:14:20,560
thing um at the heart of

2056
01:14:24,149 --> 01:14:22,560
if you like applications of free energy

2057
01:14:25,830 --> 01:14:24,159
principle to

2058
01:14:27,350 --> 01:14:25,840
inference and active inference and

2059
01:14:30,550 --> 01:14:27,360
bayesian decision theory

2060
01:14:32,790 --> 01:14:30,560
and the like is the the divergence

2061
01:14:34,630 --> 01:14:32,800
between your beliefs before

2062
01:14:35,910 --> 01:14:34,640
seeing some sensory evidence and

2063
01:14:37,750 --> 01:14:35,920

afterwards

2064
01:14:39,030 --> 01:14:37,760
so if you're a bayesian statistician

2065
01:14:40,870 --> 01:14:39,040
this would be the kl

2066
01:14:42,870 --> 01:14:40,880
divergence between the prior and the

2067
01:14:45,510 --> 01:14:42,880
posterior literally

2068
01:14:46,149 --> 01:14:45,520
how much you've changed your mind or

2069
01:14:49,270 --> 01:14:46,159
moved

2070
01:14:52,149 --> 01:14:49,280
your beliefs in response to assimilating

2071
01:14:53,750 --> 01:14:52,159
some new data am i supposed to

2072
01:14:55,830 --> 01:14:53,760
understand surprise as

2073
01:14:57,669 --> 01:14:55,840
equivalent to a mismatch between what

2074
01:15:01,350 --> 01:14:57,679
you predict and what actually happens

2075
01:15:04,229 --> 01:15:01,360
so error right that's an excellent

2076
01:15:05,270 --> 01:15:04,239
is it more complex than that well it's

2077
01:15:07,990 --> 01:15:05,280
um

2078
01:15:08,310 --> 01:15:08,000
if you want to get into the nitty gritty

2079
01:15:11,910 --> 01:15:08,320
so

2080
01:15:14,070 --> 01:15:11,920
surprise read as surprisal is um

2081
01:15:15,510 --> 01:15:14,080
a very simple concept concept it's just

2082
01:15:18,390 --> 01:15:15,520
a self-information it's a

2083
01:15:19,030 --> 01:15:18,400
the negative log probability of some

2084
01:15:21,990 --> 01:15:19,040
outcome

2085
01:15:23,430 --> 01:15:22,000
uh usually as a sensory state of of your

2086
01:15:26,630 --> 01:15:23,440
markov blanket

2087
01:15:30,470 --> 01:15:26,640
so if something is highly improbable or

2088
01:15:31,430 --> 01:15:30,480

if the outcome or your sensory state say

2089
01:15:33,910 --> 01:15:31,440
your physiological

2090
01:15:35,669 --> 01:15:33,920
sensed physiological state is high

2091
01:15:37,510 --> 01:15:35,679
unlikely given what you are

2092
01:15:39,590 --> 01:15:37,520
so the usual example here is a fish out

2093
01:15:42,390 --> 01:15:39,600
of out of water for example

2094
01:15:43,990 --> 01:15:42,400
that that has a lot of surprise um it

2095
01:15:46,630 --> 01:15:44,000
just means it's just a you know

2096
01:15:47,990 --> 01:15:46,640
a euphemism for for self-information

2097
01:15:51,430 --> 01:15:48,000
that scores

2098
01:15:53,510 --> 01:15:51,440
the kinds of outcomes that um

2099
01:15:55,189 --> 01:15:53,520
would be characteristic of this

2100
01:15:58,070 --> 01:15:55,199
self-organizing system

2101
01:15:59,669 --> 01:15:58,080
so it's just a way of writing down um or

2102
01:16:00,149 --> 01:15:59,679
scoring the probability of being in this

2103
01:16:02,550 --> 01:16:00,159
state

2104
01:16:03,270 --> 01:16:02,560
if you're that kind of system or um

2105
01:16:06,390 --> 01:16:03,280
technically if

2106
01:16:10,390 --> 01:16:06,400
you're um you have that

2107
01:16:12,709 --> 01:16:10,400
that that kind of pullback attractor

2108
01:16:14,550 --> 01:16:12,719
there's another kind of surprise um

2109
01:16:16,790 --> 01:16:14,560
which is the bayesian surprise

2110
01:16:18,550 --> 01:16:16,800
which um is often confused with that

2111
01:16:20,709 --> 01:16:18,560
which is i think closer

2112
01:16:22,070 --> 01:16:20,719
um to the notion that we're just talking

2113
01:16:22,709 --> 01:16:22,080

about which is the degree to which

2114
01:16:24,390 --> 01:16:22,719
something

2115
01:16:25,750 --> 01:16:24,400
causes me to change my mind the

2116
01:16:28,950 --> 01:16:25,760
information gain

2117
01:16:32,950 --> 01:16:28,960
um which is the complexity so

2118
01:16:35,030 --> 01:16:32,960
the complexity basically when you

2119
01:16:37,030 --> 01:16:35,040
um if you're looking at this as a

2120
01:16:39,350 --> 01:16:37,040
statistician you're given some data

2121
01:16:41,110 --> 01:16:39,360
and you had some prior beliefs about

2122
01:16:42,229 --> 01:16:41,120
what caused those data before you saw

2123
01:16:45,990 --> 01:16:42,239
the data

2124
01:16:47,990 --> 01:16:46,000
and then you use bayes rule to combine

2125
01:16:49,270 --> 01:16:48,000
the likelihood of those of those data

2126
01:16:50,550 --> 01:16:49,280
given your beliefs about how they're

2127
01:16:53,669 --> 01:16:50,560
caused with your prize

2128
01:16:55,750 --> 01:16:53,679
you can't be the posterior so posterior

2129
01:16:57,110 --> 01:16:55,760
after seeing the data this is now your

2130
01:16:58,310 --> 01:16:57,120
belief so you start with your prior

2131
01:17:00,310 --> 01:16:58,320
belief and then you have your

2132
01:17:01,350 --> 01:17:00,320
posterior belief and then there's a

2133
01:17:05,590 --> 01:17:01,360
movement

2134
01:17:07,669 --> 01:17:05,600
that we're talking about

2135
01:17:09,189 --> 01:17:07,679
that scores the amount you've changed

2136
01:17:13,030 --> 01:17:09,199
your mind that just

2137
01:17:15,110 --> 01:17:13,040
is the complexity it's the complexity

2138
01:17:17,669 --> 01:17:15,120

cost that you have paid

2139
01:17:19,189 --> 01:17:17,679
for providing a more accurate account or

2140
01:17:21,110 --> 01:17:19,199
an accurate account of the data

2141
01:17:22,950 --> 01:17:21,120
that you've explained that has moved

2142
01:17:26,229 --> 01:17:22,960
your beliefs from priors

2143
01:17:29,430 --> 01:17:26,239
to to posteriors so it is the

2144
01:17:32,870 --> 01:17:29,440
the cost of

2145
01:17:35,830 --> 01:17:32,880
changing beliefs in order

2146
01:17:36,870 --> 01:17:35,840
to do belief updating on bayesian belief

2147
01:17:37,990 --> 01:17:36,880
updating

2148
01:17:39,430 --> 01:17:38,000
i'm going on about that because it's

2149
01:17:40,310 --> 01:17:39,440
really quite interesting though because

2150
01:17:42,470 --> 01:17:40,320
you know

2151
01:17:43,669 --> 01:17:42,480
via things like landauer's principle and

2152
01:17:46,709 --> 01:17:43,679
the

2153
01:17:49,830 --> 01:17:46,719
equality that degree of movement

2154
01:17:50,709 --> 01:17:49,840
costs thermodynamic energy so that tells

2155
01:17:53,990 --> 01:17:50,719
you

2156
01:17:57,510 --> 01:17:54,000
that a good artifact a good person

2157
01:18:01,350 --> 01:17:59,590
from the point of view of existential

2158
01:18:03,910 --> 01:18:01,360
goodness as scored by

2159
01:18:06,390 --> 01:18:03,920
minimizing free energy or maximizing

2160
01:18:08,790 --> 01:18:06,400
marginal likelihood or moral evidence

2161
01:18:10,070 --> 01:18:08,800
is the kind of personal computer or

2162
01:18:11,830 --> 01:18:10,080
artifact

2163
01:18:13,270 --> 01:18:11,840

that when confronted with some new

2164
01:18:14,950 --> 01:18:13,280
information

2165
01:18:16,630 --> 01:18:14,960
will actually process and assimilate

2166
01:18:17,990 --> 01:18:16,640
that in a really thermodynamically

2167
01:18:20,149 --> 01:18:18,000
efficient way

2168
01:18:21,910 --> 01:18:20,159
so they'll do it with a very cool brain

2169
01:18:22,790 --> 01:18:21,920
they won't use very much electricity or

2170
01:18:24,709 --> 01:18:22,800
food

2171
01:18:26,310 --> 01:18:24,719
and very little will change and what

2172
01:18:28,149 --> 01:18:26,320
that basically means is

2173
01:18:30,070 --> 01:18:28,159
their prior beliefs were already quite

2174
01:18:32,149 --> 01:18:30,080
close to the posterior beliefs

2175
01:18:33,510 --> 01:18:32,159
so they already had a good idea of

2176
01:18:34,950 --> 01:18:33,520
what's going on so they were not

2177
01:18:40,229 --> 01:18:34,960
surprised

2178
01:18:41,590 --> 01:18:40,239
trying to minimize that complexity cost

2179
01:18:44,070 --> 01:18:41,600
in in terms of

2180
01:18:46,390 --> 01:18:44,080
the price you have to pay for providing

2181
01:18:49,510 --> 01:18:46,400
an accurate account of some data

2182
01:18:52,790 --> 01:18:49,520
um your

2183
01:18:54,390 --> 01:18:52,800
you are you you are also maximizing the

2184
01:18:56,229 --> 01:18:54,400
efficiency of

2185
01:18:57,510 --> 01:18:56,239
of your belief updating so i think

2186
01:18:59,270 --> 01:18:57,520
that's quite a nice thing because what

2187
01:19:02,070 --> 01:18:59,280
it says if you're going to build

2188
01:19:03,110 --> 01:19:02,080

good artifacts good artificial general

2189
01:19:05,669 --> 01:19:03,120
intelligence

2190
01:19:06,870 --> 01:19:05,679
what you're looking for is a really

2191
01:19:09,669 --> 01:19:06,880
small

2192
01:19:10,630 --> 01:19:09,679
thing that can be powered with a battery

2193
01:19:11,910 --> 01:19:10,640
that's the one

2194
01:19:13,510 --> 01:19:11,920
that's the kind of thing that will do

2195
01:19:14,790 --> 01:19:13,520
the best kind of belief updating that's

2196
01:19:17,030 --> 01:19:14,800
very tailor-made

2197
01:19:18,390 --> 01:19:17,040
for the inference problem uh inference

2198
01:19:21,110 --> 01:19:18,400
problem at hand

2199
01:19:22,790 --> 01:19:21,120
sorry so we wandered away from your

2200
01:19:23,350 --> 01:19:22,800
question about what surprises but the

2201
01:19:25,990 --> 01:19:23,360
other

2202
01:19:27,910 --> 01:19:26,000
surprise is just basically the impromptu

2203
01:19:30,149 --> 01:19:27,920
implausibility of this happening to me

2204
01:19:31,510 --> 01:19:30,159
basically

2205
01:19:33,189 --> 01:19:31,520
when you were talking about what makes a

2206
01:19:34,709 --> 01:19:33,199
good computer or a good person

2207
01:19:36,390 --> 01:19:34,719
and you're using good in a different

2208
01:19:36,950 --> 01:19:36,400
manner i assume you're using it in terms

2209
01:19:39,750 --> 01:19:36,960
of

2210
01:19:41,030 --> 01:19:39,760
adaptive or or effective or accurate or

2211
01:19:42,870 --> 01:19:41,040
at least

2212
01:19:44,310 --> 01:19:42,880
not using too much energy to accomplish

2213
01:19:47,430 --> 01:19:44,320

its tasks

2214
01:19:49,270 --> 01:19:47,440
that to me sounds like almost a

2215
01:19:50,709 --> 01:19:49,280
restatement of occam's razor that you

2216
01:19:51,590 --> 01:19:50,719
want the minimal assumptions to account

2217
01:19:53,750 --> 01:19:51,600
for the most data

2218
01:19:54,630 --> 01:19:53,760
is that similar no oh no it's exactly

2219
01:19:56,229 --> 01:19:54,640
the same thing so

2220
01:19:57,990 --> 01:19:56,239
that's excellent yeah no that that's

2221
01:20:00,709 --> 01:19:58,000
things exactly so

2222
01:20:02,070 --> 01:20:00,719
you know the the the pressure to provide

2223
01:20:05,590 --> 01:20:02,080
a simple account

2224
01:20:05,910 --> 01:20:05,600
of the uh of the data is exactly getting

2225
01:20:07,910 --> 01:20:05,920
this

2226
01:20:09,030 --> 01:20:07,920
um paying the least complexity costs

2227
01:20:11,910 --> 01:20:09,040
possible for the ac

2228
01:20:12,310 --> 01:20:11,920
for the accurate or the fitting and um

2229
01:20:18,870 --> 01:20:12,320
and

2230
01:20:20,229 --> 01:20:18,880
that's probably more important than the

2231
01:20:22,950 --> 01:20:20,239
accurate fitting

2232
01:20:23,510 --> 01:20:22,960
then you will end up with machine

2233
01:20:26,470 --> 01:20:23,520
learning

2234
01:20:27,510 --> 01:20:26,480
artifacts and devices and schemes that

2235
01:20:32,629 --> 01:20:27,520
over fit

2236
01:20:36,870 --> 01:20:32,639
minimize the complexity

2237
01:20:39,030 --> 01:20:36,880
of um the uh the explanation at hand or

2238
01:20:39,990 --> 01:20:39,040

you know that effectively their

2239
01:20:43,430 --> 01:20:40,000
inference

2240
01:20:46,390 --> 01:20:43,440
um then you will get um a

2241
01:20:47,270 --> 01:20:46,400
an inference and learning that does not

2242
01:20:49,590 --> 01:20:47,280
generalize

2243
01:20:50,870 --> 01:20:49,600
so inevitably if you allow for

2244
01:20:53,189 --> 01:20:50,880
overfitting

2245
01:20:54,709 --> 01:20:53,199
then you overfit today's data and

2246
01:20:56,229 --> 01:20:54,719
tomorrow's data

2247
01:20:58,229 --> 01:20:56,239
are very difficult to explain because

2248
01:21:00,390 --> 01:20:58,239
you've over explained today's data

2249
01:21:03,110 --> 01:21:00,400
so just practically what this manifests

2250
01:21:05,830 --> 01:21:03,120
as is a problem of sharp minima

2251
01:21:06,470 --> 01:21:05,840
and difficult to solve optimization

2252
01:21:09,590 --> 01:21:06,480
problems

2253
01:21:12,830 --> 01:21:09,600
in machine learning you get stuck

2254
01:21:15,990 --> 01:21:12,840
in local minima that have a very very

2255
01:21:18,149 --> 01:21:16,000
difficult yeah and and that's because

2256
01:21:19,590 --> 01:21:18,159
you you haven't you haven't flattened

2257
01:21:22,390 --> 01:21:19,600
the minima

2258
01:21:23,030 --> 01:21:22,400
by building into your objective function

2259
01:21:28,470 --> 01:21:23,040
this

2260
01:21:29,830 --> 01:21:28,480
complexity suppressing aspect and of

2261
01:21:32,470 --> 01:21:29,840
course once you

2262
01:21:33,590 --> 01:21:32,480
have an objective function um which

2263
01:21:36,790 --> 01:21:33,600

actually

2264
01:21:39,669 --> 01:21:36,800
entails that complexity minimizing

2265
01:21:41,189 --> 01:21:39,679
um imperative then the minima by

2266
01:21:43,430 --> 01:21:41,199
definition

2267
01:21:44,390 --> 01:21:43,440
the free energy minima are always

2268
01:21:46,310 --> 01:21:44,400
shallow

2269
01:21:48,470 --> 01:21:46,320
so that you've got a lot of latitude to

2270
01:21:50,229 --> 01:21:48,480
wander around your minima so you're not

2271
01:21:53,030 --> 01:21:50,239
committing to a particular sharp

2272
01:21:53,430 --> 01:21:53,040
explanation of over explaining the data

2273
01:21:54,870 --> 01:21:53,440
so

2274
01:21:57,110 --> 01:21:54,880
it's a really practically really

2275
01:21:58,870 --> 01:21:57,120
important you know observation though

2276
01:22:00,950 --> 01:21:58,880
i should say that when i talk about good

2277
01:22:02,470 --> 01:22:00,960
i just mean minimizing free energy or

2278
01:22:05,590 --> 01:22:02,480
maximizing evidence

2279
01:22:07,590 --> 01:22:05,600
so that's the only good for me

2280
01:22:09,590 --> 01:22:07,600
which is you know fit for purpose in

2281
01:22:11,510 --> 01:22:09,600
this world having a good model of this

2282
01:22:13,030 --> 01:22:11,520
of this particular world let me see if i

2283
01:22:15,189 --> 01:22:13,040
can explain

2284
01:22:16,709 --> 01:22:15,199
what i heard in another manner let's say

2285
01:22:19,030 --> 01:22:16,719
you're playing roulette what you want to

2286
01:22:21,030 --> 01:22:19,040
do is

2287
01:22:23,350 --> 01:22:21,040
you want to have a minimization of your

2288
01:22:26,070 --> 01:22:23,360

mismatch of prediction versus

2289
01:22:28,229 --> 01:22:26,080
actuality but let's say you have a good

2290
01:22:31,189 --> 01:22:28,239
reason to believe that 33 black

2291
01:22:32,149 --> 01:22:31,199
is going to be hit you don't put all

2292
01:22:33,669 --> 01:22:32,159
your eggs

2293
01:22:35,189 --> 01:22:33,679
in that one basket because you could be

2294
01:22:36,870 --> 01:22:35,199
wrong so you need to have some spread

2295
01:22:38,229 --> 01:22:36,880
it's not a direct delta function it's

2296
01:22:41,669 --> 01:22:38,239
not just that

2297
01:22:42,709 --> 01:22:41,679
and then that spread is equivalent to

2298
01:22:43,910 --> 01:22:42,719
entropy

2299
01:22:45,990 --> 01:22:43,920
is that correct because there's a

2300
01:22:47,350 --> 01:22:46,000
trade-off between you wanting to be

2301
01:22:49,189 --> 01:22:47,360
completely accurate but then leaving

2302
01:22:51,270 --> 01:22:49,199
one's options open yep no

2303
01:22:53,430 --> 01:22:51,280
that's absolutely right so that that

2304
01:22:55,270 --> 01:22:53,440
well you you use that wonderful phrase

2305
01:22:56,550 --> 01:22:55,280
leaving one's option open having that

2306
01:22:59,270 --> 01:22:56,560
latitude in pla

2307
01:22:59,910 --> 01:22:59,280
in in play is a very important aspect of

2308
01:23:03,430 --> 01:22:59,920
this

2309
01:23:06,310 --> 01:23:03,440
um expected complexity minimizing

2310
01:23:08,149 --> 01:23:06,320
imperative that you get from um you know

2311
01:23:11,830 --> 01:23:08,159
sort of uh trying to minimize

2312
01:23:13,990 --> 01:23:11,840
um the expected free energy for expected

2313
01:23:16,629 --> 01:23:14,000

following a particular choice or action

2314
01:23:17,350 --> 01:23:16,639
so um just in that particular instance

2315
01:23:21,030 --> 01:23:17,360
um

2316
01:23:24,950 --> 01:23:21,040
you know the if you would

2317
01:23:28,229 --> 01:23:24,960
if you were um acting according to um

2318
01:23:28,709 --> 01:23:28,239
uh expected utility maximization and you

2319
01:23:32,629 --> 01:23:28,719
thought

2320
01:23:34,709 --> 01:23:32,639
that the um the black 33 was

2321
01:23:37,110 --> 01:23:34,719
was the most likely outcome then you put

2322
01:23:39,669 --> 01:23:37,120
all your money as a delta function

2323
01:23:41,270 --> 01:23:39,679
on that outcome that's not what kl

2324
01:23:42,790 --> 01:23:41,280
control does that's not what with

2325
01:23:44,470 --> 01:23:42,800
sensitive control

2326
01:23:45,910 --> 01:23:44,480
it's not what the sort of the

2327
01:23:48,870 --> 01:23:45,920
exploitative part

2328
01:23:50,550 --> 01:23:48,880
of minimizing expected free energy does

2329
01:23:54,070 --> 01:23:50,560
it tries to match

2330
01:23:55,590 --> 01:23:54,080
your um anticipated outcomes with your

2331
01:23:57,189 --> 01:23:55,600
with your prior beliefs that

2332
01:23:58,470 --> 01:23:57,199
incorporates exactly that kind of

2333
01:24:02,149 --> 01:23:58,480
uncertainty

2334
01:24:04,950 --> 01:24:02,159
um and indeed there may be situations

2335
01:24:06,550 --> 01:24:04,960
where your behavior at the roulette

2336
01:24:09,189 --> 01:24:06,560
table

2337
01:24:11,990 --> 01:24:09,199
is doesn't look as if it's just about

2338
01:24:13,990 --> 01:24:12,000

trying to maximize the amount of money

2339
01:24:15,669 --> 01:24:14,000
that you will get following the bet you

2340
01:24:17,669 --> 01:24:15,679
may be

2341
01:24:19,189 --> 01:24:17,679
sometimes compelled to engage in

2342
01:24:20,390 --> 01:24:19,199
epistemic behaviors that resolve

2343
01:24:23,030 --> 01:24:20,400
uncertainty

2344
01:24:23,510 --> 01:24:23,040
so say that you had the hypothesis that

2345
01:24:29,430 --> 01:24:23,520
the

2346
01:24:31,590 --> 01:24:29,440
and it was rigged in a way that depended

2347
01:24:33,510 --> 01:24:31,600
upon the way that people placed bets

2348
01:24:35,030 --> 01:24:33,520
then you might actually place a bet just

2349
01:24:37,030 --> 01:24:35,040
to see what would happen

2350
01:24:38,790 --> 01:24:37,040
in terms of the you know what the person

2351
01:24:41,510 --> 01:24:38,800
who's in charge of speeding the wheel

2352
01:24:41,990 --> 01:24:41,520
does so you know not every move is just

2353
01:24:44,629 --> 01:24:42,000
about

2354
01:24:46,310 --> 01:24:44,639
minimizing um some or realizing some

2355
01:24:47,590 --> 01:24:46,320
prior preferences or minimizing some

2356
01:24:50,149 --> 01:24:47,600
loss function

2357
01:24:50,709 --> 01:24:50,159
a lot of a lot of our moves are actually

2358
01:24:53,910 --> 01:24:50,719
to

2359
01:24:56,709 --> 01:24:53,920
resolve uncertainty and disclose

2360
01:24:58,310 --> 01:24:56,719
things that we don't know uh resolve our

2361
01:24:59,270 --> 01:24:58,320
uncertainty about the other

2362
01:25:01,270 --> 01:24:59,280
contingencies

2363
01:25:03,270 --> 01:25:01,280

under which we're operating so then you

2364
01:25:06,310 --> 01:25:03,280
can get into all sorts of interesting

2365
01:25:09,590 --> 01:25:06,320
um paradoxes in terms of deceit

2366
01:25:10,550 --> 01:25:09,600
and regret and making moves just to

2367
01:25:13,030 --> 01:25:10,560
reveal

2368
01:25:14,950 --> 01:25:13,040
what's going on out there and

2369
01:25:17,350 --> 01:25:14,960
particularly in transactions with

2370
01:25:19,110 --> 01:25:17,360
with with other people so that's another

2371
01:25:21,110 --> 01:25:19,120
you know just beyond the kl the

2372
01:25:22,550 --> 01:25:21,120
engineers perspective on kl control the

2373
01:25:25,030 --> 01:25:22,560
matching behavior

2374
01:25:26,550 --> 01:25:25,040
which is in psychology that's your you

2375
01:25:27,910 --> 01:25:26,560
try to match the probability

2376
01:25:31,510 --> 01:25:27,920
distributions

2377
01:25:34,229 --> 01:25:31,520
are from which you sample your choices

2378
01:25:35,030 --> 01:25:34,239
to the underlying payoff structure at

2379
01:25:37,510 --> 01:25:35,040
hand

2380
01:25:38,709 --> 01:25:37,520
um so that you know that would be one

2381
01:25:41,669 --> 01:25:38,719
way of looking at

2382
01:25:42,310 --> 01:25:41,679
the utility of a kl controller risk

2383
01:25:44,709 --> 01:25:42,320
sensitive

2384
01:25:45,590 --> 01:25:44,719
uh kind of control but beyond that

2385
01:25:48,229 --> 01:25:45,600
there's also

2386
01:25:49,990 --> 01:25:48,239
explicit sort of uncertainty resolving

2387
01:25:53,430 --> 01:25:50,000
moves you can make

2388
01:25:55,750 --> 01:25:53,440

such as checking which is a fair fair

2389
01:25:57,189 --> 01:25:55,760
gambling house and a non-fair one on

2390
01:25:59,910 --> 01:25:57,199
google before you actually

2391
01:26:02,709 --> 01:25:59,920
start you know commit to going to gamble

2392
01:26:05,189 --> 01:26:02,719
in this house as opposed to that house

2393
01:26:07,990 --> 01:26:05,199
yeah speaking of gambling have you heard

2394
01:26:10,709 --> 01:26:08,000
of newcomb's paradox

2395
01:26:12,149 --> 01:26:10,719
oh okay well look it up at some point

2396
01:26:15,510 --> 01:26:12,159
i'll say it here but

2397
01:26:18,390 --> 01:26:15,520
the paradox is imagine you go to

2398
01:26:20,149 --> 01:26:18,400
a circus tent and then someone says here

2399
01:26:21,189 --> 01:26:20,159
is a box it's clear and it has a

2400
01:26:23,750 --> 01:26:21,199
thousand dollars in it

2401
01:26:24,390 --> 01:26:23,760
that's box a then box b is sealed can't

2402
01:26:27,669 --> 01:26:24,400
see it

2403
01:26:28,950 --> 01:26:27,679
but the fortune teller inside there says

2404
01:26:31,270 --> 01:26:28,960
i think it's you can choose either the

2405
01:26:32,470 --> 01:26:31,280
sealed box or both boxes those are your

2406
01:26:34,790 --> 01:26:32,480
only choices

2407
01:26:37,990 --> 01:26:34,800
now what's in the sealed box is one

2408
01:26:41,350 --> 01:26:40,070
ah i'm messing it up you'll just have to

2409
01:26:43,830 --> 01:26:41,360
look it up it's something

2410
01:26:45,750 --> 01:26:43,840
please let me spasmodically verbally

2411
01:26:46,790 --> 01:26:45,760
vomit here for a second as i try and get

2412
01:26:48,470 --> 01:26:46,800
it correct because it's

2413
01:26:50,310 --> 01:26:48,480

actually it's an interesting paradox and

2414
01:26:51,590 --> 01:26:50,320
i wanted to know what your theory had to

2415
01:26:52,709 --> 01:26:51,600
say about and obviously you can't answer

2416
01:26:54,950 --> 01:26:52,719
that in real time because

2417
01:26:55,830 --> 01:26:54,960
you might have to think about it but

2418
01:26:57,350 --> 01:26:55,840
it's something like okay you have a

2419
01:26:59,030 --> 01:26:57,360
sealed box you have a million dollars

2420
01:27:01,189 --> 01:26:59,040
a million dollars may be in it or it's

2421
01:27:03,189 --> 01:27:01,199
not i'm trying to work through what the

2422
01:27:05,189 --> 01:27:03,199
actual paradox is the fortune teller

2423
01:27:07,590 --> 01:27:05,199
says i have predicted

2424
01:27:08,709 --> 01:27:07,600
i'm 100 correct maybe there's a sensor

2425
01:27:09,590 --> 01:27:08,719
you can say there's a sensor that

2426
01:27:11,830 --> 01:27:09,600
analyzed your brain

2427
01:27:14,070 --> 01:27:11,840
and it knows what you're going to do and

2428
01:27:19,750 --> 01:27:14,080
she either put one million dollars in it

2429
01:27:22,390 --> 01:27:19,760
or didn't depending on if you

2430
01:27:22,870 --> 01:27:22,400
depending on if you choose ah right she

2431
01:27:24,950 --> 01:27:22,880
says

2432
01:27:28,310 --> 01:27:24,960
if you're going to choose this single

2433
01:27:30,070 --> 01:27:28,320
box just the box alone the sealed box

2434
01:27:31,669 --> 01:27:30,080
then i've included a million dollars in

2435
01:27:32,550 --> 01:27:31,679
it i've already predicted which one

2436
01:27:33,350 --> 01:27:32,560
you're going to do by the way but i'm

2437
01:27:35,030 --> 01:27:33,360
just letting you know

2438
01:27:36,550 --> 01:27:35,040

if you just picked the sealed box you

2439
01:27:37,430 --> 01:27:36,560
get a million dollars i put a million

2440
01:27:39,110 --> 01:27:37,440
dollars in it

2441
01:27:40,950 --> 01:27:39,120
if you choose both boxes because you're

2442
01:27:41,990 --> 01:27:40,960
greedy i put nothing inside the sealed

2443
01:27:43,830 --> 01:27:42,000
box

2444
01:27:45,430 --> 01:27:43,840
so then the question is what do you do

2445
01:27:46,550 --> 01:27:45,440
now you have to make many assumptions

2446
01:27:47,910 --> 01:27:46,560
you have to assume she's telling the

2447
01:27:48,550 --> 01:27:47,920
truth when she says that she's able to

2448
01:27:51,110 --> 01:27:48,560
predict you

2449
01:27:51,830 --> 01:27:51,120
with 100 accuracy but even if it's 99

2450
01:27:53,590 --> 01:27:51,840
accuracy

2451
01:27:54,870 --> 01:27:53,600
the paradox still holds the question is

2452
01:27:57,510 --> 01:27:54,880
well what do you do

2453
01:27:58,709 --> 01:27:57,520
you may say okay now that i'm there she

2454
01:28:00,790 --> 01:27:58,719
made that decision beforehand the

2455
01:28:01,189 --> 01:28:00,800
million dollars is either there or not i

2456
01:28:03,189 --> 01:28:01,199
might

2457
01:28:04,550 --> 01:28:03,199
may as well take both boxes so that's

2458
01:28:05,990 --> 01:28:04,560
one

2459
01:28:07,990 --> 01:28:06,000
way of reasoning through this problem

2460
01:28:11,350 --> 01:28:08,000
but another one is to think okay

2461
01:28:13,990 --> 01:28:11,360
all the people that just selected the

2462
01:28:14,950 --> 01:28:14,000
sealed box get one million because

2463
01:28:17,510 --> 01:28:14,960

that's the way that

2464
01:28:19,270 --> 01:28:17,520
she said it's worked she said also that

2465
01:28:21,270 --> 01:28:19,280
hey i've done this millions of times and

2466
01:28:22,629 --> 01:28:21,280
i've always predicted correctly

2467
01:28:24,470 --> 01:28:22,639
so then what do you do do you risk

2468
01:28:25,430 --> 01:28:24,480
taking both boxes or do you just take

2469
01:28:30,229 --> 01:28:25,440
one

2470
01:28:32,229 --> 01:28:30,239
and it's it shows a difference in

2471
01:28:34,149 --> 01:28:32,239
i forget what it's called either causal

2472
01:28:36,149 --> 01:28:34,159
decision theory and

2473
01:28:37,430 --> 01:28:36,159
there's another type of decision theory

2474
01:28:39,750 --> 01:28:37,440
one where you maximize

2475
01:28:41,510 --> 01:28:39,760
evidential based decision theory so

2476
01:28:43,189 --> 01:28:41,520
usually those two

2477
01:28:44,950 --> 01:28:43,199
imply the same solution but here they

2478
01:28:46,709 --> 01:28:44,960
don't

2479
01:28:47,990 --> 01:28:46,719
anyway i wanted to know what the free

2480
01:28:49,189 --> 01:28:48,000
energy principle says

2481
01:28:51,350 --> 01:28:49,199
one should do because it's a famous

2482
01:28:53,430 --> 01:28:51,360
paradox

2483
01:28:55,270 --> 01:28:53,440
let's forget about that then we're gonna

2484
01:28:57,510 --> 01:28:55,280
have to go and google that one

2485
01:28:58,470 --> 01:28:57,520
it sounds even more complicated than the

2486
01:29:02,550 --> 01:28:58,480
monty hall

2487
01:29:04,550 --> 01:29:02,560
uh um paradox problem um

2488
01:29:05,669 --> 01:29:04,560

so i know it sounds intriguing so you

2489
01:29:08,790 --> 01:29:05,679
you yeah

2490
01:29:11,750 --> 01:29:08,800
and so the paradox is is basically

2491
01:29:13,430 --> 01:29:11,760
um the paradox that is confronted by you

2492
01:29:15,590 --> 01:29:13,440
in the situation as opposed to a

2493
01:29:16,709 --> 01:29:15,600
paradoxical behavior that people

2494
01:29:18,149 --> 01:29:16,719
actually right right you want to

2495
01:29:19,910 --> 01:29:18,159
maximize the amount of money

2496
01:29:21,350 --> 01:29:19,920
so let's assume you're instrumentally

2497
01:29:21,750 --> 01:29:21,360
rational that is you want to maximize

2498
01:29:25,030 --> 01:29:21,760
your

2499
01:29:26,229 --> 01:29:25,040
do okay so forget about that something i

2500
01:29:27,990 --> 01:29:26,239
was wondering about the free energy

2501
01:29:30,310 --> 01:29:28,000
principle is how much of it do you

2502
01:29:31,270 --> 01:29:30,320
see as a principle like a law like a law

2503
01:29:34,629 --> 01:29:31,280
of physics

2504
01:29:36,870 --> 01:29:34,639
versus a compression mechanism so for

2505
01:29:39,590 --> 01:29:36,880
example what i mean by that is when you

2506
01:29:40,310 --> 01:29:39,600
look at maxwell's original paper for his

2507
01:29:42,950 --> 01:29:40,320
four

2508
01:29:44,950 --> 01:29:42,960
laws there are actually 26 different

2509
01:29:45,669 --> 01:29:44,960
equations or 24. it's two pages long

2510
01:29:47,830 --> 01:29:45,679
because he didn't

2511
01:29:49,189 --> 01:29:47,840
compress it down to the four that we now

2512
01:29:50,830 --> 01:29:49,199
use so these four

2513
01:29:52,870 --> 01:29:50,840

aren't actually four equations they're

2514
01:29:55,669 --> 01:29:52,880
just code

2515
01:29:55,990 --> 01:29:55,679
and then i i always wondered how much of

2516
01:29:58,870 --> 01:29:56,000
our

2517
01:29:59,990 --> 01:29:58,880
lagrangians are sorry the minimization

2518
01:30:02,390 --> 01:30:00,000
of action is an actual

2519
01:30:03,910 --> 01:30:02,400
principle of nature versus this

2520
01:30:05,830 --> 01:30:03,920
compression mechanism that says here are

2521
01:30:06,790 --> 01:30:05,840
your complicated equations of motion

2522
01:30:08,950 --> 01:30:06,800
what you can do

2523
01:30:10,790 --> 01:30:08,960
is you can package it into this

2524
01:30:11,270 --> 01:30:10,800
simplified little lagrangian that you

2525
01:30:12,950 --> 01:30:11,280
then

2526
01:30:14,390 --> 01:30:12,960
put into the euler lagrange equations

2527
01:30:15,430 --> 01:30:14,400
and you crank out the equations of

2528
01:30:18,870 --> 01:30:15,440
motions

2529
01:30:22,070 --> 01:30:20,470
a principle in and of itself it's more

2530
01:30:22,950 --> 01:30:22,080
like a zipping of something that's

2531
01:30:25,910 --> 01:30:22,960
convoluted

2532
01:30:26,709 --> 01:30:25,920
so do you see the free energy principle

2533
01:30:32,629 --> 01:30:26,719
as

2534
01:30:35,350 --> 01:30:32,639
made an analogy about with lagrangian

2535
01:30:36,870 --> 01:30:35,360
mechanics and the lagrangian

2536
01:30:38,390 --> 01:30:36,880
that is it's just compressing it could

2537
01:30:41,830 --> 01:30:38,400
just be compressing yeah

2538
01:30:44,950 --> 01:30:41,840

um i think that um

2539
01:30:47,350 --> 01:30:44,960
i see it as a law um but i think that

2540
01:30:49,189 --> 01:30:47,360
distinction is is

2541
01:30:50,870 --> 01:30:49,199
very nicely articulated and i think it's

2542
01:30:53,990 --> 01:30:50,880
really in play in my world

2543
01:30:54,870 --> 01:30:54,000
in a slightly different way so um i

2544
01:30:58,149 --> 01:30:54,880
repeat the

2545
01:31:00,629 --> 01:30:58,159
the free energy principle is just

2546
01:31:01,510 --> 01:31:00,639
um a variational principle of stationary

2547
01:31:04,870 --> 01:31:01,520
action

2548
01:31:08,070 --> 01:31:04,880
um cast in terms of density dynamics

2549
01:31:11,350 --> 01:31:08,080
of things that have markov blankets

2550
01:31:14,629 --> 01:31:11,360
and by implication at steady state so

2551
01:31:16,070 --> 01:31:14,639
it is as it plays a role um

2552
01:31:17,669 --> 01:31:16,080
exactly the same role as hamilton's

2553
01:31:19,910 --> 01:31:17,679
principles of um

2554
01:31:21,830 --> 01:31:19,920
stationary or at least action so it

2555
01:31:22,149 --> 01:31:21,840
either applies or it doesn't so it's not

2556
01:31:30,070 --> 01:31:22,159
a

2557
01:31:32,870 --> 01:31:30,080
useful you know it's just

2558
01:31:34,310 --> 01:31:32,880
a way of writing down and zipping things

2559
01:31:37,590 --> 01:31:34,320
up as you nicely put it

2560
01:31:39,510 --> 01:31:37,600
um in an internally coherent way that

2561
01:31:42,229 --> 01:31:39,520
speaks to sort of you know as all

2562
01:31:44,550 --> 01:31:42,239
i think these useful principles do some

2563
01:31:47,110 --> 01:31:44,560

symmetry or some invariance property

2564
01:31:48,950 --> 01:31:47,120
uh for me um the variational principles

2565
01:31:50,790 --> 01:31:48,960
of station reaction are the are the

2566
01:31:53,030 --> 01:31:50,800
simplest and most graceful way of

2567
01:31:54,629 --> 01:31:53,040
expressing these symmetries uh you can

2568
01:31:56,790 --> 01:31:54,639
do it with gage theories or

2569
01:31:58,550 --> 01:31:56,800
um i'm sure there are other formulations

2570
01:32:01,110 --> 01:31:58,560
but for me um

2571
01:32:01,910 --> 01:32:01,120
you know the the best way is just to to

2572
01:32:05,030 --> 01:32:01,920
use that

2573
01:32:06,229 --> 01:32:05,040
principle at least of of least action or

2574
01:32:08,070 --> 01:32:06,239
stationary action

2575
01:32:09,910 --> 01:32:08,080
um so that's what the free energy

2576
01:32:13,030 --> 01:32:09,920
principle does but as you say

2577
01:32:13,750 --> 01:32:13,040
um you know for the free energy

2578
01:32:16,070 --> 01:32:13,760
principle

2579
01:32:17,750 --> 01:32:16,080
um what does that actually mean in

2580
01:32:20,790 --> 01:32:17,760
practice well it means that um

2581
01:32:24,830 --> 01:32:20,800
anything that exists can be understood

2582
01:32:28,790 --> 01:32:24,840
um and simulated um or built

2583
01:32:30,390 --> 01:32:28,800
um as a gradient flow on a free energy

2584
01:32:32,790 --> 01:32:30,400
function a function of what

2585
01:32:33,430 --> 01:32:32,800
well the free energy is a function of

2586
01:32:37,350 --> 01:32:33,440
the

2587
01:32:40,629 --> 01:32:37,360
blanket

2588
01:32:43,669 --> 01:32:40,639

and the um

2589
01:32:44,229 --> 01:32:43,679
bayesian beliefs about the posterior

2590
01:32:47,430 --> 01:32:44,239
beliefs

2591
01:32:49,830 --> 01:32:47,440
about the causes of those data that are

2592
01:32:52,950 --> 01:32:49,840
encoded by the internal states

2593
01:32:55,189 --> 01:32:52,960
so um where does that um

2594
01:32:56,149 --> 01:32:55,199
where does the where do those beliefs

2595
01:32:58,229 --> 01:32:56,159
come from

2596
01:33:00,149 --> 01:32:58,239
um well they're defined or the free

2597
01:33:01,430 --> 01:33:00,159
energy is defined

2598
01:33:03,669 --> 01:33:01,440
uh if you think of this sort of

2599
01:33:06,390 --> 01:33:03,679
prediction error version or

2600
01:33:07,990 --> 01:33:06,400
um reading of free energy they are

2601
01:33:09,590 --> 01:33:08,000
defined by a genetic model

2602
01:33:12,229 --> 01:33:09,600
that predicts the sensations that you

2603
01:33:14,229 --> 01:33:12,239
would get if that model was right

2604
01:33:16,629 --> 01:33:14,239
so you have to have a genetic model so

2605
01:33:18,310 --> 01:33:16,639
you know there is going to be a universe

2606
01:33:22,070 --> 01:33:18,320
of genetic models you could plug

2607
01:33:23,750 --> 01:33:22,080
into the uh underlying um

2608
01:33:25,830 --> 01:33:23,760
uh gradient flows the helmholtz

2609
01:33:28,470 --> 01:33:25,840
decomposition that we talked about that

2610
01:33:29,669 --> 01:33:28,480
um that basically describes all dynamics

2611
