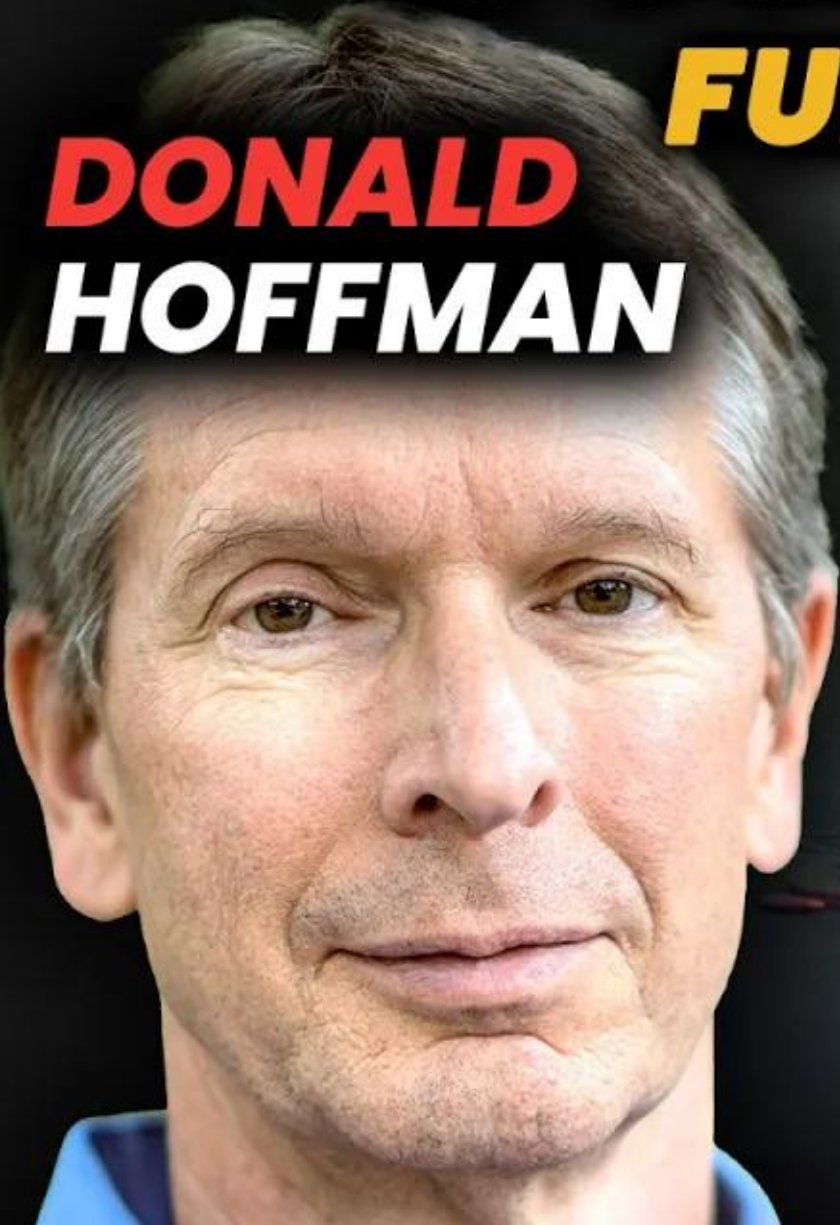