01:33:32,629 --> 01:33:29,679
you know

2612
01:33:33,990 --> 01:33:32,639
uh for systems that can be cast valve

2613
01:33:35,990 --> 01:33:34,000

with markov blankets

2614
01:33:37,510 --> 01:33:36,000
um so the question is not so much now

2615
01:33:39,030 --> 01:33:37,520
the free energy principle or the

2616
01:33:40,149 --> 01:33:39,040
application of a variation principle at

2617
01:33:42,870 --> 01:33:40,159
least action

2618
01:33:44,709 --> 01:33:42,880
but really what is the generative model

2619
01:33:46,229 --> 01:33:44,719
so at this point i think then you move

2620
01:33:48,310 --> 01:33:46,239
away from the principle

2621
01:33:50,470 --> 01:33:48,320
and you start now to get into the world

2622
01:33:53,030 --> 01:33:50,480
of process theories and

2623
01:33:54,070 --> 01:33:53,040
hypotheses so and you can ask that

2624
01:33:55,350 --> 01:33:54,080
question or you can have those

2625
01:33:55,990 --> 01:33:55,360
hypotheses at a number of different

2626
01:33:58,550 --> 01:33:56,000
levels

2627
01:34:00,629 --> 01:33:58,560
you can actually take a working system a

2628
01:34:03,030 --> 01:34:00,639
person say if you're a psychiatrist

2629
01:34:04,870 --> 01:34:03,040
you know somebody who might have

2630
01:34:06,310 --> 01:34:04,880
obsession compulsive disorder

2631
01:34:07,990 --> 01:34:06,320
and you may say well i want to

2632
01:34:11,189 --> 01:34:08,000
understand them now

2633
01:34:13,590 --> 01:34:11,199
as making decisions under some model

2634
01:34:14,310 --> 01:34:13,600
of their lived world some genetic model

2635
01:34:17,910 --> 01:34:14,320
i know

2636
01:34:18,950 --> 01:34:17,920
the principles that underwrite their

2637
01:34:20,310 --> 01:34:18,960
choices

2638
01:34:21,669 --> 01:34:20,320

but what i don't know is their journey

2639
01:34:23,910 --> 01:34:21,679
to modern their private leads so i'm

2640
01:34:25,910 --> 01:34:23,920
going to now reverse engineer

2641
01:34:27,110 --> 01:34:25,920
on the basis of their behavior what are

2642
01:34:28,790 --> 01:34:27,120
their prior beliefs

2643
01:34:30,149 --> 01:34:28,800
what what do they actually believe is

2644
01:34:32,470 --> 01:34:30,159
going on to ex

2645
01:34:33,750 --> 01:34:32,480
best explain this behavior so that would

2646
01:34:35,910 --> 01:34:33,760
be one application

2647
01:34:37,430 --> 01:34:35,920
another application might be uh building

2648
01:34:38,229 --> 01:34:37,440
artificial intelligence machine

2649
01:34:42,149 --> 01:34:38,239
artifacts

2650
01:34:45,669 --> 01:34:42,159
you know where i now write down

2651
01:34:47,189 --> 01:34:45,679
the um the prior preferences

2652
01:34:49,189 --> 01:34:47,199
of a generative model the kinds of

2653
01:34:52,390 --> 01:34:49,199
states that i want this system

2654
01:34:53,270 --> 01:34:52,400
uh to aspire to and i then just let it

2655
01:34:56,310 --> 01:34:53,280
you know i just

2656
01:34:57,350 --> 01:34:56,320
um equip it with active states and

2657
01:34:59,830 --> 01:34:57,360
actuators

2658
01:35:00,790 --> 01:34:59,840
and sensory states and sensors and make

2659
01:35:03,910 --> 01:35:00,800
a little robot

2660
01:35:07,430 --> 01:35:03,920
and off it will go and it will go and

2661
01:35:08,550 --> 01:35:07,440
epistemically forage always with a mind

2662
01:35:11,109 --> 01:35:08,560
to

2663
01:35:12,950 --> 01:35:11,119

learning about its world but also under

2664
01:35:14,709 --> 01:35:12,960
the constraint of its prior preferences

2665
01:35:16,390 --> 01:35:14,719
like keeping its battery charged

2666
01:35:18,229 --> 01:35:16,400
so that would be another instance but in

2667
01:35:21,430 --> 01:35:18,239
both applications

2668
01:35:23,510 --> 01:35:21,440
i've had to either reverse engineer

2669
01:35:25,750 --> 01:35:23,520
or commit to a particular generative

2670
01:35:28,149 --> 01:35:25,760
model and that's where i think the

2671
01:35:29,189 --> 01:35:28,159
you know you moved a long way away from

2672
01:35:32,070 --> 01:35:29,199
principles

2673
01:35:33,430 --> 01:35:32,080
and if it's a question about does this

2674
01:35:34,149 --> 01:35:33,440
person with obsessional compulsive

2675
01:35:35,750 --> 01:35:34,159
disorder

2676
01:35:37,510 --> 01:35:35,760
have this kind of genetic model of that

2677
01:35:39,189 --> 01:35:37,520
kind of narrative model

2678
01:35:42,070 --> 01:35:39,199
and that's now a hypothesis naturally

2679
01:35:44,870 --> 01:35:42,080
falsified with respect to the evidence

2680
01:35:45,830 --> 01:35:44,880
um if it's a question of building an

2681
01:35:49,189 --> 01:35:45,840
artifact

2682
01:35:51,030 --> 01:35:49,199
do i use a discrete state space um

2683
01:35:52,470 --> 01:35:51,040
generative model or a continuous one

2684
01:35:54,470 --> 01:35:52,480
which means i'm now committing to

2685
01:35:56,790 --> 01:35:54,480
different kinds of message passing

2686
01:35:58,550 --> 01:35:56,800
um is discrete it could be a variational

2687
01:36:01,109 --> 01:35:58,560
message passing or belief propagation

2688
01:36:02,709 --> 01:36:01,119

if it's continuous i'll be using things

2689
01:36:05,189 --> 01:36:02,719
like um

2690
01:36:05,990 --> 01:36:05,199
linear quadratic control or kalman busy

2691
01:36:10,310 --> 01:36:06,000
filters

2692
01:36:12,310 --> 01:36:10,320
um so again you're you're you're now um

2693
01:36:13,510 --> 01:36:12,320
in the mechanics of the processes that

2694
01:36:16,070 --> 01:36:13,520
are that are

2695
01:36:18,390 --> 01:36:16,080
realizing these gradient flows and of

2696
01:36:20,070 --> 01:36:18,400
course there are no principles or rules

2697
01:36:22,229 --> 01:36:20,080
that tell you you're right or wrong

2698
01:36:22,629 --> 01:36:22,239
these are all um process theories that

2699
01:36:24,629 --> 01:36:22,639
you know

2700
01:36:25,830 --> 01:36:24,639
that might work and that might not work

2701
01:36:27,750 --> 01:36:25,840
so you know

2702
01:36:29,510 --> 01:36:27,760
i think the zipping that you talked

2703
01:36:30,229 --> 01:36:29,520
about is from my point of view it's

2704
01:36:33,669 --> 01:36:30,239
basically

2705
01:36:37,270 --> 01:36:33,679
um uh unzipping the principle

2706
01:36:40,070 --> 01:36:37,280
to to to realize that under the hood

2707
01:36:41,510 --> 01:36:40,080
it is the generative model that supplies

2708
01:36:44,310 --> 01:36:41,520
the free energy gradients

2709
01:36:44,709 --> 01:36:44,320
that drive the gradient flows that's the

2710
01:36:46,470 --> 01:36:44,719
big

2711
01:36:47,750 --> 01:36:46,480
open question and getting the generator

2712
01:36:49,990 --> 01:36:47,760
model right

2713
01:36:51,109 --> 01:36:50,000

is in most instances scientifically or

2714
01:36:53,910 --> 01:36:51,119
indeed in industry

2715
01:36:55,350 --> 01:36:53,920
and possibly even in medical

2716
01:36:57,590 --> 01:36:55,360
translational practice

2717
01:36:58,390 --> 01:36:57,600
translation of these ideas in medical

2718
01:37:00,950 --> 01:36:58,400
practice

2719
01:37:03,270 --> 01:37:00,960
it's all about getting the right kind of

2720
01:37:05,109 --> 01:37:03,280
genetic model and your hypotheses

2721
01:37:06,790 --> 01:37:05,119
about that general about that genitive

2722
01:37:08,310 --> 01:37:06,800
model

2723
01:37:10,470 --> 01:37:08,320
you said a couple of statements that

2724
01:37:11,910 --> 01:37:10,480
reminded me of jordan peterson

2725
01:37:13,510 --> 01:37:11,920
now i'm not sure how much you follow

2726
01:37:15,030 --> 01:37:13,520
jordan peterson at all but he's a

2727
01:37:16,629 --> 01:37:15,040
proponent of

2728
01:37:18,629 --> 01:37:16,639
watching what someone does to infer

2729
01:37:19,669 --> 01:37:18,639
their beliefs so that is

2730
01:37:20,629 --> 01:37:19,679
okay well you're not good so you

2731
01:37:21,669 --> 01:37:20,639
understand what that means and then

2732
01:37:23,669 --> 01:37:21,679
number two

2733
01:37:25,030 --> 01:37:23,679
he also mentions order and chaos and the

2734
01:37:26,870 --> 01:37:25,040
balance between them which is

2735
01:37:28,950 --> 01:37:26,880
taoist that you don't want the

2736
01:37:31,830 --> 01:37:28,960
elimination of one or the predominance

2737
01:37:34,070 --> 01:37:31,840
of another you want a special balance

2738
01:37:35,910 --> 01:37:34,080

between them which reminds me of what

2739
01:37:39,189 --> 01:37:35,920
you said about surprise and then

2740
01:37:41,030 --> 01:37:39,199
i believe it's kale divergence right

2741
01:37:42,870 --> 01:37:41,040
okay you don't want one to dominate

2742
01:37:45,510 --> 01:37:42,880
there's a delicate balance have you

2743
01:37:47,270 --> 01:37:45,520
heard jordan peterson speak on order and

2744
01:37:48,229 --> 01:37:47,280
chaos and do you see any correspondence

2745
01:37:50,790 --> 01:37:48,239
between

2746
01:37:51,510 --> 01:37:50,800
the free energy principle and what he

2747
01:37:55,189 --> 01:37:51,520
says about

2748
01:37:58,310 --> 01:37:55,199
chaos and order yes i i think so um

2749
01:38:00,470 --> 01:37:58,320
i mean i would um

2750
01:38:02,550 --> 01:38:00,480
i would put this i mean there are a

2751
01:38:04,070 --> 01:38:02,560
number of different routes one could

2752
01:38:07,750 --> 01:38:04,080
take to that kind of issue

2753
01:38:11,270 --> 01:38:07,760
um you could ask yourself um

2754
01:38:13,270 --> 01:38:11,280
is there any um first principal account

2755
01:38:14,390 --> 01:38:13,280
for example of self-organized

2756
01:38:16,870 --> 01:38:14,400
criticality

2757
01:38:17,510 --> 01:38:16,880
um so you do you remember the edge of

2758
01:38:20,709 --> 01:38:17,520
chaos

2759
01:38:23,590 --> 01:38:20,719
notions from um from the

2760
01:38:25,030 --> 01:38:23,600
stu kaufman and self-organized

2761
01:38:26,709 --> 01:38:25,040
criticality that was the

2762
01:38:28,070 --> 01:38:26,719
the self i was trying to remember before

2763
01:38:31,910 --> 01:38:28,080

but that's another

2764
01:38:35,270 --> 01:38:31,920
one of these branches of um of physics

2765
01:38:37,030 --> 01:38:35,280
um which starts off with self so soc

2766
01:38:40,390 --> 01:38:37,040
self-organized criticality

2767
01:38:43,669 --> 01:38:40,400
so this is a notion um that

2768
01:38:45,750 --> 01:38:43,679
it is um inevitably the case that any

2769
01:38:49,270 --> 01:38:45,760
self-organizing system will organize

2770
01:38:53,270 --> 01:38:49,280
itself to a regime of critical slowing

2771
01:38:55,750 --> 01:38:53,280
um and dynamical instability

2772
01:38:57,669 --> 01:38:55,760
which you know stuart kaufman might

2773
01:38:59,590 --> 01:38:57,679
might have articulated in terms of

2774
01:39:01,109 --> 01:38:59,600
systems moving themselves towards the

2775
01:39:04,390 --> 01:39:01,119
edge of chaos so

2776
01:39:06,310 --> 01:39:04,400
towards um separate seas towards sort of

2777
01:39:10,470 --> 01:39:06,320
bifurcation

2778
01:39:13,750 --> 01:39:10,480
into regimes usually associated with

2779
01:39:15,270 --> 01:39:13,760
multi-stability or meta stability um um

2780
01:39:17,030 --> 01:39:15,280
you know depending on the nature of the

2781
01:39:21,669 --> 01:39:17,040
dynamical system but this

2782
01:39:24,830 --> 01:39:21,679
tendency to um to

2783
01:39:28,070 --> 01:39:24,840
do to put yourself

2784
01:39:31,189 --> 01:39:28,080
um in a state where

2785
01:39:34,390 --> 01:39:31,199
you have a repertoire of

2786
01:39:38,709 --> 01:39:34,400
dynamics available to you simply because

2787
01:39:41,510 --> 01:39:38,719
you are near disorder you're near chaos

2788
01:39:42,149 --> 01:39:41,520

so but you never actually go chaotic but

2789
01:39:45,750 --> 01:39:42,159
you just

2790
01:39:49,109 --> 01:39:45,760
increase the latitude of of of um

2791
01:39:52,070 --> 01:39:49,119
or the repertoire um of of things

2792
01:39:53,590 --> 01:39:52,080
you know um of dynamics that you you

2793
01:39:56,790 --> 01:39:53,600
that might happen to you

2794
01:39:58,629 --> 01:39:56,800
and that from that perspective um

2795
01:40:00,070 --> 01:39:58,639
then there are sort of there are i think

2796
01:40:02,390 --> 01:40:00,080
a number of interesting

2797
01:40:03,510 --> 01:40:02,400
um things that the free energy

2798
01:40:06,070 --> 01:40:03,520
formulation

2799
01:40:07,590 --> 01:40:06,080
um brings to the table the first we've

2800
01:40:09,030 --> 01:40:07,600
actually already touched on which was

2801
01:40:12,149 --> 01:40:09,040
this

2802
01:40:15,590 --> 01:40:12,159
building in to an optimization

2803
01:40:18,709 --> 01:40:15,600
perspective shallow minima to

2804
01:40:21,990 --> 01:40:18,719
preclude the existence of sharp minima

2805
01:40:24,390 --> 01:40:22,000
and just by having effectively

2806
01:40:25,510 --> 01:40:24,400
occam's principle baked into your

2807
01:40:28,790 --> 01:40:25,520
understanding

2808
01:40:30,270 --> 01:40:28,800
of uh um life

2809
01:40:32,550 --> 01:40:30,280
uh or indeed any kind of

2810
01:40:36,709 --> 01:40:32,560
self-organization um

2811
01:40:39,910 --> 01:40:36,719
as you know um trying to

2812
01:40:42,790 --> 01:40:39,920
optimize this bound on evidence um

2813
01:40:44,790 --> 01:40:42,800

or marginal likelihood then you're

2814
01:40:45,830 --> 01:40:44,800
necessarily saying that you want to have

2815
01:40:48,550 --> 01:40:45,840
these

2816
01:40:50,229 --> 01:40:48,560
low curvature minima you want to occupy

2817
01:40:53,270 --> 01:40:50,239
low curvature minima

2818
01:40:55,030 --> 01:40:53,280
that if you if you now ask what would

2819
01:40:57,590 --> 01:40:55,040
that look like in terms of

2820
01:40:59,669 --> 01:40:57,600
um you know coupling between internal

2821
01:41:03,430 --> 01:40:59,679
and external states in the context

2822
01:41:06,550 --> 01:41:03,440
that the the gradient flows are informed

2823
01:41:08,550 --> 01:41:06,560
when when out free energy minima um

2824
01:41:10,310 --> 01:41:08,560
by very shallow gradients what do you

2825
01:41:13,430 --> 01:41:10,320
get well you get exactly the sort of

2826
01:41:15,750 --> 01:41:13,440
um this latitude um

2827
01:41:17,030 --> 01:41:15,760
for excursions which have a long

2828
01:41:19,910 --> 01:41:17,040
correlation length

2829
01:41:21,430 --> 01:41:19,920
so you get this you know the kind of

2830
01:41:23,270 --> 01:41:21,440
critical slowing

2831
01:41:24,790 --> 01:41:23,280
that is associated with self-organized

2832
01:41:26,709 --> 01:41:24,800
criticality so

2833
01:41:28,390 --> 01:41:26,719
often so heavy-tailed distributions in

2834
01:41:36,070 --> 01:41:28,400
terms of um

2835
01:41:38,629 --> 01:41:36,080
sort of covariance functions for example

2836
01:41:40,070 --> 01:41:38,639
so that i think there's a simple and

2837
01:41:43,430 --> 01:41:40,080
mathematically

2838
01:41:46,709 --> 01:41:43,440

and deflationary account of

2839
01:41:49,750 --> 01:41:46,719
um the balance between

2840
01:41:52,870 --> 01:41:49,760
order and um

2841
01:41:57,030 --> 01:41:52,880
chaos at least from a purely dynamical

2842
01:42:00,229 --> 01:41:57,040
perspective that is on offer

2843
01:42:02,310 --> 01:42:00,239
via the um the minimization of free

2844
01:42:05,189 --> 01:42:02,320
energy with gradient flows

2845
01:42:06,070 --> 01:42:05,199
simply because you are dealing with

2846
01:42:08,790 --> 01:42:06,080
minima

2847
01:42:09,830 --> 01:42:08,800
that don't trap you they allow for that

2848
01:42:11,990 --> 01:42:09,840
latitude

2849
01:42:14,149 --> 01:42:12,000
so that you avoid i see i see a

2850
01:42:16,229 --> 01:42:14,159
particular solution

2851
01:42:18,149 --> 01:42:16,239
how sharp would be too much order

2852
01:42:19,830 --> 01:42:18,159
absolutely yeah so you just get locked

2853
01:42:20,550 --> 01:42:19,840
in you get you literally get stuck in a

2854
01:42:22,550 --> 01:42:20,560
rut you get

2855
01:42:25,030 --> 01:42:22,560
locked into this particular explanation

2856
01:42:25,990 --> 01:42:25,040
and any slight movement away from a very

2857
01:42:29,109 --> 01:42:26,000
sharp

2858
01:42:30,790 --> 01:42:29,119
minima incurs an enormous penalty um

2859
01:42:33,669 --> 01:42:30,800
right and you just don't make that move

2860
01:42:35,189 --> 01:42:33,679
but if you've got a very shallow basin

2861
01:42:37,510 --> 01:42:35,199
of attraction if you like

2862
01:42:38,629 --> 01:42:37,520
um and i repeat i think the beautiful

2863
01:42:40,709 --> 01:42:38,639

thing about the sort of

2864
01:42:42,229 --> 01:42:40,719
the free energy functionals or this free

2865
01:42:46,070 --> 01:42:42,239
energy functional

2866
01:42:47,910 --> 01:42:46,080
is that it's built to be shallow

2867
01:42:49,750 --> 01:42:47,920
perhaps an analogy would help here that

2868
01:42:53,590 --> 01:42:49,760
but um

2869
01:42:57,350 --> 01:42:53,600
if you think of a free energy landscape

2870
01:43:00,470 --> 01:42:57,360
that is parroted by

2871
01:43:02,149 --> 01:43:00,480
a mountain landscape right from the high

2872
01:43:03,990 --> 01:43:02,159
the mountains mountains and the scottish

2873
01:43:06,310 --> 01:43:04,000
highlands right down to the estuaries

2874
01:43:07,189 --> 01:43:06,320
at sea level then what you typically

2875
01:43:10,950 --> 01:43:07,199
tend to get

2876
01:43:12,229 --> 01:43:10,960
is that very high um terrains of any

2877
01:43:15,270 --> 01:43:12,239
landscape

2878
01:43:18,790 --> 01:43:15,280
have lots of high frequency ravines

2879
01:43:21,189 --> 01:43:18,800
and sharp valleys and sharp minima

2880
01:43:22,149 --> 01:43:21,199
so that a little stream at the top of a

2881
01:43:25,350 --> 01:43:22,159
mountain

2882
01:43:26,870 --> 01:43:25,360
will be um will be cut carving its way

2883
01:43:29,990 --> 01:43:26,880
through very sharp

2884
01:43:31,910 --> 01:43:30,000
um trajectories um

2885
01:43:33,590 --> 01:43:31,920
and then meeting slower and slower and

2886
01:43:35,030 --> 01:43:33,600
wider and wider streams as it comes down

2887
01:43:37,189 --> 01:43:35,040
as it comes down the mountain

2888
01:43:39,109 --> 01:43:37,199

but also what happens is that as you

2889
01:43:41,510 --> 01:43:39,119
come down towards sea level

2890
01:43:42,709 --> 01:43:41,520
as you get to lower lower free energy

2891
01:43:45,430 --> 01:43:42,719
levels

2892
01:43:46,550 --> 01:43:45,440
the terrain itself becomes smoother so

2893
01:43:49,109 --> 01:43:46,560
all the minima

2894
01:43:50,149 --> 01:43:49,119
now have smaller curvature so that you

2895
01:43:53,109 --> 01:43:50,159
don't get those

2896
01:43:53,990 --> 01:43:53,119
sharp little landscape features uh that

2897
01:43:55,830 --> 01:43:54,000
you saw

2898
01:43:58,070 --> 01:43:55,840
high in the free energy or high in the

2899
01:43:58,470 --> 01:43:58,080
mountains anymore what you get a now

2900
01:44:02,629 --> 01:43:58,480
much

2901
01:44:05,350 --> 01:44:02,639
everything because it's a lower

2902
01:44:06,629 --> 01:44:05,360
altitude or a lower free energy has to

2903
01:44:08,310 --> 01:44:06,639
be smoother it has to have a

2904
01:44:10,629 --> 01:44:08,320
you know by occam's principle it has to

2905
01:44:13,430 --> 01:44:10,639
be it has to have less of a curvature

2906
01:44:14,229 --> 01:44:13,440
and what that affords is the latitude

2907
01:44:17,430 --> 01:44:14,239
for

2908
01:44:19,350 --> 01:44:17,440
the river now to start meandering around

2909
01:44:20,629 --> 01:44:19,360
like you know you know sometimes

2910
01:44:23,270 --> 01:44:20,639
following oxbow

2911
01:44:25,270 --> 01:44:23,280
uh legs and features that you that this

2912
01:44:28,390 --> 01:44:25,280
kind of meandering that you see

2913
01:44:30,470 --> 01:44:28,400

as a large river starts to um

2914
01:44:32,149 --> 01:44:30,480
wander and oscillate as as it gets

2915
01:44:32,629 --> 01:44:32,159
towards the estuary and gets towards the

2916
01:44:35,590 --> 01:44:32,639
sea

2917
01:44:37,270 --> 01:44:35,600
and it's that sort of wandering around

2918
01:44:38,790 --> 01:44:37,280
which is that if you like the sort of

2919
01:44:41,910 --> 01:44:38,800
the um

2920
01:44:43,109 --> 01:44:41,920
the permissive or the reflection of what

2921
01:44:46,390 --> 01:44:43,119
can happen

2922
01:44:48,390 --> 01:44:46,400
um with a low curvature um free energy

2923
01:44:51,270 --> 01:44:48,400
functional or objective function

2924
01:44:52,629 --> 01:44:51,280
which is in itself in the sense that if

2925
01:44:53,590 --> 01:44:52,639
the system is trying to minimize its

2926
01:44:56,149 --> 01:44:53,600
free energy and get

2927
01:44:57,669 --> 01:44:56,159
to those estuaries so it can do its once

2928
01:44:59,990 --> 01:44:57,679
slow wandering around

2929
01:45:02,310 --> 01:45:00,000
you get this critical slowing that you

2930
01:45:05,590 --> 01:45:02,320
see dynamically that characterizes

2931
01:45:08,709 --> 01:45:05,600
your all kinds of interesting um

2932
01:45:09,270 --> 01:45:08,719
uh behaviors from sort of um avalanches

2933
01:45:12,550 --> 01:45:09,280
in

2934
01:45:13,830 --> 01:45:12,560
to the markets

2935
01:45:16,149 --> 01:45:13,840
in the old days this might have been

2936
01:45:18,070 --> 01:45:16,159
known as catastrophe theory um

2937
01:45:19,830 --> 01:45:18,080
but you know it's the same notion that

2938
01:45:21,270 --> 01:45:19,840

when we're close to the edge of

2939
01:45:22,870 --> 01:45:21,280
instability

2940
01:45:24,629 --> 01:45:22,880
which means we have the latitude to

2941
01:45:27,910 --> 01:45:24,639
explore different

2942
01:45:29,910 --> 01:45:27,920
states on some objective function

2943
01:45:31,669 --> 01:45:29,920
um that we wouldn't have if we were

2944
01:45:32,870 --> 01:45:31,679
stuck in a rut and committed to a

2945
01:45:34,870 --> 01:45:32,880
particular solution

2946
01:45:37,510 --> 01:45:34,880
and we've overfit the data for example

2947
01:45:39,350 --> 01:45:37,520
or we've got trapped in a local minima

2948
01:45:40,870 --> 01:45:39,360
so that's that's one that's one thing

2949
01:45:42,950 --> 01:45:40,880
that there is another

2950
01:45:44,310 --> 01:45:42,960
aspect though which um we haven't

2951
01:45:46,790 --> 01:45:44,320
touched upon which

2952
01:45:47,910 --> 01:45:46,800
in um i think nicely follows on from

2953
01:45:49,590 --> 01:45:47,920
this notion of the

2954
01:45:52,070 --> 01:45:49,600
you know getting the generative model

2955
01:45:53,830 --> 01:45:52,080
right so if you remember the

2956
01:45:55,750 --> 01:45:53,840
free energy functional or the model

2957
01:45:57,430 --> 01:45:55,760
evidence needs a model

2958
01:45:59,270 --> 01:45:57,440
in order to have so the model can have

2959
01:46:01,590 --> 01:45:59,280
the evidence

2960
01:46:02,709 --> 01:46:01,600
and of course you know most of the time

2961
01:46:06,390 --> 01:46:02,719
you're dealing with

2962
01:46:08,550 --> 01:46:06,400
models that have unknown states such as

2963
01:46:10,870 --> 01:46:08,560

models that underwrite things like

2964
01:46:13,350 --> 01:46:10,880
kalman filters

2965
01:46:16,070 --> 01:46:13,360
unknown parameters such as the generated

2966
01:46:19,189 --> 01:46:16,080
models that might do weather forecasting

2967
01:46:21,189 --> 01:46:19,199
um but there's another level which is

2968
01:46:21,750 --> 01:46:21,199
the very structure of the model itself

2969
01:46:24,790 --> 01:46:21,760
so

2970
01:46:28,229 --> 01:46:24,800
you know even um

2971
01:46:28,629 --> 01:46:28,239
even if i knew all the states um the

2972
01:46:31,109 --> 01:46:28,639
time

2973
01:46:32,229 --> 01:46:31,119
varying unknowns generated by a

2974
01:46:34,550 --> 01:46:32,239
particular model

2975
01:46:35,270 --> 01:46:34,560
and even if i knew exactly all the

2976
01:46:37,109 --> 01:46:35,280
particular

2977
01:46:38,830 --> 01:46:37,119
connections strengths and rate constants

2978
01:46:40,149 --> 01:46:38,840
and every all the other parameters and

2979
01:46:42,310 --> 01:46:40,159
contingencies i

2980
01:46:43,830 --> 01:46:42,320
you would need to know to uh to make

2981
01:46:46,790 --> 01:46:43,840
this model predict the perfect

2982
01:46:47,830 --> 01:46:46,800
data perfect explanation for for for

2983
01:46:51,030 --> 01:46:47,840
these

2984
01:46:52,629 --> 01:46:51,040
for this observed world

2985
01:46:54,550 --> 01:46:52,639
i may not know the structure of the

2986
01:46:55,270 --> 01:46:54,560
model so if i was doing say deep

2987
01:46:57,430 --> 01:46:55,280
learning

2988
01:46:59,030 --> 01:46:57,440

and i wanted to build um a deep

2989
01:47:00,229 --> 01:46:59,040
convolutional network how many how many

2990
01:47:03,430 --> 01:47:00,239
layers do i use

2991
01:47:05,030 --> 01:47:03,440
two four eight sixteen um

2992
01:47:07,030 --> 01:47:05,040
so these are really important

2993
01:47:08,629 --> 01:47:07,040
architectural structural problems that

2994
01:47:10,629 --> 01:47:08,639
are attributes of the model

2995
01:47:11,669 --> 01:47:10,639
but the model can always be scored given

2996
01:47:14,790 --> 01:47:11,679
some data

2997
01:47:16,149 --> 01:47:14,800
in terms of its free energy or elbow

2998
01:47:19,030 --> 01:47:16,159
evidence lower bound

2999
01:47:19,910 --> 01:47:19,040
which means there's always an answer if

3000
01:47:22,870 --> 01:47:19,920
you can

3001
01:47:23,910 --> 01:47:22,880
create a space of models to evaluate so

3002
01:47:25,669 --> 01:47:23,920
this is known as in

3003
01:47:28,629 --> 01:47:25,679
in cognitive neuroscience by people like

3004
01:47:30,790 --> 01:47:28,639
josh turner bound as structure learning

3005
01:47:32,870 --> 01:47:30,800
and it's the problem of basically

3006
01:47:33,270 --> 01:47:32,880
exploring the right structure of models

3007
01:47:34,790 --> 01:47:33,280
by

3008
01:47:36,870 --> 01:47:34,800
you're adding things in taking things

3009
01:47:39,189 --> 01:47:36,880
away collapsing things together you

3010
01:47:41,350 --> 01:47:39,199
talked about modularity before

3011
01:47:43,350 --> 01:47:41,360
that's a really important architectural

3012
01:47:45,669 --> 01:47:43,360
uh aspect of these models

3013
01:47:48,149 --> 01:47:45,679

usually cast in terms of factorization

3014
01:47:48,470 --> 01:47:48,159
uh exploiting conditional dependencies

3015
01:47:51,030 --> 01:47:48,480
to

3016
01:47:52,950 --> 01:47:51,040
get simpler models that you can have a

3017
01:47:53,669 --> 01:47:52,960
modular architecture in the generator

3018
01:47:55,830 --> 01:47:53,679
model

3019
01:47:57,750 --> 01:47:55,840
um so all of these structural the

3020
01:48:00,229 --> 01:47:57,760
hierarchical depth the degree of

3021
01:48:01,910 --> 01:48:00,239
lateral factorization or modularity the

3022
01:48:04,070 --> 01:48:01,920
number of parallel streams

3023
01:48:05,590 --> 01:48:04,080
the number of nonlinearities all of

3024
01:48:07,430 --> 01:48:05,600
these things

3025
01:48:09,750 --> 01:48:07,440
need to be optimized to get the good

3026
01:48:11,830 --> 01:48:09,760
model the free energy minimizing model

3027
01:48:13,669 --> 01:48:11,840
so how would you do that and it's at

3028
01:48:16,070 --> 01:48:13,679
this point that you come back to

3029
01:48:18,310 --> 01:48:16,080
disorder and chaos so one really

3030
01:48:19,430 --> 01:48:18,320
efficient way of exploring a space of

3031
01:48:23,109 --> 01:48:19,440
models

3032
01:48:26,390 --> 01:48:23,119
is to actually exploit the um

3033
01:48:29,590 --> 01:48:26,400
the you know the the the um

3034
01:48:31,510 --> 01:48:29,600
the chaotic dynamics that you get um

3035
01:48:33,669 --> 01:48:31,520
or certainly stochastic dynamics that

3036
01:48:36,950 --> 01:48:33,679
you that you get for example

3037
01:48:39,030 --> 01:48:36,960
um in natural um selection um

3038
01:48:41,109 --> 01:48:39,040

the you know you could you could you

3039
01:48:43,510 --> 01:48:41,119
could um

3040
01:48:45,430 --> 01:48:43,520
take arguments from uh evolutionary

3041
01:48:46,310 --> 01:48:45,440
theory and again coming back to stu

3042
01:48:48,390 --> 01:48:46,320
kaufman

3043
01:48:50,070 --> 01:48:48,400
um in terms of his formulation of

3044
01:48:52,070 --> 01:48:50,080
selection for selectability

3045
01:48:54,070 --> 01:48:52,080
i don't know have you come across this

3046
01:48:55,750 --> 01:48:54,080
second order selection

3047
01:48:58,550 --> 01:48:55,760
no actually the way that i encountered

3048
01:49:01,030 --> 01:48:58,560
stuart kaufman was reading about his

3049
01:49:02,550 --> 01:49:01,040
expansion of schrodinger's what is life

3050
01:49:03,830 --> 01:49:02,560
and then schrodinger opposed to three

3051
01:49:05,109 --> 01:49:03,840
questions that is how

3052
01:49:07,830 --> 01:49:05,119
whatever he posts three questions and

3053
01:49:09,990 --> 01:49:07,840
stuart kaufman answers the second

3054
01:49:11,430 --> 01:49:10,000
two so two and three all right i didn't

3055
01:49:13,189 --> 01:49:11,440
read much about him afterward and i'll

3056
01:49:14,390 --> 01:49:13,199
ask you about start afterwards but do

3057
01:49:15,510 --> 01:49:14,400
you what do you have to tell me what the

3058
01:49:16,070 --> 01:49:15,520
questions well that sounds very

3059
01:49:18,709 --> 01:49:16,080
interesting

3060
01:49:19,189 --> 01:49:18,719
yeah sure i i'm talking about his work

3061
01:49:23,510 --> 01:49:19,199
um

3062
01:49:25,750 --> 01:49:23,520
artificial life

3063
01:49:26,550 --> 01:49:25,760

um that speaks to this edge of chaos and

3064
01:49:30,149 --> 01:49:26,560
the

3065
01:49:32,550 --> 01:49:30,159
in any

3066
01:49:33,990 --> 01:49:32,560
evolving system that needs to explore

3067
01:49:36,950 --> 01:49:34,000
different ways of being

3068
01:49:37,910 --> 01:49:36,960
um so it's interesting because of course

3069
01:49:40,950 --> 01:49:37,920
you can now

3070
01:49:42,550 --> 01:49:40,960
um the degree of um

3071
01:49:45,669 --> 01:49:42,560
chaos that you bring to the table the

3072
01:49:48,070 --> 01:49:45,679
degree of mutation for example

3073
01:49:50,149 --> 01:49:48,080
you know um there will be an optimum

3074
01:49:51,750 --> 01:49:50,159
degree of mutation that depends upon the

3075
01:49:54,149 --> 01:49:51,760
volatility of the environment

3076
01:49:54,950 --> 01:49:54,159
and the degree at which you exploit or

3077
01:49:58,229 --> 01:49:54,960
leverage

3078
01:49:59,109 --> 01:49:58,239
chaos now becomes subject to selected

3079
01:50:02,390 --> 01:49:59,119
pressure

3080
01:50:03,430 --> 01:50:02,400
um and um just as an aside you can

3081
01:50:05,350 --> 01:50:03,440
always recast

3082
01:50:06,629 --> 01:50:05,360
selective pressure as basically a

3083
01:50:08,790 --> 01:50:06,639
pressure to minimize

3084
01:50:10,870 --> 01:50:08,800
free energy uh if you read free energy

3085
01:50:11,910 --> 01:50:10,880
as the you know the adaptive fitness of

3086
01:50:14,950 --> 01:50:11,920
any of any

3087
01:50:17,030 --> 01:50:14,960
uh phenotype in a in a

3088
01:50:19,030 --> 01:50:17,040

natural setting natural selection so

3089
01:50:22,070 --> 01:50:19,040
what he's saying is that there is

3090
01:50:24,790 --> 01:50:22,080
an optimal degree of um

3091
01:50:26,870 --> 01:50:24,800
changeability and chaotic exploration of

3092
01:50:30,709 --> 01:50:26,880
of any modern space or any wave

3093
01:50:31,990 --> 01:50:30,719
wave being um the to my mind provides a

3094
01:50:35,030 --> 01:50:32,000
very nice

3095
01:50:36,870 --> 01:50:35,040
um perspective on this tendency for

3096
01:50:39,270 --> 01:50:36,880
self-organized criticality that

3097
01:50:40,149 --> 01:50:39,280
we actually move ourselves to the edge

3098
01:50:41,750 --> 01:50:40,159
of chaos

3099
01:50:43,910 --> 01:50:41,760
just to position ourselves so we can

3100
01:50:46,149 --> 01:50:43,920
explore and make sure there are no

3101
01:50:47,669 --> 01:50:46,159
better ways of doing things so i think

3102
01:50:49,990 --> 01:50:47,679
that that that aspect of

3103
01:50:52,070 --> 01:50:50,000
your own the right mixture of order

3104
01:50:55,270 --> 01:50:52,080
versus disorder

3105
01:50:57,109 --> 01:50:55,280
order versus chaos you know comes at out

3106
01:50:58,310 --> 01:50:57,119
at the level of the structured learning

3107
01:51:00,790 --> 01:50:58,320
itself from the sort of

3108
01:51:02,310 --> 01:51:00,800
the repertoires of different alternative

3109
01:51:04,070 --> 01:51:02,320
hypotheses about

3110
01:51:06,229 --> 01:51:04,080
you know modeling our world or making

3111
01:51:08,229 --> 01:51:06,239
making decisions in that world

3112
01:51:09,750 --> 01:51:08,239
okay when we're modeling this world most

3113
01:51:10,310 --> 01:51:09,760

of the time what we do is we look at

3114
01:51:11,830 --> 01:51:10,320
nature

3115
01:51:13,270 --> 01:51:11,840
and then we see principles and then

3116
01:51:14,149 --> 01:51:13,280
sometimes we can infer about the brain

3117
01:51:15,910 --> 01:51:14,159
so

3118
01:51:16,950 --> 01:51:15,920
let's say we understand how atoms

3119
01:51:18,870 --> 01:51:16,960
assemble then we understand the

3120
01:51:20,790 --> 01:51:18,880
molecules symbol then we understand

3121
01:51:22,550 --> 01:51:20,800
cells and so on so obviously it's not as

3122
01:51:24,470 --> 01:51:22,560
simple as that but then

3123
01:51:26,229 --> 01:51:24,480
you in one of your interviews posed

3124
01:51:28,070 --> 01:51:26,239
another mechanism that is that we can

3125
01:51:30,550 --> 01:51:28,080
look at the brain structures

3126
01:51:32,470 --> 01:51:30,560
and we can infer about the world so for

3127
01:51:33,669 --> 01:51:32,480
example i believe you said that the fact

3128
01:51:35,750 --> 01:51:33,679
that an axon

3129
01:51:36,950 --> 01:51:35,760
is long and reaches out is a reflection

3130
01:51:38,870 --> 01:51:36,960
of

3131
01:51:40,950 --> 01:51:38,880
spooky action at a distance or action at

3132
01:51:43,669 --> 01:51:40,960
a distance and then i was thinking well

3133
01:51:44,629 --> 01:51:43,679
what about the hierarchical structures

3134
01:51:46,629 --> 01:51:44,639
of

3135
01:51:47,669 --> 01:51:46,639
pyramidal neurons do they reflect that

3136
01:51:50,550 --> 01:51:47,679
our world is

3137
01:51:52,070 --> 01:51:50,560
hierarchical and first of all why would

3138
01:51:53,189 --> 01:51:52,080

that be the case why does it have to be

3139
01:51:54,470 --> 01:51:53,199
mirrored second of all

3140
01:51:56,550 --> 01:51:54,480
there's another structure that is the

3141
01:51:57,350 --> 01:51:56,560
biohemispheric structure of the brain so

3142
01:51:59,430 --> 01:51:57,360
one is

3143
01:52:01,350 --> 01:51:59,440
i know there's a fair bit of myths about

3144
01:52:03,430 --> 01:52:01,360
the brain left brain versus right brain

3145
01:52:05,350 --> 01:52:03,440
but there's also some truth to some

3146
01:52:07,910 --> 01:52:05,360
parts of that now ian mcgillcrist

3147
01:52:08,950 --> 01:52:07,920
i'm sure you're aware of his work or his

3148
01:52:11,990 --> 01:52:08,960
name sounds familiar

3149
01:52:12,629 --> 01:52:12,000
he explored that as well so my question

3150
01:52:15,189 --> 01:52:12,639
is

3151
01:52:16,870 --> 01:52:15,199
what can you infer well why does it have

3152
01:52:18,310 --> 01:52:16,880
to be the case that your

3153
01:52:19,910 --> 01:52:18,320
internal structure of your brain would

3154
01:52:21,910 --> 01:52:19,920
mirror reality in some manner

3155
01:52:24,229 --> 01:52:21,920
and second what about the biohemispheric

3156
01:52:27,990 --> 01:52:24,239
structure what does that say about our

3157
01:52:29,510 --> 01:52:28,000
world okay well that that's a

3158
01:52:30,870 --> 01:52:29,520
really good question which could you

3159
01:52:32,229 --> 01:52:30,880
know could take us in a number of

3160
01:52:35,910 --> 01:52:32,239
different directions

3161
01:52:39,430 --> 01:52:35,920
um the notion that the

3162
01:52:42,470 --> 01:52:39,440
if you are in the game of um

3163
01:52:44,950 --> 01:52:42,480

predicting minimizing surprise

3164
01:52:46,470 --> 01:52:44,960
through the lens of minimizing

3165
01:52:48,550 --> 01:52:46,480
prediction error

3166
01:52:49,830 --> 01:52:48,560
then you want to generate a model that

3167
01:52:52,550 --> 01:52:49,840
can faithfully but

3168
01:52:54,550 --> 01:52:52,560
simply reproduce the kind of sensory

3169
01:52:55,589 --> 01:52:54,560
data sensory impressions that the world

3170
01:52:58,709 --> 01:52:55,599
is generating

3171
01:53:01,830 --> 01:52:58,719
so the formal structure of the

3172
01:53:03,709 --> 01:53:01,840
process that generates the sensory input

3173
01:53:04,870 --> 01:53:03,719
has to be to a certain level

3174
01:53:07,430 --> 01:53:04,880
recapitulated

3175
01:53:07,990 --> 01:53:07,440
on the inside in order to generate and

3176
01:53:10,790 --> 01:53:08,000
afford

3177
01:53:11,589 --> 01:53:10,800
those the right kind of predictions so

3178
01:53:14,790 --> 01:53:11,599
that is

3179
01:53:17,510 --> 01:53:14,800
a statement um uh really

3180
01:53:18,550 --> 01:53:17,520
i think um the good regulator theorem

3181
01:53:21,830 --> 01:53:18,560
which which arose

3182
01:53:25,430 --> 01:53:21,840
towards the end of the the cybernetics

3183
01:53:28,390 --> 01:53:25,440
movement by people um like ross ashby

3184
01:53:30,149 --> 01:53:28,400
um uh sort of you know regarded myself

3185
01:53:31,669 --> 01:53:30,159
as a father of self-organization this

3186
01:53:34,470 --> 01:53:31,679
notion that

3187
01:53:35,669 --> 01:53:34,480
every system that controls or regulates

3188
01:53:38,390 --> 01:53:35,679

its environment

3189
01:53:39,189 --> 01:53:38,400
must in essence be a model of that

3190
01:53:41,430 --> 01:53:39,199
environment

3191
01:53:42,310 --> 01:53:41,440
so there's an isomorphism between the

3192
01:53:45,350 --> 01:53:42,320
controller

3193
01:53:45,990 --> 01:53:45,360
and the controlled and that certainly is

3194
01:53:48,790 --> 01:53:46,000
the case

3195
01:53:49,350 --> 01:53:48,800
um uh is it sorry to interrupt i'm so

3196
01:53:52,070 --> 01:53:49,360
sorry

3197
01:53:53,669 --> 01:53:52,080
is it an isomorphism like is it exactly

3198
01:53:55,589 --> 01:53:53,679
mirrored because i recall when i was

3199
01:53:57,750 --> 01:53:55,599
speaking to bernardo castro he said

3200
01:53:59,030 --> 01:53:57,760
we can't model our reality exactly

3201
01:54:00,790 --> 01:53:59,040
because if we did

3202
01:54:02,149 --> 01:54:00,800
we would dissolve into an entropic soup

3203
01:54:04,310 --> 01:54:02,159
and then i said what do you mean and

3204
01:54:06,709 --> 01:54:04,320
then he said the argument was

3205
01:54:09,109 --> 01:54:06,719
it was too convoluted for him to state

3206
01:54:09,669 --> 01:54:09,119
at the time and i think he was referring

3207
01:54:12,149 --> 01:54:09,679
to you

3208
01:54:12,950 --> 01:54:12,159
so is it isomorphic or is it just no

3209
01:54:14,950 --> 01:54:12,960
you're absolutely

3210
01:54:16,470 --> 01:54:14,960
it's certainly not isomorphic because as

3211
01:54:18,149 --> 01:54:16,480
you save you if you want

3212
01:54:19,750 --> 01:54:18,159
i mean the best model in the world is

3213
01:54:20,629 --> 01:54:19,760

the world itself i mean that's that's a

3214
01:54:23,669 --> 01:54:20,639
tourism whichever

3215
01:54:26,790 --> 01:54:23,679
everyone celebrates and so um

3216
01:54:28,390 --> 01:54:26,800
no it's a it's a sufficiently good model

3217
01:54:29,830 --> 01:54:28,400
or an ultimately good model in the sense

3218
01:54:33,510 --> 01:54:29,840
that it's the simplest

3219
01:54:35,109 --> 01:54:33,520
um caricature of the system

3220
01:54:36,870 --> 01:54:35,119
or parts of the system the subspace

3221
01:54:39,669 --> 01:54:36,880
you're trying to control so

3222
01:54:40,390 --> 01:54:39,679
you know i still think it's um useful to

3223
01:54:43,430 --> 01:54:40,400
consider

3224
01:54:45,750 --> 01:54:43,440
um the good regulator theorem um

3225
01:54:47,109 --> 01:54:45,760
but you're right it's not not isomorphic

3226
01:54:48,870 --> 01:54:47,119
in any sense it's

3227
01:54:50,709 --> 01:54:48,880
an even lesser when you when you

3228
01:54:51,189 --> 01:54:50,719
consider that a lot of the time we

3229
01:54:54,229 --> 01:54:51,199
actually

3230
01:54:56,390 --> 01:54:54,239
build our own sensations when we move um

3231
01:54:57,270 --> 01:54:56,400
and certainly in terms of sensing our

3232
01:55:00,310 --> 01:54:57,280
own body

3233
01:55:04,310 --> 01:55:00,320
uh you know we are in charge of

3234
01:55:06,790 --> 01:55:04,320
basically creating that sensorium um

3235
01:55:08,950 --> 01:55:06,800
however let's just stick to the to your

3236
01:55:11,109 --> 01:55:08,960
original question

3237
01:55:12,790 --> 01:55:11,119
you know so no it's not it's not an

3238
01:55:15,350 --> 01:55:12,800

isomorphic but it certainly

3239
01:55:16,070 --> 01:55:15,360
has the right architecture to be able to

3240
01:55:17,990 --> 01:55:16,080
produce

3241
01:55:19,189 --> 01:55:18,000
a simplified summary or prediction of

3242
01:55:22,310 --> 01:55:19,199
what's going on

3243
01:55:24,709 --> 01:55:22,320
that is conserved every time around so

3244
01:55:25,510 --> 01:55:24,719
you're only interested in predicting um

3245
01:55:27,109 --> 01:55:25,520
things on

3246
01:55:28,870 --> 01:55:27,119
average so that you're revisiting

3247
01:55:30,870 --> 01:55:28,880
particular states so

3248
01:55:31,990 --> 01:55:30,880
you just need to get the gist of what's

3249
01:55:33,990 --> 01:55:32,000
going on

3250
01:55:35,750 --> 01:55:34,000
so it's a much simpler one but it still

3251
01:55:36,950 --> 01:55:35,760
must fundamentally have the same kind of

3252
01:55:39,030 --> 01:55:36,960
causal architecture

3253
01:55:40,070 --> 01:55:39,040
the same conditional dependencies and

3254
01:55:42,550 --> 01:55:40,080
you've highlighted

3255
01:55:43,109 --> 01:55:42,560
um a really important one which is the

3256
01:55:45,270 --> 01:55:43,119
um

3257
01:55:46,550 --> 01:55:45,280
the the symmetry between our two

3258
01:55:50,550 --> 01:55:46,560
hemispheres

3259
01:55:52,629 --> 01:55:50,560
the um you also mentioned this this um

3260
01:55:53,830 --> 01:55:52,639
which i've forgotten about which is the

3261
01:55:57,109 --> 01:55:53,840
or the very existence

3262
01:55:59,990 --> 01:55:57,119
of neural processes long thin

3263
01:56:01,189 --> 01:56:00,000

connections um that our neurons are

3264
01:56:03,270 --> 01:56:01,199
equipped with which you won't find

3265
01:56:05,830 --> 01:56:03,280
anywhere else in any other organ

3266
01:56:06,709 --> 01:56:05,840
um you know the liver doesn't have them

3267
01:56:11,350 --> 01:56:06,719
the

3268
01:56:14,390 --> 01:56:11,360
and long

3269
01:56:16,310 --> 01:56:14,400
um which which you know just reading

3270
01:56:18,310 --> 01:56:16,320
the structure of the generative model is

3271
01:56:19,109 --> 01:56:18,320
telling you something about the kind of

3272
01:56:20,709 --> 01:56:19,119
universe

3273
01:56:22,310 --> 01:56:20,719
that's generating the data that this

3274
01:56:23,589 --> 01:56:22,320
model is trying to predict

3275
01:56:25,350 --> 01:56:23,599
tells you immediately you've got action

3276
01:56:28,310 --> 01:56:25,360
at a distance

3277
01:56:30,149 --> 01:56:28,320
which is not necessarily a given um but

3278
01:56:33,189 --> 01:56:30,159
it tells you that this creature

3279
01:56:35,109 --> 01:56:33,199
must contend with a world where there's

3280
01:56:36,870 --> 01:56:35,119
some kind of action at a distance

3281
01:56:38,390 --> 01:56:36,880
it can see things in the distance for

3282
01:56:41,109 --> 01:56:38,400
example so

3283
01:56:42,470 --> 01:56:41,119
you know the contention would be if you

3284
01:56:45,830 --> 01:56:42,480
had a

3285
01:56:49,030 --> 01:56:45,840
um a worm that could not

3286
01:56:51,350 --> 01:56:49,040
um see things at a distance then it

3287
01:56:53,430 --> 01:56:51,360
probably wouldn't have very long axons

3288
01:56:54,870 --> 01:56:53,440

um and it would be quite comfortable

3289
01:56:56,550 --> 01:56:54,880
having lots of short range

3290
01:56:58,229 --> 01:56:56,560
axons they were quite sufficient for

3291
01:57:00,310 --> 01:56:58,239
modeling a world where it's just

3292
01:57:01,830 --> 01:57:00,320
immediate contact and short-range

3293
01:57:05,430 --> 01:57:01,840
causality that's generating

3294
01:57:07,189 --> 01:57:05,440
its sensations okay

3295
01:57:08,950 --> 01:57:07,199
quick question so i'm speaking to a

3296
01:57:10,709 --> 01:57:08,960
camera right now and its sensor is

3297
01:57:12,790 --> 01:57:10,719
fairly flat

3298
01:57:14,310 --> 01:57:12,800
and yet it can pick up from far away it

3299
01:57:16,149 --> 01:57:14,320
can pick up a mountain

3300
01:57:17,669 --> 01:57:16,159
now i understand that the camera isn't

3301
01:57:19,510 --> 01:57:17,679
acting on the world are you saying that

3302
01:57:20,550 --> 01:57:19,520
if it was to have some embodied

3303
01:57:21,910 --> 01:57:20,560
enactment then

3304
01:57:23,990 --> 01:57:21,920
well it wouldn't use this sensor in the

3305
01:57:25,589 --> 01:57:24,000
way that it's formulated right now it

3306
01:57:27,990 --> 01:57:25,599
would use axons in some way

3307
01:57:28,790 --> 01:57:28,000
would use long wires in some way you'd

3308
01:57:31,270 --> 01:57:28,800
um

3309
01:57:32,790 --> 01:57:31,280
if you actually well okay let's pursue

3310
01:57:35,910 --> 01:57:32,800
that that analogy then so

3311
01:57:37,270 --> 01:57:35,920
um so you know let's pursue assume

3312
01:57:42,790 --> 01:57:37,280
you're going to be using

3313
01:57:50,229 --> 01:57:47,350

computer graphics to generate um um

3314
01:57:51,830 --> 01:57:50,239
you know um a visual scene that you

3315
01:57:54,070 --> 01:57:51,840
could

3316
01:57:56,550 --> 01:57:54,080
use in a movie so what that would

3317
01:57:59,430 --> 01:57:56,560
necessitate is basically a machine

3318
01:58:00,790 --> 01:57:59,440
with lots of wires because it's all

3319
01:58:04,629 --> 01:58:00,800
action at a distance

3320
01:58:07,669 --> 01:58:04,639
so you couldn't do it on a a computer

3321
01:58:10,950 --> 01:58:07,679
um that didn't have big buses

3322
01:58:14,229 --> 01:58:10,960
and the ability to to move data around

3323
01:58:17,270 --> 01:58:14,239
um in a way that would recapitulate

3324
01:58:20,550 --> 01:58:17,280
the um the action at a distance

3325
01:58:23,669 --> 01:58:20,560
that is necessary for um

3326
01:58:30,229 --> 01:58:26,870
vgi so particularly sort of um you know

3327
01:58:34,470 --> 01:58:30,239
the ray tracing that's required um to

3328
01:58:36,550 --> 01:58:34,480
to basically you know render a scene

3329
01:58:37,910 --> 01:58:36,560
you know that's massively com you know

3330
01:58:41,109 --> 01:58:37,920
computer intensive that

3331
01:58:43,270 --> 01:58:41,119
requires a lot of if you like hardware

3332
01:58:44,709 --> 01:58:43,280
that you cannot do with just local

3333
01:58:45,109 --> 01:58:44,719
computing you actually have to do lots

3334
01:58:49,910 --> 01:58:45,119
of

3335
01:58:50,390 --> 01:58:49,920
architectures that computer scientists

3336
01:58:55,669 --> 01:58:50,400
would

3337
01:58:58,550 --> 01:58:55,679
certain computations you can do

3338
01:59:00,390 --> 01:58:58,560

um without sort of the other the kinds

3339
01:59:01,350 --> 01:59:00,400
of architectures you'd find in computer

3340
01:59:04,229 --> 01:59:01,360
science

3341
01:59:05,030 --> 01:59:04,239
that just involve local interactions but

3342
01:59:07,830 --> 01:59:05,040
as soon as you

3343
01:59:08,790 --> 01:59:07,840
have to actually generate virtual worlds

3344
01:59:11,830 --> 01:59:08,800
or worlds

3345
01:59:13,669 --> 01:59:11,840
um that they entail action distance you

3346
01:59:15,669 --> 01:59:13,679
get a different kind of connectivity

3347
01:59:17,030 --> 01:59:15,679
and a different kind of structure so

3348
01:59:17,589 --> 01:59:17,040
that's all i was really trying to

3349
01:59:23,109 --> 01:59:17,599
intimate

3350
01:59:25,910 --> 01:59:23,119
my favorite example is is before we turn

3351
01:59:29,109 --> 01:59:25,920
to the into hemispheric one is the um

3352
01:59:31,669 --> 01:59:29,119
a a a differentiation between a

3353
01:59:34,310 --> 01:59:31,679
a dorsal stream and a ventral stream

3354
01:59:37,510 --> 01:59:34,320
primarily concerned with what things are

3355
01:59:38,870 --> 01:59:37,520
and where they are and this speaks to

3356
01:59:40,709 --> 01:59:38,880
that modularity that we were talking

3357
01:59:44,390 --> 01:59:40,719
about earlier on that

3358
01:59:47,830 --> 01:59:44,400
somehow our brain has found

3359
01:59:49,990 --> 01:59:47,840
a really simplifying device to create a

3360
01:59:52,149 --> 01:59:50,000
modular architecture by

3361
01:59:53,990 --> 01:59:52,159
leveraging the conditional independences

3362
01:59:55,830 --> 01:59:54,000
between whatnots and awareness

3363
01:59:57,109 --> 01:59:55,840

in objects in the kind of universe we

3364
01:59:59,270 --> 01:59:57,119
live in so

3365
02:00:00,390 --> 01:59:59,280
put that simply there you're knowing

3366
02:00:02,950 --> 02:00:00,400
that this is

3367
02:00:03,589 --> 02:00:02,960
a cup doesn't tell me where it is

3368
02:00:05,510 --> 02:00:03,599
knowing

3369
02:00:06,629 --> 02:00:05,520
something is over there doesn't tell me

3370
02:00:08,870 --> 02:00:06,639
what it is

3371
02:00:10,629 --> 02:00:08,880
so that means that if i'm trying to

3372
02:00:12,629 --> 02:00:10,639
generate predictions i only need

3373
02:00:14,390 --> 02:00:12,639
i can have one part of my brain doing

3374
02:00:15,750 --> 02:00:14,400
the whoppness and the other part of my

3375
02:00:17,510 --> 02:00:15,760
brain doing the awareness

3376
02:00:19,430 --> 02:00:17,520
and then i can bring them together to

3377
02:00:21,350 --> 02:00:19,440
actually explain the sensory input

3378
02:00:23,830 --> 02:00:21,360
and that keeping things apart keeping

3379
02:00:25,189 --> 02:00:23,840
these parallel parallel streams apart

3380
02:00:26,870 --> 02:00:25,199
means i don't have to have the

3381
02:00:28,310 --> 02:00:26,880
complexity cost of all

3382
02:00:30,390 --> 02:00:28,320
the connections between them i don't

3383
02:00:31,350 --> 02:00:30,400
have to represent every object in every

3384
02:00:34,790 --> 02:00:31,360
position

3385
02:00:37,030 --> 02:00:34,800
in the world i can just represent um

3386
02:00:37,830 --> 02:00:37,040
your what it is and where it is and then

3387
02:00:39,910 --> 02:00:37,840
just bring the

3388
02:00:41,270 --> 02:00:39,920

bring them together as part of my

3389
02:00:42,709 --> 02:00:41,280
genitive models so that

3390
02:00:45,510 --> 02:00:42,719
that you know that tells you something

3391
02:00:47,910 --> 02:00:45,520
quite fundamental if i find a brain

3392
02:00:48,629 --> 02:00:47,920
that has this segregation into what and

3393
02:00:50,229 --> 02:00:48,639
where

3394
02:00:51,750 --> 02:00:50,239
i know that they live in a world of

3395
02:00:54,310 --> 02:00:51,760
objects where they

3396
02:00:55,910 --> 02:00:54,320
in their universe things don't really

3397
02:00:56,870 --> 02:00:55,920
things are conserved when they move

3398
02:01:00,870 --> 02:00:56,880
around

3399
02:01:03,270 --> 02:01:00,880
ah aha interesting

3400
02:01:04,709 --> 02:01:03,280
so um that brings us to the delicate

3401
02:01:05,189 --> 02:01:04,719
issue of why we've got symmetrical

3402
02:01:06,950 --> 02:01:05,199
brains

3403
02:01:08,470 --> 02:01:06,960
i think quite simply because we got

3404
02:01:12,070 --> 02:01:08,480
symmetrical bodies

3405
02:01:13,430 --> 02:01:12,080
um i think that you know

3406
02:01:14,950 --> 02:01:13,440
but then you may be asking why we've got

3407
02:01:16,229 --> 02:01:14,960
symmetrical bodies but sorry i'm not

3408
02:01:17,830 --> 02:01:16,239
going to try to answer that

3409
02:01:19,350 --> 02:01:17,840
well i was actually referring to the

3410
02:01:22,709 --> 02:01:19,360
asymmetry of the brains

3411
02:01:24,310 --> 02:01:22,719
all right that the left as let's say

3412
02:01:26,149 --> 02:01:24,320
ian mcgilchrist would say that the left

3413
02:01:27,109 --> 02:01:26,159

is more concerned with manipulation and

3414
02:01:29,910 --> 02:01:27,119
pinpointing

3415
02:01:32,310 --> 02:01:29,920
making definitive and the right is more

3416
02:01:33,990 --> 02:01:32,320
concerned with exploratory

3417
02:01:36,070 --> 02:01:34,000
motion so even actually at night time

3418
02:01:37,990 --> 02:01:36,080
when you're looking for your watch

3419
02:01:39,350 --> 02:01:38,000
or your clock you actually explore with

3420
02:01:40,709 --> 02:01:39,360
your

3421
02:01:42,390 --> 02:01:40,719
left hand because it's controlled by the

3422
02:01:44,149 --> 02:01:42,400
right brain naturally

3423
02:01:45,510 --> 02:01:44,159
you move you make more exploratory

3424
02:01:46,790 --> 02:01:45,520
movements with your left i'm not saying

3425
02:01:48,149 --> 02:01:46,800
anything you probably don't know

3426
02:01:49,990 --> 02:01:48,159
and then with your right most people are

3427
02:01:53,189 --> 02:01:50,000
right-handed and they like

3428
02:01:55,270 --> 02:01:53,199
to well whatever so then i was wondering

3429
02:01:57,750 --> 02:01:55,280
is that a reflection of what the world

3430
02:01:58,390 --> 02:01:57,760
is composed of or comprises in some

3431
02:01:59,990 --> 02:01:58,400
manner

3432
02:02:02,149 --> 02:02:00,000
and then also how does one know when one

3433
02:02:03,270 --> 02:02:02,159
is taking this too far so for example

3434
02:02:05,270 --> 02:02:03,280
just because the brain has a

3435
02:02:06,950 --> 02:02:05,280
morphological structure of foldiness and

3436
02:02:10,229 --> 02:02:06,960
gyruses and sulky and so on

3437
02:02:14,310 --> 02:02:10,239
doesn't mean the world is full d

3438
02:02:15,750 --> 02:02:14,320

or my experience is hilly

3439
02:02:18,870 --> 02:02:15,760
how does one know when to apply it and

3440
02:02:20,870 --> 02:02:18,880
when not to

3441
02:02:22,790 --> 02:02:20,880
so i was just you know thinking about

3442
02:02:25,030 --> 02:02:22,800
all your challenging questions

3443
02:02:26,950 --> 02:02:25,040
one by one um well i like the one about

3444
02:02:27,510 --> 02:02:26,960
the the world isn't folding that's very

3445
02:02:32,310 --> 02:02:27,520
nice

3446
02:02:33,910 --> 02:02:32,320
um uh and mystically one can make an

3447
02:02:36,070 --> 02:02:33,920
an analogy and say well the world is

3448
02:02:37,350 --> 02:02:36,080
complex and fractal-like and nothing is

3449
02:02:38,870 --> 02:02:37,360
ever the same and

3450
02:02:41,270 --> 02:02:38,880
and you can look at it from multiple

3451
02:02:43,189 --> 02:02:41,280
vantage points so it sounds to me more

3452
02:02:45,430 --> 02:02:43,199
like one is playing a linguistic game

3453
02:02:46,709 --> 02:02:45,440
in that example that i just gave rather

3454
02:02:49,189 --> 02:02:46,719
than actually giving

3455
02:02:49,750 --> 02:02:49,199
a property of the world that's reflected

3456
02:02:53,109 --> 02:02:49,760
in the

3457
02:02:55,030 --> 02:02:53,119
morphology of the brain yes yes um so i

3458
02:02:57,189 --> 02:02:55,040
i'd also just remembered that

3459
02:02:58,470 --> 02:02:57,199
i saw a presentation by colleagues of

3460
02:03:00,950 --> 02:02:58,480
mine recently that

3461
02:03:01,830 --> 02:03:00,960
actually interestingly made the

3462
02:03:05,189 --> 02:03:01,840
foldiness

3463
02:03:07,270 --> 02:03:05,199

um a possible reality um

3464
02:03:09,109 --> 02:03:07,280
but that's a distraction and a unique

3465
02:03:11,189 --> 02:03:09,119
and very exciting observation

3466
02:03:12,149 --> 02:03:11,199
but you're right so when i'm talking

3467
02:03:14,629 --> 02:03:12,159
about structure

3468
02:03:16,070 --> 02:03:14,639
i the only structure that matters is the

3469
02:03:18,070 --> 02:03:16,080
same kind of structure

3470
02:03:19,350 --> 02:03:18,080
that underwrites a markov blanket is

3471
02:03:21,109 --> 02:03:19,360
conditional dependencies

3472
02:03:23,109 --> 02:03:21,119
so i'm talking about a connectivity

3473
02:03:25,350 --> 02:03:23,119
architecture here i'm not talking about

3474
02:03:27,030 --> 02:03:25,360
the physical shape of the brain i'm just

3475
02:03:28,229 --> 02:03:27,040
talking about what is connected to what

3476
02:03:31,350 --> 02:03:28,239
is not connected

3477
02:03:31,910 --> 02:03:31,360
um so you know you you all i need is the

3478
02:03:35,589 --> 02:03:31,920
graph

3479
02:03:37,109 --> 02:03:35,599
theoretician i just need the adjacency

3480
02:03:39,589 --> 02:03:37,119
machines on the connectivity

3481
02:03:40,950 --> 02:03:39,599
usually the directed connectivity matrix

3482
02:03:44,070 --> 02:03:40,960
that's for me is what

3483
02:03:47,589 --> 02:03:44,080
what defines the structure so um

3484
02:03:51,990 --> 02:03:47,599
you know at that level

3485
02:03:54,550 --> 02:03:52,000
um the kinds of structures

3486
02:03:55,270 --> 02:03:54,560
that can be defined purely in terms of

3487
02:03:59,030 --> 02:03:55,280
the

3488
02:04:02,629 --> 02:03:59,040

things

3489
02:04:05,270 --> 02:04:02,639
like um the number of hierarchies

3490
02:04:06,390 --> 02:04:05,280
or the number of parallel streams or the

3491
02:04:09,510 --> 02:04:06,400
number of

3492
02:04:12,950 --> 02:04:09,520
modular um um uh

3493
02:04:16,310 --> 02:04:12,960
the number of uh um modules

3494
02:04:18,470 --> 02:04:16,320
uh or or uh clusters you know the degree

3495
02:04:20,629 --> 02:04:18,480
of small world is if you if you like

3496
02:04:21,830 --> 02:04:20,639
uh clustering indices i can't remember

3497
02:04:25,109 --> 02:04:21,840
all the um

3498
02:04:27,189 --> 02:04:25,119
the graphic terms for them but crucially

3499
02:04:28,390 --> 02:04:27,199
it's just that defined in terms of

3500
02:04:31,510 --> 02:04:28,400
connectivity

3501
02:04:33,830 --> 02:04:31,520
and i think um i think you can you can

3502
02:04:34,550 --> 02:04:33,840
within that remit and without going into

3503
02:04:36,870 --> 02:04:34,560
the world is

3504
02:04:42,950 --> 02:04:36,880
doesn't have cortical folds you know i

3505
02:04:47,990 --> 02:04:46,069
within the remit of um

3506
02:04:49,990 --> 02:04:48,000
instantiating and biophysically

3507
02:04:53,350 --> 02:04:50,000
realizing

3508
02:04:56,390 --> 02:04:53,360
causal contingencies and associations uh

3509
02:04:58,149 --> 02:04:56,400
in terms of connections between um

3510
02:05:00,870 --> 02:04:58,159
biological systems in particular

3511
02:05:02,790 --> 02:05:00,880
neuronal systems i think i think you can

3512
02:05:05,270 --> 02:05:02,800
um i think you can actually play this

3513
02:05:07,430 --> 02:05:05,280

game and play it for quite a long time

3514
02:05:09,669 --> 02:05:07,440
in terms of the hierarchical depth and

3515
02:05:11,109 --> 02:05:09,679
in terms of this modularity and this

3516
02:05:12,629 --> 02:05:11,119
factorization that we're just talking

3517
02:05:13,669 --> 02:05:12,639
about and in particular the hierarchical

3518
02:05:15,750 --> 02:05:13,679
depth i think is

3519
02:05:17,189 --> 02:05:15,760
is a very important one because you know

3520
02:05:20,149 --> 02:05:17,199
you're asking me well why should the

3521
02:05:22,390 --> 02:05:20,159
world be hierarchically structured

3522
02:05:23,589 --> 02:05:22,400
but it is necessarily hierarchically

3523
02:05:25,830 --> 02:05:23,599
structured if one

3524
02:05:27,830 --> 02:05:25,840
um just considers a you know a

3525
02:05:31,830 --> 02:05:27,840
separation of temporal scales so

3526
02:05:34,950 --> 02:05:31,840
you know there just has to exist

3527
02:05:37,109 --> 02:05:34,960
in terms of a course grading um applied

3528
02:05:41,030 --> 02:05:37,119
to any dynamical system

3529
02:05:44,149 --> 02:05:41,040
um a progression of slower stuff

3530
02:05:44,709 --> 02:05:44,159
that is has a your more course grained

3531
02:05:48,310 --> 02:05:44,719
aspect

3532
02:05:51,350 --> 02:05:48,320
to it uh that you could add your know

3533
02:05:53,270 --> 02:05:51,360
you you could elaborate recursively um

3534
02:05:55,030 --> 02:05:53,280
you know in principle for you know for

3535
02:05:57,189 --> 02:05:55,040
an infinite number of levels

3536
02:05:58,229 --> 02:05:57,199
so there does exist causal structure out

3537
02:06:01,510 --> 02:05:58,239
there in

3538
02:06:04,709 --> 02:06:01,520

any sparsely connected um

3539
02:06:08,069 --> 02:06:04,719
in the dynamical sense

3540
02:06:09,870 --> 02:06:08,079
world that i think fully licenses an

3541
02:06:11,750 --> 02:06:09,880
interpretation of the corresponding

3542
02:06:13,189 --> 02:06:11,760
architecture

3543
02:06:15,270 --> 02:06:13,199
and in particular it's hierarchical

3544
02:06:17,030 --> 02:06:15,280
depth as somehow

3545
02:06:18,709 --> 02:06:17,040
mirroring or reflecting that

3546
02:06:21,510 --> 02:06:18,719
hierarchical structure out there

3547
02:06:22,629 --> 02:06:21,520
with the obvious example of course is is

3548
02:06:25,990 --> 02:06:22,639
um

3549
02:06:27,030 --> 02:06:26,000
all of that machinery that aspect of our

3550
02:06:29,750 --> 02:06:27,040
brains

3551
02:06:31,189 --> 02:06:29,760
that is devoted to providing an apt

3552
02:06:34,550 --> 02:06:31,199
generative model

3553
02:06:37,350 --> 02:06:34,560
for interpersonal interactions so

3554
02:06:37,990 --> 02:06:37,360
you know if one realizes that most of

3555
02:06:41,189 --> 02:06:38,000
our

3556
02:06:42,550 --> 02:06:41,199
lived world is or at least the

3557
02:06:45,510 --> 02:06:42,560
sensations

3558
02:06:46,870 --> 02:06:45,520
generated by that world are generated by

3559
02:06:49,510 --> 02:06:46,880
other creatures like me

3560
02:06:50,709 --> 02:06:49,520
namely you uh you know where they were

3561
02:06:54,069 --> 02:06:50,719
driving around in cars

3562
02:06:55,310 --> 02:06:54,079
walking in parks talking on zoom reading

3563
02:06:58,310 --> 02:06:55,320

books

3564
02:07:00,790 --> 02:06:58,320
99.9 of us our sensorim is

3565
02:07:01,910 --> 02:07:00,800
generated by another human being that is

3566
02:07:04,950 --> 02:07:01,920
like me

3567
02:07:05,990 --> 02:07:04,960
so that actually says there has to be a

3568
02:07:09,270 --> 02:07:06,000
lot of the

3569
02:07:11,669 --> 02:07:09,280
brain has to be devoted to modeling

3570
02:07:13,510 --> 02:07:11,679
me and people like me and making

3571
02:07:15,990 --> 02:07:13,520
inferences about me

3572
02:07:16,629 --> 02:07:16,000
and as soon as you start to get to this

3573
02:07:18,629 --> 02:07:16,639
um

3574
02:07:19,669 --> 02:07:18,639
think about what kinds of genitive

3575
02:07:23,109 --> 02:07:19,679
models would be

3576
02:07:25,189 --> 02:07:23,119
fit for purpose in in that context then

3577
02:07:26,229 --> 02:07:25,199
the imperatives to resolve uncertainty

3578
02:07:29,830 --> 02:07:26,239
are basically

3579
02:07:32,709 --> 02:07:29,840
the drives for me to understand you

3580
02:07:34,229 --> 02:07:32,719
so this epistemic part of the free

3581
02:07:36,870 --> 02:07:34,239
energy minimization

3582
02:07:37,669 --> 02:07:36,880
as a consequence of action translates

3583
02:07:39,430 --> 02:07:37,679
into

3584
02:07:40,709 --> 02:07:39,440
an imperative to understand the world

3585
02:07:42,709 --> 02:07:40,719
but the live world now with

3586
02:07:43,830 --> 02:07:42,719
is basically you in this instance i need

3587
02:07:45,109 --> 02:07:43,840
to understand you

3588
02:07:47,350 --> 02:07:45,119

how do i do that we have to have a

3589
02:07:48,390 --> 02:07:47,360
shared narrative what does that require

3590
02:07:50,149 --> 02:07:48,400
language

3591
02:07:53,030 --> 02:07:50,159
it could be maths it could be could be

3592
02:07:55,669 --> 02:07:53,040
english but that narrative has

3593
02:07:57,990 --> 02:07:55,679
many many different scales to it that

3594
02:08:00,390 --> 02:07:58,000
has itself a deep temporal structure

3595
02:08:01,030 --> 02:08:00,400
so there's the concept that i that we're

3596
02:08:02,709 --> 02:08:01,040
conveying

3597
02:08:04,229 --> 02:08:02,719
there's a temporal scale of the duration

3598
02:08:07,830 --> 02:08:04,239
of this of this

3599
02:08:08,790 --> 02:08:07,840
exchange there are much recursively much

3600
02:08:10,870 --> 02:08:08,800
finer

3601
02:08:12,390 --> 02:08:10,880
temporal structures in terms of the

3602
02:08:15,189 --> 02:08:12,400
structure of the sentence

3603
02:08:16,229 --> 02:08:15,199
the phrases that i'm using the words the

3604
02:08:17,910 --> 02:08:16,239
phonemes

3605
02:08:20,069 --> 02:08:17,920
all the way down to the millisecond by

3606
02:08:23,750 --> 02:08:20,079
millisecond

3607
02:08:26,069 --> 02:08:23,760
activation of your

3608
02:08:27,830 --> 02:08:26,079
sensory epithelia in your ears or my

3609
02:08:31,030 --> 02:08:27,840
neuromuscular junctions

3610
02:08:34,069 --> 02:08:31,040
controlling my articular articulatory

3611
02:08:35,030 --> 02:08:34,079
apparatus so we wouldn't be able to talk

3612
02:08:36,709 --> 02:08:35,040
to each other

3613
02:08:38,069 --> 02:08:36,719

or comply with this imperative to

3614
02:08:41,270 --> 02:08:38,079
resolve uncertainty

3615
02:08:42,069 --> 02:08:41,280
to explore the world that i have to

3616
02:08:44,550 --> 02:08:42,079
model

3617
02:08:45,910 --> 02:08:44,560
um without language and without a deep

3618
02:08:47,669 --> 02:08:45,920
genetic model with a deep

3619
02:08:49,109 --> 02:08:47,679
hierarchical structure there can be no

3620
02:08:51,669 --> 02:08:49,119
language there's a natural

3621
02:08:52,310 --> 02:08:51,679
if you like not pressure but there's

3622
02:08:54,550 --> 02:08:52,320
certainly

3623
02:08:56,069 --> 02:08:54,560
uh an easy way to understand why we have

3624
02:08:57,830 --> 02:08:56,079
deep generative models

3625
02:08:59,270 --> 02:08:57,840
in our brain in fact we do i mean you

3626
02:09:02,390 --> 02:08:59,280
know nearly

3627
02:09:05,030 --> 02:09:02,400
all the interesting connectivity all the

3628
02:09:07,990 --> 02:09:05,040
interesting architectural aspects

3629
02:09:09,990 --> 02:09:08,000
of brain connectivity speak to a

3630
02:09:12,229 --> 02:09:10,000
hierarchical organization at some level

3631
02:09:14,790 --> 02:09:12,239
it's cortical subcortical the very word

3632
02:09:16,709 --> 02:09:14,800
sub means below below is only an

3633
02:09:18,390 --> 02:09:16,719
attribute of hierarchy it can't be

3634
02:09:19,750 --> 02:09:18,400
any other thing you know the visual

3635
02:09:23,350 --> 02:09:19,760
hierarchy being the sort of

3636
02:09:26,550 --> 02:09:23,360
the the poster child for um very well

3637
02:09:28,870 --> 02:09:26,560
um defined subsumption hierarchies

3638
02:09:30,149 --> 02:09:28,880

but you know beyond that wherever you

3639
02:09:31,990 --> 02:09:30,159
look in the brain there is some

3640
02:09:34,229 --> 02:09:32,000
hierarchical organization where

3641
02:09:35,510 --> 02:09:34,239
where slow stuff is in training fast

3642
02:09:38,390 --> 02:09:35,520
stuff at the lower below

3643
02:09:39,430 --> 02:09:38,400
and then all the way down to the um to

3644
02:09:41,910 --> 02:09:39,440
the sensory

3645
02:09:42,470 --> 02:09:41,920
inputs on the uh the actuators or the

3646
02:09:46,950 --> 02:09:42,480
active

3647
02:09:52,069 --> 02:09:49,109
okay so hierarchy is another way of

3648
02:09:54,390 --> 02:09:52,079
saying difference that can be compared

3649
02:09:55,830 --> 02:09:54,400
say that again so a hierarchy a

3650
02:09:57,270 --> 02:09:55,840
difference that can be compared

3651
02:09:59,350 --> 02:09:57,280
so these two are different but there's

3652
02:10:01,510 --> 02:09:59,360
no hierarchy between them if it's like

3653
02:10:03,430 --> 02:10:01,520
someone may say apples and oranges but

3654
02:10:04,790 --> 02:10:03,440
if it's between apples and two apples

3655
02:10:06,390 --> 02:10:04,800
then there's a hierarchy there because

3656
02:10:08,390 --> 02:10:06,400
there's a quantity that we can reduce

3657
02:10:11,189 --> 02:10:08,400
down and put a comparison between them

3658
02:10:13,189 --> 02:10:11,199
oh i see yeah no absolutely so the the

3659
02:10:14,709 --> 02:10:13,199
height the way i'm using hierarchy here

3660
02:10:18,149 --> 02:10:14,719
is certainly

3661
02:10:20,390 --> 02:10:18,159
um sort of so when people talk about say

3662
02:10:21,910 --> 02:10:20,400
deep learning um what they're talking

3663
02:10:25,350 --> 02:10:21,920

about is um

3664
02:10:27,589 --> 02:10:25,360
inference and classification under a um

3665
02:10:29,189 --> 02:10:27,599
under a hierarchical genitive model that

3666
02:10:32,310 --> 02:10:29,199
has a number of hidden layers

3667
02:10:35,430 --> 02:10:32,320
so the depth of the the learning machine

3668
02:10:37,589 --> 02:10:35,440
refers to how many layers you build

3669
02:10:38,870 --> 02:10:37,599
and so what you do is you put the data

3670
02:10:41,109 --> 02:10:38,880
in um

3671
02:10:43,030 --> 02:10:41,119
and then you try and explain it with one

3672
02:10:44,550 --> 02:10:43,040
there and then those explanations and

3673
02:10:45,750 --> 02:10:44,560
that you then try and explain it with a

3674
02:10:47,350 --> 02:10:45,760
layer

3675
02:10:49,510 --> 02:10:47,360
on top of that and then you keep on

3676
02:10:50,310 --> 02:10:49,520
going until ultimately you get to some

3677
02:10:53,030 --> 02:10:50,320
very very

3678
02:10:55,030 --> 02:10:53,040
coarse grain very abstract explanations

3679
02:10:56,950 --> 02:10:55,040
that are predicting if you like

3680
02:10:59,030 --> 02:10:56,960
the there below and then they're

3681
02:11:01,189 --> 02:10:59,040
unpacked to predict hierarchically

3682
02:11:03,830 --> 02:11:01,199
right down to the level of say pixel

3683
02:11:06,790 --> 02:11:03,840
elements in a tv screen or sort of um

3684
02:11:07,189 --> 02:11:06,800
you know some image that's been grabbed

3685
02:11:09,350 --> 02:11:07,199
so

3686
02:11:10,790 --> 02:11:09,360
the deep the hierarchical depth is

3687
02:11:14,310 --> 02:11:10,800
basically how many

3688
02:11:17,270 --> 02:11:14,320

subordinate layers do you have i see one

3689
02:11:18,870 --> 02:11:17,280
higher level providing getting

3690
02:11:22,229 --> 02:11:18,880
information from the lower level

3691
02:11:25,030 --> 02:11:22,239
but also providing um constraints

3692
02:11:26,229 --> 02:11:25,040
i'm saying well if this hierarch if this

3693
02:11:27,830 --> 02:11:26,239
context is in play

3694
02:11:29,990 --> 02:11:27,840
then i expect this kind of thing to

3695
02:11:31,350 --> 02:11:30,000
happen over here in that modality and

3696
02:11:33,470 --> 02:11:31,360
that kind of thing to happen over there

3697
02:11:34,950 --> 02:11:33,480
in that modality so it brings a

3698
02:11:37,990 --> 02:11:34,960
simplification

3699
02:11:39,030 --> 02:11:38,000
and a a better way of modeling provided

3700
02:11:40,069 --> 02:11:39,040
that you've got this hierarchical

3701
02:11:41,589 --> 02:11:40,079
structure

3702
02:11:43,189 --> 02:11:41,599
what you were talking about i think is

3703
02:11:45,510 --> 02:11:43,199
more the modularity of the sort of

3704
02:11:46,229 --> 02:11:45,520
is this a an apple or is this an orange

3705
02:11:48,229 --> 02:11:46,239
i think that

3706
02:11:49,830 --> 02:11:48,239
within the hierarchy within the depth

3707
02:11:51,189 --> 02:11:49,840
from sort of um

3708
02:11:52,790 --> 02:11:51,199
you know the lower level which are

3709
02:11:54,390 --> 02:11:52,800
usually at the level of the sensors and

3710
02:11:57,189 --> 02:11:54,400
the actuators

3711
02:11:58,550 --> 02:11:57,199
and the higher level um is usually um

3712
02:11:59,990 --> 02:11:58,560
the top of a pyramid

3713
02:12:01,589 --> 02:12:00,000

of course you know there isn't a pyramid

3714
02:12:02,950 --> 02:12:01,599
in the brain it's you can imagine it

3715
02:12:05,350 --> 02:12:02,960
more like a circle

3716