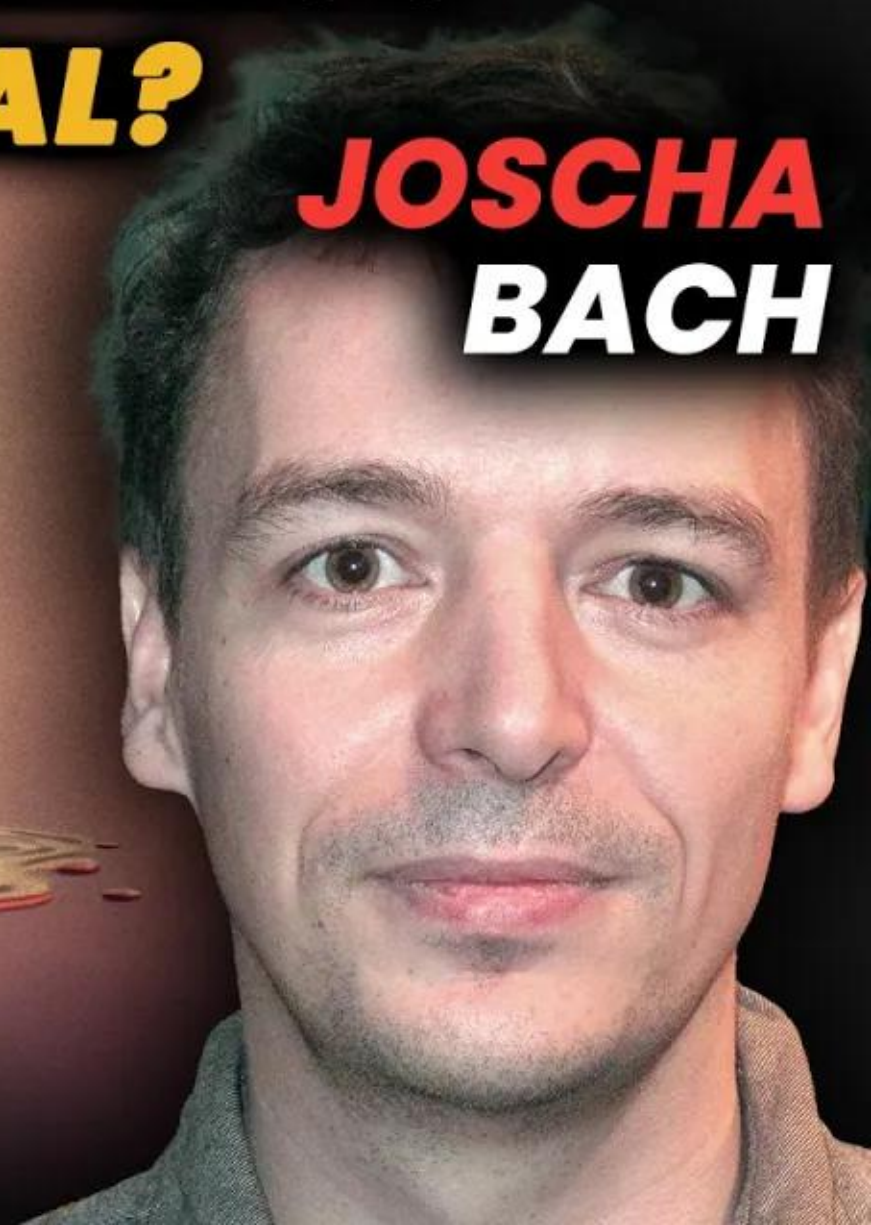