02:12:06,390 --> 02:12:05,360
and the center being being the deeper

3717
02:12:09,430 --> 02:12:06,400
parts of it

3718
02:12:11,990 --> 02:12:09,440
um so but there's a there's another

3719
02:12:12,550 --> 02:12:12,000
architectural structure which is um not

3720
02:12:14,149 --> 02:12:12,560
in the

3721
02:12:16,550 --> 02:12:14,159
the depth of the hierarchy from the

3722
02:12:19,109 --> 02:12:16,560
bottom of the circle say to the center

3723
02:12:20,550 --> 02:12:19,119
but actually the the different streams

3724
02:12:21,430 --> 02:12:20,560
you talk about the apples and oranges

3725
02:12:23,669 --> 02:12:21,440
and it's that

3726
02:12:24,709 --> 02:12:23,679
factorization that what awareness that i

3727
02:12:26,629 --> 02:12:24,719
was you know

3728
02:12:27,910 --> 02:12:26,639
hinting at before which is a lovely

3729
02:12:31,270 --> 02:12:27,920
example of

3730
02:12:33,430 --> 02:12:31,280
um you know things i know about oranges

3731
02:12:34,709 --> 02:12:33,440
are not relevant for things i know about

3732
02:12:36,709 --> 02:12:34,719
apples i mean

3733
02:12:38,069 --> 02:12:36,719
that's probably a silly example because

3734
02:12:38,950 --> 02:12:38,079
there are there are things that are

3735
02:12:41,189 --> 02:12:38,960
concerned but

3736
02:12:42,629 --> 02:12:41,199
things i know about fruit i'm not going

3737
02:12:43,990 --> 02:12:42,639
to be terribly useful for things i know

3738
02:12:46,709 --> 02:12:44,000

about tools

3739
02:12:47,669 --> 02:12:46,719
so i can actually have my genitive model

3740
02:12:51,430 --> 02:12:47,679
generating

3741
02:12:53,589 --> 02:12:51,440
a cascade of abstract

3742
02:12:54,790 --> 02:12:53,599
representations becoming more and more

3743
02:12:57,589 --> 02:12:54,800
detailed committed

3744
02:12:58,069 --> 02:12:57,599
right down to a picture of or a sound of

3745
02:13:00,870 --> 02:12:58,079
or

3746
02:13:01,430 --> 02:13:00,880
me moving this particular artifact but

3747
02:13:04,470 --> 02:13:01,440
of course

3748
02:13:05,430 --> 02:13:04,480
this artifact can be either a tool or a

3749
02:13:08,470 --> 02:13:05,440
face

3750
02:13:09,910 --> 02:13:08,480
you know or an apple a fruit

3751
02:13:11,910 --> 02:13:09,920
and because you've got you know these

3752
02:13:13,270 --> 02:13:11,920
conditional dependencies tools don't

3753
02:13:17,109 --> 02:13:13,280
behave like fruit

3754
02:13:20,550 --> 02:13:17,119
and i don't in particular um i don't

3755
02:13:22,709 --> 02:13:20,560
um actively engage with tools

3756
02:13:24,790 --> 02:13:22,719
in the same way that i engage with fruit

3757
02:13:26,470 --> 02:13:24,800
i eat fruit but i use tools

3758
02:13:28,149 --> 02:13:26,480
so it's likely that you get this the

3759
02:13:31,750 --> 02:13:28,159
separation through

3760
02:13:33,990 --> 02:13:31,760
this um this factorization or modular

3761
02:13:36,149 --> 02:13:34,000
parallel architecture

3762
02:13:38,550 --> 02:13:36,159
in the setting of a hierarchical

3763
02:13:39,990 --> 02:13:38,560

composition

3764
02:13:41,589 --> 02:13:40,000
so these are really important sort of

3765
02:13:42,709 --> 02:13:41,599
sort of architectural principles if you

3766
02:13:44,790 --> 02:13:42,719
have to actually build

3767
02:13:45,750 --> 02:13:44,800
or understand the brain but also if you

3768
02:13:48,069 --> 02:13:45,760
wanted to build

3769
02:13:49,270 --> 02:13:48,079
a you know a conscious artifact or an

3770
02:13:51,430 --> 02:13:49,280
intelligent artifact

3771
02:13:53,510 --> 02:13:51,440
you'd have to equip it with a with this

3772
02:13:54,229 --> 02:13:53,520
you know with both a deep genitive model

3773
02:13:56,629 --> 02:13:54,239
but also

3774
02:13:57,589 --> 02:13:56,639
had this sort of um these parallel

3775
02:13:59,109 --> 02:13:57,599
streams to them

3776
02:14:00,870 --> 02:13:59,119
which brings us back to the right brain

3777
02:14:02,390 --> 02:14:00,880
versus left brain i still don't

3778
02:14:04,390 --> 02:14:02,400
i don't have a neat answer for you i'm

3779
02:14:06,390 --> 02:14:04,400
afraid but you're right i mean

3780
02:14:07,750 --> 02:14:06,400
you know language lateralization is a

3781
02:14:11,589 --> 02:14:07,760
classic um

3782
02:14:13,990 --> 02:14:11,599
a classic uh and conserved

3783
02:14:15,589 --> 02:14:14,000
aspect of our brains but i can't think

3784
02:14:16,069 --> 02:14:15,599
of a first principle account as to why

3785
02:14:18,550 --> 02:14:16,079
that

3786
02:14:19,990 --> 02:14:18,560
might be the case you mentioned the word

3787
02:14:21,189 --> 02:14:20,000
narrative that we have to have a shared

3788
02:14:22,390 --> 02:14:21,199

narrative now were you saying that we

3789
02:14:24,470 --> 02:14:22,400
have to have a shared narrative

3790
02:14:26,229 --> 02:14:24,480
in order to have peace between us or in

3791
02:14:27,350 --> 02:14:26,239
order to interact or in order to

3792
02:14:29,109 --> 02:14:27,360
understand one another

3793
02:14:31,990 --> 02:14:29,119
and then also does that narrative have

3794
02:14:32,390 --> 02:14:32,000
to be encapsulated in language or can it

3795
02:14:36,470 --> 02:14:32,400
be

3796
02:14:38,069 --> 02:14:36,480
can get along

3797
02:14:40,550 --> 02:14:38,079
and they don't have language at least

3798
02:14:41,910 --> 02:14:40,560
not the way we do and presumably we

3799
02:14:44,950 --> 02:14:41,920
didn't have language

3800
02:14:47,830 --> 02:14:44,960
prior to a million years ago

3801
02:14:49,830 --> 02:14:47,840
yeah we got along yeah well i meant it

3802
02:14:52,870 --> 02:14:49,840
in exactly the same the sense that you

3803
02:14:56,149 --> 02:14:52,880
um you intimated there so

3804
02:14:59,350 --> 02:14:56,159
um yeah it it is just there if we

3805
02:14:59,910 --> 02:14:59,360
have a shared narrative um that i'm i'm

3806
02:15:02,470 --> 02:14:59,920
now

3807
02:15:03,350 --> 02:15:02,480
using narrative to describe a generative

3808
02:15:07,189 --> 02:15:03,360
model

3809
02:15:08,069 --> 02:15:07,199
that entails um sequences of things that

3810
02:15:11,270 --> 02:15:08,079
happen over time

3811
02:15:13,350 --> 02:15:11,280
so it's a model of sequences um

3812
02:15:15,270 --> 02:15:13,360
that usually has a deep deep temporal

3813
02:15:19,109 --> 02:15:15,280

structure to it

3814
02:15:22,149 --> 02:15:19,119
so if i want to understand you

3815
02:15:23,990 --> 02:15:22,159
and i want to communicate with you um in

3816
02:15:25,990 --> 02:15:24,000
order to understand you and to

3817
02:15:27,189 --> 02:15:26,000
and to ask you questions to understand

3818
02:15:30,069 --> 02:15:27,199
more about your

3819
02:15:31,589 --> 02:15:30,079
your intentional stance your knowledge

3820
02:15:34,950 --> 02:15:31,599
then i'm going to need

3821
02:15:37,589 --> 02:15:34,960
to infer what you're thinking

3822
02:15:38,629 --> 02:15:37,599
and i can do that if i know what i'm

3823
02:15:40,709 --> 02:15:38,639
thinking

3824
02:15:42,709 --> 02:15:40,719
but only and then under the assumption

3825
02:15:43,510 --> 02:15:42,719
that you're using the same kind of model

3826
02:15:45,750 --> 02:15:43,520
as me

3827
02:15:46,950 --> 02:15:45,760
so we're both using the same code or

3828
02:15:50,229 --> 02:15:46,960
singing from the same hymn

3829
02:15:51,270 --> 02:15:50,239
sheet so you know when you start to

3830
02:15:54,310 --> 02:15:51,280
model this you don't

3831
02:15:56,870 --> 02:15:54,320
you well we have models of of of um

3832
02:15:57,589 --> 02:15:56,880
linguistic exchange which are cast in

3833
02:15:59,910 --> 02:15:57,599
terms of

3834
02:16:02,149 --> 02:15:59,920
simple games of 20 questions so you know

3835
02:16:04,870 --> 02:16:02,159
one agent has to ask another agent

3836
02:16:05,669 --> 02:16:04,880
um through linguistic exchange but it

3837
02:16:08,149 --> 02:16:05,679
does depend

3838
02:16:09,030 --> 02:16:08,159

depend upon them both committing to the

3839
02:16:11,350 --> 02:16:09,040
same

3840
02:16:12,550 --> 02:16:11,360
generative model of this linguistic

3841
02:16:15,669 --> 02:16:12,560
exchange in the meaning

3842
02:16:19,109 --> 02:16:15,679
a simpler a simpler set of simulations

3843
02:16:20,790 --> 02:16:19,119
um arises when you think about sort of

3844
02:16:22,950 --> 02:16:20,800
just birds singing to each other so they

3845
02:16:25,510 --> 02:16:22,960
can recognize con specifics

3846
02:16:27,109 --> 02:16:25,520
so you know what that's quite that's

3847
02:16:30,310 --> 02:16:27,119
much easier to simulate

3848
02:16:32,790 --> 02:16:30,320
when you just have two dynamical systems

3849
02:16:34,230 --> 02:16:32,800
talking to each other and they're both

3850
02:16:35,990 --> 02:16:34,240
now becoming trained to show

3851
02:16:37,030 --> 02:16:36,000
synchronization of chaos than we were

3852
02:16:39,509 --> 02:16:37,040
talking about before

3853
02:16:41,750 --> 02:16:39,519
in a different context but here in the

3854
02:16:43,830 --> 02:16:41,760
service of mutual predictability

3855
02:16:46,150 --> 02:16:43,840
so another way of thinking about what's

3856
02:16:48,709 --> 02:16:46,160
the best way to minimize surprise

3857
02:16:50,629 --> 02:16:48,719
surprise or self-information when

3858
02:16:52,549 --> 02:16:50,639
exchange with another

3859
02:16:54,549 --> 02:16:52,559
is to make sure that i only exchange

3860
02:16:56,389 --> 02:16:54,559
with other people exactly like me

3861
02:16:57,750 --> 02:16:56,399
because i can predict exactly what

3862
02:16:59,030 --> 02:16:57,760
you're going to do next because i know

3863
02:17:00,950 --> 02:16:59,040

exactly what i'm going to do next

3864
02:17:02,309 --> 02:17:00,960
i'm doing it so you know we could be

3865
02:17:04,309 --> 02:17:02,319
singing or talking together

3866
02:17:05,910 --> 02:17:04,319
clearly we take turns but there are

3867
02:17:08,389 --> 02:17:05,920
situations where we could be actually

3868
02:17:09,110 --> 02:17:08,399
singing in the choir together but i can

3869
02:17:11,910 --> 02:17:09,120
only

3870
02:17:13,910 --> 02:17:11,920
sing with people that have a

3871
02:17:14,549 --> 02:17:13,920
sufficiently similar generative model to

3872
02:17:17,669 --> 02:17:14,559
me

3873
02:17:21,030 --> 02:17:17,679
that makes it um that licenses

3874
02:17:23,270 --> 02:17:21,040
the use of my model of how

3875
02:17:24,150 --> 02:17:23,280
this kind of creature interacts with the

3876
02:17:27,190 --> 02:17:24,160
world

3877
02:17:29,270 --> 02:17:27,200
uh license licenses its use

3878
02:17:30,469 --> 02:17:29,280
as a model of how you are interacting

3879
02:17:32,709 --> 02:17:30,479
with the world and

3880
02:17:34,150 --> 02:17:32,719
interacting with interacting with me so

3881
02:17:34,549 --> 02:17:34,160
that's what i meant by shared narrative

3882
02:17:38,469 --> 02:17:34,559
just

3883
02:17:41,509 --> 02:17:38,479
model

3884
02:17:44,709 --> 02:17:41,519
between um creatures that typically

3885
02:17:46,709 --> 02:17:44,719
um act together in terms of things like

3886
02:17:49,030 --> 02:17:46,719
joint attention or

3887
02:17:50,230 --> 02:17:49,040
familial bonds or sort of con specifics

3888
02:17:54,389 --> 02:17:50,240

in an evolutionary

3889
02:17:58,469 --> 02:17:57,190
that generalizes um in terms of your

3890
02:18:01,990 --> 02:17:58,479
cultural takes on

3891
02:18:03,910 --> 02:18:02,000
um uh niche construction you know

3892
02:18:05,750 --> 02:18:03,920
the existence of things like signs and

3893
02:18:06,549 --> 02:18:05,760
traffic lights and elephant and desire

3894
02:18:09,589 --> 02:18:06,559
paths

3895
02:18:10,150 --> 02:18:09,599
these are all manifestations of um you

3896
02:18:12,309 --> 02:18:10,160
know

3897
02:18:13,910 --> 02:18:12,319
living sharing a world with other

3898
02:18:16,469 --> 02:18:13,920
creatures like myself

3899
02:18:17,030 --> 02:18:16,479
that after a while there they become

3900
02:18:20,150 --> 02:18:17,040
very

3901
02:18:22,150 --> 02:18:20,160
communicating

3902
02:18:25,190 --> 02:18:22,160
possibly as you say don't involve spoken

3903
02:18:26,950 --> 02:18:25,200
language and non-verbal communication

3904
02:18:28,629 --> 02:18:26,960
is clearly an incredibly important part

3905
02:18:30,709 --> 02:18:28,639
of that but even beyond that

3906
02:18:32,150 --> 02:18:30,719
just the fact that we have a shared

3907
02:18:34,629 --> 02:18:32,160
commitment to

3908
02:18:35,509 --> 02:18:34,639
stopping when a traffic signal or light

3909
02:18:37,589 --> 02:18:35,519
goes red

3910
02:18:39,750 --> 02:18:37,599
you know that's a shared narrative we

3911
02:18:41,429 --> 02:18:39,760
have that enables us to drive around and

3912
02:18:43,030 --> 02:18:41,439
occupy the same streets

3913
02:18:45,349 --> 02:18:43,040

when some of us are driving and some of

3914
02:18:46,629 --> 02:18:45,359
us are walking or both of us are driving

3915
02:18:49,190 --> 02:18:46,639
so that's what i meant by shared

3916
02:18:52,070 --> 02:18:49,200
narrative is sort of you know a common

3917
02:18:53,030 --> 02:18:52,080
a common generative model of how to live

3918
02:18:56,070 --> 02:18:53,040
in this world

3919
02:18:58,230 --> 02:18:56,080
with things like me interesting

3920
02:18:59,830 --> 02:18:58,240
interesting okay now it can't simply be

3921
02:19:01,270 --> 02:18:59,840
just shared there has to be some other

3922
02:19:02,629 --> 02:19:01,280
criteria only because

3923
02:19:04,309 --> 02:19:02,639
me and you can still share the same

3924
02:19:05,669 --> 02:19:04,319
model that says that you're an enemy and

3925
02:19:07,110 --> 02:19:05,679
i'm supposed to kill you and i'm

3926
02:19:09,270 --> 02:19:07,120
and you're supposed to kill me so then

3927
02:19:11,349 --> 02:19:09,280
it's not just shared that allows us to

3928
02:19:12,870 --> 02:19:11,359
be peaceful cohabitants and i was

3929
02:19:15,509 --> 02:19:12,880
wondering

3930
02:19:17,190 --> 02:19:15,519
then do you think religion is an attempt

3931
02:19:18,950 --> 02:19:17,200
to make a hypothesis or

3932
02:19:20,389 --> 02:19:18,960
or to generate possibilities as to

3933
02:19:22,709 --> 02:19:20,399
generative models that

3934
02:19:24,870 --> 02:19:22,719
a large class of people could share and

3935
02:19:27,030 --> 02:19:24,880
minimize the suffering of

3936
02:19:27,910 --> 02:19:27,040
both the society and the individuals at

3937
02:19:29,750 --> 02:19:27,920
the same time

3938
02:19:31,830 --> 02:19:29,760

yeah i haven't thought deeply about this

3939
02:19:35,190 --> 02:19:31,840
but that's a very plausible

3940
02:19:38,790 --> 02:19:35,200
very plausible explanation for why um

3941
02:19:40,150 --> 02:19:38,800
religious narratives have have emerged

3942
02:19:43,270 --> 02:19:40,160
and that's so successful

3943
02:19:45,830 --> 02:19:43,280
in maintaining themselves um so

3944
02:19:47,429 --> 02:19:45,840
you know just in in terms of a simple

3945
02:19:51,349 --> 02:19:47,439
analysis

3946
02:19:53,190 --> 02:19:51,359
of the minimizing complexity arguments

3947
02:19:55,349 --> 02:19:53,200
that we were rehearsing before

3948
02:19:57,990 --> 02:19:55,359
your if you want to find a really simple

3949
02:19:59,510 --> 02:19:58,000
explanation that accommodates a lot of

3950
02:20:01,030 --> 02:19:59,520
difficult to explain stuff very

3951
02:20:04,150 --> 02:20:01,040
accurately then

3952
02:20:06,230 --> 02:20:04,160
a a deity that can cause all this stuff

3953
02:20:09,030 --> 02:20:06,240
is a really simple explanation

3954
02:20:11,349 --> 02:20:09,040
and you know if it accurately explains

3955
02:20:13,349 --> 02:20:11,359
your sensorium and your world

3956
02:20:15,590 --> 02:20:13,359
then it's it's a beautiful example of a

3957
02:20:18,070 --> 02:20:15,600
very parsimonious hypothesis

3958
02:20:19,510 --> 02:20:18,080
now it may not be sufficiently accurate

3959
02:20:22,550 --> 02:20:19,520
for

3960
02:20:24,469 --> 02:20:22,560
a scientist who does not accept

3961
02:20:25,990 --> 02:20:24,479
you know a religious explanation for

3962
02:20:30,389 --> 02:20:26,000
this or that

3963
02:20:32,389 --> 02:20:30,399

but if you are not um if you are not um

3964
02:20:33,429 --> 02:20:32,399
sampling that kind of sensory

3965
02:20:35,590 --> 02:20:33,439
information or

3966
02:20:36,469 --> 02:20:35,600
that kind of scientific data then that

3967
02:20:38,150 --> 02:20:36,479
doesn't matter

3968
02:20:39,910 --> 02:20:38,160
um because you know you only need to

3969
02:20:44,630 --> 02:20:39,920
explain what you need to explain

3970
02:20:48,469 --> 02:20:44,640
so just as um just as a broad um

3971
02:20:51,190 --> 02:20:48,479
comment upon religious beliefs um

3972
02:20:52,389 --> 02:20:51,200
and i think you can generalize that to

3973
02:20:54,870 --> 02:20:52,399
societal norms

3974
02:20:55,990 --> 02:20:54,880
you know just ways of behaving the right

3975
02:20:58,389 --> 02:20:56,000
way to behave

3976
02:20:59,830 --> 02:20:58,399
um you know these are just simple

3977
02:21:01,990 --> 02:20:59,840
hypotheses

3978
02:21:03,349 --> 02:21:02,000
that explain a lot of my behavior and a

3979
02:21:04,550 --> 02:21:03,359
lot of your behavior in a really

3980
02:21:06,309 --> 02:21:04,560
parsimonious way

3981
02:21:08,230 --> 02:21:06,319
and therefore they have big evidence

3982
02:21:12,070 --> 02:21:08,240
although free energy because

3983
02:21:13,270 --> 02:21:12,080
they provide simple explanations um so

3984
02:21:14,550 --> 02:21:13,280
but you're bringing something else to

3985
02:21:15,670 --> 02:21:14,560
the table which is which is

3986
02:21:17,429 --> 02:21:15,680
an interesting one which i haven't

3987
02:21:18,070 --> 02:21:17,439
thought about which of course these

3988
02:21:21,190 --> 02:21:18,080

kinds of

3989
02:21:24,309 --> 02:21:21,200
um hypotheses are easy to share as well

3990
02:21:25,830 --> 02:21:24,319
in virtue of their simplicity um and

3991
02:21:28,710 --> 02:21:25,840
there's always going to be benefit in

3992
02:21:31,910 --> 02:21:28,720
having um a shared or conserved

3993
02:21:32,790 --> 02:21:31,920
or a common genitive model um provided

3994
02:21:34,309 --> 02:21:32,800
as you say that

3995
02:21:36,150 --> 02:21:34,319
we're all cooperating we're all acting

3996
02:21:38,469 --> 02:21:36,160
as con specifics um

3997
02:21:39,670 --> 02:21:38,479
it's interesting to um and you know so

3998
02:21:43,270 --> 02:21:39,680
in answer to your question

3999
02:21:46,309 --> 02:21:43,280
i am sure that if you simulated multiple

4000
02:21:47,750 --> 02:21:46,319
agents all free energy minimizing all

4001
02:21:49,910 --> 02:21:47,760
trying to predict each other

4002
02:21:50,950 --> 02:21:49,920
in the most efficient way possible and

4003
02:21:53,990 --> 02:21:50,960
then one of them had

4004
02:21:57,030 --> 02:21:54,000
this simple hypothesis of a religious

4005
02:21:59,190 --> 02:21:57,040
or a ideological or theological sword

4006
02:22:01,110 --> 02:21:59,200
that made sense of lots of things to

4007
02:22:03,030 --> 02:22:01,120
which everybody could subscribe

4008
02:22:04,309 --> 02:22:03,040
you'd suddenly see the consolidation and

4009
02:22:06,309 --> 02:22:04,319
the emergence of that

4010
02:22:07,830 --> 02:22:06,319
of that aspect of the generative model

4011
02:22:08,550 --> 02:22:07,840
absolutely and that would render

4012
02:22:12,469 --> 02:22:08,560
everybody

4013
02:22:15,830 --> 02:22:12,479

be reducing their surprise

4014
02:22:17,670 --> 02:22:15,840
um you know and that would

4015
02:22:19,990 --> 02:22:17,680
mathematically be expressed as a

4016
02:22:20,710 --> 02:22:20,000
you know a collective decrease in free

4017
02:22:22,710 --> 02:22:20,720
energy or an

4018
02:22:23,990 --> 02:22:22,720
increase in the adaptive fitness in the

4019
02:22:25,510 --> 02:22:24,000
sense of you know

4020
02:22:27,190 --> 02:22:25,520
increasing the marginal likelihood of

4021
02:22:28,469 --> 02:22:27,200
finding that phenotype around

4022
02:22:30,790 --> 02:22:28,479
if you're simulating multiple

4023
02:22:32,630 --> 02:22:30,800
generations um

4024
02:22:34,389 --> 02:22:32,640
but the well in that case that would be

4025
02:22:35,429 --> 02:22:34,399
trivially correct in saying that there's

4026
02:22:38,710 --> 02:22:35,439
a deity because

4027
02:22:40,150 --> 02:22:38,720
you're the simulator yes

4028
02:22:42,710 --> 02:22:40,160
well that's an interesting hypothesis

4029
02:22:45,270 --> 02:22:42,720
which um interestingly if you

4030
02:22:46,710 --> 02:22:45,280
um if you do philosophy of course then

4031
02:22:48,630 --> 02:22:46,720
you've got the brain in the vat

4032
02:22:49,990 --> 02:22:48,640
thought experiment which indeed actually

4033
02:22:52,950 --> 02:22:50,000
has that exactly

4034
02:22:54,309 --> 02:22:52,960
as an alternative hypothesis uh to

4035
02:22:57,429 --> 02:22:54,319
confound the uh

4036
02:22:59,110 --> 02:22:57,439
um you know the philosophy of of of

4037
02:23:01,270 --> 02:22:59,120
realism versus skepticism

4038
02:23:02,150 --> 02:23:01,280

um but coming to you to your interesting

4039
02:23:03,830 --> 02:23:02,160
point that you know

4040
02:23:05,830 --> 02:23:03,840
what happens if my genitive model is

4041
02:23:09,349 --> 02:23:05,840
that you know you're my enemy

4042
02:23:10,309 --> 02:23:09,359
you're going to you're going to cause me

4043
02:23:12,469 --> 02:23:10,319
surprises

4044
02:23:14,070 --> 02:23:12,479
i think that's that's an interesting one

4045
02:23:15,670 --> 02:23:14,080
you know the level at which we

4046
02:23:17,110 --> 02:23:15,680
simulate these things really only

4047
02:23:19,750 --> 02:23:17,120
addresses um

4048
02:23:21,190 --> 02:23:19,760
cooperation and systems that have

4049
02:23:22,150 --> 02:23:21,200
different components and trying to find

4050
02:23:25,670 --> 02:23:22,160
their place

4051
02:23:27,910 --> 02:23:25,680
with a shared narrative um

4052
02:23:29,910 --> 02:23:27,920
so you know what one would predict is

4053
02:23:32,950 --> 02:23:29,920
that if there were

4054
02:23:35,110 --> 02:23:32,960
um the the there were other kinds of

4055
02:23:37,830 --> 02:23:35,120
agents that were not like you

4056
02:23:38,710 --> 02:23:37,840
um then you would certainly be have to

4057
02:23:39,910 --> 02:23:38,720
represent them

4058
02:23:40,870 --> 02:23:39,920
in virtue of the fact that they're not

4059
02:23:42,070 --> 02:23:40,880
lucky you wouldn't be able to

4060
02:23:44,230 --> 02:23:42,080
communicate with them

4061
02:23:45,830 --> 02:23:44,240
so you know my prediction would be that

4062
02:23:46,870 --> 02:23:45,840
you know whether it's a theological or a

4063
02:23:49,910 --> 02:23:46,880

political

4064
02:23:51,830 --> 02:23:49,920
or other kind of um commitment

4065
02:23:53,750 --> 02:23:51,840
um if there's an in-group and an out

4066
02:23:55,750 --> 02:23:53,760
group for any one given individual

4067
02:23:57,110 --> 02:23:55,760
it is highly unlikely that there will be

4068
02:23:59,190 --> 02:23:57,120
a shared language

4069
02:24:00,950 --> 02:23:59,200
or indeed a big transaction of

4070
02:24:02,550 --> 02:24:00,960
communication between these two groups

4071
02:24:03,990 --> 02:24:02,560
so there will be a mark off blanket if

4072
02:24:04,950 --> 02:24:04,000
you like between the between the

4073
02:24:07,429 --> 02:24:04,960
in-group and the aggro

4074
02:24:08,950 --> 02:24:07,439
the blues and the reds the uh um you

4075
02:24:11,830 --> 02:24:08,960
know wherever you go

4076
02:24:13,270 --> 02:24:11,840
an interesting observation which is not

4077
02:24:14,630 --> 02:24:13,280
mine but i've heard a number of people

4078
02:24:18,150 --> 02:24:14,640
make is that the

4079
02:24:21,429 --> 02:24:18,160
the only um stable

4080
02:24:24,230 --> 02:24:21,439
um non-equilibrium for that in-group out

4081
02:24:26,389 --> 02:24:24,240
group is a 50-50 split

4082
02:24:27,349 --> 02:24:26,399
so the you know in the language of

4083
02:24:29,349 --> 02:24:27,359
theoretical

4084
02:24:30,630 --> 02:24:29,359
biology the evolutionary stable

4085
02:24:34,710 --> 02:24:30,640
strategies for

4086
02:24:37,670 --> 02:24:34,720
opponents um is a 50-50 split

4087
02:24:39,190 --> 02:24:37,680
which is borne out you know time and

4088
02:24:42,389 --> 02:24:39,200

time again in terms of what do you mean

4089
02:24:44,150 --> 02:24:42,399
a 50-50 split of what population

4090
02:24:46,070 --> 02:24:44,160
of the number of people that would

4091
02:24:46,870 --> 02:24:46,080
identify with one group versus another

4092
02:24:49,030 --> 02:24:46,880
group

4093
02:24:50,070 --> 02:24:49,040
yeah so it's become voting interesting

4094
02:24:53,110 --> 02:24:50,080
yeah so

4095
02:24:56,150 --> 02:24:53,120
um brexit versus non-brexit in the in

4096
02:24:59,349 --> 02:24:56,160
the uk or trump versus biden

4097
02:25:01,429 --> 02:24:59,359
um in the most recent american elections

4098
02:25:02,550 --> 02:25:01,439
you know wherever you get something

4099
02:25:04,309 --> 02:25:02,560
where um

4100
02:25:05,910 --> 02:25:04,319
that where there is contention where you

4101
02:25:07,030 --> 02:25:05,920
could commit to one side or the other

4102
02:25:09,510 --> 02:25:07,040
side

4103
02:25:11,750 --> 02:25:09,520
the only if you like contentions or

4104
02:25:15,030 --> 02:25:11,760
dialectics which seem to survive

4105
02:25:19,349 --> 02:25:15,040
is when there's a roughly 50 50 split

4106
02:25:22,710 --> 02:25:19,359
between you um so okay so in other words

4107
02:25:25,270 --> 02:25:22,720
the fact that we stably defer somewhat

4108
02:25:27,110 --> 02:25:25,280
down the line on many important issues

4109
02:25:29,270 --> 02:25:27,120
is adaptive

4110
02:25:30,950 --> 02:25:29,280
yep for the collective as a whole it's

4111
02:25:34,070 --> 02:25:30,960
just maintaining a non-equilibrium

4112
02:25:35,910 --> 02:25:34,080
steady state yeah i mean adaptive in

4113
02:25:38,790 --> 02:25:35,920

their deflationary sense that

4114
02:25:39,510 --> 02:25:38,800
you know that is one way to to to

4115
02:25:41,910 --> 02:25:39,520
maintain

4116
02:25:43,190 --> 02:25:41,920
you know a uh an extended

4117
02:25:45,349 --> 02:25:43,200
non-equilibrium

4118
02:25:46,870 --> 02:25:45,359
um you know where now we're talking

4119
02:25:48,550 --> 02:25:46,880
about markov blankets and mark off

4120
02:25:51,110 --> 02:25:48,560
blankets and sort of applying

4121
02:25:53,429 --> 02:25:51,120
blankets to um you know to multiple

4122
02:25:55,750 --> 02:25:53,439
agents

4123
02:25:57,110 --> 02:25:55,760
there's one quote that i love that i i

4124
02:25:59,670 --> 02:25:57,120
try to live by and it's

4125
02:26:01,349 --> 02:25:59,680
only the shallowest of minds would think

4126
02:26:02,309 --> 02:26:01,359
that in great controversy one side is

4127
02:26:04,469 --> 02:26:02,319
mere folly

4128
02:26:06,550 --> 02:26:04,479
i'm sure you've heard that before i

4129
02:26:08,469 --> 02:26:06,560
haven't heard that particular one but

4130
02:26:09,590 --> 02:26:08,479
i've heard something similar which which

4131
02:26:11,270 --> 02:26:09,600
is

4132
02:26:13,190 --> 02:26:11,280
okay so do you believe in free will and

4133
02:26:16,469 --> 02:26:13,200
if so how do you define it

4134
02:26:20,070 --> 02:26:16,479
so um free will um yup um

4135
02:26:23,270 --> 02:26:20,080
i mean you ask do i believe in it

4136
02:26:27,750 --> 02:26:23,280
there's certainly space for um free will

4137
02:26:29,190 --> 02:26:27,760
um in the um the realization of a free

4138
02:26:32,790 --> 02:26:29,200

energy principle

4139
02:26:35,110 --> 02:26:32,800
in sentient artifacts at many levels um

4140
02:26:36,389 --> 02:26:35,120
you you when you actually come to write

4141
02:26:39,670 --> 02:26:36,399
down and simulate

4142
02:26:42,630 --> 02:26:39,680
or build little toy um agents

4143
02:26:44,550 --> 02:26:42,640
you very quickly realize that the most

4144
02:26:47,190 --> 02:26:44,560
interesting in fact the only

4145
02:26:48,070 --> 02:26:47,200
interesting behaviors um that you can

4146
02:26:50,469 --> 02:26:48,080
simulate

4147
02:26:51,590 --> 02:26:50,479
arise when you write down the generative

4148
02:26:54,790 --> 02:26:51,600
models

4149
02:26:55,670 --> 02:26:54,800
as containing um autonomous dynamics

4150
02:26:59,030 --> 02:26:55,680
usually of a

4151
02:27:02,230 --> 02:26:59,040
chaotic sort so the reason i

4152
02:27:02,870 --> 02:27:02,240
i use the word autonomous dynamics is

4153
02:27:04,870 --> 02:27:02,880
that

4154
02:27:07,510 --> 02:27:04,880
you know mathematically speaking there's

4155
02:27:10,230 --> 02:27:07,520
a sort of free will in the autonomy

4156
02:27:10,630 --> 02:27:10,240
there's even in a deterministic setting

4157
02:27:14,950 --> 02:27:10,640
there

4158
02:27:17,270 --> 02:27:14,960
is um um you know

4159
02:27:18,550 --> 02:27:17,280
an unpredictability given the initial

4160
02:27:23,349 --> 02:27:18,560
conditions

4161
02:27:24,870 --> 02:27:23,359
um that cannot be determined so um

4162
02:27:27,750 --> 02:27:24,880
in that sense there has to be a

4163
02:27:31,190 --> 02:27:27,760

mathematical kind of of free will

4164
02:27:33,349 --> 02:27:31,200
at play um the the um

4165
02:27:35,030 --> 02:27:33,359
the other the other sort of take i guess

4166
02:27:36,790 --> 02:27:35,040
on free will is it comes back to what we

4167
02:27:38,790 --> 02:27:36,800
were talking about before about

4168
02:27:40,790 --> 02:27:38,800
you know making our own sensations

4169
02:27:41,830 --> 02:27:40,800
creating our own sensorium so if you

4170
02:27:44,870 --> 02:27:41,840
remember that

4171
02:27:48,550 --> 02:27:44,880
um the you know

4172
02:27:51,750 --> 02:27:48,560
from the point of view of minimizing um

4173
02:27:54,550 --> 02:27:51,760
prediction error as surprise there are

4174
02:27:57,590 --> 02:27:54,560
two ways i can do that i can

4175
02:27:57,990 --> 02:27:57,600
change my mind so that my predictions

4176
02:28:00,230 --> 02:27:58,000
are more

4177
02:28:02,230 --> 02:28:00,240
like what i'm sensing and that would be

4178
02:28:03,190 --> 02:28:02,240
a minimization of particular through

4179
02:28:05,349 --> 02:28:03,200
perception

4180
02:28:06,710 --> 02:28:05,359
but there's another way of doing that

4181
02:28:08,230 --> 02:28:06,720
minimizing the prediction

4182
02:28:10,309 --> 02:28:08,240
i can actually just change what i'm

4183
02:28:11,670 --> 02:28:10,319
sampling to make the sensations more

4184
02:28:13,990 --> 02:28:11,680
like the predictions

4185
02:28:15,590 --> 02:28:14,000
so that's you know that's action in the

4186
02:28:16,550 --> 02:28:15,600
service of minimizing surprise or

4187
02:28:19,910 --> 02:28:16,560
prediction

4188
02:28:24,389 --> 02:28:19,920

but what that means is that my actions

4189
02:28:28,070 --> 02:28:24,399
are basically in enslaved

4190
02:28:31,349 --> 02:28:28,080
to where they can fulfill my predictions

4191
02:28:33,750 --> 02:28:31,359
so they are in the service of um

4192
02:28:35,349 --> 02:28:33,760
fulfilling prophecies so collectively

4193
02:28:36,150 --> 02:28:35,359
action perception is a self-fulfilling

4194
02:28:38,870 --> 02:28:36,160
prophecy

4195
02:28:39,349 --> 02:28:38,880
and in that sense i think you know um

4196
02:28:42,950 --> 02:28:39,359
you can

4197
02:28:46,230 --> 02:28:42,960
find free will you know if if we are

4198
02:28:48,710 --> 02:28:46,240
creating our own worlds and our own um

4199
02:28:49,750 --> 02:28:48,720
sensory inputs we're constructing our

4200
02:28:52,950 --> 02:28:49,760
sensorium

4201
02:28:53,349 --> 02:28:52,960
uh who else is doing it no so in that

4202
02:28:56,309 --> 02:28:53,359
very

4203
02:28:58,710 --> 02:28:56,319
simple um i won't say deflationary but

4204
02:29:01,270 --> 02:28:58,720
simple account of free will

4205
02:29:02,630 --> 02:29:01,280
then i i can't see how it can be any

4206
02:29:05,270 --> 02:29:02,640
other way really

4207
02:29:06,790 --> 02:29:05,280
i had there's something that i've been

4208
02:29:07,670 --> 02:29:06,800
wanting to study for quite some time and

4209
02:29:09,349 --> 02:29:07,680
i've been making

4210
02:29:11,110 --> 02:29:09,359
extensive notes on which is

4211
02:29:12,950 --> 02:29:11,120
self-fulfilling prophecies i find it to

4212
02:29:15,349 --> 02:29:12,960
be an extremely interesting area

4213
02:29:16,550 --> 02:29:15,359

of research the fact that you can have

4214
02:29:18,790 --> 02:29:16,560
them

4215
02:29:19,670 --> 02:29:18,800
it's like you have a model of the world

4216
02:29:20,950 --> 02:29:19,680
and

4217
02:29:22,389 --> 02:29:20,960
most of the time what you want to do is

4218
02:29:23,910 --> 02:29:22,399
make sure that your model comports with

4219
02:29:25,429 --> 02:29:23,920
reality but then it's as if there are

4220
02:29:26,790 --> 02:29:25,439
these blank spots in reality

4221
02:29:28,389 --> 02:29:26,800
where whatever you think if you think

4222
02:29:30,070 --> 02:29:28,399
there's a chair there then a chair

4223
02:29:32,070 --> 02:29:30,080
becomes

4224
02:29:33,190 --> 02:29:32,080
i know that that's an extreme example

4225
02:29:37,190 --> 02:29:33,200
but what i mean is that

4226
02:29:38,630 --> 02:29:37,200
if you imagine that your wife loves you

4227
02:29:39,990 --> 02:29:38,640
then you're going to act in a manner

4228
02:29:41,590 --> 02:29:40,000
that makes her love you more and if you

4229
02:29:42,790 --> 02:29:41,600
mistrust and so on so on so they're

4230
02:29:44,230 --> 02:29:42,800
self-fulfilling so it's as if there's

4231
02:29:46,150 --> 02:29:44,240
these lacunas in the world

4232
02:29:48,550 --> 02:29:46,160
that whatever you think is there becomes

4233
02:29:50,950 --> 02:29:48,560
there i wanted to know what your

4234
02:29:52,630 --> 02:29:50,960
free energy principle had to say about

4235
02:29:55,670 --> 02:29:52,640
self-fulfilling prophecies i imagine

4236
02:29:57,750 --> 02:29:55,680
quite a quite a lot but

4237
02:30:00,550 --> 02:29:57,760
i don't not sure if we have enough time

4238
02:30:02,469 --> 02:30:00,560

do you have any quick notes on

4239
02:30:04,230 --> 02:30:02,479
well i mean the way that you just

4240
02:30:05,429 --> 02:30:04,240
articulated that is it's spot on from

4241
02:30:06,389 --> 02:30:05,439
the point of view of the free energy

4242
02:30:09,510 --> 02:30:06,399
principles so we

4243
02:30:12,630 --> 02:30:09,520
we often use the phrase action is there

4244
02:30:13,349 --> 02:30:12,640
to realize and fulfill uh the prophecies

4245
02:30:16,309 --> 02:30:13,359
supplied

4246
02:30:17,270 --> 02:30:16,319
by the brain yeah it is literally a way

4247
02:30:23,670 --> 02:30:17,280
of

4248
02:30:25,190 --> 02:30:23,680
self uh realizing and um you know

4249
02:30:27,030 --> 02:30:25,200
self-fulfilling prophecies

4250
02:30:29,190 --> 02:30:27,040
you know i think that and the question

4251
02:30:31,830 --> 02:30:29,200
is can you keep on doing that

4252
02:30:33,110 --> 02:30:31,840
um in the face of a particular

4253
02:30:34,950 --> 02:30:33,120
environment that may allow you to do

4254
02:30:36,870 --> 02:30:34,960
that or may not and in particular

4255
02:30:38,230 --> 02:30:36,880
if you do it lots of other people who

4256
02:30:40,389 --> 02:30:38,240
are also

4257
02:30:42,710 --> 02:30:40,399
trying to pursue and self-fulfill their

4258
02:30:45,429 --> 02:30:42,720
their their purposes so

4259
02:30:46,230 --> 02:30:45,439
like what are the limitations of it yeah

4260
02:30:47,910 --> 02:30:46,240
yeah so

4261
02:30:49,349 --> 02:30:47,920
you know i i think that that's

4262
02:30:53,030 --> 02:30:49,359
absolutely right and it also

4263
02:30:54,230 --> 02:30:53,040

speaks to um you know seeing stuff which

4264
02:30:57,590 --> 02:30:54,240
is not there

4265
02:30:59,650 --> 02:30:57,600
um um starts to talk uh

4266
02:31:00,790 --> 02:30:59,660
brings us into the world

4267
02:31:03,670 --> 02:31:00,800
[Music]

4268
02:31:05,030 --> 02:31:03,680
of false inference and delusions and

4269
02:31:08,230 --> 02:31:05,040
hallucinations and

4270
02:31:10,469 --> 02:31:08,240
the kinds of um fulfilling self

4271
02:31:12,309 --> 02:31:10,479
sorry self-fulfilling prophecies of a

4272
02:31:14,469 --> 02:31:12,319
perceptual sort that people with

4273
02:31:16,790 --> 02:31:14,479
things like autism or schizophrenia

4274
02:31:19,910 --> 02:31:16,800
might be subject to so

4275
02:31:22,710 --> 02:31:19,920
you can go too far but on the other hand

4276
02:31:23,429 --> 02:31:22,720
you know there are many people who um

4277
02:31:26,389 --> 02:31:23,439
now

4278
02:31:28,630 --> 02:31:26,399
consider perception basically as sort of

4279
02:31:30,950 --> 02:31:28,640
hallucinations that are entrained by

4280
02:31:31,830 --> 02:31:30,960
by sensory input that your what we

4281
02:31:33,670 --> 02:31:31,840
actually see is

4282
02:31:35,750 --> 02:31:33,680
is it's sort of you know a product of

4283
02:31:36,950 --> 02:31:35,760
the hypotheses about what best explain

4284
02:31:38,870 --> 02:31:36,960
what's going on

4285
02:31:40,550 --> 02:31:38,880
and there are occasions when we can get

4286
02:31:42,469 --> 02:31:40,560
those hypotheses wrong

4287
02:31:45,110 --> 02:31:42,479
and that we have we're then subject to

4288
02:31:49,190 --> 02:31:45,120

illusions for example in psychophysics

4289
02:31:51,910 --> 02:31:49,200
or hallucinations um

4290
02:31:54,469 --> 02:31:51,920
and indeed delusions you know if we've

4291
02:31:55,030 --> 02:31:54,479
taken some psychedelic drugs or that we

4292
02:31:57,990 --> 02:31:55,040
have

4293
02:31:59,750 --> 02:31:58,000
conditions such as say schizophrenia so

4294
02:32:01,510 --> 02:31:59,760
then is schizophrenia a pathology of

4295
02:32:04,230 --> 02:32:01,520
free will

4296
02:32:05,270 --> 02:32:04,240
i don't think so no no i i think it's a

4297
02:32:08,870 --> 02:32:05,280
pathology of

4298
02:32:10,550 --> 02:32:08,880
of um that can be understood as a false

4299
02:32:13,590 --> 02:32:10,560
inference but i i don't

4300
02:32:17,830 --> 02:32:13,600
think that there's any um

4301
02:32:20,070 --> 02:32:17,840
uh aspect of um um

4302
02:32:21,349 --> 02:32:20,080
that would enable you to sort of isolate

4303
02:32:25,030 --> 02:32:21,359
free will as the

4304
02:32:27,030 --> 02:32:25,040
as the locus of that false inference

4305
02:32:28,230 --> 02:32:27,040
there's certainly a lot of a lot of work

4306
02:32:30,309 --> 02:32:28,240
suggesting that it

4307
02:32:31,270 --> 02:32:30,319
that the people with schizophrenia when

4308
02:32:34,469 --> 02:32:31,280
they are

4309
02:32:37,429 --> 02:32:34,479
acutely psychotic may have difficulties

4310
02:32:37,670 --> 02:32:37,439
um inferring who did that so assignment

4311
02:32:40,630 --> 02:32:37,680
of

4312
02:32:40,950 --> 02:32:40,640
agency so in the sense that you know who

4313
02:32:43,190 --> 02:32:40,960

will

4314
02:32:44,389 --> 02:32:43,200
that was it you or me there may be a

4315
02:32:47,510 --> 02:32:44,399
slight confusion

4316
02:32:47,910 --> 02:32:47,520
so i if i say something to myself i may

4317
02:32:49,270 --> 02:32:47,920
have

4318
02:32:51,030 --> 02:32:49,280
actually you said it you put that

4319
02:32:52,790 --> 02:32:51,040
thought into my head so

4320
02:32:54,469 --> 02:32:52,800
you know that's just your a false

4321
02:32:56,309 --> 02:32:54,479
attribution of agency

4322
02:32:58,309 --> 02:32:56,319
um so in that sense perhaps you could

4323
02:33:01,270 --> 02:32:58,319
say that that is a form of

4324
02:33:01,670 --> 02:33:01,280
disorganized free will um but certainly

4325
02:33:04,230 --> 02:33:01,680
the

4326
02:33:06,150 --> 02:33:04,240
people with schizophrenia that i have

4327
02:33:09,030 --> 02:33:06,160
treated or worked with in the past

4328
02:33:10,150 --> 02:33:09,040
um you know i think they would have a

4329
02:33:12,469 --> 02:33:10,160
sense of self

4330
02:33:14,630 --> 02:33:12,479
and um you know a sense of free will

4331
02:33:15,270 --> 02:33:14,640
which which would be indistinguishable

4332
02:33:18,790 --> 02:33:15,280
from uh

4333
02:33:20,469 --> 02:33:18,800
from yours and mine you know i know that

4334
02:33:22,469 --> 02:33:20,479
we have to wrap up at some point soon

4335
02:33:23,190 --> 02:33:22,479
and i wanted to bring this up i didn't

4336
02:33:25,830 --> 02:33:23,200
know how

4337
02:33:27,429 --> 02:33:25,840
but i'll just tell you quickly the a few

4338
02:33:27,990 --> 02:33:27,439

months ago maybe i'll even take this out

4339
02:33:30,230 --> 02:33:28,000
of the

4340
02:33:31,670 --> 02:33:30,240
actual clip but a few months ago january

4341
02:33:33,190 --> 02:33:31,680
february i was

4342
02:33:34,790 --> 02:33:33,200
i woke up in the middle of the night and

4343
02:33:35,510 --> 02:33:34,800
then i had a conversation with my wife

4344
02:33:37,349 --> 02:33:35,520
it was minor

4345
02:33:39,030 --> 02:33:37,359
neutral wasn't positive or negative and

4346
02:33:40,790 --> 02:33:39,040
then as i was going back to sleep she

4347
02:33:42,710 --> 02:33:40,800
either said yes or okay

4348
02:33:44,469 --> 02:33:42,720
or she could have not said it but i was

4349
02:33:46,309 --> 02:33:44,479
in this hypnagogic

4350
02:33:48,309 --> 02:33:46,319
almost sleep-like state and i've never

4351
02:33:48,950 --> 02:33:48,319
had a panic attack in my life but for

4352
02:33:50,950 --> 02:33:48,960
some reason

4353
02:33:52,630 --> 02:33:50,960
i wasn't sure if she said okay or yes or

4354
02:33:53,110 --> 02:33:52,640
whatever it was or if it was in my own

4355
02:33:55,830 --> 02:33:53,120
head

4356
02:33:56,469 --> 02:33:55,840
and then i thought am i am i psychotic

4357
02:33:58,710 --> 02:33:56,479
am i getting

4358
02:34:00,389 --> 02:33:58,720
schizophrenia i don't know why it's not

4359
02:34:02,070 --> 02:34:00,399
like that was a background anxiety of

4360
02:34:03,270 --> 02:34:02,080
mine before maybe it was maybe it's

4361
02:34:05,190 --> 02:34:03,280
latent but

4362
02:34:06,950 --> 02:34:05,200
then i started to have a panic attack

4363
02:34:09,190 --> 02:34:06,960

because i didn't want to hear

4364
02:34:11,190 --> 02:34:09,200
anything and i felt like i may be able

4365
02:34:12,070 --> 02:34:11,200
to will myself to hear something by

4366
02:34:13,830 --> 02:34:12,080
telling myself

4367
02:34:15,429 --> 02:34:13,840
don't hear then i'm like well what would

4368
02:34:17,030 --> 02:34:15,439
it sound like if i were to hear

4369
02:34:18,950 --> 02:34:17,040
then it's like no no don't go down there

4370
02:34:21,590 --> 02:34:18,960
because you may hear a voice

4371
02:34:23,750 --> 02:34:21,600
and i don't want to go i don't want to

4372
02:34:25,429 --> 02:34:23,760
be crazy i don't want to be psychotic

4373
02:34:28,230 --> 02:34:25,439
a couple days later i had another panic

4374
02:34:31,110 --> 02:34:28,240
attack almost based on the worry

4375
02:34:31,429 --> 02:34:31,120
that i'm going to be psychotic rather

4376
02:34:34,710 --> 02:34:31,439
than

4377
02:34:35,429 --> 02:34:34,720
i am at all and and i'm i've been afraid

4378
02:34:38,790 --> 02:34:35,439
to search

4379
02:34:40,790 --> 02:34:38,800
about schizophrenia because i don't want

4380
02:34:41,349 --> 02:34:40,800
to read that i have the symptoms of it

4381
02:34:43,429 --> 02:34:41,359
and

4382
02:34:45,429 --> 02:34:43,439
there's nothing else other than that i

4383
02:34:46,630 --> 02:34:45,439
may have heard my wife say okay or yes

4384
02:34:48,790 --> 02:34:46,640
in a state where i was

4385
02:34:50,309 --> 02:34:48,800
about to sleep and that she actually may

4386
02:34:52,469 --> 02:34:50,319
have in fact said it

4387
02:34:53,510 --> 02:34:52,479
or not i talked to my doctor about this

4388
02:34:55,750 --> 02:34:53,520

on the phone because it's

4389
02:34:57,190 --> 02:34:55,760
kovit and she said oh kurt well you can

4390
02:34:58,790 --> 02:34:57,200
hear many things you can hear

4391
02:35:00,230 --> 02:34:58,800
music when you're about to sleep you can

4392
02:35:01,750 --> 02:35:00,240
your foot can feel like you're about to

4393
02:35:03,670 --> 02:35:01,760
fall off and you

4394
02:35:05,190 --> 02:35:03,680
so don't worry about that and i found

4395
02:35:06,150 --> 02:35:05,200
that when i talk about it i feel much

4396
02:35:08,790 --> 02:35:06,160
more at ease

4397
02:35:10,469 --> 02:35:08,800
but ever since then for three months

4398
02:35:12,630 --> 02:35:10,479
carl for three months

4399
02:35:14,070 --> 02:35:12,640
at night time i've had such a difficult

4400
02:35:16,550 --> 02:35:14,080
time falling asleep

4401
02:35:17,750 --> 02:35:16,560
because i'm afraid of my own mind i

4402
02:35:19,270 --> 02:35:17,760
can't let myself be

4403
02:35:20,870 --> 02:35:19,280
alone with my own thoughts because i'm

4404
02:35:24,070 --> 02:35:20,880
afraid of what i might find

4405
02:35:26,710 --> 02:35:24,080
and it's created such anxiety in me that

4406
02:35:28,389 --> 02:35:26,720
i while i can't rely on any

4407
02:35:29,670 --> 02:35:28,399
benzodiazepine to sleep because that can

4408
02:35:32,070 --> 02:35:29,680
just put you in a

4409
02:35:33,590 --> 02:35:32,080
that'll create way worse problems so i

4410
02:35:34,389 --> 02:35:33,600
have to find some way of sleeping

4411
02:35:36,550 --> 02:35:34,399
without any

4412
02:35:37,750 --> 02:35:36,560
medication besides maybe melatonin

4413
02:35:39,429 --> 02:35:37,760

that's difficult

4414
02:35:41,429 --> 02:35:39,439
and i'm just not sure what to do with

4415
02:35:43,030 --> 02:35:41,439
that issue i brought this up on one of

4416
02:35:44,469 --> 02:35:43,040
my podcasts because

4417
02:35:45,990 --> 02:35:44,479
i feel like there are plenty of people

4418
02:35:47,030 --> 02:35:46,000
who may be experiencing what i'm

4419
02:35:49,590 --> 02:35:47,040
experiencing

4420
02:35:50,950 --> 02:35:49,600
but but people don't talk about it it

4421
02:35:52,230 --> 02:35:50,960
turns out when i did talk about it many

4422
02:35:53,349 --> 02:35:52,240
people in the comments section said

4423
02:35:55,510 --> 02:35:53,359
i can't believe you've been going

4424
02:35:57,590 --> 02:35:55,520
through this that's i've been going

4425
02:35:59,270 --> 02:35:57,600
through something similar

4426
02:36:01,429 --> 02:35:59,280
when i study about consciousness and so

4427
02:36:02,070 --> 02:36:01,439
on for this for these types of

4428
02:36:04,070 --> 02:36:02,080
interviews

4429
02:36:05,429 --> 02:36:04,080
i feel like i don't know what reality is

4430
02:36:06,309 --> 02:36:05,439
anymore because there's so many

4431
02:36:09,349 --> 02:36:06,319
different theories

4432
02:36:10,550 --> 02:36:09,359
and so that is destabilizing me on top

4433
02:36:12,389 --> 02:36:10,560
of what i've already been feeling and

4434
02:36:14,150 --> 02:36:12,399
i'm unsure what to do about it

4435
02:36:15,510 --> 02:36:14,160
and i just want to know what what advice

4436
02:36:17,990 --> 02:36:15,520
do you have i know that that's

4437
02:36:19,590 --> 02:36:18,000
extremely personal question but what

4438
02:36:22,790 --> 02:36:19,600

what do you recommend that i do

4439
02:36:23,349 --> 02:36:22,800
or not do well ironically you've just

4440
02:36:26,710 --> 02:36:23,359
done it

4441
02:36:29,910 --> 02:36:26,720
um um so um

4442
02:36:32,150 --> 02:36:29,920
now you i i i'm responding as in my role

4443
02:36:32,790 --> 02:36:32,160
as a psychiatrist not not obviously

4444
02:36:34,950 --> 02:36:32,800
author of

4445
02:36:36,309 --> 02:36:34,960
the free energy principle although much

4446
02:36:37,990 --> 02:36:36,319
of the free energy principle was

4447
02:36:39,270 --> 02:36:38,000
actually inspired by

4448
02:36:41,190 --> 02:36:39,280
exactly the questions that you're

4449
02:36:44,469 --> 02:36:41,200
contending with you know

4450
02:36:46,309 --> 02:36:44,479
how do i maintain a sense of self

4451
02:36:47,910 --> 02:36:46,319
which is the most important part of my

4452
02:36:50,790 --> 02:36:47,920
narratives

4453
02:36:51,510 --> 02:36:50,800
explain explain me and what can go wrong

4454
02:36:54,790 --> 02:36:51,520
when you have

4455
02:36:55,670 --> 02:36:54,800
um psychosis i think the first thing to

4456
02:36:57,650 --> 02:36:55,680
say

4457
02:36:58,870 --> 02:36:57,660
is that

4458
02:37:01,590 --> 02:36:58,880
[Music]