IS CONSCIOUSNESS FUNDAMENTAL?

**DONALD
HOFFMAN**



**JOSCHA
BACH**



1
00:00:05,030 --> 00:00:01,910
this is an episode that's been almost

2
00:00:07,590 --> 00:00:05,040
one year in the making the theo locution

3
00:00:09,669 --> 00:00:07,600
of donald hoffman and yoshibok both of

4
00:00:11,509 --> 00:00:09,679
whom should be extremely familiar to you

5
00:00:13,749 --> 00:00:11,519
if you've surveyed this channel before

6
00:00:15,669 --> 00:00:13,759
as we've done an unduly technical dive

7
00:00:17,510 --> 00:00:15,679
into donald hoffman's research papers

8
00:00:19,189 --> 00:00:17,520
and we've spoken to yoshibach several

9
00:00:21,670 --> 00:00:19,199
times before as well if you're

10
00:00:23,910 --> 00:00:21,680
unfamiliar donald hoffman is a professor

11
00:00:25,830 --> 00:00:23,920
at the university of irvine california

12
00:00:28,150 --> 00:00:25,840
studying consciousness and evolutionary

13
00:00:30,470 --> 00:00:28,160

psychology using mathematical models and

14

00:00:32,709 --> 00:00:30,480

yoshibak is a cognitive scientist

15

00:00:34,870 --> 00:00:32,719

recognized in the field of ai as being

16

00:00:37,110 --> 00:00:34,880

exceptionally ingenious both have

17

00:00:39,430 --> 00:00:37,120

unexampled views of consciousness and

18

00:00:41,590 --> 00:00:39,440

free will which harmonize and contradict

19

00:00:42,630 --> 00:00:41,600

in pre-possessing and informative ways

20

00:00:44,150 --> 00:00:42,640

click on the timestamp in the

21

00:00:46,630 --> 00:00:44,160

description if you'd like to skip this

22

00:00:48,950 --> 00:00:46,640

intro my name is kirchey mungle i'm a

23

00:00:51,430 --> 00:00:48,960

torontonian filmmaker with a background

24

00:00:53,910 --> 00:00:51,440

in mathematical physics dedicated to the

25

00:00:55,670 --> 00:00:53,920

explication of the variegated terrain of

26

00:00:57,590 --> 00:00:55,680

theories of everything from a

27

00:00:59,590 --> 00:00:57,600

theoretical physics perspective but as

28

00:01:01,349 --> 00:00:59,600

well as analyzing consciousness and

29

00:01:03,510 --> 00:01:01,359

seeing its potential connection to

30

00:01:05,429 --> 00:01:03,520

fundamental reality whatever that is

31

00:01:07,990 --> 00:01:05,439

essentially this channel is dedicated to

32

00:01:10,070 --> 00:01:08,000

exploring the under nature of reality

33

00:01:11,670 --> 00:01:10,080

the constitutional laws that govern it

34

00:01:14,070 --> 00:01:11,680

provided those laws exist at all and are

35

00:01:15,990 --> 00:01:14,080

even noble to us if you enjoy witnessing

36

00:01:18,710 --> 00:01:16,000

and engaging with others on the topics

37

00:01:20,950 --> 00:01:18,720

of psychology consciousness physics etc

38

00:01:22,630 --> 00:01:20,960

the channel's themes then do consider

39

00:01:24,469 --> 00:01:22,640

going to the discord and the subreddit

40

00:01:26,310 --> 00:01:24,479

which are linked in the description

41

00:01:27,990 --> 00:01:26,320

there's also a link to the patreon that

42

00:01:29,749 --> 00:01:28,000

is patreon.com

43

00:01:31,830 --> 00:01:29,759

kerchamungle if you'd like to support

44

00:01:33,670 --> 00:01:31,840

this podcast as the patrons and the

45

00:01:36,149 --> 00:01:33,680

sponsors are the only reasons that i'm

46

00:01:38,069 --> 00:01:36,159

able to have podcasts of this quality

47

00:01:40,310 --> 00:01:38,079

and this depth given that i can do this

48

00:01:42,069 --> 00:01:40,320

now full time thanks to both the patrons