4459
02:37:02,230 --> 02:37:01,600
there have been an enormous number of

4460
02:37:05,349 --> 02:37:02,240
people

4461
02:37:07,349 --> 02:37:05,359
um around the world during um

4462
02:37:08,710 --> 02:37:07,359
lockdown and during the coronavirus

4463
02:37:11,429 --> 02:37:08,720

crisis with reduced

4464
02:37:12,230 --> 02:37:11,439
social contacts and changing points of

4465
02:37:14,870 --> 02:37:12,240
reference so

4466
02:37:16,630 --> 02:37:14,880
your old narratives your old models are

4467
02:37:18,309 --> 02:37:16,640
just not fit for purpose

4468
02:37:20,230 --> 02:37:18,319
and in a sense you've got to be able to

4469
02:37:22,550 --> 02:37:20,240
grieve for the things what that

4470
02:37:23,270 --> 02:37:22,560
your the way that things were and it's

4471
02:37:25,670 --> 02:37:23,280
quite

4472
02:37:27,349 --> 02:37:25,680
frightening to actually relearn how to

4473
02:37:30,230 --> 02:37:27,359
live even for a few months

4474
02:37:31,510 --> 02:37:30,240
um you're in in a new covered world and

4475
02:37:34,230 --> 02:37:31,520
certainly if there's been

4476
02:37:35,830 --> 02:37:34,240
um you know so changes in in social

4477
02:37:36,550 --> 02:37:35,840
distancing on the way that you interact

4478
02:37:39,590 --> 02:37:36,560
with people

4479
02:37:42,469 --> 02:37:39,600
and i should say also when and if

4480
02:37:43,429 --> 02:37:42,479
you um have to unlock that will also be

4481
02:37:45,429 --> 02:37:43,439
very uh you know

4482
02:37:46,630 --> 02:37:45,439
anxiety provoking as well because of the

4483
02:37:47,510 --> 02:37:46,640
uncertainty you've got to really learn

4484
02:37:49,750 --> 02:37:47,520
how to do it

4485
02:37:51,030 --> 02:37:49,760
so lots of my colleagues have had um

4486
02:37:54,389 --> 02:37:51,040
psychotic breaks

4487
02:37:56,309 --> 02:37:54,399
um and you i i talking to you i think

4488
02:37:57,830 --> 02:37:56,319

it's highly unlikely that you have any

4489
02:38:00,469 --> 02:37:57,840
form of psychosis

4490
02:38:02,070 --> 02:38:00,479
or indeed an acute psychotic episode

4491
02:38:04,389 --> 02:38:02,080
just by your composure

4492
02:38:05,670 --> 02:38:04,399
your theory of mind um a lot of other

4493
02:38:07,990 --> 02:38:05,680
non-verbal cues

4494
02:38:09,670 --> 02:38:08,000
however i do have many colleagues who've

4495
02:38:12,710 --> 02:38:09,680
actually had an acute psychotic

4496
02:38:14,309 --> 02:38:12,720
episode uh in response to this um

4497
02:38:16,630 --> 02:38:14,319
i been you know a lot of my close

4498
02:38:19,990 --> 02:38:16,640
colleagues have um

4499
02:38:21,190 --> 02:38:20,000
and it's perfectly natural they usually

4500
02:38:23,590 --> 02:38:21,200
last about sort of

4501
02:38:24,630 --> 02:38:23,600
um you know sort of a few weeks to a

4502
02:38:27,670 --> 02:38:24,640
month or two

4503
02:38:29,110 --> 02:38:27,680
um may respond to medication if if if

4504
02:38:30,950 --> 02:38:29,120
the person is becoming

4505
02:38:33,190 --> 02:38:30,960
sufficiently agitated or they're

4506
02:38:36,550 --> 02:38:33,200
worrying their their the close family

4507
02:38:38,389 --> 02:38:36,560
um you know it

4508
02:38:40,550 --> 02:38:38,399
needs containment pharmacologically

4509
02:38:41,349 --> 02:38:40,560
that's certainly viable if it gets that

4510
02:38:43,590 --> 02:38:41,359
far

4511
02:38:45,030 --> 02:38:43,600
usually it doesn't but the important

4512
02:38:45,670 --> 02:38:45,040
thing to know is this is perfectly

4513
02:38:48,790 --> 02:38:45,680

normal

4514
02:38:51,349 --> 02:38:48,800
you know um even if you haven't had a

4515
02:38:53,270 --> 02:38:51,359
psychotic episode if you had had

4516
02:38:55,510 --> 02:38:53,280
it's lots of people are going through

4517
02:38:58,389 --> 02:38:55,520
this which brings me to

4518
02:39:00,309 --> 02:38:58,399
the answer to your question um you can

4519
02:39:02,309 --> 02:39:00,319
certainly talk to your gp

4520
02:39:04,309 --> 02:39:02,319
um and talk to health care professionals

4521
02:39:08,309 --> 02:39:04,319
and mental health care professionals

4522
02:39:10,870 --> 02:39:08,319
and um there will be the option of

4523
02:39:11,510 --> 02:39:10,880
medication uh either to help with sleep

4524
02:39:14,469 --> 02:39:11,520
or to

4525
02:39:14,950 --> 02:39:14,479
if you actually did have a psychotic um

4526
02:39:17,270 --> 02:39:14,960
break

4527
02:39:18,469 --> 02:39:17,280
to take the edge off that and enable

4528
02:39:20,309 --> 02:39:18,479
everybody to cope with

4529
02:39:21,830 --> 02:39:20,319
you know with the consequences that's

4530
02:39:23,190 --> 02:39:21,840
always an option should you want to go

4531
02:39:25,510 --> 02:39:23,200
for it and you shouldn't feel

4532
02:39:26,230 --> 02:39:25,520
ashamed of doing that or in any way

4533
02:39:28,630 --> 02:39:26,240
hesitant

4534
02:39:30,150 --> 02:39:28,640
i have to say that the nature of these

4535
02:39:32,950 --> 02:39:30,160
episodes is such that

4536
02:39:34,469 --> 02:39:32,960
it won't be the person who has the

4537
02:39:36,630 --> 02:39:34,479
psychotic episode

4538
02:39:38,469 --> 02:39:36,640

who knows that they they need

4539
02:39:40,870 --> 02:39:38,479
containment and looking after

4540
02:39:42,469 --> 02:39:40,880
of a particular kind it's usually the

4541
02:39:43,270 --> 02:39:42,479
the next of kin their children their

4542
02:39:45,429 --> 02:39:43,280
parents or

4543
02:39:47,030 --> 02:39:45,439
or their wife or their husband uh who

4544
02:39:48,870 --> 02:39:47,040
has to take the initiative to

4545
02:39:50,710 --> 02:39:48,880
to bring in support and help to get that

4546
02:39:52,550 --> 02:39:50,720
done and that help is there

4547
02:39:53,750 --> 02:39:52,560
the very fact you're worrying about it

4548
02:39:56,469 --> 02:39:53,760
because you're

4549
02:39:57,429 --> 02:39:56,479
you're almost by definition it can't be

4550
02:39:59,910 --> 02:39:57,439
psychotic because you

4551
02:40:00,550 --> 02:39:59,920
you've got inside uh so just by worrying

4552
02:40:03,590 --> 02:40:00,560
about it i'm

4553
02:40:04,950 --> 02:40:03,600
afraid uh takes you off that list um but

4554
02:40:06,389 --> 02:40:04,960
it doesn't mean to say the anxiety

4555
02:40:07,910 --> 02:40:06,399
doesn't go away doesn't mean

4556
02:40:10,230 --> 02:40:07,920
you can't you're not actually uh

4557
02:40:11,110 --> 02:40:10,240
psychotic and the other thing which

4558
02:40:13,910 --> 02:40:11,120
which

4559
02:40:14,790 --> 02:40:13,920
really helps um is just what you've

4560
02:40:17,030 --> 02:40:14,800
already said

4561
02:40:17,990 --> 02:40:17,040
it it's basically sharing in the group

4562
02:40:20,230 --> 02:40:18,000
so you know

4563
02:40:21,670 --> 02:40:20,240

the angst that these things generate and

4564
02:40:23,830 --> 02:40:21,680
the you know whether it's a psychotic

4565
02:40:24,550 --> 02:40:23,840
break or not always worrying about it or

4566
02:40:27,429 --> 02:40:24,560
not

4567
02:40:28,950 --> 02:40:27,439
everybody's going through this um and

4568
02:40:32,469 --> 02:40:28,960
being able to share that

4569
02:40:33,429 --> 02:40:32,479
in a group is uh can be enormously

4570
02:40:35,990 --> 02:40:33,439
therapeutic

4571
02:40:37,670 --> 02:40:36,000
for everybody in in the group you know

4572
02:40:40,550 --> 02:40:37,680
so if you can set up

4573
02:40:41,269 --> 02:40:40,560
by sharing a safe environment within

4574
02:40:44,309 --> 02:40:41,279
which

4575
02:40:46,710 --> 02:40:44,319
to share these experiences and anxieties

4576
02:40:48,870 --> 02:40:46,720
and by safe i mean very clearly bounded

4577
02:40:50,150 --> 02:40:48,880
so it starts at a particular time and it

4578
02:40:52,150 --> 02:40:50,160
finishes exactly

4579
02:40:53,190 --> 02:40:52,160
one hour later so you've got this

4580
02:40:55,670 --> 02:40:53,200
boundary so that

4581
02:40:57,110 --> 02:40:55,680
anything that comes out in that context

4582
02:40:59,990 --> 02:40:57,120
can't spill over

4583
02:41:00,389 --> 02:41:00,000
and affect um and can be put back in the

4584
02:41:04,469 --> 02:41:00,399
box

4585
02:41:06,550 --> 02:41:04,479
next week or tomorrow

4586
02:41:08,070 --> 02:41:06,560
with a very very carefree time you know

4587
02:41:09,670 --> 02:41:08,080
who's going to be there

4588
02:41:11,510 --> 02:41:09,680

or you know what kind of people are

4589
02:41:12,870 --> 02:41:11,520
going to be there so boundaries are very

4590
02:41:13,670 --> 02:41:12,880
very important when it comes to group

4591
02:41:16,469 --> 02:41:13,680
therapy that

4592
02:41:17,670 --> 02:41:16,479
that in my in my experience that's the

4593
02:41:19,670 --> 02:41:17,680
most effective

4594
02:41:20,710 --> 02:41:19,680
kind of talking therapy in this

4595
02:41:22,950 --> 02:41:20,720
situation

4596
02:41:24,230 --> 02:41:22,960
how do you get a group together you have

4597
02:41:27,190 --> 02:41:24,240
to say well this is a

4598
02:41:28,950 --> 02:41:27,200
a thing um how do you do that you just

4599
02:41:31,269 --> 02:41:28,960
have to declare you have to come out say

4600
02:41:31,990 --> 02:41:31,279
i'm upset by this i can't get to sleep

4601
02:41:34,550 --> 02:41:32,000
because of this

4602
02:41:36,150 --> 02:41:34,560
this you know you know if i'd told

4603
02:41:37,830 --> 02:41:36,160
myself these worries a year ago i

4604
02:41:39,190 --> 02:41:37,840
thought i was stupid but these are real

4605
02:41:41,750 --> 02:41:39,200
worries they're stopping me

4606
02:41:42,790 --> 02:41:41,760
thinking i can't you know just saying

4607
02:41:44,790 --> 02:41:42,800
that out loud

4608
02:41:45,910 --> 02:41:44,800
means that other people now are aware

4609
02:41:47,030 --> 02:41:45,920
that this is a thing

4610
02:41:49,269 --> 02:41:47,040
and it's something that can be talked

4611
02:41:51,830 --> 02:41:49,279
about so when i said you've just done it

4612
02:41:52,870 --> 02:41:51,840
by just going public in this kind of

4613
02:41:55,830 --> 02:41:52,880

interview

4614
02:41:56,790 --> 02:41:55,840
is the first move the next move is then

4615
02:41:59,990 --> 02:41:56,800
to find

4616
02:42:03,110 --> 02:42:00,000
um you know a a a network

4617
02:42:05,990 --> 02:42:03,120
or a structure that will support um

4618
02:42:06,790 --> 02:42:06,000
either therapist-led or self-help groups

4619
02:42:10,150 --> 02:42:06,800
usually

4620
02:42:11,990 --> 02:42:10,160
small enough that you actually have the

4621
02:42:14,150 --> 02:42:12,000
the intimacy of a small group dynamic

4622
02:42:16,230 --> 02:42:14,160
you know so not more than 12 people

4623
02:42:17,670 --> 02:42:16,240
you usually about so eight people with

4624
02:42:19,030 --> 02:42:17,680
or without a therapist

4625
02:42:21,990 --> 02:42:19,040
you don't need the therapist but it's

4626
02:42:24,469 --> 02:42:22,000
useful um you know if somebody is

4627
02:42:26,070 --> 02:42:24,479
just to get used to the importance of

4628
02:42:28,230 --> 02:42:26,080
boundaries and

4629
02:42:29,269 --> 02:42:28,240
um and group dynamics but it's not

4630
02:42:30,550 --> 02:42:29,279
necessary if

4631
02:42:34,070 --> 02:42:30,560
you know the important things you're

4632
02:42:37,110 --> 02:42:34,080
getting together in a bounded way

4633
02:42:40,469 --> 02:42:37,120
um to to you know to to share

4634
02:42:43,269 --> 02:42:40,479
and um and to just in

4635
02:42:43,830 --> 02:42:43,279
a completely open and non-judgmental way

4636
02:42:45,670 --> 02:42:43,840
um

4637
02:42:47,510 --> 02:42:45,680
tell other people how what they are

4638
02:42:50,469 --> 02:42:47,520

saying makes you feel

4639
02:42:51,830 --> 02:42:50,479
um and just use them to reflect

4640
02:42:53,190 --> 02:42:51,840
literally like a mirror

4641
02:42:55,110 --> 02:42:53,200
you know so come back to the shared

4642
02:42:57,670 --> 02:42:55,120
narrative again and you can

4643
02:42:59,429 --> 02:42:57,680
you can get a long way with that so um

4644
02:43:01,110 --> 02:42:59,439
that that's what i would recommend that

4645
02:43:03,190 --> 02:43:01,120
you you you know

4646
02:43:04,950 --> 02:43:03,200
somebody in your position may well feel

4647
02:43:06,870 --> 02:43:04,960
that perhaps you should start

4648
02:43:08,230 --> 02:43:06,880
um an initiative along these lines or

4649
02:43:09,750 --> 02:43:08,240
actually start you

4650
02:43:11,269 --> 02:43:09,760
you should take the initiative and

4651
02:43:13,910 --> 02:43:11,279
actually set up

4652
02:43:14,309 --> 02:43:13,920
a discussion group or a self-help group

4653
02:43:16,309 --> 02:43:14,319
um

4654
02:43:18,230 --> 02:43:16,319
but if not then certainly look around on

4655
02:43:21,990 --> 02:43:18,240
the web and i'm sure you'll find

4656
02:43:25,110 --> 02:43:22,000
um you know some somebody over the past

4657
02:43:26,150 --> 02:43:25,120
few months um and uh we will have

4658
02:43:29,910 --> 02:43:26,160
started this

4659
02:43:33,269 --> 02:43:29,920
um and be mindful

4660
02:43:35,429 --> 02:43:33,279
that you should tell your wife

4661
02:43:37,110 --> 02:43:35,439
if you do get a psychotic yeah just kind

4662
02:43:39,110 --> 02:43:37,120
of get the doctors into

4663
02:43:40,870 --> 02:43:39,120

to get you medicated because that'll go

4664
02:43:42,710 --> 02:43:40,880
away in about three weeks once you

4665
02:43:44,870 --> 02:43:42,720
you know if you just take the right kind

4666
02:43:46,550 --> 02:43:44,880
of medication it's not a big thing

4667
02:43:48,630 --> 02:43:46,560
you know i repeat it's happened to

4668
02:43:50,870 --> 02:43:48,640
several of my colleagues and friends

4669
02:43:52,070 --> 02:43:50,880
um and you know they're back in the

4670
02:43:53,670 --> 02:43:52,080
saddle now

4671
02:43:55,670 --> 02:43:53,680
and it's been a useful experience

4672
02:43:57,590 --> 02:43:55,680
sometimes people get um

4673
02:43:58,790 --> 02:43:57,600
they get more creative they go slightly

4674
02:44:02,070 --> 02:43:58,800
manic

4675
02:44:03,670 --> 02:44:02,080
i don't sense that in you but um

4676
02:44:05,429 --> 02:44:03,680
i do notice that when i was having my

4677
02:44:06,550 --> 02:44:05,439
high anxiety periods right after the

4678
02:44:09,190 --> 02:44:06,560
initial episode

4679
02:44:10,230 --> 02:44:09,200
that i saw many more connections almost

4680
02:44:12,950 --> 02:44:10,240
like i imagine

4681
02:44:14,790 --> 02:44:12,960
when you're on lsd or a psychedelic that

4682
02:44:16,550 --> 02:44:14,800
everything is imbued with meaning

4683
02:44:18,630 --> 02:44:16,560
that every other sentence someone would

4684
02:44:19,110 --> 02:44:18,640
say in a movie i'm like oh that's so

4685
02:44:21,750 --> 02:44:19,120
deep

4686
02:44:22,630 --> 02:44:21,760
that it makes me want to cry almost now

4687
02:44:25,590 --> 02:44:22,640
that's not there

4688
02:44:27,349 --> 02:44:25,600

i still do see connections but i tend to

4689
02:44:30,870 --> 02:44:27,359
have always seen connections to some

4690
02:44:32,950 --> 02:44:30,880
degree anyway yeah so i mean

4691
02:44:34,309 --> 02:44:32,960
these episodes um will either just

4692
02:44:37,030 --> 02:44:34,319
reveal innate sort of

4693
02:44:38,790 --> 02:44:37,040
you know ways of thinking and seeing and

4694
02:44:41,910 --> 02:44:38,800
making sense of the world

4695
02:44:44,710 --> 02:44:41,920
in particular pro-social context um

4696
02:44:45,590 --> 02:44:44,720
but but certainly you know what i was

4697
02:44:47,590 --> 02:44:45,600
going to say is that

4698
02:44:49,429 --> 02:44:47,600
there can be some um if you keep a

4699
02:44:51,429 --> 02:44:49,439
record of these

4700
02:44:52,469 --> 02:44:51,439
if you can if you just see associations

4701
02:44:55,429 --> 02:44:52,479
and links and just

4702
02:44:57,590 --> 02:44:55,439
keep a documentary every record of it it

4703
02:45:00,389 --> 02:44:57,600
may actually be something quite useful

4704
02:45:02,309 --> 02:45:00,399
either to go back to as a you know an

4705
02:45:03,429 --> 02:45:02,319
essay in the way that you saw the world

4706
02:45:05,110 --> 02:45:03,439
in that particular state of that

4707
02:45:05,910 --> 02:45:05,120
particular time but sometimes you

4708
02:45:08,230 --> 02:45:05,920
actually get some

4709
02:45:09,750 --> 02:45:08,240
quite profound insights you know again a

4710
02:45:11,990 --> 02:45:09,760
number of my colleagues actually do

4711
02:45:13,190 --> 02:45:12,000
suffer from manic depressive psychosis

4712
02:45:15,990 --> 02:45:13,200
uh and of course if you look at the

4713
02:45:17,830 --> 02:45:16,000

history of of your creative people

4714
02:45:19,030 --> 02:45:17,840
in both the you know the arts and the

4715
02:45:20,790 --> 02:45:19,040
sciences uh

4716
02:45:22,070 --> 02:45:20,800
you know you're you're on this edge of

4717
02:45:24,389 --> 02:45:22,080
chaos

4718
02:45:25,750 --> 02:45:24,399
this the the instability that is

4719
02:45:28,550 --> 02:45:25,760
associated with um

4720
02:45:29,990 --> 02:45:28,560
with psychosis so it's not an

4721
02:45:33,030 --> 02:45:30,000
unproductive

4722
02:45:34,870 --> 02:45:33,040
time um you know if you are if you did

4723
02:45:36,070 --> 02:45:34,880
get close to the edge then then make

4724
02:45:39,110 --> 02:45:36,080
sure you keep a very

4725
02:45:41,349 --> 02:45:39,120
um if you can keep a very clear document

4726
02:45:42,630 --> 02:45:41,359
doc document what happened to you and

4727
02:45:44,790 --> 02:45:42,640
everything you can

4728
02:45:45,910 --> 02:45:44,800
this would be nice for you to go back to

4729
02:45:47,990 --> 02:45:45,920
next year yeah i

4730
02:45:49,670 --> 02:45:48,000
definitely take notes on all my thoughts

4731
02:45:51,750 --> 02:45:49,680
i've done so for years anyway

4732
02:45:53,429 --> 02:45:51,760
i'm always constantly saying i can't say

4733
02:45:55,910 --> 02:45:53,439
now cause it'll turn on but

4734
02:45:58,389 --> 02:45:55,920
okay and then the name of my device and

4735
02:46:00,630 --> 02:45:58,399
then i say make notes and so on so on

4736
02:46:02,469 --> 02:46:00,640
yeah okay well thank you so much doc i

4737
02:46:04,150 --> 02:46:02,479
want to say doctor thank you so much

4738
02:46:05,510 --> 02:46:04,160

professor you are a doctor obviously

4739
02:46:07,670 --> 02:46:05,520
professors

4740
02:46:09,269 --> 02:46:07,680
thank you so much carl there was a

4741
02:46:11,030 --> 02:46:09,279
statement that you said before

4742
02:46:13,349 --> 02:46:11,040
many times actually it's that you are

4743
02:46:14,950 --> 02:46:13,359
your own existence proof

4744
02:46:19,190 --> 02:46:14,960
can you explain what that is what that

4745
02:46:25,349 --> 02:46:23,269
it is one of those deflationary um

4746
02:46:26,389 --> 02:46:25,359
summaries of the free energy principle

4747
02:46:29,110 --> 02:46:26,399
that says

4748
02:46:30,230 --> 02:46:29,120
the very fact you exist tells you a lot

4749
02:46:32,389 --> 02:46:30,240
about

4750
02:46:34,230 --> 02:46:32,399
the mechanics and the things that you

4751
02:46:34,710 --> 02:46:34,240
must do or the properties that you must

4752
02:46:37,670 --> 02:46:34,720
possess

4753
02:46:38,469 --> 02:46:37,680
in order to exist so you turn that on

4754
02:46:40,950 --> 02:46:38,479
its head

4755
02:46:43,030 --> 02:46:40,960
and the fact that you exist is proof of

4756
02:46:46,550 --> 02:46:43,040
your own existence again in this

4757
02:46:50,150 --> 02:46:46,560
tautological sense um

4758
02:46:51,429 --> 02:46:50,160
you could also read it as one way of um

4759
02:46:53,590 --> 02:46:51,439
encapsulating the notion of

4760
02:46:57,230 --> 02:46:53,600
self-evidencing so

4761
02:47:00,550 --> 02:46:57,240
if you read um

4762
02:47:04,150 --> 02:47:00,560
self-organization as

4763
02:47:07,590 --> 02:47:04,160

a system trying to minimize its

4764
02:47:10,870 --> 02:47:07,600
free energy or maximize the evidence

4765
02:47:12,790 --> 02:47:10,880
for its models of the world then

4766
02:47:14,070 --> 02:47:12,800
what you can say is that these kinds of

4767
02:47:17,190 --> 02:47:14,080
systems

4768
02:47:18,830 --> 02:47:17,200
change in such a way to increase the

4769
02:47:22,469 --> 02:47:18,840
evidence for their own

4770
02:47:24,630 --> 02:47:22,479
existence so it comes to

4771
02:47:27,030 --> 02:47:24,640
um very close to the notion of this

4772
02:47:30,469 --> 02:47:27,040
self-fulfilling prophecy that you know

4773
02:47:32,790 --> 02:47:30,479
i expect to exist um

4774
02:47:33,590 --> 02:47:32,800
and i'm going to act on the world in a

4775
02:47:36,309 --> 02:47:33,600
way

4776
02:47:38,230 --> 02:47:36,319
that solicits or secures evidence for

4777
02:47:40,790 --> 02:47:38,240
that existence and if i have a good

4778
02:47:41,990 --> 02:47:40,800
model of that world then i will be

4779
02:47:44,950 --> 02:47:42,000
successful

4780
02:47:45,590 --> 02:47:44,960
in soliciting that evidence and in so

4781
02:47:48,870 --> 02:47:45,600
doing

4782
02:47:51,590 --> 02:47:48,880
i will persevere and i will simply exist

4783
02:47:52,389 --> 02:47:51,600
and i look as if i'm self evidencing and

4784
02:47:54,950 --> 02:47:52,399
of course

4785
02:47:56,070 --> 02:47:54,960
evidence for what well evidence to prove

4786
02:47:59,510 --> 02:47:56,080
that i exist

4787
02:48:03,030 --> 02:47:59,520
so it's it's a rather sort of um cheeky

4788
02:48:05,670 --> 02:48:03,040

um way of celebrating the

4789
02:48:06,790 --> 02:48:05,680
the tautology of existence in the in in

4790
02:48:09,110 --> 02:48:06,800
the sense that

4791
02:48:10,389 --> 02:48:09,120
just existing is really all you need to

4792
02:48:12,150 --> 02:48:10,399
know and you can

4793
02:48:13,590 --> 02:48:12,160
spin off everything else all the

4794
02:48:16,469 --> 02:48:13,600
attributes of

4795
02:48:17,349 --> 02:48:16,479
artifacts particles people plants that

4796
02:48:21,990 --> 02:48:17,359
exist

4797
02:48:23,910 --> 02:48:22,000
what happens if you start looking for

4798
02:48:25,910 --> 02:48:23,920
evidence that you don't exist

4799
02:48:27,590 --> 02:48:25,920
like let's say you're on the eastern end

4800
02:48:29,269 --> 02:48:27,600
of the philosophical spectrum

4801
02:48:31,110 --> 02:48:29,279
and you say that the eye is illusory

4802
02:48:33,590 --> 02:48:31,120
that maybe this is all a dream

4803
02:48:34,469 --> 02:48:33,600
whatever that may be what happens is

4804
02:48:37,349 --> 02:48:34,479
that

4805
02:48:39,110 --> 02:48:37,359
you look for evidence of your

4806
02:48:41,190 --> 02:48:39,120
non-existence can you think yourself

4807
02:48:43,750 --> 02:48:41,200
into non-existence i know that

4808
02:48:45,030 --> 02:48:43,760
likely not but please run with that idea

4809
02:48:47,190 --> 02:48:45,040
oh well

4810
02:48:48,230 --> 02:48:47,200
you know it's a wonderful question i

4811
02:48:50,230 --> 02:48:48,240
mean yes i think you

4812
02:48:52,070 --> 02:48:50,240
you could certainly um think yourself

4813
02:48:54,150 --> 02:48:52,080

into non-existence i mean just

4814
02:48:55,750 --> 02:48:54,160
you know a trivial thought experiment

4815
02:48:58,389 --> 02:48:55,760
would be somebody who's a very

4816
02:48:59,590 --> 02:48:58,399
committed meditator who forgets to drink

4817
02:49:02,950 --> 02:48:59,600
or eat

4818
02:49:04,950 --> 02:49:02,960
and dies through dehydration um so no it

4819
02:49:06,790 --> 02:49:04,960
is certainly possible

4820
02:49:08,070 --> 02:49:06,800
it's a wonderful question because it it

4821
02:49:10,710 --> 02:49:08,080
speaks to something in

4822
02:49:11,990 --> 02:49:10,720
um philosophy called the dark room

4823
02:49:15,590 --> 02:49:12,000
problem

4824
02:49:19,349 --> 02:49:15,600
so it is certainly possible to simulate

4825
02:49:20,469 --> 02:49:19,359
in silico in computers and agents that

4826
02:49:24,230 --> 02:49:20,479
deliberately

4827
02:49:27,750 --> 02:49:24,240
do not believe that they exist and

4828
02:49:30,870 --> 02:49:27,760
will avoid sampling data that would

4829
02:49:31,910 --> 02:49:30,880
otherwise um provide evidence for their

4830
02:49:33,830 --> 02:49:31,920
existence

4831
02:49:36,230 --> 02:49:33,840
and what that translates into is

4832
02:49:39,269 --> 02:49:36,240
essentially um

4833
02:49:41,910 --> 02:49:39,279
an artifact or a creature that

4834
02:49:43,750 --> 02:49:41,920
turns off the lights it you know

4835
02:49:45,429 --> 02:49:43,760
deliberately avoids any

4836
02:49:47,750 --> 02:49:45,439
information from the world and

4837
02:49:49,110 --> 02:49:47,760
sequesters itself from the world but in

4838
02:49:51,510 --> 02:49:49,120

so doing of course

4839
02:49:53,429 --> 02:49:51,520
um there are profound implications for

4840
02:49:55,830 --> 02:49:53,439
its homeostasis

4841
02:49:56,630 --> 02:49:55,840
and you know from a sensory point of

4842
02:49:58,870 --> 02:49:56,640
view it

4843
02:50:00,389 --> 02:49:58,880
hides away in dark corners and is now

4844
02:50:03,830 --> 02:50:00,399
subject to the dark room

4845
02:50:05,670 --> 02:50:03,840
problem um but at the same time

4846
02:50:07,990 --> 02:50:05,680
it will not be able to maintain its

4847
02:50:10,230 --> 02:50:08,000
markov uh blanket

4848
02:50:11,990 --> 02:50:10,240
and ultimately it will dissipate so if

4849
02:50:15,030 --> 02:50:12,000
it doesn't comply

4850
02:50:16,309 --> 02:50:15,040
with the existential principles that

4851
02:50:18,230 --> 02:50:16,319
maintain

4852
02:50:19,910 --> 02:50:18,240
its structure and form and its

4853
02:50:22,790 --> 02:50:19,920
organization technically

4854
02:50:23,830 --> 02:50:22,800
if it doesn't um comply with the

4855
02:50:25,429 --> 02:50:23,840
principles that

4856
02:50:27,190 --> 02:50:25,439
underwrite the maintenance of a markov

4857
02:50:28,870 --> 02:50:27,200
blanket then that markov blanket will

4858
02:50:31,830 --> 02:50:28,880
cease to exist and so

4859
02:50:32,230 --> 02:50:31,840
will you if you are that markov blanket

4860
02:50:34,070 --> 02:50:32,240
so

4861
02:50:35,590 --> 02:50:34,080
you know it's practically a very very

4862
02:50:38,550 --> 02:50:35,600
interesting

4863
02:50:39,429 --> 02:50:38,560

question because um it all rests upon

4864
02:50:41,750 --> 02:50:39,439
having a good

4865
02:50:42,469 --> 02:50:41,760
generative model of the world so you

4866
02:50:44,790 --> 02:50:42,479
know

4867
02:50:45,750 --> 02:50:44,800
there's a sort of dual dependency here

4868
02:50:48,790 --> 02:50:45,760
that you know

4869
02:50:50,630 --> 02:50:48,800
it looks as if creatures that or systems

4870
02:50:53,030 --> 02:50:50,640
more generally that exist

4871
02:50:54,230 --> 02:50:53,040
are seeking out evidence for their

4872
02:50:56,230 --> 02:50:54,240
internal model

4873
02:50:57,590 --> 02:50:56,240
of how the world works and how the world

4874
02:51:00,710 --> 02:50:57,600
generates its

4875
02:51:02,830 --> 02:51:00,720
sensory samples and that's

4876
02:51:04,309 --> 02:51:02,840
only an apt explanation for

4877
02:51:07,429 --> 02:51:04,319
self-organization

4878
02:51:10,870 --> 02:51:07,439
if the generative model is a fair

4879
02:51:13,510 --> 02:51:10,880
or a good enough explanation for the way

4880
02:51:16,070 --> 02:51:13,520
that those sensory samples are generated

4881
02:51:17,429 --> 02:51:16,080
um technically that's an idea which

4882
02:51:18,870 --> 02:51:17,439
dates back to the inception of

4883
02:51:21,030 --> 02:51:18,880
cybernetics

4884
02:51:23,190 --> 02:51:21,040
in the early half of the 20th century

4885
02:51:26,389 --> 02:51:23,200
known as a good regulator theorem that

4886
02:51:27,510 --> 02:51:26,399
in order to regulate to to control to

4887
02:51:31,030 --> 02:51:27,520
survive

4888
02:51:33,830 --> 02:51:31,040

in your environment you have to be

4889
02:51:34,309 --> 02:51:33,840
effectively a model of that environment

4890
02:51:37,830 --> 02:51:34,319
so

4891
02:51:41,510 --> 02:51:37,840
your whether you're a thermostat or um

4892
02:51:44,150 --> 02:51:41,520
or a person you know your structure

4893
02:51:45,429 --> 02:51:44,160
and the way that you exchange with the

4894
02:51:48,469 --> 02:51:45,439
environment

4895
02:51:50,230 --> 02:51:48,479
works

4896
02:51:51,670 --> 02:51:50,240
when you are a good model of that

4897
02:51:53,349 --> 02:51:51,680
environment

4898
02:51:54,790 --> 02:51:53,359
when you say generative model what's the

4899
02:51:56,710 --> 02:51:54,800
difference between a generative model

4900
02:51:58,230 --> 02:51:56,720
and just a model

4901
02:52:01,349 --> 02:51:58,240
um well genetic model is just a

4902
02:52:04,469 --> 02:52:01,359
technical term yeah strictly speaking it

4903
02:52:06,950 --> 02:52:04,479
it's just a specification of the

4904
02:52:08,790 --> 02:52:06,960
probabilistic relationship between

4905
02:52:11,670 --> 02:52:08,800
causes and consequences so

4906
02:52:13,590 --> 02:52:11,680
you literally you write down um a

4907
02:52:15,030 --> 02:52:13,600
probability density or a probability

4908
02:52:16,950 --> 02:52:15,040
distribution over causes and

4909
02:52:19,349 --> 02:52:16,960
consequences

4910
02:52:20,389 --> 02:52:19,359
and that allows you then to evaluate the

4911
02:52:23,750 --> 02:52:20,399
evidence

4912
02:52:26,469 --> 02:52:23,760
in some data for that model

4913
02:52:28,630 --> 02:52:26,479

so in this instance the causes are

4914
02:52:31,510 --> 02:52:28,640
unobservable sometimes referred to

4915
02:52:32,389 --> 02:52:31,520
as latent or hidden states say of a

4916
02:52:35,030 --> 02:52:32,399
world

4917
02:52:36,150 --> 02:52:35,040
and the consequences are observable

4918
02:52:39,110 --> 02:52:36,160
consequences

4919
02:52:40,469 --> 02:52:39,120
say sensory samples that we solicit with

4920
02:52:43,830 --> 02:52:40,479
our sensory epithelia

4921
02:52:47,030 --> 02:52:43,840
our eyes our ears or indeed our

4922
02:52:49,269 --> 02:52:47,040
our interception so the genitive model

4923
02:52:50,389 --> 02:52:49,279
read like that is just a probabilistic

4924
02:52:53,670 --> 02:52:50,399
specification

4925
02:52:56,230 --> 02:52:53,680
of how hidden or latent states hidden

4926
02:52:59,510 --> 02:52:56,240
behind say a markov blanket

4927
02:53:01,110 --> 02:52:59,520
generate observable consequences and if

4928
02:53:05,429 --> 02:53:01,120
you've got that model

4929
02:53:07,910 --> 02:53:05,439
then you can assess how likely

4930
02:53:09,750 --> 02:53:07,920
those sensory samples those sensations

4931
02:53:12,070 --> 02:53:09,760
as sensory impressions

4932
02:53:13,269 --> 02:53:12,080
were under your model and if they were

4933
02:53:15,510 --> 02:53:13,279
very likely you're not going to be

4934
02:53:16,870 --> 02:53:15,520
surprised

4935
02:53:19,110 --> 02:53:16,880
and you know that you've got a good

4936
02:53:20,070 --> 02:53:19,120
model of the world if you're constantly

4937
02:53:22,550 --> 02:53:20,080
surprised

4938
02:53:23,750 --> 02:53:22,560

unable to predict then you've got a bad

4939
02:53:26,389 --> 02:53:23,760
model of the world

4940
02:53:27,830 --> 02:53:26,399
and remember that surprise can also be

4941
02:53:31,110 --> 02:53:27,840
used as prediction error

4942
02:53:34,309 --> 02:53:31,120
so if you constantly subject yourself

4943
02:53:35,910 --> 02:53:34,319
actively to lots of prediction errors

4944
02:53:37,670 --> 02:53:35,920
you're going to be constantly surprised

4945
02:53:39,429 --> 02:53:37,680
in the state of high free energy

4946
02:53:41,110 --> 02:53:39,439
but think about what that means these

4947
02:53:42,630 --> 02:53:41,120
are not just prediction errors

4948
02:53:44,469 --> 02:53:42,640
in fact they are not prediction errors

4949
02:53:46,550 --> 02:53:44,479
of a sort of personal sort

4950
02:53:48,309 --> 02:53:46,560
you know a propositional thing i could i

4951
02:53:50,870 --> 02:53:48,319
could say oh i didn't expect that

4952
02:53:52,790 --> 02:53:50,880
these are sort of um fundamental

4953
02:53:54,469 --> 02:53:52,800
deviations from your expectations like

4954
02:53:57,349 --> 02:53:54,479
your bodily temperature

4955
02:53:57,910 --> 02:53:57,359
um the amount of blood sugar that you

4956
02:54:01,349 --> 02:53:57,920
your

4957
02:54:03,670 --> 02:54:01,359
so when these get

4958
02:54:05,670 --> 02:54:03,680
out of physiological bounds you start to

4959
02:54:08,070 --> 02:54:05,680
literally disintegrate and die

4960
02:54:09,349 --> 02:54:08,080
and your markov blanket dissolves so

4961
02:54:12,710 --> 02:54:09,359
it's important to keep these

4962
02:54:13,990 --> 02:54:12,720
prediction errors within bounds or

4963
02:54:16,309 --> 02:54:14,000

in the language of the free energy

4964
02:54:19,429 --> 02:54:16,319
principle to you to keep on top

4965
02:54:22,309 --> 02:54:19,439
of your surprise self-information

4966
02:54:24,710 --> 02:54:22,319
or free energy all words for essentially

4967
02:54:26,309 --> 02:54:24,720
the same thing

4968
02:54:28,309 --> 02:54:26,319
okay what do you make of donald

4969
02:54:32,230 --> 02:54:28,319
hoffman's ideas on consciousness

4970
02:54:34,389 --> 02:54:32,240
i know that's broad right yeah

4971
02:54:36,710 --> 02:54:34,399
i had a mentor once called um jerry

4972
02:54:39,269 --> 02:54:36,720
edelman as a nobel laureate uh

4973
02:54:40,790 --> 02:54:39,279
famed for uh understanding the

4974
02:54:43,910 --> 02:54:40,800
evolutionary basis of

4975
02:54:46,309 --> 02:54:43,920
um our immune systems

4976
02:54:47,990 --> 02:54:46,319
uh uh he used to call me an intellectual

4977
02:54:51,030 --> 02:54:48,000
thug because i didn't

4978
02:54:54,870 --> 02:54:51,040
know anything outside of my own sphere

4979
02:54:56,550 --> 02:54:54,880
so if you tell me um what uh

4980
02:54:58,150 --> 02:54:56,560
yeah so forget about that forget about

4981
02:55:00,150 --> 02:54:58,160
because in order for me to say that it

4982
02:55:01,590 --> 02:55:00,160
would take too much time in them

4983
02:55:03,590 --> 02:55:01,600
and i probably wouldn't do it service

4984
02:55:04,630 --> 02:55:03,600
okay how about orchestrated objective

4985
02:55:07,510 --> 02:55:04,640
reduction from

4986
02:55:08,790 --> 02:55:07,520
penrose roger penrose stewart hammer off

4987
02:55:12,230 --> 02:55:08,800
if you've heard of them

4988
02:55:15,590 --> 02:55:12,240

yes yes yes certainly um so

4989
02:55:16,150 --> 02:55:15,600
yeah i certainly read um roger penrose's

4990
02:55:19,269 --> 02:55:16,160
uh

4991
02:55:23,030 --> 02:55:19,279
new mind

4992
02:55:25,110 --> 02:55:23,040
um so um so what what what

4993
02:55:26,790 --> 02:55:25,120
sorry can you repeat well yeah what do

4994
02:55:28,950 --> 02:55:26,800
you think what do you think about it

4995
02:55:32,150 --> 02:55:28,960
does it comport with your theory

4996
02:55:35,269 --> 02:55:32,160
does it contradict it do you think it's

4997
02:55:37,030 --> 02:55:35,279
too unfalsifiable do you like it do you

4998
02:55:38,950 --> 02:55:37,040
think it's creative like what are your

4999
02:55:42,150 --> 02:55:38,960
broad thoughts about it

5000
02:55:43,510 --> 02:55:42,160
um i think it's entertaining um so i'm

5001
02:55:45,910 --> 02:55:43,520
going to lump that in

5002
02:55:47,349 --> 02:55:45,920
with um quantum theories of

5003
02:55:50,469 --> 02:55:47,359
consciousness or you know

5004
02:55:53,990 --> 02:55:50,479
um which is entertaining

5005
02:55:56,150 --> 02:55:54,000
um i don't see it as a serious

5006
02:55:59,110 --> 02:55:56,160
contender that offers any explanatory

5007
02:56:01,349 --> 02:55:59,120
power in terms of sentient behavior

5008
02:56:02,309 --> 02:56:01,359
i should say of course the you know my

5009
02:56:03,830 --> 02:56:02,319
work um

5010
02:56:05,750 --> 02:56:03,840
with the free energy principle and

5011
02:56:08,230 --> 02:56:05,760
things like active inference

5012
02:56:09,910 --> 02:56:08,240
these are not theories of consciousness

5013
02:56:13,269 --> 02:56:09,920

they can certainly be deployed

5014
02:56:14,550 --> 02:56:13,279
to set some parameters on questions that

5015
02:56:16,309 --> 02:56:14,560
arise in consciousness

5016
02:56:17,990 --> 02:56:16,319
uh research but in and of themselves

5017
02:56:20,469 --> 02:56:18,000
that they're not there is

5018
02:56:21,590 --> 02:56:20,479
um or principles that would underwrite

5019
02:56:24,630 --> 02:56:21,600
consciousness

5020
02:56:27,269 --> 02:56:24,640
um having said that

5021
02:56:28,309 --> 02:56:27,279
you know they do tell you where the

5022
02:56:32,309 --> 02:56:28,319
mechanics

5023
02:56:34,870 --> 02:56:32,319
of sentience

5024
02:56:36,469 --> 02:56:34,880
lie in the physical world and it is not

5025
02:56:39,910 --> 02:56:36,479
at the quantum level

5026
02:56:41,190 --> 02:56:39,920
um so you know from the perspective of a

5027
02:56:44,469 --> 02:56:41,200
theory of every

5028
02:56:47,910 --> 02:56:44,479
space thing and the you know there

5029
02:56:49,670 --> 02:56:47,920
are there is a a range um

5030
02:56:51,910 --> 02:56:49,680
you can formalize mathematically under

5031
02:56:54,550 --> 02:56:51,920
things like the renormalization group

5032
02:56:55,750 --> 02:56:54,560
of things you can have very very small

5033
02:56:57,830 --> 02:56:55,760
things that have

5034
02:56:59,349 --> 02:56:57,840
very large amplitude random fluctuations

5035
02:57:01,750 --> 02:56:59,359
very very fast things

5036
02:57:03,830 --> 02:57:01,760
you can have very very big things very

5037
02:57:05,830 --> 02:57:03,840
slow things very cool things

5038
02:57:07,030 --> 02:57:05,840

that where the the other randomness

5039
02:57:09,750 --> 02:57:07,040
averages the way

5040
02:57:12,389 --> 02:57:09,760
so you know one can envisage this as a

5041
02:57:15,429 --> 02:57:12,399
spectrum between quantum mechanics

5042
02:57:18,230 --> 02:57:15,439
um at the very fast small

5043
02:57:18,870 --> 02:57:18,240
end and classical mechanics at the very

5044
02:57:21,990 --> 02:57:18,880
very

5045
02:57:24,389 --> 02:57:22,000
slow large end of the song that would

5046
02:57:25,269 --> 02:57:24,399
describe the the orbits of heavenly

5047
02:57:29,110 --> 02:57:25,279
bodies

5048
02:57:31,510 --> 02:57:29,120
um which means that you um

5049
02:57:32,790 --> 02:57:31,520
you you ask well where do where do we

5050
02:57:35,910 --> 02:57:32,800
fit and we

5051
02:57:37,870 --> 02:57:35,920
being um biotic systems that

5052
02:57:39,429 --> 02:57:37,880
show a particular kind of

5053
02:57:40,630 --> 02:57:39,439
self-organization that we would

5054
02:57:43,990 --> 02:57:40,640
associate with

5055
02:57:46,309 --> 02:57:44,000
um with life um and

5056
02:57:47,830 --> 02:57:46,319
it's in that it's in that intermediate

5057
02:57:51,030 --> 02:57:47,840
zone where

5058
02:57:54,630 --> 02:57:51,040
both the um the you know

5059
02:57:56,469 --> 02:57:54,640
the random fluctuations and um

5060
02:57:58,389 --> 02:57:56,479
what underwrites classical mechanics

5061
02:58:01,590 --> 02:57:58,399
which is this solenoidal

5062
02:58:02,150 --> 02:58:01,600
um circular motion that doesn't actually

5063
02:58:05,110 --> 02:58:02,160

change

5064
02:58:06,389 --> 02:58:05,120
surprisal or the marginal likelihood

5065
02:58:08,870 --> 02:58:06,399
that's where we live

5066
02:58:10,870 --> 02:58:08,880
so we know it's not at the quantum level

5067
02:58:13,830 --> 02:58:10,880
so we know that sentient behavior

5068
02:58:15,590 --> 02:58:13,840
and by implication sentience um cannot

5069
02:58:17,830 --> 02:58:15,600
be found at the quantum level

5070
02:58:19,830 --> 02:58:17,840
in the same sense it cannot be found in

5071
02:58:21,429 --> 02:58:19,840
the motion of the heavenly bodies

5072
02:58:22,550 --> 02:58:21,439
simply because they're too cool they

5073
02:58:23,750 --> 02:58:22,560
don't have the right kind of eye

5074
02:58:26,070 --> 02:58:23,760
tingency they're right

5075
02:58:26,950 --> 02:58:26,080
um if you like an adaptation the

5076
02:58:31,510 --> 02:58:26,960
challenges

5077
02:58:32,070 --> 02:58:31,520
destroy their mark off blankets are

5078
02:58:39,510 --> 02:58:32,080
simply

5079
02:58:43,030 --> 02:58:41,910
there's effectively no interesting

5080
02:58:45,429 --> 02:58:43,040
itinerancy that

5081
02:58:46,230 --> 02:58:45,439
is that defines non-equilibrium steady

5082
02:58:48,630 --> 02:58:46,240
state

5083
02:58:50,790 --> 02:58:48,640
so if i was responding oh no i'm not but

5084
02:58:54,230 --> 02:58:50,800
if i was responding to

5085
02:58:56,389 --> 02:58:54,240
a physicist asking asking that question

5086
02:58:58,950 --> 02:58:56,399
what you what i would be saying would be

5087
02:59:02,230 --> 02:58:58,960
that if we consider life

5088
02:59:04,870 --> 02:59:02,240

to be um self-organization

5089
02:59:05,830 --> 02:59:04,880
to some form of non-equilibrium far from

5090
02:59:09,510 --> 02:59:05,840
equilibrium

5091
02:59:09,830 --> 02:59:09,520
uh non-organization then stipulatively i

5092
02:59:12,830 --> 02:59:09,840
am

5093
02:59:14,630 --> 02:59:12,840
saying that we have to account for this

5094
02:59:17,910 --> 02:59:14,640
non-dissipative there

5095
02:59:18,950 --> 02:59:17,920
these non dissipative dynamics that are

5096
02:59:21,429 --> 02:59:18,960
mathematically

5097
02:59:23,190 --> 02:59:21,439
the solenoidal part if they are dwarfed

5098
02:59:24,469 --> 02:59:23,200
by random fluctuations that you find in

5099
02:59:26,550 --> 02:59:24,479
quantum physics

5100
02:59:28,950 --> 02:59:26,560
then you know we're not talking about

5101
02:59:30,309 --> 02:59:28,960
anymore um non-equilibrium we're talking

5102
02:59:32,550 --> 02:59:30,319
about equilibria we're talking about

5103
02:59:35,750 --> 02:59:32,560
solutions to the scrolling wave equation

5104
02:59:38,550 --> 02:59:35,760
so you know i re in conclusion you know

5105
02:59:38,870 --> 02:59:38,560
quantum neurobiology is entertaining

5106
02:59:43,190 --> 02:59:38,880
it's

5107
02:59:46,550 --> 02:59:43,200
right place to

5108
02:59:49,910 --> 02:59:46,560
um to you know create

5109
02:59:52,389 --> 02:59:49,920
a uh mechanics of um

5110
02:59:53,830 --> 02:59:52,399
of sentient behavior and by that you

5111
02:59:55,910 --> 02:59:53,840
know i would guess that

5112
02:59:58,630 --> 02:59:55,920
that precludes it from being an apt

5113
03:00:00,389 --> 02:59:58,640

description of conscious artifacts

5114
03:00:01,990 --> 03:00:00,399
is one to understand the free energy

5115
03:00:03,990 --> 03:00:02,000
principle as giving

5116
03:00:06,150 --> 03:00:04,000
any indication as to what consciousness

5117
03:00:07,750 --> 03:00:06,160
is so for example the self-evidencing

5118
03:00:09,349 --> 03:00:07,760
is that consciousness or is it when it's

5119
03:00:10,230 --> 03:00:09,359
minimizing the free energy or is it the

5120
03:00:12,630 --> 03:00:10,240
fact that it

5121
03:00:13,910 --> 03:00:12,640
has a markov blanket because when i was

5122
03:00:15,990 --> 03:00:13,920
looking at the nodes

5123
03:00:17,030 --> 03:00:16,000
any point you can define a markov

5124
03:00:18,710 --> 03:00:17,040
blanket too so it doesn't

5125
03:00:20,150 --> 03:00:18,720
seem like the fact that there exists a

5126
03:00:22,469 --> 03:00:20,160
markov blanket means it's conscious

5127
03:00:23,830 --> 03:00:22,479
so what are the conclusions one is to

5128
03:00:25,349 --> 03:00:23,840
take from reading your free energy

5129
03:00:27,910 --> 03:00:25,359
principle

5130
03:00:28,550 --> 03:00:27,920
that someone can draw for consciousness

5131
03:00:34,389 --> 03:00:28,560
yeah

5132
03:00:36,150 --> 03:00:34,399
i i mean this is again an excellent

5133
03:00:39,030 --> 03:00:36,160
question because it's one being posed

5134
03:00:40,630 --> 03:00:39,040
um around the world as we speak you know

5135
03:00:42,630 --> 03:00:40,640
so

5136
03:00:44,309 --> 03:00:42,640
people like the uh john templeton

5137
03:00:45,990 --> 03:00:44,319
foundation are sort of earnestly looking

5138
03:00:48,630 --> 03:00:46,000

at ways to sort of

5139
03:00:50,389 --> 03:00:48,640
um put up for example the free energy

5140
03:00:51,110 --> 03:00:50,399
principle against integrated information

5141
03:00:54,230 --> 03:00:51,120
theory as

5142
03:00:55,750 --> 03:00:54,240
formalism that might speak to um speak

5143
03:00:59,269 --> 03:00:55,760
to consciousness research

5144
03:01:01,910 --> 03:00:59,279
so it's a it's a great question um

5145
03:01:02,550 --> 03:01:01,920
the normal answer from people in my

5146
03:01:06,070 --> 03:01:02,560
world

5147
03:01:08,550 --> 03:01:06,080
um would start off by saying that

5148
03:01:10,150 --> 03:01:08,560
consciousness is probably a vague notion

5149
03:01:11,429 --> 03:01:10,160
and i mean vague in a philosophical

5150
03:01:14,469 --> 03:01:11,439
sense that you know

5151
03:01:18,790 --> 03:01:14,479
at what point does a collection of

5152
03:01:21,670 --> 03:01:18,800