49

00:01:44,389 --> 00:01:42,079

and the sponsors support speaking of

50

00:01:46,389 --> 00:01:44,399

sponsors there are two the first sponsor

51
00:01:47,749 --> 00:01:46,399
is brilliant during the winter break i

52
00:01:49,590 --> 00:01:47,759
decided to brush up on some of the

53
00:01:51,749 --> 00:01:49,600
fundamentals of physics particularly

54
00:01:53,670 --> 00:01:51,759
with regard to information theory as i'd

55
00:01:55,350 --> 00:01:53,680
like to interview chiara marletto on

56
00:01:56,950 --> 00:01:55,360
constructor theory which is heavily

57
00:01:58,630 --> 00:01:56,960
based in information theory now

58
00:01:59,990 --> 00:01:58,640
information theory is predicated on

59
00:02:02,389 --> 00:02:00,000
entropy at least there's a fundamental

60
00:02:04,149 --> 00:02:02,399
formula for entropy so i ended up taking

61
00:02:06,230 --> 00:02:04,159
the brilliant course i challenged myself

62
00:02:08,229 --> 00:02:06,240
to do one lesson per day and i took the

63
00:02:09,350 --> 00:02:08,239

course's random variable distributions

64

00:02:11,670 --> 00:02:09,360

and knowledge

65

00:02:13,350 --> 00:02:11,680

uncertainty what i loved is that despite

66

00:02:14,949 --> 00:02:13,360

knowing the formula for entropy which is

67

00:02:16,869 --> 00:02:14,959

essentially hammered into you as an

68

00:02:19,190 --> 00:02:16,879

undergraduate it seems like it comes

69

00:02:20,949 --> 00:02:19,200

down from the sky arbitrarily and with

70

00:02:22,710 --> 00:02:20,959

brilliance for the first time i was able

71

00:02:24,229 --> 00:02:22,720

to see how the formula for entropy which

72

00:02:26,390 --> 00:02:24,239

you're seeing right now is actually

73

00:02:28,150 --> 00:02:26,400

extremely natural and it'd be strange to

74

00:02:30,070 --> 00:02:28,160

define it in any other manner there are

75

00:02:31,589 --> 00:02:30,080

plenty of courses and you can even learn

76

00:02:32,710 --> 00:02:31,599

group theory which is what's being

77

00:02:35,030 --> 00:02:32,720

referenced when you hear that the

78

00:02:37,270 --> 00:02:35,040

standard model is predicated on u1 cross

79

00:02:38,630 --> 00:02:37,280

su 2 cross su 3 those are league groups

80

00:02:40,150 --> 00:02:38,640

continuous lead groups visit

81

00:02:42,790 --> 00:02:40,160

brilliant.org

82

00:02:44,470 --> 00:02:42,800

tow t-o-e to get 20 off an annual

83

00:02:46,630 --> 00:02:44,480

subscription and i recommend that you

84

00:02:48,390 --> 00:02:46,640

don't stop before four lessons i think

85

00:02:50,229 --> 00:02:48,400

you'll be greatly surprised at the ease

86

00:02:52,070 --> 00:02:50,239

at which you can now comprehend subjects

87

00:02:54,790 --> 00:02:52,080

you previously had a difficult time

88

00:02:56,869 --> 00:02:54,800

grokking the second sponsor is also now

89

00:02:58,869 --> 00:02:56,879

also is an end-to-end supply chain

90

00:03:00,949 --> 00:02:58,879

optimization software company with

91

00:03:02,949 --> 00:03:00,959

software that helps business users

92

00:03:05,190 --> 00:03:02,959

optimize sales and operations planning

93

00:03:07,110 --> 00:03:05,200

to avoid stockouts reduce return and

94

00:03:09,430 --> 00:03:07,120

inventory write-downs while reducing

95

00:03:12,630 --> 00:03:09,440

inventory investment it's a supply chain

96

00:03:14,710 --> 00:03:12,640

ai that drives smart roi headed by amjad

97

00:03:17,110 --> 00:03:14,720

hussein who's been a huge supporter of

98

00:03:20,149 --> 00:03:17,120

this podcast since near its inception in

99

00:03:21,990 --> 00:03:20,159

fact amjad has his own podcast on ai and

100

00:03:23,910 --> 00:03:22,000

consciousness and business growth and if

101
00:03:25,830 --> 00:03:23,920
you'd like to support the tow podcast

102
00:03:27,509 --> 00:03:25,840
then visit the link in the description

103
00:03:29,589 --> 00:03:27,519
to see amjad's podcast because

104
00:03:31,990 --> 00:03:29,599
subscribing to him or at least visiting

105
00:03:33,670 --> 00:03:32,000
supports the toe podcast indirectly

106
00:03:36,550 --> 00:03:33,680
thank you and enjoy

107
00:03:39,750 --> 00:03:36,560
okay this should be live if you can see

108
00:03:41,670 --> 00:03:39,760
this type in animaniacs into the chat

109
00:03:44,949 --> 00:03:41,680
animaniacs

110
00:03:46,869 --> 00:03:44,959
great there are already 275 people

111
00:03:50,550 --> 00:03:46,879
watching firstly it's a distinct honor

112
00:03:51,910 --> 00:03:50,560
to be here thank you both don and yosha

113
00:03:54,149 --> 00:03:51,920

i appreciate it tremendously in the

114

00:03:55,110 --> 00:03:54,159

audience does as well this theories of

115

00:03:57,830 --> 00:03:55,120

everything

116

00:03:59,910 --> 00:03:57,840

project is about exploring grand unified

117

00:04:01,509 --> 00:03:59,920

theories in theoretical physics as you

118

00:04:03,429 --> 00:04:01,519

know and understanding consciousness and

119

00:04:05,750 --> 00:04:03,439

free will i see those are at least

120

00:04:07,350 --> 00:04:05,760

intuit that those are integrally tied

121

00:04:09,270 --> 00:04:07,360

and it's those

122

00:04:10,070 --> 00:04:09,280

the latter two topics that bring us here

123

00:04:13,670 --> 00:04:10,080

don

124

00:04:15,589 --> 00:04:13,680

of free will as well as how you view

125

00:04:17,909 --> 00:04:15,599

consciousness and you mentioned that you

126

00:04:20,069 --> 00:04:17,919

would like to give an overview of your

127

00:04:21,590 --> 00:04:20,079

point of view on science and theories of

128

00:04:23,350 --> 00:04:21,600

everything in general

129

00:04:26,230 --> 00:04:23,360

and then yosha

130

00:04:28,310 --> 00:04:26,240

you'll join afterward and commend

131

00:04:29,909 --> 00:04:28,320

donald or amend him and then i'll pretty

132

00:04:31,909 --> 00:04:29,919

much shut my mouth and allow you both to

133

00:04:33,830 --> 00:04:31,919

speak to one another interjecting only

134

00:04:36,230 --> 00:04:33,840

seldom

135

00:04:37,990 --> 00:04:36,240

okay thank you kurt and good to see you

136

00:04:40,629 --> 00:04:38,000

yosha um

137

00:04:42,230 --> 00:04:40,639

my my attitude about science

138

00:04:43,909 --> 00:04:42,240

is

139

00:04:45,670 --> 00:04:43,919

sort of like what

140

00:04:47,590 --> 00:04:45,680

newton famously said

141

00:04:49,670 --> 00:04:47,600

right he said that toward the end of his

142

00:04:51,270 --> 00:04:49,680

career that he thought of himself as

143

00:04:52,790 --> 00:04:51,280

like

144

00:04:54,469 --> 00:04:52,800

a little boy

145

00:04:56,950 --> 00:04:54,479

playing on the on the seashore looking

146

00:04:59,110 --> 00:04:56,960

at uh some nice

147

00:05:01,350 --> 00:04:59,120

pebbles and shells while

148

00:05:03,909 --> 00:05:01,360

all before him lay the um

149

00:05:05,350 --> 00:05:03,919

the vast ocean of of truth that was

150

00:05:07,110 --> 00:05:05,360

undiscovered

151