sand um grains become a pile of sand

5153
03:01:22,550 --> 03:01:21,680
so it admits the possibility that a

5154
03:01:24,550 --> 03:01:22,560
thing

5155
03:01:26,309 --> 03:01:24,560
may not be conscious yes it certainly

5156
03:01:27,510 --> 03:01:26,319
would by definition have to have a

5157
03:01:30,150 --> 03:01:27,520
markov blanket

5158
03:01:31,030 --> 03:01:30,160
you know in our formalism um but that

5159
03:01:32,550 --> 03:01:31,040
does not mean

5160
03:01:34,630 --> 03:01:32,560
it is conscious it will be

5161
03:01:37,510 --> 03:01:34,640
self-evidencing in the sense of

5162
03:01:38,230 --> 03:01:37,520
having gradient flows that um try to

5163
03:01:40,469 --> 03:01:38,240

minimize

5164
03:01:41,830 --> 03:01:40,479
self-information but that's as far as it

5165
03:01:45,030 --> 03:01:41,840
goes so then you ask yourself

5166
03:01:48,150 --> 03:01:45,040
well what kind of systems first of all

5167
03:01:50,950 --> 03:01:48,160
look as if they are living and then

5168
03:01:51,269 --> 03:01:50,960
as we move through this vague landscape

5169
03:01:53,590 --> 03:01:51,279
or

5170
03:01:54,550 --> 03:01:53,600
vague dimension towards very

5171
03:01:57,830 --> 03:01:54,560
sophisticated

5172
03:01:59,429 --> 03:01:57,840
um uh you know particles like like

5173
03:02:02,870 --> 03:01:59,439
yourself and myself

5174
03:02:06,309 --> 03:02:02,880
and what would take us from living

5175
03:02:06,870 --> 03:02:06,319
to um systems that had a you know a

5176
03:02:10,070 --> 03:02:06,880
minimal

5177
03:02:11,349 --> 03:02:10,080
selfhood and then even further what

5178
03:02:12,309 --> 03:02:11,359
would take us to systems like

5179
03:02:14,150 --> 03:02:12,319
philosophers

5180
03:02:16,309 --> 03:02:14,160
so to puzzle over the fact that they

5181
03:02:19,510 --> 03:02:16,319
have minimal selfhood and

5182
03:02:20,710 --> 03:02:19,520
i think the answer lies really in the

5183
03:02:23,110 --> 03:02:20,720
generative model

5184
03:02:24,389 --> 03:02:23,120
so if you remember um we were talking

5185
03:02:26,710 --> 03:02:24,399
about a genitive model as being a

5186
03:02:28,070 --> 03:02:26,720
probabilistic specification of causes

5187
03:02:30,790 --> 03:02:28,080
and consequences

5188
03:02:32,870 --> 03:02:30,800

that underwrites the free energy or

5189
03:02:34,870 --> 03:02:32,880
specifically the free energy gradients

5190
03:02:36,950 --> 03:02:34,880
that provide an explanation for our

5191
03:02:37,990 --> 03:02:36,960
dynamics so it all boils down to the

5192
03:02:40,070 --> 03:02:38,000
genetic model

5193
03:02:41,190 --> 03:02:40,080
so first of all what would it mean to be

5194
03:02:45,110 --> 03:02:41,200
alive

5195
03:02:47,590 --> 03:02:45,120
um and you know we have discussed this

5196
03:02:49,110 --> 03:02:47,600
in terms of just moving to you know to

5197
03:02:51,349 --> 03:02:49,120
have an itinerancy

5198
03:02:54,309 --> 03:02:51,359
to actually act upon the world so you

5199
03:02:55,750 --> 03:02:54,319
you need to see a particle moving around

5200
03:02:57,590 --> 03:02:55,760
and it would look as if it was moving

5201
03:02:59,830 --> 03:02:57,600
around in the service

5202
03:03:00,790 --> 03:02:59,840
of um sampling evidence for its own

5203
03:03:03,830 --> 03:03:00,800
existence

5204
03:03:07,510 --> 03:03:03,840
uh and maintaining itself in um you know

5205
03:03:09,910 --> 03:03:07,520
in this in these characteristic ranges

5206
03:03:12,710 --> 03:03:09,920
showing some generalized homeostasis you

5207
03:03:16,230 --> 03:03:12,720
know of the sort you might expect um

5208
03:03:18,309 --> 03:03:16,240
a worm or a single celled

5209
03:03:20,389 --> 03:03:18,319
system um some kinds of behavior a

5210
03:03:23,429 --> 03:03:20,399
single cell system might show

5211
03:03:26,309 --> 03:03:23,439
is that does that have any sense of self

5212
03:03:26,950 --> 03:03:26,319
or any sense of consciousness probably

5213
03:03:29,910 --> 03:03:26,960

not

5214
03:03:31,110 --> 03:03:29,920
and then so you then take it up to say

5215
03:03:34,230 --> 03:03:31,120
insects and

5216
03:03:35,269 --> 03:03:34,240
and and you know and small mammals and

5217
03:03:38,630 --> 03:03:35,279
at some point

5218
03:03:41,269 --> 03:03:38,640
um in this vague continuum um

5219
03:03:42,870 --> 03:03:41,279
you you come across the next milestone

5220
03:03:45,590 --> 03:03:42,880
or marker on the way

5221
03:03:46,870 --> 03:03:45,600
which is the kind of generative moral

5222
03:03:50,790 --> 03:03:46,880
that would uh

5223
03:03:53,590 --> 03:03:50,800
explain the consequences of action so

5224
03:03:55,429 --> 03:03:53,600
put it very very simply though there are

5225
03:03:58,150 --> 03:03:55,439
some creatures that

5226
03:03:59,269 --> 03:03:58,160
are systems at least that will respond

5227
03:04:01,670 --> 03:03:59,279
reflexively

5228
03:04:02,710 --> 03:04:01,680
like say microbes and uh indeed

5229
03:04:04,710 --> 03:04:02,720
thermostats

5230
03:04:06,830 --> 03:04:04,720
that will respond in a way that seems to

5231
03:04:08,150 --> 03:04:06,840
keep themselves within a particular

5232
03:04:11,590 --> 03:04:08,160
range

5233
03:04:15,030 --> 03:04:11,600
but crucially they don't plan

5234
03:04:16,469 --> 03:04:15,040
so what would it mean in terms of

5235
03:04:18,710 --> 03:04:16,479
planning in a deliberate work

5236
03:04:20,950 --> 03:04:18,720
deliberative way basically selecting

5237
03:04:22,950 --> 03:04:20,960
among a number of ways forward a number

5238
03:04:25,990 --> 03:04:22,960

of courses of action

5239
03:04:28,550 --> 03:04:26,000
that will lead you to

5240
03:04:30,230 --> 03:04:28,560
reduce uncertainty minimize your free

5241
03:04:31,269 --> 03:04:30,240
energy or minimize your expected

5242
03:04:33,349 --> 03:04:31,279
surprise

5243
03:04:35,030 --> 03:04:33,359
as a consequence of that action well you

5244
03:04:38,070 --> 03:04:35,040
would require a genetic model

5245
03:04:40,630 --> 03:04:38,080
of what would happen if i did that now

5246
03:04:41,590 --> 03:04:40,640
because what would happen is in the

5247
03:04:43,269 --> 03:04:41,600
future

5248
03:04:45,110 --> 03:04:43,279
that's a very sophisticated genitive

5249
03:04:47,429 --> 03:04:45,120
model so now you're actually

5250
03:04:49,349 --> 03:04:47,439
equipping this charity model with a

5251
03:04:50,550 --> 03:04:49,359
temporal depth it can reach into the

5252
03:04:53,670 --> 03:04:50,560
future

5253
03:04:56,230 --> 03:04:53,680
and if a creature or a system is endowed

5254
03:04:58,389 --> 03:04:56,240
with a deep genitive model that

5255
03:05:00,309 --> 03:04:58,399
encompasses the consequences of action

5256
03:05:01,110 --> 03:05:00,319
it's now in a position to choose those

5257
03:05:03,349 --> 03:05:01,120
actions

5258
03:05:04,469 --> 03:05:03,359
that it thinks will either resolve

5259
03:05:06,630 --> 03:05:04,479
uncertainty or

5260
03:05:07,830 --> 03:05:06,640
supply the most evidence for its own

5261
03:05:10,790 --> 03:05:07,840
existence or

5262
03:05:11,910 --> 03:05:10,800
put more simply um invince the

5263
03:05:14,790 --> 03:05:11,920

characteristic

5264
03:05:16,070 --> 03:05:14,800
sensory states that define it and define

5265
03:05:19,429 --> 03:05:16,080
uh what it is

5266
03:05:22,630 --> 03:05:19,439
um so then we're moving on now to

5267
03:05:22,950 --> 03:05:22,640
creatures that plan um and if creatures

5268
03:05:25,910 --> 03:05:22,960
that

5269
03:05:26,950 --> 03:05:25,920
plan and now have an extra bit to their

5270
03:05:29,670 --> 03:05:26,960
generative models

5271
03:05:31,670 --> 03:05:29,680
which recognize that they are planning

5272
03:05:34,469 --> 03:05:31,680
that have this hypothesis that

5273
03:05:35,670 --> 03:05:34,479
hang on um it may be the simplest

5274
03:05:38,870 --> 03:05:35,680
explanation

5275
03:05:43,670 --> 03:05:38,880
for all these multimodal

5276
03:05:47,190 --> 03:05:43,680
sensations is that i am a thing

5277
03:05:49,590 --> 03:05:47,200
and that i it is me that is um

5278
03:05:50,870 --> 03:05:49,600
prosecuting these reflexes or moving or

5279
03:05:52,870 --> 03:05:50,880
it is me that is looking

5280
03:05:54,469 --> 03:05:52,880
over there and now you've got a very

5281
03:05:55,670 --> 03:05:54,479
sophisticated generative model where you

5282
03:05:59,269 --> 03:05:55,680
can certainly

5283
03:06:01,269 --> 03:05:59,279
um imagine that there is a minimal

5284
03:06:02,710 --> 03:06:01,279
representation of self like self

5285
03:06:05,750 --> 03:06:02,720
modeling

5286
03:06:06,309 --> 03:06:05,760
so now we're moving closer to um the

5287
03:06:09,429 --> 03:06:06,319
notion

5288
03:06:10,870 --> 03:06:09,439

of uh conscious artifacts would they be

5289
03:06:12,389 --> 03:06:10,880
fully conscious would they

5290
03:06:14,630 --> 03:06:12,399
would they have qualitative experiences

5291
03:06:17,030 --> 03:06:14,640
would they have qualia um

5292
03:06:17,830 --> 03:06:17,040
and then the next argument is what would

5293
03:06:20,469 --> 03:06:17,840
license

5294
03:06:21,429 --> 03:06:20,479
um qualitative experience you know see

5295
03:06:24,469 --> 03:06:21,439
you know

5296
03:06:27,910 --> 03:06:24,479
what it would be like to see um red

5297
03:06:28,950 --> 03:06:27,920
or any other attribute of the censorium

5298
03:06:31,750 --> 03:06:28,960
that usually

5299
03:06:33,429 --> 03:06:31,760
the argument then is well that's um that

5300
03:06:36,230 --> 03:06:33,439
would require

5301
03:06:37,190 --> 03:06:36,240
the kind of genetic model that was able

5302
03:06:40,950 --> 03:06:37,200
to

5303
03:06:44,230 --> 03:06:40,960
essentially infer on its own inference

5304
03:06:47,990 --> 03:06:44,240
that would be able to

5305
03:06:51,190 --> 03:06:48,000
enact a kind of mental or covert action

5306
03:06:53,110 --> 03:06:51,200
in order to select in

5307
03:06:54,870 --> 03:06:53,120
the model itself in the message passing

5308
03:06:58,309 --> 03:06:54,880
in the brain for example

5309
03:06:59,990 --> 03:06:58,319
be able to select certain um sources of

5310
03:07:01,910 --> 03:07:00,000
information in the service of this

5311
03:07:04,950 --> 03:07:01,920
hierarchical self-evidence where

5312
03:07:06,309 --> 03:07:04,960
from the hierarchy like layers of of an

5313
03:07:06,870 --> 03:07:06,319

onion and the deeper you get into the

5314
03:07:09,030 --> 03:07:06,880
onion

5315
03:07:10,230 --> 03:07:09,040
the higher you are in this hierarchy

5316
03:07:12,070 --> 03:07:10,240
with the you know

5317
03:07:13,349 --> 03:07:12,080
recurrent message passing between each

5318
03:07:15,830 --> 03:07:13,359
of the layers but

5319
03:07:16,870 --> 03:07:15,840
if the if the deeper the core of the

5320
03:07:18,950 --> 03:07:16,880
onion

5321
03:07:20,150 --> 03:07:18,960
was now able to act upon the

5322
03:07:22,830 --> 03:07:20,160
intermediate

5323
03:07:24,870 --> 03:07:22,840
layers or levels of this hierarchical

5324
03:07:27,590 --> 03:07:24,880
construct

5325
03:07:29,750 --> 03:07:27,600
then you might now suppose that this is

5326
03:07:33,110 --> 03:07:29,760
a kind of mental action

5327
03:07:33,590 --> 03:07:33,120
that licenses you to say now this is an

5328
03:07:38,230 --> 03:07:33,600
agent

5329
03:07:40,790 --> 03:07:38,240
acting um

5330
03:07:42,790 --> 03:07:40,800
psychologically this would be

5331
03:07:46,630 --> 03:07:42,800
effectively attention

5332
03:07:49,990 --> 03:07:46,640
so if you can plan what to attend to

5333
03:07:53,670 --> 03:07:50,000
or generate

5334
03:07:56,389 --> 03:07:53,680
attentional selection of the

5335
03:07:57,830 --> 03:07:56,399
um the way that you go and secure

5336
03:08:01,269 --> 03:07:57,840
evidence from your world

5337
03:08:04,309 --> 03:08:01,279
then you might now start to develop

5338
03:08:07,190 --> 03:08:04,319

um a theory of what it is like to

5339
03:08:08,790 --> 03:08:07,200
actively perceive something um you know

5340
03:08:10,790 --> 03:08:08,800
i could go on at length and

5341
03:08:12,790 --> 03:08:10,800
probably not very usefully in terms of

5342
03:08:15,990 --> 03:08:12,800
how you might cast that in terms

5343
03:08:18,309 --> 03:08:16,000
of phenomenal transparency and opacity

5344
03:08:19,910 --> 03:08:18,319
in brief what was saying is that there

5345
03:08:21,510 --> 03:08:19,920
are certain generative models there are

5346
03:08:25,269 --> 03:08:21,520
certain creatures

5347
03:08:29,110 --> 03:08:25,279
that can um render their

5348
03:08:32,150 --> 03:08:29,120
percepts experienced by rendering them

5349
03:08:35,750 --> 03:08:32,160
opaque by acting upon them by having

5350
03:08:37,590 --> 03:08:35,760
this capacity of attentional selection

5351
03:08:39,510 --> 03:08:37,600
so now you've got to some a very

5352
03:08:41,830 --> 03:08:39,520
sophisticated generative model

5353
03:08:42,950 --> 03:08:41,840
that not only has temporal depth that

5354
03:08:46,150 --> 03:08:42,960
enables the

5355
03:08:48,550 --> 03:08:46,160
agent to plan it's also truly an

5356
03:08:49,590 --> 03:08:48,560
agent that may be self-aware or at least

5357
03:08:53,110 --> 03:08:49,600
aware of what it is

5358
03:08:54,469 --> 03:08:53,120
um uh it is perceiving because it can

5359
03:08:57,590 --> 03:08:54,479
now act upon

5360
03:08:59,030 --> 03:08:57,600
um the the the perception the perceptual

5361
03:09:00,550 --> 03:08:59,040
inference that's implicit in the

5362
03:09:01,830 --> 03:09:00,560
self-evidencing

5363
03:09:03,990 --> 03:09:01,840

but we still haven't got to

5364
03:09:07,110 --> 03:09:04,000
self-awareness here so

5365
03:09:10,389 --> 03:09:07,120
these things might be apt to describe um

5366
03:09:11,990 --> 03:09:10,399
um say mice um

5367
03:09:13,510 --> 03:09:12,000
but we don't know whether mice are

5368
03:09:16,230 --> 03:09:13,520
self-aware they could

5369
03:09:17,670 --> 03:09:16,240
you know probably they can attend to

5370
03:09:20,550 --> 03:09:17,680
this or that and then

5371
03:09:21,269 --> 03:09:20,560
you know under this if you like spectrum

5372
03:09:28,070 --> 03:09:21,279
of

5373
03:09:29,190 --> 03:09:28,080
um you know they could be said to be

5374
03:09:31,830 --> 03:09:29,200
conscious in the sense

5375
03:09:33,190 --> 03:09:31,840
that they are sentient and have

5376
03:09:35,429 --> 03:09:33,200
qualitative experiences

5377
03:09:37,429 --> 03:09:35,439
but are they self-aware and if you want

5378
03:09:38,630 --> 03:09:37,439
to be self-aware you've now got to by

5379
03:09:41,030 --> 03:09:38,640
definition have

5380
03:09:42,630 --> 03:09:41,040
um part of your genetic model literally

5381
03:09:45,190 --> 03:09:42,640
part of your brain

5382
03:09:45,670 --> 03:09:45,200
that stands in and represents selfhood

5383
03:09:47,590 --> 03:09:45,680
so

5384
03:09:48,710 --> 03:09:47,600
just then we come back to this notion

5385
03:09:51,910 --> 03:09:48,720
that your

5386
03:09:55,590 --> 03:09:51,920
highest forms of um of

5387
03:09:59,590 --> 03:09:55,600
life on earth would would probably

5388
03:10:03,190 --> 03:09:59,600

have realized and learned

5389
03:10:06,150 --> 03:10:03,200
and infer that they are entities

5390
03:10:07,510 --> 03:10:06,160
they are agents and that becomes me and

5391
03:10:09,990 --> 03:10:07,520
it's me that's doing this

5392
03:10:10,950 --> 03:10:10,000
overt action and this covert action this

5393
03:10:15,030 --> 03:10:10,960
attentional

5394
03:10:17,349 --> 03:10:15,040
selection and then the final step would

5395
03:10:19,349 --> 03:10:17,359
be to go from this highest form of life

5396
03:10:20,950 --> 03:10:19,359
to become a philosopher when you start

5397
03:10:23,830 --> 03:10:20,960
to have mental models

5398
03:10:25,349 --> 03:10:23,840
of how it is that some people are

5399
03:10:27,190 --> 03:10:25,359
self-aware

5400
03:10:28,950 --> 03:10:27,200
and someone added for an item in terms

5401
03:10:29,910 --> 03:10:28,960
of the numbers is there an ed infinitum

5402
03:10:32,309 --> 03:10:29,920
what's the next step

5403
03:10:33,830 --> 03:10:32,319
after philosophy yeah as soon as i said

5404
03:10:37,110 --> 03:10:33,840
that i realized that i was stupid and

5405
03:10:39,269 --> 03:10:37,120
you'd stop me yeah no it's not okay

5406
03:10:40,870 --> 03:10:39,279
i think i think probably we've probably

5407
03:10:43,910 --> 03:10:40,880
got as far as we can

5408
03:10:45,190 --> 03:10:43,920
in terms of levels of recursion and i

5409
03:10:47,990 --> 03:10:45,200
say that because

5410
03:10:49,110 --> 03:10:48,000
there's a lovely um notion which i'm

5411
03:10:51,110 --> 03:10:49,120
sure you're aware of

5412
03:10:52,389 --> 03:10:51,120
this is a notion of the meta hard

5413
03:10:54,790 --> 03:10:52,399

problem um

5414
03:10:56,150 --> 03:10:54,800
no i never heard of that i should know

5415
03:10:57,830 --> 03:10:56,160
you'll love this

5416
03:10:59,190 --> 03:10:57,840
i i think it's something that was

5417
03:11:01,190 --> 03:10:59,200
introduced um

5418
03:11:03,269 --> 03:11:01,200
just in a presentation or taught by andy

5419
03:11:06,229 --> 03:11:03,279
clark in about 2001

5420
03:11:06,870 --> 03:11:06,239
and then seriously um taken up by david

5421
03:11:09,429 --> 03:11:06,880
chalmers

5422
03:11:11,269 --> 03:11:09,439
uh you know about two to three years ago

5423
03:11:13,750 --> 03:11:11,279
in 2018

5424
03:11:14,389 --> 03:11:13,760
so this is this is not the hard problem

5425
03:11:18,389 --> 03:11:14,399
of

5426
03:11:21,590 --> 03:11:18,399
um finding an explanation

5427
03:11:22,870 --> 03:11:21,600
for sentience uh you know what is it

5428
03:11:26,229 --> 03:11:22,880
like to perceive

5429
03:11:28,950 --> 03:11:26,239
red um it's

5430
03:11:30,790 --> 03:11:28,960
more why do we find why do we find

5431
03:11:32,790 --> 03:11:30,800
ourselves puzzling over it why do we

5432
03:11:35,269 --> 03:11:32,800
think it's such a it's interesting

5433
03:11:36,870 --> 03:11:35,279
yeah so this is not the hard problem but

5434
03:11:37,750 --> 03:11:36,880
what sits next to the heart problem

5435
03:11:40,550 --> 03:11:37,760
which is

5436
03:11:42,790 --> 03:11:40,560
why is it that we find it so perplexing

5437
03:11:44,790 --> 03:11:42,800
and difficult to explain

5438
03:11:46,389 --> 03:11:44,800

why is the heart problem a problem for

5439
03:11:49,590 --> 03:11:46,399
us um

5440
03:11:51,590 --> 03:11:49,600
and um you know

5441
03:11:52,950 --> 03:11:51,600
that that's you know to my mind it's

5442
03:11:53,830 --> 03:11:52,960
it's an extra level that you were

5443
03:11:56,150 --> 03:11:53,840
talking about so

5444
03:11:57,510 --> 03:11:56,160
you know now now we're asking we're

5445
03:11:58,550 --> 03:11:57,520
trying to explain the emergence of

5446
03:12:01,830 --> 03:11:58,560
philosophers

5447
03:12:04,389 --> 03:12:01,840
so without them to the next level

5448
03:12:05,269 --> 03:12:04,399
and it's a very very interesting problem

5449
03:12:12,550 --> 03:12:05,279
um

5450
03:12:13,110 --> 03:12:12,560
you know if i am puzzled about the fact

5451
03:12:17,590 --> 03:12:13,120
that i

5452
03:12:19,190 --> 03:12:17,600
tells you immediately that your

5453
03:12:22,389 --> 03:12:19,200
generative model

5454
03:12:24,710 --> 03:12:22,399
has to have a model of a counter factual

5455
03:12:26,710 --> 03:12:24,720
where i can see red but not experience

5456
03:12:29,030 --> 03:12:26,720
it now that's quite remarkable

5457
03:12:30,550 --> 03:12:29,040
yeah to actually have that kind of

5458
03:12:31,750 --> 03:12:30,560
genitive model where you can imagine

5459
03:12:34,229 --> 03:12:31,760
yourself

5460
03:12:36,070 --> 03:12:34,239
you're in a structured in a very very

5461
03:12:39,590 --> 03:12:36,080
different way

5462
03:12:41,670 --> 03:12:39,600
so i use the word counterfactual there

5463
03:12:43,110 --> 03:12:41,680

so deliberately because you know it may

5464
03:12:47,830 --> 03:12:43,120
be just because we

5465
03:12:50,150 --> 03:12:47,840
are systems artifacts sentient artifacts

5466
03:12:51,910 --> 03:12:50,160
that have these very very deep genitive

5467
03:12:53,990 --> 03:12:51,920
models that entertain

5468
03:12:56,150 --> 03:12:54,000
counterfactuals and neil seth calls his

5469
03:13:00,150 --> 03:12:56,160
counterfactual depth

5470
03:13:01,990 --> 03:13:00,160
now allows us oh i spoke to neil seth

5471
03:13:03,910 --> 03:13:02,000
for this program he's a great guy

5472
03:13:05,429 --> 03:13:03,920
well i i hope he mentioned

5473
03:13:06,950 --> 03:13:05,439
counterfactual depth and he'd if he

5474
03:13:08,550 --> 03:13:06,960
doesn't he'll have to get him back and

5475
03:13:10,710 --> 03:13:08,560
yeah yeah no i don't think he did or

5476
03:13:13,750 --> 03:13:10,720
maybe i slipped up and don't remember

5477
03:13:15,910 --> 03:13:13,760
okay sorry yeah so the you know

5478
03:13:17,590 --> 03:13:15,920
this notion of counterfactual depth you

5479
03:13:20,070 --> 03:13:17,600
know i think is is very important

5480
03:13:20,710 --> 03:13:20,080
i mean it's absolutely requisite for

5481
03:13:24,630 --> 03:13:20,720
planning

5482
03:13:26,070 --> 03:13:24,640
choosing the right course of action

5483
03:13:27,990 --> 03:13:26,080
which means you've got a series of

5484
03:13:30,630 --> 03:13:28,000
options all of which have these counter

5485
03:13:32,229 --> 03:13:30,640
factual outcomes um but of course if

5486
03:13:34,630 --> 03:13:32,239
you've given that model

5487
03:13:35,830 --> 03:13:34,640
you're given that kind of model you're

5488
03:13:38,870 --> 03:13:35,840

now in a position

5489
03:13:40,070 --> 03:13:38,880
to hypothesize counter factuals that

5490
03:13:43,190 --> 03:13:40,080
could never occur

5491
03:13:46,469 --> 03:13:43,200
such as seeing red without seeing red uh

5492
03:13:48,550 --> 03:13:46,479
such as um you know seeing but looking

5493
03:13:50,309 --> 03:13:48,560
but not seeing for example such as the

5494
03:13:52,150 --> 03:13:50,319
the other thought experiments that

5495
03:13:53,910 --> 03:13:52,160
philosophers like like you know uh

5496
03:13:57,190 --> 03:13:53,920
philosophical zombies

5497
03:14:00,309 --> 03:13:57,200
um yeah the very fact that there is

5498
03:14:03,030 --> 03:14:00,319
this meme of a philosophical zombie

5499
03:14:04,070 --> 03:14:03,040
tells you immediately that we are in

5500
03:14:06,790 --> 03:14:04,080
discourse

5501
03:14:08,229 --> 03:14:06,800
with creatures namely philosophers that

5502
03:14:11,670 --> 03:14:08,239
have the capacity

5503
03:14:14,309 --> 03:14:11,680
to um um represent

5504
03:14:16,550 --> 03:14:14,319
in their genitive models impossible

5505
03:14:18,950 --> 03:14:16,560
scenarios and counterfactuals

5506
03:14:20,070 --> 03:14:18,960
of the kind that you would have to uh

5507
03:14:23,349 --> 03:14:20,080
bring to the table

5508
03:14:26,309 --> 03:14:23,359
to you know to to conceive of a

5509
03:14:28,150 --> 03:14:26,319
of a philosophical zombie so just

5510
03:14:29,910 --> 03:14:28,160
perhaps even put even more simply the

5511
03:14:31,510 --> 03:14:29,920
fact that people can do these kinds of

5512
03:14:32,070 --> 03:14:31,520
thought experiments tells you a lot

5513
03:14:33,750 --> 03:14:32,080

about

5514
03:14:35,750 --> 03:14:33,760
the kinds of genetic models they use to

5515
03:14:37,510 --> 03:14:35,760
explain their world

5516
03:14:40,229 --> 03:14:37,520
and that is possibly a sufficient

5517
03:14:43,349 --> 03:14:40,239
explanation for the meta hard problem

5518
03:14:45,190 --> 03:14:43,359
uh just because we can

5519
03:14:46,469 --> 03:14:45,200
uh-huh okay i'm going to need to think

5520
03:14:47,510 --> 03:14:46,479
about that there's this lady named

5521
03:14:49,030 --> 03:14:47,520
annika harris

5522
03:14:50,550 --> 03:14:49,040
who's sam harris's wife and she has a

5523
03:14:52,070 --> 03:14:50,560
book on consciousness i believe it's

5524
03:14:54,550 --> 03:14:52,080
just called consciousness

5525
03:14:55,349 --> 03:14:54,560
and no offense to annika harris but the

5526
03:14:57,190 --> 03:14:55,359
book was

5527
03:14:58,870 --> 03:14:57,200
the book the best part of the book to me

5528
03:15:01,670 --> 03:14:58,880
was when she was talking about

5529
03:15:02,790 --> 03:15:01,680
philosophical zombies

5530
03:15:04,870 --> 03:15:02,800
that is for the people who aren't

5531
03:15:06,870 --> 03:15:04,880
listening how

5532
03:15:07,910 --> 03:15:06,880
can there be robots that look like us

5533
03:15:10,469 --> 03:15:07,920
that aren't conscious

5534
03:15:11,750 --> 03:15:10,479
and it produces an equivalent world and

5535
03:15:15,269 --> 03:15:11,760
she said

5536
03:15:15,830 --> 03:15:15,279
is that the fact that we're talking

5537
03:15:17,349 --> 03:15:15,840
about

5538
03:15:19,510 --> 03:15:17,359

consciousness implies that we're

5539
03:15:21,750 --> 03:15:19,520
conscious is because in an equivalent

5540
03:15:23,910 --> 03:15:21,760
zombie-like world

5541
03:15:24,790 --> 03:15:23,920
it's hard to imagine why they would come

5542
03:15:26,469 --> 03:15:24,800
up with that question

5543
03:15:29,190 --> 03:15:26,479
so that's what separates us from them

5544
03:15:33,269 --> 03:15:31,429
that sounds exactly and that that sounds

5545
03:15:34,710 --> 03:15:33,279
exactly like how andy clark would phrase

5546
03:15:36,710 --> 03:15:34,720
it you know the big thing is

5547
03:15:38,229 --> 03:15:36,720
why are we so puzzled about

5548
03:15:41,349 --> 03:15:38,239
consciousness and sentience

5549
03:15:42,950 --> 03:15:41,359
so that sounds very very close to to

5550
03:15:45,110 --> 03:15:42,960
you know the core question that

5551
03:15:46,309 --> 03:15:45,120
underwrites the the meta heart problem

5552
03:15:49,110 --> 03:15:46,319
or the meta problem

5553
03:15:50,469 --> 03:15:49,120
yeah anna lukomsky asks she says that's

5554
03:15:50,790 --> 03:15:50,479
lovely to hear when i told her that i

5555
03:15:52,389 --> 03:15:50,800
was

5556
03:15:54,150 --> 03:15:52,399
speaking to you she's fantastic news

5557
03:15:56,389 --> 03:15:54,160
about carl fristen i'm

5558
03:15:57,349 --> 03:15:56,399
curious to know if he's an idealist or a

5559
03:15:59,269 --> 03:15:57,359
physicalist

5560
03:16:01,269 --> 03:15:59,279
now i'm biased towards idealism i'm

5561
03:16:03,190 --> 03:16:01,279
speaking in terms of her

5562
03:16:05,429 --> 03:16:03,200
she's a psychiatrist by the way or a

5563
03:16:07,110 --> 03:16:05,439

psychologist and she says

5564
03:16:09,510 --> 03:16:07,120
well first of all are you an idealist or

5565
03:16:12,229 --> 03:16:09,520
a physicalist

5566
03:16:13,510 --> 03:16:12,239
um i i'm very happy to bat for both

5567
03:16:16,550 --> 03:16:13,520
sides depending on

5568
03:16:18,070 --> 03:16:16,560
who who i'm talking to so okay so you're

5569
03:16:21,190 --> 03:16:18,080
uncommitted right now

5570
03:16:22,150 --> 03:16:21,200
um no no i mean i i'm happy to commit to

5571
03:16:24,070 --> 03:16:22,160
either so

5572
03:16:26,229 --> 03:16:24,080
you're i see this through the lens of

5573
03:16:29,590 --> 03:16:26,239
the people i know in philosophy so

5574
03:16:32,790 --> 03:16:29,600
on the one hand my friend andy clark um

5575
03:16:35,429 --> 03:16:32,800
would would be um

5576
03:16:36,150 --> 03:16:35,439
somebody who believes you know certainly

5577
03:16:39,190 --> 03:16:36,160
would not

5578
03:16:42,870 --> 03:16:39,200
um adopt a a radical

5579
03:16:46,389 --> 03:16:45,030
would celebrate the markov blanket that

5580
03:16:48,150 --> 03:16:46,399
separates you

5581
03:16:50,229 --> 03:16:48,160
from the external world and therefore

5582
03:16:53,750 --> 03:16:50,239
the external world can never be known

5583
03:16:55,349 --> 03:16:53,760
um it's only ever accessed vicariously

5584
03:16:58,070 --> 03:16:55,359
by the markov blanket

5585
03:17:00,070 --> 03:16:58,080
and he might he might then um take a

5586
03:17:02,790 --> 03:17:00,080
more skeptical uh position

5587
03:17:04,150 --> 03:17:02,800
um you know i think that the maths of

5588
03:17:07,190 --> 03:17:04,160

the free energy principle

5589
03:17:10,630 --> 03:17:07,200
um really forces you to to um

5590
03:17:12,950 --> 03:17:10,640
um uh two back for both sides on the one

5591
03:17:17,190 --> 03:17:12,960
hand it is absolutely true

5592
03:17:20,550 --> 03:17:17,200
that our making sense of the world

5593
03:17:24,229 --> 03:17:20,560
through the sensory veil

5594
03:17:27,190 --> 03:17:24,239
supplied by the markov blanket precludes

5595
03:17:27,990 --> 03:17:27,200
any anything out there that will be ever

5596
03:17:29,990 --> 03:17:28,000
known

5597
03:17:31,830 --> 03:17:30,000
um that is certainly true so it's only

5598
03:17:33,510 --> 03:17:31,840
consistent with brain and of that like

5599
03:17:35,830 --> 03:17:33,520
thought experiments there

5600
03:17:37,030 --> 03:17:35,840
there will be no way um that you could

5601
03:17:38,950 --> 03:17:37,040
verify or not

5602
03:17:40,790 --> 03:17:38,960
what's actually going on out there

5603
03:17:41,990 --> 03:17:40,800
everything is this sort of delusion or

5604
03:17:44,870 --> 03:17:42,000
hallucination

5605
03:17:46,309 --> 03:17:44,880
that is entrained and grounded by

5606
03:17:48,550 --> 03:17:46,319
sensory evidence but

5607
03:17:50,389 --> 03:17:48,560
you know you know you never know the

5608
03:17:52,309 --> 03:17:50,399
causes of that sensory evidence that's

5609
03:17:55,030 --> 03:17:52,319
the whole premise of imprints you know

5610
03:17:58,070 --> 03:17:55,040
active imprints encapsulating

5611
03:18:00,309 --> 03:17:58,080
or the um encapsulating

5612
03:18:01,990 --> 03:18:00,319
the take on self-organization as a

5613
03:18:03,590 --> 03:18:02,000

process of inference

5614
03:18:05,269 --> 03:18:03,600
so that's that that would be sort of you

5615
03:18:06,710 --> 03:18:05,279
know the you know one side of the

5616
03:18:09,269 --> 03:18:06,720
defense

5617
03:18:10,150 --> 03:18:09,279
the problem is that when you um if you

5618
03:18:12,790 --> 03:18:10,160
commit to that

5619
03:18:13,349 --> 03:18:12,800
it's very difficult to actually simulate

5620
03:18:16,150 --> 03:18:13,359
um

5621
03:18:17,510 --> 03:18:16,160
or engineer sentience because in order

5622
03:18:19,349 --> 03:18:17,520
to do that you've actually got to

5623
03:18:21,110 --> 03:18:19,359
generate the sensations

5624
03:18:22,710 --> 03:18:21,120
um the sensory states of the markov

5625
03:18:25,269 --> 03:18:22,720
blanket on uh

5626
03:18:27,110 --> 03:18:25,279
that the the agent can infer and of

5627
03:18:30,229 --> 03:18:27,120
course when i talk about

5628
03:18:32,389 --> 03:18:30,239
or refer to the good regulator theorem

5629
03:18:34,469 --> 03:18:32,399
um i'm implicitly assuming that there is

5630
03:18:36,710 --> 03:18:34,479
a world out there to be regulated

5631
03:18:38,309 --> 03:18:36,720
i am assuming that you know the quality

5632
03:18:42,070 --> 03:18:38,319
of a generative model

5633
03:18:44,469 --> 03:18:42,080
as measured by its free energy um

5634
03:18:45,990 --> 03:18:44,479
is in relation to what is being modeled

5635
03:18:49,269 --> 03:18:46,000
so i have to commit

5636
03:18:50,550 --> 03:18:49,279
to some realism uh in the sense that i'm

5637
03:18:52,150 --> 03:18:50,560
saying there is a model

5638
03:18:53,990 --> 03:18:52,160

so it's very difficult for me to answer

5639
03:18:56,469 --> 03:18:54,000
that because on the one hand

5640
03:18:58,229 --> 03:18:56,479
um is if it's a model of something then

5641
03:19:00,070 --> 03:18:58,239
the something must be real

5642
03:19:01,750 --> 03:19:00,080
on the other hand it's always the on the

5643
03:19:02,389 --> 03:19:01,760
process of inference under a particular

5644
03:19:03,910 --> 03:19:02,399
model

5645
03:19:05,510 --> 03:19:03,920
means i'll never know whether there's

5646
03:19:08,309 --> 03:19:05,520
anything real or not so

5647
03:19:09,429 --> 03:19:08,319
you know it it it sort of accommodates

5648
03:19:15,030 --> 03:19:09,439
both points of view

5649
03:19:18,950 --> 03:19:16,950
the psychological reason you're saying

5650
03:19:19,750 --> 03:19:18,960
sorry there's not a psychological reason

5651
03:19:22,710 --> 03:19:19,760
that you're saying

5652
03:19:23,030 --> 03:19:22,720
you're both a physicalist and a realist

5653
03:19:25,830 --> 03:19:23,040
or

5654
03:19:27,190 --> 03:19:25,840
neither it's it's not because you don't

5655
03:19:30,070 --> 03:19:27,200
want to offend anyone

5656
03:19:31,590 --> 03:19:30,080
it's actually because your your model

5657
03:19:33,110 --> 03:19:31,600
accounts for both

5658
03:19:34,710 --> 03:19:33,120
well one is like ontological the other

5659
03:19:36,870 --> 03:19:34,720
is epistemic so one is like we can't

5660
03:19:38,150 --> 03:19:36,880
have knowledge of it but the other one

5661
03:19:39,349 --> 03:19:38,160
but at the same time you're assuming

5662
03:19:40,469 --> 03:19:39,359
that there exists a world that's

5663
03:19:41,670 --> 03:19:40,479

independent

5664
03:19:44,150 --> 03:19:41,680
yes and that's a beautiful way of

5665
03:19:46,550 --> 03:19:44,160
putting it but but also i also don't

5666
03:19:47,910 --> 03:19:46,560
want to offend anybody as well but yes

5667
03:19:49,990 --> 03:19:47,920
you're a lovely chap you want to keep

5668
03:19:52,469 --> 03:19:50,000
your charming nature okay

5669
03:19:53,590 --> 03:19:52,479
so this person named matthew nahemi says

5670
03:19:57,190 --> 03:19:53,600
does

5671
03:19:58,830 --> 03:19:57,200
alfred korczymski

5672
03:20:00,710 --> 03:19:58,840
and what does he think about his

5673
03:20:02,229 --> 03:20:00,720
theories

5674
03:20:04,229 --> 03:20:02,239
that deserve a vague bell but you're

5675
03:20:05,349 --> 03:20:04,239
going to have to um tell me

5676
03:20:07,030 --> 03:20:05,359
then forget it because i actually don't

5677
03:20:08,150 --> 03:20:07,040
know this person and i have been told

5678
03:20:08,870 --> 03:20:08,160
that i need to learn more about this

5679
03:20:11,349 --> 03:20:08,880
person

5680
03:20:12,830 --> 03:20:11,359
dr jt velikovsky of the university of

5681
03:20:15,830 --> 03:20:12,840
newcastle from austra

5682
03:20:17,590 --> 03:20:15,840
australia who has published some work on

5683
03:20:18,150 --> 03:20:17,600
holland part-time theory structure of

5684
03:20:20,950 --> 03:20:18,160
the meme

5685
03:20:23,190 --> 03:20:20,960
some memes like richard dawkins memes he

5686
03:20:26,389 --> 03:20:23,200
asks

5687
03:20:30,070 --> 03:20:26,399
do you expect like david boehm suggested

5688
03:20:30,790 --> 03:20:30,080

that the scale size of entities in the

5689
03:20:34,389 --> 03:20:30,800
universe

5690
03:20:36,870 --> 03:20:34,399
eg matter energy go infinitely smaller

5691
03:20:37,910 --> 03:20:36,880
eg smaller beyond quarks and also

5692
03:20:42,469 --> 03:20:37,920
infinitely larger

5693
03:20:44,150 --> 03:20:42,479
eg to multiple universes um

5694
03:20:46,150 --> 03:20:44,160
yes i mean i think that would be that

5695
03:20:49,190 --> 03:20:46,160
would be a sort of mathematical take

5696
03:20:52,229 --> 03:20:49,200
um on um the application

5697
03:20:54,229 --> 03:20:52,239
if we wanted to do that of of the the

5698
03:20:56,070 --> 03:20:54,239
apparatus of the renormalization group

5699
03:20:58,710 --> 03:20:56,080
when trying to understand

5700
03:20:59,269 --> 03:20:58,720
um the separation of temporal scales

5701
03:21:01,510 --> 03:20:59,279
between

5702
03:21:03,110 --> 03:21:01,520
different levels of organization which

5703
03:21:05,110 --> 03:21:03,120
is an important part

5704
03:21:08,229 --> 03:21:05,120
of the free energy formalism when it

5705
03:21:09,910 --> 03:21:08,239
comes to thinking about

5706
03:21:12,309 --> 03:21:09,920
markov blankets and mark off blankets

5707
03:21:15,110 --> 03:21:12,319
say you know organs that comprise

5708
03:21:16,070 --> 03:21:15,120
cells where each cell comprises

5709
03:21:18,309 --> 03:21:16,080
organelles

5710
03:21:19,590 --> 03:21:18,319
that themselves comprise molecules that

5711
03:21:21,110 --> 03:21:19,600
themselves comprise out

5712
03:21:23,190 --> 03:21:21,120
and so on and so forth and then the

5713
03:21:24,469 --> 03:21:23,200

other way organs constituting phenotypes

5714
03:21:26,389 --> 03:21:24,479
phenotypes

5715
03:21:29,110 --> 03:21:26,399
cons constituting populations across

5716
03:21:30,870 --> 03:21:29,120
specifics constituting in groups and out

5717
03:21:33,590 --> 03:21:30,880
groups constituting species and

5718
03:21:34,710 --> 03:21:33,600
and so on right up to um sort of a

5719
03:21:38,070 --> 03:21:34,720
cosmological

5720
03:21:41,110 --> 03:21:38,080
scale so you know i think mathematically

5721
03:21:42,630 --> 03:21:41,120
um that that's a very comfortable

5722
03:21:45,750 --> 03:21:42,640
position to adopt

5723
03:21:48,269 --> 03:21:45,760
um so that you know there is no lower

5724
03:21:49,590 --> 03:21:48,279
upper bound on the application of the

5725
03:21:53,510 --> 03:21:49,600
renormalization

5726
03:21:54,550 --> 03:21:53,520
group when you move from one scale to

5727
03:21:57,110 --> 03:21:54,560
the next

5728
03:21:59,030 --> 03:21:57,120
um which you can do very gracefully when

5729
03:22:03,590 --> 03:21:59,040
it comes to

5730
03:22:06,150 --> 03:22:03,600
certainly modeling for example um

5731
03:22:09,190 --> 03:22:06,160
applying the free energy principle to

5732
03:22:12,389 --> 03:22:09,200
single cells in a network of neurons

5733
03:22:16,630 --> 03:22:12,399
and then core straining that to try

5734
03:22:20,389 --> 03:22:16,640
to model um you know parts of the brain

5735
03:22:22,790 --> 03:22:20,399
as self-evidencing through

5736
03:22:24,550 --> 03:22:22,800
you know physical motion through to

5737
03:22:25,269 --> 03:22:24,560
course training that and then trying to

5738
03:22:28,070 --> 03:22:25,279

model

5739
03:22:29,830 --> 03:22:28,080
um populations talking to each other or

5740
03:22:31,590 --> 03:22:29,840
interacting through them uh the markov

5741
03:22:34,550 --> 03:22:31,600
blankets that defines

5742
03:22:36,710 --> 03:22:34,560
an organization or a family or a set of

5743
03:22:39,830 --> 03:22:36,720
con specifics

5744
03:22:42,150 --> 03:22:39,840
defines it in relation to say the uh the

5745
03:22:43,349 --> 03:22:42,160
environment or the econish so these are

5746
03:22:48,309 --> 03:22:43,359
just examples

5747
03:22:50,469 --> 03:22:48,319
of um lifting exactly the same dynamics

5748
03:22:51,670 --> 03:22:50,479
the gradient flows uh that underwrite

5749
03:22:54,309 --> 03:22:51,680
the free energy principle

5750
03:22:54,870 --> 03:22:54,319
from one scale to the next and in so

5751
03:22:57,269 --> 03:22:54,880
doing

5752
03:22:58,790 --> 03:22:57,279
working out what the states are what the

5753
03:22:59,510 --> 03:22:58,800
you know when you say the states of

5754
03:23:01,269 --> 03:22:59,520
affairs

5755
03:23:03,110 --> 03:23:01,279
or the sensory states or the internal

5756
03:23:05,670 --> 03:23:03,120
states yeah what are they

5757
03:23:06,550 --> 03:23:05,680
and um when you sort of drill down on

5758
03:23:10,309 --> 03:23:06,560
that

5759
03:23:13,429 --> 03:23:10,319
what you can do is use the um the

5760
03:23:17,670 --> 03:23:13,439
renormalization group formalism um

5761
03:23:20,309 --> 03:23:17,680
to be moving from one scale to the next

5762
03:23:21,830 --> 03:23:20,319
you basically take um mixtures of

5763
03:23:24,229 --> 03:23:21,840

blanket states

5764
03:23:24,870 --> 03:23:24,239
uh and then those mixtures of blanket

5765
03:23:26,630 --> 03:23:24,880
states

5766
03:23:28,870 --> 03:23:26,640
technically the eigenfunctions of the

5767
03:23:30,550 --> 03:23:28,880
blanket states now become the states of

5768
03:23:31,830 --> 03:23:30,560
the next level and then

5769
03:23:33,670 --> 03:23:31,840
you look at the conditional dependencies

5770
03:23:35,349 --> 03:23:33,680
of the states the next level then you

5771
03:23:36,309 --> 03:23:35,359
find the markov blanket then you take

5772
03:23:38,389 --> 03:23:36,319
the eigen

5773
03:23:39,830 --> 03:23:38,399
functions of those states and then they

5774
03:23:42,469 --> 03:23:39,840
become states in the next level

5775
03:23:43,269 --> 03:23:42,479
at each level of course graining you get

5776
03:23:46,469 --> 03:23:43,279
bigger

5777
03:23:47,030 --> 03:23:46,479
and slower so before we were talking

5778
03:23:50,229 --> 03:23:47,040
about

5779
03:23:53,990 --> 03:23:50,239
sort of this from quantum to classical

5780
03:23:57,110 --> 03:23:54,000
um um that inherits simply from

5781
03:23:59,429 --> 03:23:57,120
this um successive course graining but

5782
03:24:02,870 --> 03:23:59,439
at each point exactly the same

5783
03:24:05,590 --> 03:24:02,880
free energy um um

5784
03:24:06,870 --> 03:24:05,600
for like lagrangian you know the way

5785
03:24:09,590 --> 03:24:06,880
that you would write down

5786
03:24:10,870 --> 03:24:09,600
the dynamics and you know on one region

5787
03:24:12,550 --> 03:24:10,880
the energetics

5788
03:24:14,070 --> 03:24:12,560

this functional forms are exactly

5789
03:24:17,830 --> 03:24:14,080
preserved you're just

5790
03:24:22,229 --> 03:24:17,840
swapping out sort of um your microscopic

5791
03:24:24,070 --> 03:24:22,239
states um for mixtures of microscopic

5792
03:24:25,510 --> 03:24:24,080
states in particular repeat the eigen

5793
03:24:27,269 --> 03:24:25,520
functions or mixtures

5794
03:24:29,110 --> 03:24:27,279
of blanket states to get to the next

5795
03:24:31,030 --> 03:24:29,120
level noting that

5796
03:24:33,110 --> 03:24:31,040
the black you're throwing away the

5797
03:24:34,070 --> 03:24:33,120
internal states remember the internal

5798
03:24:36,950 --> 03:24:34,080
states

5799
03:24:37,750 --> 03:24:36,960
um are independent of the external

5800
03:24:40,630 --> 03:24:37,760
states

5801
03:24:41,990 --> 03:24:40,640
given the markov blanket and vice versa

5802
03:24:43,830 --> 03:24:42,000
which means there's nothing in the

5803
03:24:45,030 --> 03:24:43,840
internal states or any particular

5804
03:24:48,630 --> 03:24:45,040
particle

5805
03:24:50,630 --> 03:24:48,640
that is not if you like um encoded

5806
03:24:51,990 --> 03:24:50,640
in the blanket states if you wanted to

5807
03:24:54,070 --> 03:24:52,000
move to the next level

5808
03:24:55,590 --> 03:24:54,080
so each level you're throwing away the

5809
03:24:58,630 --> 03:24:55,600
internal states

5810
03:25:00,150 --> 03:24:58,640
um that can have very fast dynamics and

5811
03:25:02,630 --> 03:25:00,160
you're picking out

5812
03:25:03,830 --> 03:25:02,640
the slower fluctuations of them on the

5813
03:25:06,229 --> 03:25:03,840

markov blanket

5814
03:25:08,150 --> 03:25:06,239
on the blanket states themselves so the

5815
03:25:11,030 --> 03:25:08,160
states at the next level up

5816
03:25:12,950 --> 03:25:11,040
now fluctuate much much more slowly and

5817
03:25:15,750 --> 03:25:12,960
they encompass

5818
03:25:16,389 --> 03:25:15,760
they have a larger spatial scale as well

5819
03:25:19,910 --> 03:25:16,399
so

5820
03:25:23,590 --> 03:25:19,920
um you know once one has that um

5821
03:25:25,670 --> 03:25:23,600
that that sort of um recursive um

5822
03:25:27,510 --> 03:25:25,680
you know not proof by induction but the

5823
03:25:28,630 --> 03:25:27,520
same spirit as a proof by induction

5824
03:25:32,229 --> 03:25:28,640
where you move from

5825
03:25:35,429 --> 03:25:32,239
from one level to the next level uh that

5826
03:25:37,670 --> 03:25:35,439
once one has that apparatus in play

5827
03:25:39,510 --> 03:25:37,680
there is no need to ask when does when

5828
03:25:40,229 --> 03:25:39,520
does the process stop or where did it

5829
03:25:42,790 --> 03:25:40,239
begin

5830
03:25:44,710 --> 03:25:42,800
um and in a sense you dissolve those

5831
03:25:46,550 --> 03:25:44,720
questions because you're only interested

5832
03:25:47,830 --> 03:25:46,560
in one particular scale and how it

5833
03:25:51,110 --> 03:25:47,840
relates to scale above

5834
03:25:54,229 --> 03:25:51,120
and the scale below i mean you can go um

5835
03:25:56,550 --> 03:25:54,239
if you're if you like um astronomy

5836
03:25:57,990 --> 03:25:56,560
uh or you know um you're interested in

5837
03:26:00,630 --> 03:25:58,000
the physics

5838
03:26:01,990 --> 03:26:00,640

of the cosmos then you know you'll be

5839
03:26:04,630 --> 03:26:02,000
going i'd say six

5840
03:26:06,070 --> 03:26:04,640
scales uh you know towards towards

5841
03:26:08,790 --> 03:26:06,080
classical mechanics

5842
03:26:09,269 --> 03:26:08,800
if you're interested in string theory

5843
03:26:11,670 --> 03:26:09,279
and

5844
03:26:13,510 --> 03:26:11,680
uh small particle accelerators then

5845
03:26:14,710 --> 03:26:13,520
you'd be going to say six scales down to

5846
03:26:17,429 --> 03:26:14,720
very very small things

5847
03:26:19,910 --> 03:26:17,439
you know towards the quantum level um

5848
03:26:21,830 --> 03:26:19,920
but we is six just a number

5849
03:26:23,429 --> 03:26:21,840
for an example or are you specifying

5850
03:26:26,229 --> 03:26:23,439
something in particular um

5851
03:26:27,349 --> 03:26:26,239
well yeah yeah it is a number i pulled

5852
03:26:29,349 --> 03:26:27,359
out of the hat but

5853
03:26:31,429 --> 03:26:29,359
but it's probably about that when one

5854
03:26:34,950 --> 03:26:31,439
looks at um

5855
03:26:38,389 --> 03:26:34,960
when one looks at

5856
03:26:40,790 --> 03:26:38,399
the time constants empirically

5857
03:26:42,389 --> 03:26:40,800
associated with any particular scale or

5858
03:26:43,190 --> 03:26:42,399
any set of markov blanks at different

5859
03:26:45,429 --> 03:26:43,200
scales

5860
03:26:46,710 --> 03:26:45,439
and then one goes to the next scale

5861
03:26:48,630 --> 03:26:46,720
using

5862
03:26:49,910 --> 03:26:48,640
you know this is not this is not um

5863
03:26:52,150 --> 03:26:49,920

magic

5864
03:26:54,070 --> 03:26:52,160
it has been applied for example to brain

5865
03:26:59,030 --> 03:26:54,080
imaging time series where you

5866
03:27:01,190 --> 03:26:59,040
you look at every um little cubic

5867
03:27:02,870 --> 03:27:01,200
patch of the brains see a few

5868
03:27:04,229 --> 03:27:02,880
millimeters in size

5869
03:27:06,070 --> 03:27:04,239
and then you say well that's the scale

5870
03:27:06,550 --> 03:27:06,080
i'm going to start with and i'll take

5871
03:27:14,309 --> 03:27:06,560
the

5872
03:27:16,150 --> 03:27:14,319
this little chunk of brain

5873
03:27:17,590 --> 03:27:16,160
and then i've got say thousands of

5874
03:27:19,269 --> 03:27:17,600
states and then i'll look at the

5875
03:27:20,790 --> 03:27:19,279
dependencies and i'll work out a markov

5876
03:27:22,710 --> 03:27:20,800
blanket and it could be

5877
03:27:25,750 --> 03:27:22,720
a markov blanket around a little chunk

5878
03:27:28,950 --> 03:27:25,760
of brain the size of your thumbnail

5879
03:27:29,830 --> 03:27:28,960
and then you can take the eigen

5880
03:27:32,309 --> 03:27:29,840
functions

5881
03:27:33,510 --> 03:27:32,319
of the markov blanket of that little

5882
03:27:36,070 --> 03:27:33,520
chunk of brain

5883
03:27:37,510 --> 03:27:36,080
um and then you put the chunks together

5884
03:27:39,190 --> 03:27:37,520
and you find the markov blanket at that

5885
03:27:40,229 --> 03:27:39,200
level and then you talk about lobes of

5886
03:27:41,990 --> 03:27:40,239
the brain

5887
03:27:43,349 --> 03:27:42,000
and then you talk about the entire brain

5888
03:27:44,309 --> 03:27:43,359

and then you think about well lots of

5889
03:27:46,309 --> 03:27:44,319
brains together

5890
03:27:47,750 --> 03:27:46,319
at a scientific conference there's so

5891
03:27:50,229 --> 03:27:47,760
many

5892
03:27:51,030 --> 03:27:50,239
whatever almost every four sentences

5893
03:27:54,710 --> 03:27:51,040
that you

5894
03:27:55,030 --> 03:27:54,720
speak three ideas occurred to me and i

5895
03:27:56,870 --> 03:27:55,040
just

5896
03:27:57,990 --> 03:27:56,880
want to explore them all so here's an

5897
03:27:59,429 --> 03:27:58,000
example we're not going to explore them

5898
03:28:01,030 --> 03:27:59,439
i'll just say them

5899
03:28:02,309 --> 03:28:01,040
when you mention that the internal

5900
03:28:03,990 --> 03:28:02,319
states are independent of the external

5901
03:28:05,429 --> 03:28:04,000
vice versa that means there's almost an

5902
03:28:06,070 --> 03:28:05,439
arbitrariness as to which one you call

5903
03:28:08,630 --> 03:28:06,080
internal

5904
03:28:10,389 --> 03:28:08,640
and which means that you can at least

5905
03:28:12,309 --> 03:28:10,399
i'm surmising i'm gonna

5906
03:28:14,070 --> 03:28:12,319
i'm pretty much asking but either way

5907
03:28:15,990 --> 03:28:14,080
then that means that you can

5908
03:28:17,910 --> 03:28:16,000
imagine the environment models you in a

5909
03:28:19,269 --> 03:28:17,920
sense and then i wondered

5910
03:28:20,950 --> 03:28:19,279
well what's the connection between that

5911
03:28:21,429 --> 03:28:20,960
and the holographic principle in string

5912
03:28:23,830 --> 03:28:21,439
theory

5913
03:28:26,150 --> 03:28:23,840

which says that at the boundary it

5914
03:28:28,150 --> 03:28:26,160
encodes the information

5915
03:28:29,830 --> 03:28:28,160
anyway okay that's just what occurs to

5916
03:28:31,830 --> 03:28:29,840
me and also multiple

5917
03:28:32,870 --> 03:28:31,840
dissociative personality disorder i also

5918
03:28:35,190 --> 03:28:32,880
want to know about that

5919
03:28:35,910 --> 03:28:35,200
but it's not about me joanna dong has a

5920
03:28:39,750 --> 03:28:35,920
question

5921
03:28:41,269 --> 03:28:39,760
do you explain the meaning of life using

5922
03:28:42,469 --> 03:28:41,279
the free energy principle that's the

5923
03:28:45,990 --> 03:28:42,479
easy question you can answer that in

5924
03:28:49,910 --> 03:28:48,309
um i've never been asked that before the

5925
03:28:51,670 --> 03:28:49,920
meaning of life

5926
03:28:53,910 --> 03:28:51,680
so no i just got to use my favorite

5927
03:28:56,309 --> 03:28:53,920
words tautology and deflation

5928
03:28:57,110 --> 03:28:56,319
um you know the meaning is in the

5929
03:29:03,590 --> 03:28:57,120
existence

5930
03:29:07,750 --> 03:29:03,600
the goals for um the

5931
03:29:10,790 --> 03:29:07,760
existential imperatives to keep yourself

5932
03:29:12,870 --> 03:29:10,800
in the in those existential domains so

5933
03:29:13,830 --> 03:29:12,880
it's just in the existence it's just the

5934
03:29:16,790 --> 03:29:13,840
shape

5935
03:29:18,309 --> 03:29:16,800
of things that exist that define their

5936
03:29:21,429 --> 03:29:18,319
own meaning

5937
03:29:23,750 --> 03:29:21,439
and you know in a sense um you could

5938
03:29:24,550 --> 03:29:23,760

look at self-evidencing as finding

5939
03:29:27,830 --> 03:29:24,560
meaning

5940
03:29:32,070 --> 03:29:27,840
uh for your life or your

5941
03:29:35,670 --> 03:29:32,080
fi finding um or understanding

5942
03:29:38,870 --> 03:29:35,680
the um

5943
03:29:41,910 --> 03:29:38,880
the model for which you're trying

5944
03:29:44,550 --> 03:29:41,920
to accrue evidence um

5945
03:29:45,590 --> 03:29:44,560
and what that basically means is if

5946
03:29:48,710 --> 03:29:45,600
you're reading that

5947
03:29:49,750 --> 03:29:48,720
as a um as a psychiatrist or a

5948
03:29:51,590 --> 03:29:49,760
philosopher

5949
03:29:52,790 --> 03:29:51,600
you're basically trying to understand

5950
03:29:54,790 --> 03:29:52,800
yourself and your own

5951
03:29:55,990 --> 03:29:54,800
genitive models so if you understand

5952
03:29:57,990 --> 03:29:56,000
your own purpose

5953
03:29:59,269 --> 03:29:58,000
for your purpose is just to aspire to

5954
03:30:02,229 --> 03:29:59,279
this these attracting

5955
03:30:03,030 --> 03:30:02,239
sets um that define you as the kind of

5956
03:30:05,429 --> 03:30:03,040
thing you are

5957
03:30:06,229 --> 03:30:05,439
and then the meaning would i think rest

5958
03:30:08,790 --> 03:30:06,239
upon this

5959
03:30:11,269 --> 03:30:08,800
some kind of self moral where now you

5960
03:30:13,349 --> 03:30:11,279
recognize you you're this kind of person

5961
03:30:14,309 --> 03:30:13,359
so you you can spin it off at a number

5962
03:30:16,710 --> 03:30:14,319
of different levels

5963
03:30:18,550 --> 03:30:16,720

so it wasn't a very i'll think of a more

5964
03:30:20,309 --> 03:30:18,560
succinct access to yeah

5965
03:30:22,630 --> 03:30:20,319
psychologically and attracting set would

5966
03:30:24,710 --> 03:30:22,640
be what mathematically that's fine but

5967
03:30:26,710 --> 03:30:24,720
for someone who is just interested in

5968
03:30:28,950 --> 03:30:26,720
how one lives their life

5969
03:30:31,030 --> 03:30:28,960
is this just a recapitulation of know

5970
03:30:33,349 --> 03:30:31,040
thyself

5971
03:30:34,630 --> 03:30:33,359
yes or the thing the things that the the

5972
03:30:37,110 --> 03:30:34,640
things that um

5973
03:30:38,469 --> 03:30:37,120
you are attracted to literally the

5974
03:30:39,990 --> 03:30:38,479
things that you see yourself being

5975
03:30:42,830 --> 03:30:40,000
attracted to the things that you see

5976
03:30:45,190 --> 03:30:42,840
yourself aspiring and working towards

5977
03:30:45,910 --> 03:30:45,200
um so what do you find interesting and

5978
03:30:47,670 --> 03:30:45,920
admirable

5979
03:30:49,590 --> 03:30:47,680
is that what you mean yeah yeah yeah

5980
03:30:52,229 --> 03:30:49,600
that was that at a very high level

5981
03:30:53,349 --> 03:30:52,239
but remember you know this operates at

5982
03:30:55,190 --> 03:30:53,359
all scales

5983
03:30:57,190 --> 03:30:55,200
of of a deep charging model where

5984
03:30:58,710 --> 03:30:57,200
remember the core

5985
03:31:00,630 --> 03:30:58,720
is dealing with with sort of more

5986
03:31:02,630 --> 03:31:00,640
abstract things such as

5987
03:31:03,830 --> 03:31:02,640
you know being likable being loved being

5988
03:31:06,150 --> 03:31:03,840

rich

5989
03:31:07,750 --> 03:31:06,160
but at the periphery you know there are

5990
03:31:09,510 --> 03:31:07,760
still um

5991
03:31:11,750 --> 03:31:09,520
there's a model of basically body

5992
03:31:15,510 --> 03:31:11,760
temperature body

5993
03:31:17,110 --> 03:31:15,520
um not being in pain so these are also

5994
03:31:18,950 --> 03:31:17,120
things that make me happy

5995
03:31:20,229 --> 03:31:18,960
in a sense you know these are the these

5996
03:31:21,990 --> 03:31:20,239
are attracting states

5997
03:31:24,070 --> 03:31:22,000
it's attractive to be at a particular

5998
03:31:27,190 --> 03:31:24,080
temperature attractive not

5999
03:31:27,510 --> 03:31:27,200
to sense pain it's attractive um you

6000
03:31:30,790 --> 03:31:27,520
know

6001
03:31:33,830 --> 03:31:30,800
to be hydrated to a particular extent uh

6002
03:31:34,229 --> 03:31:33,840
at some level it is also attractive you

6003
03:31:37,349 --> 03:31:34,239
know

6004
03:31:40,229 --> 03:31:37,359
if you have very deep genitive models

6005
03:31:41,429 --> 03:31:40,239
um that have this counter factual depth

6006
03:31:44,309 --> 03:31:41,439
then there are certain

6007
03:31:45,830 --> 03:31:44,319
counter factual outcomes that you would

6008
03:31:46,950 --> 03:31:45,840
find very surprising will be

6009
03:31:49,349 --> 03:31:46,960
unattractive

6010
03:31:50,790 --> 03:31:49,359
and there'll be other outcomes which you

6011
03:31:52,710 --> 03:31:50,800
would have learned

6012
03:31:54,790 --> 03:31:52,720
this is the kind of outcome that i

6013
03:31:55,349 --> 03:31:54,800

aspire to this is the kind of gender

6014
03:31:57,910 --> 03:31:55,359
model i

6015
03:31:59,510 --> 03:31:57,920
am you know at that point that i think

6016
03:32:02,550 --> 03:31:59,520
it would be

6017
03:32:03,990 --> 03:32:02,560
quite fair um to start thinking about

6018
03:32:06,150 --> 03:32:04,000
this in terms of you know

6019
03:32:07,510 --> 03:32:06,160
i'm going to develop this reputation you

6020
03:32:10,630 --> 03:32:07,520
know if i if i

6021
03:32:13,670 --> 03:32:10,640
say this or if i donate this or

6022
03:32:14,309 --> 03:32:13,680
i'm going to um i'm going to be this

6023
03:32:17,510 --> 03:32:14,319
kind of

6024
03:32:20,309 --> 03:32:17,520
uh person uh if i take these actions

6025
03:32:21,110 --> 03:32:20,319
so there are certainly entailed in the

6026
03:32:23,030 --> 03:32:21,120
prior

6027
03:32:26,309 --> 03:32:23,040
beliefs that constitute the genetic

6028
03:32:29,510 --> 03:32:26,319
model ways of behaving ways of being

6029
03:32:30,309 --> 03:32:29,520
outcomes that you a priori expect to

6030
03:32:33,510 --> 03:32:30,319
happen

6031
03:32:34,950 --> 03:32:33,520
and generally these are going to be

6032
03:32:37,110 --> 03:32:34,960
things that are consistent with your

6033
03:32:39,190 --> 03:32:37,120
self-image with the with with your

6034
03:32:40,630 --> 03:32:39,200
self-model and interestingly also

6035
03:32:43,910 --> 03:32:40,640
require

6036
03:32:45,750 --> 03:32:43,920
um an optimism bias to sort of you know

6037
03:32:47,510 --> 03:32:45,760
because of this self-fulfilling prophecy

6038
03:32:48,950 --> 03:32:47,520

of all our actions and decisions and

6039
03:32:50,469 --> 03:32:48,960
choices and behavior

6040
03:32:51,990 --> 03:32:50,479
if they're all in the service of

6041
03:32:54,469 --> 03:32:52,000
realizing

6042
03:32:55,910 --> 03:32:54,479
our fantasy about the kind of thing that

6043
03:33:00,229 --> 03:32:55,920
we are

6044
03:33:04,469 --> 03:33:00,239
selecting those information and

6045
03:33:07,349 --> 03:33:04,479
ignoring other kinds of information um

6046
03:33:08,710 --> 03:33:07,359
in order to find evidence indeed this is

6047
03:33:10,469 --> 03:33:08,720
the kind of thing i am so i'm going to

6048
03:33:14,070 --> 03:33:10,479
ignore any evidence

6049
03:33:15,750 --> 03:33:14,080
that run runs counter to my self-image

6050
03:33:17,990 --> 03:33:15,760
you know that i'm not liked or not

6051
03:33:20,550 --> 03:33:18,000
believed or that i'm very poor or

6052
03:33:21,349 --> 03:33:20,560
very hungry unless i can do something

6053
03:33:24,870 --> 03:33:21,359
about it

6054
03:33:26,070 --> 03:33:24,880
um so so you know

6055
03:33:29,590 --> 03:33:26,080
that's a real i think it's a really

6056
03:33:34,389 --> 03:33:32,550
it speaks to the um both the

6057
03:33:37,429 --> 03:33:34,399
self-fulfilling prophecy

6058
03:33:39,750 --> 03:33:37,439
but and this sort of optimism

6059
03:33:41,429 --> 03:33:39,760
optimistic aspect of active inference

6060
03:33:44,150 --> 03:33:41,439
which is not a fallacy

6061
03:33:44,790 --> 03:33:44,160
it is it is absolutely essential in

6062
03:33:47,510 --> 03:33:44,800
keeping us

6063
03:33:48,389 --> 03:33:47,520

on track and keeping it as within these

6064
03:33:51,830 --> 03:33:48,399
attracted

6065
03:33:53,190 --> 03:33:51,840
attracting or attractive states

6066
03:33:55,349 --> 03:33:53,200
so if you were doing if you're a

6067
03:33:56,150 --> 03:33:55,359
behavioral psychologist this would just

6068
03:34:00,710 --> 03:33:56,160
be

6069
03:34:03,190 --> 03:34:00,720
um some kind of reward if you're a

6070
03:34:05,590 --> 03:34:03,200
control engineer it would be some kind

6071
03:34:09,190 --> 03:34:05,600
of negative loss function

6072
03:34:10,790 --> 03:34:09,200
so you just score being in a given state

6073
03:34:12,229 --> 03:34:10,800
in terms of the probability that you

6074
03:34:15,910 --> 03:34:12,239
would find me

6075
03:34:17,510 --> 03:34:15,920
in that state and if it is unattractive

6076
03:34:19,349 --> 03:34:17,520
and the kind of thing i would avoid

6077
03:34:20,870 --> 03:34:19,359
that simply is a statement that has a

6078
03:34:22,469 --> 03:34:20,880
very low probability

6079
03:34:24,229 --> 03:34:22,479
that means that the negative logarithm

6080
03:34:25,110 --> 03:34:24,239
is very very high it just means it's

6081
03:34:27,990 --> 03:34:25,120
surprising

6082
03:34:28,950 --> 03:34:28,000
so it's just another way of saying that

6083
03:34:31,590 --> 03:34:28,960
the attracting

6084
03:34:33,590 --> 03:34:31,600
set of states or the attractive states

6085
03:34:36,070 --> 03:34:33,600
are those that i am not surprised

6086
03:34:37,190 --> 03:34:36,080
to be in that they are comfortable

6087
03:34:39,750 --> 03:34:37,200
they're familiar

6088
03:34:41,510 --> 03:34:39,760

given i am who i am this is exactly the

6089
03:34:44,870 --> 03:34:41,520
kind of state that i think i should

6090
03:34:47,510 --> 03:34:44,880
i should pause and be occupied

6091
03:34:48,710 --> 03:34:47,520
again almost all that you say there's so

6092
03:34:50,790 --> 03:34:48,720
many thoughts that occur

6093
03:34:52,150 --> 03:34:50,800
i'll say some of them now not for you to

6094
03:34:54,150 --> 03:34:52,160
explore but maybe for people in the

6095
03:34:55,349 --> 03:34:54,160
comments section to explore

6096
03:34:56,950 --> 03:34:55,359
i was thinking when you were talking

6097
03:34:58,469 --> 03:34:56,960
about different goals that one has and

6098
03:34:58,790 --> 03:34:58,479
there's different levels of abstraction

6099
03:35:00,309 --> 03:34:58,800
so

6100
03:35:01,990 --> 03:35:00,319
one is to regulate your body temperature

6101
03:35:03,190 --> 03:35:02,000
at an extremely low level then at a high

6102
03:35:05,190 --> 03:35:03,200
level one might be to

6103
03:35:07,269 --> 03:35:05,200
be a lovable person or to love someone

6104
03:35:09,349 --> 03:35:07,279
else then i was wondering well though

6105
03:35:11,030 --> 03:35:09,359
you can go much much lower to parts that

6106
03:35:14,710 --> 03:35:11,040
you don't have control over so

6107
03:35:16,870 --> 03:35:14,720
it's it's you want to have

6108
03:35:18,469 --> 03:35:16,880
transcriptase in your cells so that you

6109
03:35:20,550 --> 03:35:18,479
can have

6110
03:35:21,990 --> 03:35:20,560
a replication of dna but you also want

6111
03:35:23,429 --> 03:35:22,000
to have cell walls it's not like you can

6112
03:35:24,229 --> 03:35:23,439
control that but that's at the extremely

6113
03:35:25,670 --> 03:35:24,239

low level

6114
03:35:27,110 --> 03:35:25,680
and then at a high level what i'm

6115
03:35:29,349 --> 03:35:27,120
wondering is is there a relationship

6116
03:35:30,790 --> 03:35:29,359
between the highest ideal and then god

6117
03:35:32,630 --> 03:35:30,800
and then is there a relationship to

6118
03:35:34,630 --> 03:35:32,640
being fragmented there and having

6119
03:35:35,910 --> 03:35:34,640
what's not monotheistic so that is

6120
03:35:39,910 --> 03:35:35,920
polytheistic

6121
03:35:41,590 --> 03:35:39,920
and there's a contradiction between them

6122
03:35:43,910 --> 03:35:41,600
is that one of the reasons why in

6123
03:35:44,389 --> 03:35:43,920
monotheism they say you cannot serve two

6124
03:35:46,150 --> 03:35:44,399
gods

6125
03:35:47,750 --> 03:35:46,160
and is that related to people who are

6126
03:35:49,990 --> 03:35:47,760
well all of us are in some degree

6127
03:35:52,229 --> 03:35:50,000
psychologically

6128
03:35:53,990 --> 03:35:52,239
not fully integrated but is there a

6129
03:35:55,830 --> 03:35:54,000
relationship between monotheism and

6130
03:35:56,710 --> 03:35:55,840
being fully integrated as a person where

6131
03:35:58,550 --> 03:35:56,720
you have one

6132
03:35:59,910 --> 03:35:58,560
goal that you're working toward and

6133
03:36:02,229 --> 03:35:59,920
they're not contradicted

6134
03:36:05,429 --> 03:36:02,239
at some higher step so you're living in

6135
03:36:07,030 --> 03:36:05,439
a in a more congruent fashion

6136
03:36:08,070 --> 03:36:07,040
you don't have to comment on that you

6137
03:36:08,950 --> 03:36:08,080
could probably say that's all

6138
03:36:10,870 --> 03:36:08,960

foolishness but

6139
03:36:12,550 --> 03:36:10,880
people oh no no no don't do i can't

6140
03:36:13,429 --> 03:36:12,560
resist because when you say i have lots

6141
03:36:16,469 --> 03:36:13,439
of thoughts as well

6142
03:36:18,389 --> 03:36:16,479
um so that that sort of can we act in

6143
03:36:20,309 --> 03:36:18,399
order to make sure that our messenger

6144
03:36:23,269 --> 03:36:20,319
rna is working properly

6145
03:36:25,110 --> 03:36:23,279
um yes you can actually but you'd have

6146
03:36:28,710 --> 03:36:25,120
to use this sort of um

6147
03:36:29,590 --> 03:36:28,720
sort of scale different scales of markov

6148
03:36:32,710 --> 03:36:29,600
blankets

6149
03:36:36,309 --> 03:36:32,720
uh but also there's there is actually

6150
03:36:37,990 --> 03:36:36,319
a formalism that allows you to um

6151
03:36:39,590 --> 03:36:38,000
look at the way that say the central

6152
03:36:41,349 --> 03:36:39,600
nervous system

6153
03:36:42,950 --> 03:36:41,359
through neuroendocrinology and through

6154
03:36:45,110 --> 03:36:42,960
sort of your

6155
03:36:46,229 --> 03:36:45,120
neuro immunological mechanisms does

6156
03:36:48,469 --> 03:36:46,239
actually

6157
03:36:49,510 --> 03:36:48,479
have an express effect on on gene

6158
03:36:51,910 --> 03:36:49,520
expression and

6159
03:36:53,030 --> 03:36:51,920
right so this speaks to the sort of the

6160
03:36:55,429 --> 03:36:53,040
you know the

6161
03:36:56,790 --> 03:36:55,439
the transactions both between markov

6162
03:36:59,750 --> 03:36:56,800
blankets but also

6163
03:37:01,349 --> 03:36:59,760

if a markov blanket at one scale exists

6164
03:37:02,229 --> 03:37:01,359
that necessarily implies existence at

6165
03:37:04,070 --> 03:37:02,239
another scale

6166
03:37:05,670 --> 03:37:04,080
so a cell can only exist if the organ

6167
03:37:08,710 --> 03:37:05,680
exists but in the same

6168
03:37:10,870 --> 03:37:08,720
spirit and in in reverse the organelle

6169
03:37:12,550 --> 03:37:10,880
exists in virtue of the cells existing

6170
03:37:14,710 --> 03:37:12,560
and all of this has to maintain

6171
03:37:15,990 --> 03:37:14,720
a free energy minimizing dynamic in

6172
03:37:18,309 --> 03:37:16,000
order to keep uh

6173
03:37:19,990 --> 03:37:18,319
you know both scales in play at the same

6174
03:37:21,190 --> 03:37:20,000
time so you know it's a really

6175
03:37:23,510 --> 03:37:21,200
i think that's a really interesting

6176
03:37:26,469 --> 03:37:23,520
example the god versus

6177
03:37:27,110 --> 03:37:26,479
um or monit uh polytheistic versus

6178
03:37:30,070 --> 03:37:27,120
monitors

6179
03:37:30,389 --> 03:37:30,080
monotheistic models of the world i think

6180
03:37:33,830 --> 03:37:30,399
that

6181
03:37:36,950 --> 03:37:33,840
description of

6182
03:37:38,710 --> 03:37:36,960
um um sort of you know sources of

6183
03:37:40,469 --> 03:37:38,720
cognitive dissonance but possibly of a

6184
03:37:43,030 --> 03:37:40,479
theological or existential

6185
03:37:45,110 --> 03:37:43,040
um or the sort that might underwrite or

6186
03:37:47,950 --> 03:37:45,120
not ontological security

6187
03:37:49,349 --> 03:37:47,960
that you know if i do have these

6188
03:37:51,750 --> 03:37:49,359

counterfactuals

6189
03:37:52,630 --> 03:37:51,760
about different things of the kind of

6190
03:37:57,030 --> 03:37:52,640
person that i

6191
03:38:00,389 --> 03:37:57,040
am or the um the date is that

6192
03:38:01,110 --> 03:38:00,399
i commit or subscribe to um then that's

6193
03:38:04,229 --> 03:38:01,120
just

6194
03:38:05,910 --> 03:38:04,239
another example of the opportunity to

6195
03:38:07,750 --> 03:38:05,920
resolve uncertainty but

6196
03:38:09,110 --> 03:38:07,760
in that sense there's also uncertainty

6197
03:38:10,150 --> 03:38:09,120
there there's this puzzlement that

6198
03:38:12,630 --> 03:38:10,160
underwrites

6199
03:38:14,309 --> 03:38:12,640
the meta heart problem that is it this

6200
03:38:14,950 --> 03:38:14,319
kind of god of that kind of god is it

6201
03:38:21,510 --> 03:38:14,960
the

6202
03:38:24,469 --> 03:38:21,520
um and

6203
03:38:25,030 --> 03:38:24,479
into g by introducing that uncertainty

6204
03:38:27,590 --> 03:38:25,040
you do

6205
03:38:28,870 --> 03:38:27,600
you may well um expose yourself to

6206
03:38:32,150 --> 03:38:28,880
culture dissonance

6207
03:38:33,269 --> 03:38:32,160
and ambiguity and an existential angst

6208
03:38:35,990 --> 03:38:33,279
out that level

6209
03:38:37,429 --> 03:38:36,000
which you will actually try to resolve

6210
03:38:39,910 --> 03:38:37,439
so that's this again this

6211
03:38:42,389 --> 03:38:39,920
imperative for self-evidencing is acting

6212
03:38:45,429 --> 03:38:42,399
in a way to minimize expected surprise

6213
03:38:46,870 --> 03:38:45,439

or uncertainty in the future so it may

6214
03:38:50,389 --> 03:38:46,880
well be that certain

6215
03:38:54,550 --> 03:38:50,399
um clerics

6216
03:38:57,750 --> 03:38:54,560
certain sorry what clerics uh clerics

6217
03:39:00,790 --> 03:38:57,760
clerics yes or people people people

6218
03:39:04,710 --> 03:39:00,800
you know with an ecclesiastical

6219
03:39:05,990 --> 03:39:04,720
uh um leaning they may spend a lot of

6220
03:39:07,429 --> 03:39:06,000
time trying to resolve

6221
03:39:09,590 --> 03:39:07,439
that kind of uncertainty that kind of

6222
03:39:11,590 --> 03:39:09,600
come to distance yeah

6223
03:39:13,670 --> 03:39:11,600
okay two quick questions that's it faraz

6224
03:39:15,269 --> 03:39:13,680
says in the context of embody cognition

6225
03:39:18,389 --> 03:39:15,279
and by the way faraz is someone

6226
03:39:21,269 --> 03:39:18,399
who graduated from u of t

6227
03:39:22,790 --> 03:39:21,279
right around here in neuroscience and i

6228
03:39:23,990 --> 03:39:22,800
forgot the other one so he's going to

6229
03:39:25,910 --> 03:39:24,000
comment in the comment section about

6230
03:39:27,349 --> 03:39:25,920
what i forgot in the context of embody

6231
03:39:29,349 --> 03:39:27,359
cognition what is the relationship

6232
03:39:31,830 --> 03:39:29,359
between perception and mathematics

6233
03:39:32,710 --> 03:39:31,840
and furthermore if the external world

6234
03:39:35,429 --> 03:39:32,720
perceives

6235
03:39:36,070 --> 03:39:35,439
our actions can we extrapolate from that

6236
03:39:38,469 --> 03:39:36,080
assertion

6237
03:39:41,590 --> 03:39:38,479
the idea that our actions matter to the

6238
03:39:44,630 --> 03:39:43,990

so that um that question you you sort of

6239
03:39:47,349 --> 03:39:44,640
hinted at

6240
03:39:50,150 --> 03:39:47,359
before when you were when you were um

6241
03:39:52,630 --> 03:39:50,160
the duality between internal external

6242
03:39:53,990 --> 03:39:52,640
exactly yeah that that sort of um

6243
03:39:56,070 --> 03:39:54,000
perfect symmetry

6244
03:39:57,910 --> 03:39:56,080
um which i thought was you know that

6245
03:39:59,910 --> 03:39:57,920
that was insightful and i think

6246
03:40:02,389 --> 03:39:59,920
um that insight sort of speaks to the

6247
03:40:06,469 --> 03:40:02,399
second half half of this question here

6248
03:40:06,950 --> 03:40:06,479
um so you know it is certainly the case

6249
03:40:10,469 --> 03:40:06,960
that

6250
03:40:11,910 --> 03:40:10,479
when you uh simulate um agents

6251
03:40:13,830 --> 03:40:11,920
con specifics in a particular

6252
03:40:17,670 --> 03:40:13,840
environment or eco niche

6253
03:40:21,189 --> 03:40:17,680
um and you just integrate these

6254
03:40:25,349 --> 03:40:21,199
uh simulation of physics engines um

6255
03:40:28,630 --> 03:40:25,359
using um uh the free energy principle

6256
03:40:32,389 --> 03:40:28,640
you get the um the kind of

6257
03:40:33,110 --> 03:40:32,399
um learning that um you would normally

6258
03:40:35,590 --> 03:40:33,120
expect to see

6259
03:40:37,429 --> 03:40:35,600
in the agents about the environment but

6260
03:40:40,469 --> 03:40:37,439
that is exactly mirrored

6261
03:40:44,070 --> 03:40:40,479
by the environment learning about the

6262
03:40:47,110 --> 03:40:44,080
denizens that you know it plays host to

6263
03:40:50,070 --> 03:40:47,120

so i'm sure you know this but you know

6264
03:40:51,830 --> 03:40:50,080
my favorite example from colleagues who

6265
03:40:52,469 --> 03:40:51,840
really you know push these arguments as

6266
03:40:54,710 --> 03:40:52,479
far as they

6267
03:40:55,910 --> 03:40:54,720
they can go at the present time uh my

6268
03:40:58,070 --> 03:40:55,920
favorite um

6269
03:40:59,349 --> 03:40:58,080
their favorite and my favorite example

6270
03:41:02,070 --> 03:40:59,359
is a notion of a

6271
03:41:02,469 --> 03:41:02,080
desire path or an elephant path which is

6272
03:41:15,030 --> 03:41:02,479
the

6273
03:41:18,790 --> 03:41:15,040
pavement or i can take a shortcut

6274
03:41:22,389 --> 03:41:18,800
across the grass and if i so do

6275
03:41:24,309 --> 03:41:22,399
um i will eventually me and all my con

6276
03:41:28,710 --> 03:41:24,319
specifics will eventually

6277
03:41:32,309 --> 03:41:28,720
wear a a dusty trail

6278
03:41:35,670 --> 03:41:32,319
uh of grassless signs and queues

6279
03:41:36,870 --> 03:41:35,680
uh from uh you know my office directly

6280
03:41:38,309 --> 03:41:36,880
to the cafe

6281
03:41:40,070 --> 03:41:38,319
so from the point of view of the

6282
03:41:42,150 --> 03:41:40,080
environment this is basically the

6283
03:41:45,830 --> 03:41:42,160
environment learning about the behavior

6284
03:41:50,070 --> 03:41:45,840
of the kinds of agents that you know

6285
03:41:52,070 --> 03:41:50,080
that occupies that that

6286
03:41:53,670 --> 03:41:52,080
that environment so the environment is

6287
03:41:56,710 --> 03:41:53,680
learning about the behavior

6288
03:41:57,750 --> 03:41:56,720

by being eroded by being changed so it's

6289
03:42:00,229 --> 03:41:57,760
literally just

6290
03:42:01,349 --> 03:42:00,239
remembering in its structure in its

6291
03:42:04,309 --> 03:42:01,359
subpersonal

6292
03:42:05,590 --> 03:42:04,319
structure it is learning about the uh

6293
03:42:07,429 --> 03:42:05,600
the con specifics

6294
03:42:09,189 --> 03:42:07,439
that are good for occupying that

6295
03:42:10,870 --> 03:42:09,199
environment

6296
03:42:12,229 --> 03:42:10,880
the con specifics that are occupying

6297
03:42:13,349 --> 03:42:12,239
that environment what are the con

6298
03:42:16,790 --> 03:42:13,359
specifics

6299
03:42:17,990 --> 03:42:16,800
oh a con a con specific um you and i are

6300
03:42:20,710 --> 03:42:18,000
con specifics because we're

6301
03:42:22,550 --> 03:42:20,720
from the same species so is it sorry

6302
03:42:25,429 --> 03:42:22,560
it's just a way of describing

6303
03:42:26,309 --> 03:42:25,439
an ensemble of or a collection of

6304
03:42:29,590 --> 03:42:26,319
phenotypes

6305
03:42:30,790 --> 03:42:29,600
agents that have the you know come from

6306
03:42:33,670 --> 03:42:30,800
the same species

6307
03:42:35,429 --> 03:42:33,680
um and the environment can learn this is

6308
03:42:38,710 --> 03:42:35,439
the kind of phenotype

6309
03:42:41,110 --> 03:42:38,720
that operates well in my environment

6310
03:42:42,630 --> 03:42:41,120
whilst at the same time the phenotypes

6311
03:42:44,070 --> 03:42:42,640
are trying to change to operate better

6312
03:42:47,189 --> 03:42:44,080
in this environment so there's

6313
03:42:50,950 --> 03:42:47,199

a there's a your circular causality

6314
03:42:53,670 --> 03:42:50,960
your while while the while the the

6315
03:42:55,590 --> 03:42:53,680
the phenotypes or the con specifics are

6316
03:42:57,269 --> 03:42:55,600
trying to adapt to the environment

6317
03:42:59,830 --> 03:42:57,279
the environment is also adapting to

6318
03:43:03,110 --> 03:42:59,840
those con specifics so it's a dance

6319
03:43:06,309 --> 03:43:03,120
um that in fact can get quite high order

6320
03:43:09,429 --> 03:43:06,319
in the sense now that that you and i

6321
03:43:10,469 --> 03:43:09,439
will now see the path and realize oh

6322
03:43:13,429 --> 03:43:10,479
that must

6323
03:43:16,070 --> 03:43:13,439
this path leads to to somewhere that it

6324
03:43:19,349 --> 03:43:16,080
must be nice for things like me to go

6325
03:43:21,670 --> 03:43:19,359
so i can just infer seeing a desire path

6326
03:43:22,710 --> 03:43:21,680
that it will lead to something i desire

6327
03:43:24,790 --> 03:43:22,720
because i know

6328
03:43:25,990 --> 03:43:24,800
that everybody else who has used that

6329
03:43:27,670 --> 03:43:26,000
are con specifics

6330
03:43:29,830 --> 03:43:27,680
they like the same kinds of things they

6331
03:43:33,030 --> 03:43:29,840
have the same attracting sets

6332
03:43:36,630 --> 03:43:33,040
so now the environment has learned about

6333
03:43:38,630 --> 03:43:36,640
the the phenotypes and has

6334
03:43:40,630 --> 03:43:38,640
memorized it in its structure and now

6335
03:43:42,309 --> 03:43:40,640
the phenotypes are now using that to

6336
03:43:42,790 --> 03:43:42,319
infer the kinds of things that i should

6337
03:43:44,950 --> 03:43:42,800
do

6338
03:43:46,150 --> 03:43:44,960

so now you get something like just using

6339
03:43:49,910 --> 03:43:46,160
the environment

6340
03:43:52,229 --> 03:43:49,920
to cooperate and to signal and to change

6341
03:43:53,990 --> 03:43:52,239
um and to provide information for other

6342
03:43:55,590 --> 03:43:54,000
things other creatures like me

6343
03:43:57,670 --> 03:43:55,600
and you can take that right through to

6344
03:44:00,469 --> 03:43:57,680
the emergence of roads

6345
03:44:02,870 --> 03:44:00,479
of traffic lights of language so you

6346
03:44:05,750 --> 03:44:02,880
move these arguments that's interesting

6347
03:44:06,309 --> 03:44:05,760
cultural domain um and now you've you

6348
03:44:08,150 --> 03:44:06,319
know

6349
03:44:09,910 --> 03:44:08,160
so language is that part of the

6350
03:44:11,110 --> 03:44:09,920
environment or is it part of papa's

6351
03:44:13,269 --> 03:44:11,120
third world or

6352
03:44:14,950 --> 03:44:13,279
is it you know is it part of your brain

6353
03:44:16,229 --> 03:44:14,960
i i yeah i don't think you tie it down

6354
03:44:17,429 --> 03:44:16,239
like that because of this circular

6355
03:44:20,309 --> 03:44:17,439
causality

6356
03:44:20,950 --> 03:44:20,319
um that you you hinted at more than

6357
03:44:22,710 --> 03:44:20,960
hinted at

6358
03:44:23,990 --> 03:44:22,720
when you're when you recognize that a

6359
03:44:25,269 --> 03:44:24,000
markov blanket

6360
03:44:27,110 --> 03:44:25,279
you know it's quite arbitrary what is

6361
03:44:29,269 --> 03:44:27,120
internal external just depends upon

6362
03:44:30,790 --> 03:44:29,279
which point of view you're taking so

6363
03:44:31,910 --> 03:44:30,800

there's a really interesting question

6364
03:44:33,590 --> 03:44:31,920
which you can take in many many

6365
03:44:36,870 --> 03:44:33,600
different directions

6366
03:44:39,429 --> 03:44:36,880
you know i i i'm personally not

6367
03:44:41,910 --> 03:44:39,439
um not taking it in those directions

6368
03:44:43,349 --> 03:44:41,920
because i got distracted by other things

6369
03:44:44,870 --> 03:44:43,359
but i have lots of young colleagues

6370
03:44:45,189 --> 03:44:44,880
around the world who are really trying

6371
03:44:49,750 --> 03:44:45,199
to

6372
03:44:52,389 --> 03:44:49,760
evolutionary psychology

6373
03:44:53,429 --> 03:44:52,399
evo devo uh the relationship to niche

6374
03:44:55,910 --> 03:44:53,439
construction

6375
03:44:56,870 --> 03:44:55,920
and the relationship to what andy clark

6376
03:44:58,870 --> 03:44:56,880
would have would have

6377
03:45:00,389 --> 03:44:58,880
promoted which is the designed

6378
03:45:03,510 --> 03:45:00,399
environment so one of the

6379
03:45:06,150 --> 03:45:03,520
one of the sort of um you know p

6380
03:45:06,950 --> 03:45:06,160
parts of the triple uh you know the four

6381
03:45:09,510 --> 03:45:06,960
e's

6382
03:45:10,309 --> 03:45:09,520
you know so yes it is embodied but

6383
03:45:13,349 --> 03:45:10,319
there's also

6384
03:45:16,790 --> 03:45:13,359
um you know an extension it's situated

6385
03:45:17,910 --> 03:45:16,800
um so the environment not just the

6386
03:45:19,510 --> 03:45:17,920
physical environment

6387
03:45:21,590 --> 03:45:19,520
outside my body but my body as

6388
03:45:23,590 --> 03:45:21,600

environment as well starts to become

6389
03:45:25,429 --> 03:45:23,600
you know an important part of this

6390
03:45:28,870 --> 03:45:25,439
reciprocal loop and this sort of

6391
03:45:32,229 --> 03:45:28,880
joint free energy minimizing mechanics

6392
03:45:32,950 --> 03:45:32,239
that rests upon a reciprocal exchange

6393
03:45:34,870 --> 03:45:32,960
between

6394
03:45:37,030 --> 03:45:34,880
you know one side of a markov blanket

6395
03:45:39,990 --> 03:45:37,040
and the other side of the markov blanket

6396
03:45:41,030 --> 03:45:40,000
i'll just close with with the first part

6397
03:45:44,229 --> 03:45:41,040
of the question which is

6398
03:45:47,750 --> 03:45:44,239
does that mean the environment perceives

6399
03:45:49,030 --> 03:45:47,760
i i would say possibly not um

6400
03:45:50,469 --> 03:45:49,040
it certainly would be the case

6401
03:45:51,269 --> 03:45:50,479
mathematically speaking that the

6402
03:45:54,150 --> 03:45:51,279
environment is

6403
03:45:56,469 --> 03:45:54,160
learning but we generally reserve the

6404
03:45:58,950 --> 03:45:56,479
notion of perception to refer to

6405
03:46:00,389 --> 03:45:58,960
to perceptual inference or inference

6406
03:46:03,030 --> 03:46:00,399
about states

6407
03:46:04,870 --> 03:46:03,040
of the world as opposed to the

6408
03:46:07,750 --> 03:46:04,880
parameters of a generative model

6409
03:46:08,790 --> 03:46:07,760
which um are more attributes of

6410
03:46:13,269 --> 03:46:08,800
contingencies

6411
03:46:15,269 --> 03:46:13,279
laws and the like so that we we infer

6412
03:46:16,950 --> 03:46:15,279
that the world is in this state or that

6413
03:46:19,030 --> 03:46:16,960

state at this point in time

6414
03:46:21,429 --> 03:46:19,040
but we learn the contingencies and the

6415
03:46:24,309 --> 03:46:21,439
lawful mappings the likelihoods

6416
03:46:25,349 --> 03:46:24,319
and the transition probabilities um that

6417
03:46:27,510 --> 03:46:25,359
underwrite

6418
03:46:30,070 --> 03:46:27,520
the changes and transitions in the state

6419
03:46:33,590 --> 03:46:30,080
the other flux of states in the world

6420
03:46:35,990 --> 03:46:33,600
so um it it's it's probably the case

6421
03:46:38,070 --> 03:46:36,000
that the environment

6422
03:46:39,670 --> 03:46:38,080
the physical environment not the body

6423
03:46:41,349 --> 03:46:39,680
environment but so you know things like

6424
03:46:44,550 --> 03:46:41,359
roads and paths and buildings

6425
03:46:45,990 --> 03:46:44,560
trees um

6426
03:46:47,670 --> 03:46:46,000
they learn that they probably don't

6427
03:46:49,830 --> 03:46:47,680
infer and perceive in the sense of

6428
03:46:51,269 --> 03:46:49,840
having qualitative experience of qualia

6429
03:46:53,510 --> 03:46:51,279
but they do learn

6430
03:46:54,950 --> 03:46:53,520
um you know they do update their

6431
03:46:56,630 --> 03:46:54,960
parameters in a way

6432
03:46:58,150 --> 03:46:56,640
to model what's on the other side of

6433
03:47:01,189 --> 03:46:58,160
their mark off blanket which is you and

6434
03:47:04,630 --> 03:47:03,110
thank you sir you've given you've been

6435
03:47:06,950 --> 03:47:04,640
far too generous with your time

6436
03:47:08,790 --> 03:47:06,960
and i appreciate it immensely i think

6437
03:47:10,309 --> 03:47:08,800
this conversation will be

6438
03:47:12,070 --> 03:47:10,319

fruitful for quite a few people

6439
03:47:14,229 --> 03:47:12,080
especially more on the

6440
03:47:15,349 --> 03:47:14,239
philosophical end there's not many most

6441
03:47:16,070 --> 03:47:15,359
of the interviews with you are more

6442
03:47:17,910 --> 03:47:16,080
technical so

6443
03:47:19,830 --> 03:47:17,920
i'm glad that we got a bit philosophical

6444
03:47:20,870 --> 03:47:19,840
even though i love some of the technical

6445
03:47:23,189 --> 03:47:20,880
questions

6446
03:47:24,070 --> 03:47:23,199
i have maybe the 30 30 more that i

6447
03:47:28,070 --> 03:47:24,080
didn't get to but

6448
03:47:29,590 --> 03:47:28,080
we'll save that for the next time well

6449
03:47:31,590 --> 03:47:29,600
as as last time it's been a real

6450
03:47:34,150 --> 03:47:31,600
pleasure talking to you

6451
03:47:35,670 --> 03:47:34,160
thank you i look forward to our next uh

6452
03:47:37,750 --> 03:47:35,680
next exchange

6453
03:47:39,189 --> 03:47:37,760
thank you man appreciate it honestly i

6454
03:47:41,269 --> 03:47:39,199
do thank you so much and you've helped

6455
03:47:43,429 --> 03:47:41,279
me psychologically as well because

6456
03:47:44,710 --> 03:47:43,439
well just you telling me that other

6457
03:47:46,229 --> 03:47:44,720
people are

6458
03:47:47,990 --> 03:47:46,239
are going through what i'm going through

6459
03:47:49,510 --> 03:47:48,000
but sometimes even worse and sometimes

6460
03:47:51,349 --> 03:47:49,520
better but it's normal

6461
03:47:53,030 --> 03:47:51,359
that gave me at first some anxiety

6462
03:47:54,469 --> 03:47:53,040
because i was thinking well

6463
03:47:56,229 --> 03:47:54,479

if your colleagues are going through

6464
03:47:58,229 --> 03:47:56,239
psychotic breaks i'm not at a psychotic

6465
03:48:00,950 --> 03:47:58,239
break but that means that it's possible

6466
03:48:01,349 --> 03:48:00,960
and if cantor studying infinity could go

6467
03:48:03,189 --> 03:48:01,359
through

6468
03:48:05,030 --> 03:48:03,199
psychotic breaks i wonder how much of

6469
03:48:06,950 --> 03:48:05,040
what i'm doing is self-imposed from

6470
03:48:08,870 --> 03:48:06,960
my own study of consciousness and

6471
03:48:10,710 --> 03:48:08,880
investigating the universe

6472
03:48:12,309 --> 03:48:10,720
so it gives me a bit of anxiety because

6473
03:48:13,349 --> 03:48:12,319
it's like okay well this is a path that

6474
03:48:15,110 --> 03:48:13,359
may lead to that

6475
03:48:16,870 --> 03:48:15,120
but at the same time it gives me some

6476
03:48:19,349 --> 03:48:16,880
calm because you're saying

6477
03:48:21,030 --> 03:48:19,359
it's okay first of all if it gets

6478
03:48:23,910 --> 03:48:21,040
serious it can be treated

6479
03:48:26,150 --> 03:48:23,920
don't worry about that and and it

6480
03:48:26,710 --> 03:48:26,160
doesn't seem like i give off any signs

6481
03:48:28,389 --> 03:48:26,720
of

6482
03:48:31,349 --> 03:48:28,399
being schizophrenic even though i'm

6483
03:48:34,950 --> 03:48:31,359
concerned about it so

6484
03:48:38,309 --> 03:48:34,960
yes you're concerned means you can't be

6485
03:48:40,309 --> 03:48:38,319
you can't be psychotic i i did cross my

6486
03:48:43,189 --> 03:48:40,319
mind when you're talking about the

6487
03:48:44,790 --> 03:48:43,199
monotheism versus polytheism um and

6488
03:48:46,790 --> 03:48:44,800

resolving that sort of cognitive

6489
03:48:48,229 --> 03:48:46,800
dissonance and that existential angst

6490
03:48:49,269 --> 03:48:48,239
you get when you you know you could be

6491
03:48:52,389 --> 03:48:49,279
this way or that way

6492
03:48:54,070 --> 03:48:52,399
i mean the very ability to entertain

6493
03:48:56,790 --> 03:48:54,080
these counterfactuals

6494
03:48:57,429 --> 03:48:56,800
is very very close to to to psychosis

6495
03:48:59,590 --> 03:48:57,439
and sorry

6496
03:49:02,070 --> 03:48:59,600
um you know the kind of the kind of

6497
03:49:04,790 --> 03:49:02,080
angst you see manic depressive psychosis

6498
03:49:06,070 --> 03:49:04,800
so it's a natural state for curious

6499
03:49:08,070 --> 03:49:06,080
creatures

6500
03:49:10,389 --> 03:49:08,080
so the anxiety you're gonna go over the

6501
03:49:11,670 --> 03:49:10,399
edge is just a price you pay for being a

6502
03:49:14,150 --> 03:49:11,680
curious creature

6503
03:49:15,349 --> 03:49:14,160
um and as you say you'll know when

6504
03:49:17,030 --> 03:49:15,359
you're going too far

6505
03:49:18,389 --> 03:49:17,040
and you either get your wife to call him

6506
03:49:20,550 --> 03:49:18,399
the doctor or

6507
03:49:21,910 --> 03:49:20,560
you'll just sort of commit to one way of

6508
03:49:24,630 --> 03:49:21,920
being on another way of being

6509
03:49:25,269 --> 03:49:24,640
um you know you you you will know that

6510
03:49:28,309 --> 03:49:25,279
but it's

6511
03:49:29,590 --> 03:49:28,319
you know what i'm saying is don't

6512
03:49:31,349 --> 03:49:29,600
you shouldn't be frightened of this you

6513
03:49:33,269 --> 03:49:31,359

should you should celebrate this

6514
03:49:35,030 --> 03:49:33,279
you know which is why i always encourage

6515
03:49:42,150 --> 03:49:35,040
you to make sure you write down

6516
03:49:46,550 --> 03:49:44,950
of ontological security what i don't do

6517
03:49:48,550 --> 03:49:46,560
is rewrite and that's my problem

6518
03:49:49,670 --> 03:49:48,560
as well because plenty of the writing is

6519
03:49:52,790 --> 03:49:49,680
in the rewriting

6520
03:49:55,030 --> 03:49:52,800
well

6521
03:49:55,830 --> 03:49:55,040
but anyway i got to work on that thank

6522
03:49:58,309 --> 03:49:55,840
you sir

6523
03:50:00,150 --> 03:49:58,319
you're i gotta i feel like i've gotten

6524
03:50:01,349 --> 03:50:00,160
along with you

6525
03:50:02,790 --> 03:50:01,359
more than almost anyone that i've

6526
03:50:04,309 --> 03:50:02,800
interviewed and i've interviewed almost

6527
03:50:06,469 --> 03:50:04,319
50 or

6528
03:50:08,469 --> 03:50:06,479
50 plus people so i don't i don't know

6529
03:50:11,429 --> 03:50:08,479
what to attribute to that but

6530
03:50:12,710 --> 03:50:11,439
it's probably your your demeanor and

6531
03:50:14,389 --> 03:50:12,720
your

6532
03:50:16,469 --> 03:50:14,399
there's a caringness that comes across

6533
03:50:18,309 --> 03:50:16,479
in your voice and i appreciate that and

6534
03:50:20,550 --> 03:50:18,319
humbleness as well thank you