00:05:11,590 --> 00:05:07,120
and

152
00:05:13,590 --> 00:05:11,600
good attitude for us as scientists to

153
00:05:15,350 --> 00:05:13,600
have is that

154
00:05:16,950 --> 00:05:15,360
as much as we've done

155
00:05:20,550 --> 00:05:16,960
um

156
00:05:23,350 --> 00:05:20,560
we've really not even begun to explore

157
00:05:25,670 --> 00:05:23,360
the possibilities of truth and what's

158
00:05:27,270 --> 00:05:25,680
interesting is that newton's followers

159
00:05:28,790 --> 00:05:27,280
uh famously

160
00:05:30,390 --> 00:05:28,800
didn't

161
00:05:31,510 --> 00:05:30,400
follow him on that

162
00:05:33,909 --> 00:05:31,520
in the late

163
00:05:35,510 --> 00:05:33,919

19th century a lot of newtonians thought

164

00:05:36,950 --> 00:05:35,520

that it was pretty much over they had a

165

00:05:39,350 --> 00:05:36,960

theory of everything

166

00:05:41,830 --> 00:05:39,360

there were a few little wrinkles

167

00:05:43,110 --> 00:05:41,840

you know there was the you know

168

00:05:44,710 --> 00:05:43,120

problem with michaelson morally

169

00:05:46,469 --> 00:05:44,720

experiment and

170

00:05:47,590 --> 00:05:46,479

and black body radiation wasn't quite

171

00:05:48,790 --> 00:05:47,600

working out

172

00:05:50,230 --> 00:05:48,800

according to newton but they thought

173

00:05:52,070 --> 00:05:50,240

that that was pretty minor stuff and

174

00:05:54,230 --> 00:05:52,080

they would figure that all out and

175

00:05:56,710 --> 00:05:54,240

physics was pretty much done

176
00:05:58,309 --> 00:05:56,720
and and we've discovered that no physics

177
00:06:00,550 --> 00:05:58,319
would was hardly

178
00:06:05,510 --> 00:06:00,560
beginning there was so much more to

179
00:06:09,350 --> 00:06:06,469
science

180
00:06:11,430 --> 00:06:09,360
cannot have a theory of everything

181
00:06:13,510 --> 00:06:11,440
in principle

182
00:06:15,350 --> 00:06:13,520
that we will always be on newton's

183
00:06:17,909 --> 00:06:15,360
seashore we'll always be

184
00:06:19,350 --> 00:06:17,919
like newton the the little boy playing

185
00:06:22,870 --> 00:06:19,360
with pebbles and

186
00:06:24,710 --> 00:06:22,880
and shells while the vast uh truth lays

187
00:06:26,950 --> 00:06:24,720
undiscovered before us the ocean of

188
00:06:28,070 --> 00:06:26,960

truth and and it's for a principled

189

00:06:28,870 --> 00:06:28,080

reason

190

00:06:30,550 --> 00:06:28,880

that

191

00:06:32,230 --> 00:06:30,560

scientific theories

192

00:06:34,550 --> 00:06:32,240

if you look at how

193

00:06:36,230 --> 00:06:34,560

they're structured we start with

194

00:06:38,150 --> 00:06:36,240

a good scientific theory tells you

195

00:06:39,909 --> 00:06:38,160

exactly what its assumptions are this is

196

00:06:41,990 --> 00:06:39,919

what i'm assuming

197

00:06:42,870 --> 00:06:42,000

these are the derivation rules that i

198

00:06:44,790 --> 00:06:42,880

allow

199

00:06:47,830 --> 00:06:44,800

and then everything about the theory

200

00:06:49,670 --> 00:06:47,840

follows from that but that that theory

201
00:06:51,749 --> 00:06:49,680
doesn't explain its assumptions the

202
00:06:53,990 --> 00:06:51,759
assumptions are what's

203
00:06:56,469 --> 00:06:54,000
assumed so einstein in this special

204
00:06:57,670 --> 00:06:56,479
theory of relativity assumes you know

205
00:06:59,990 --> 00:06:57,680
that light

206
00:07:01,670 --> 00:07:00,000
uh travels at the same speed for for all

207
00:07:02,790 --> 00:07:01,680
observers in all inertial reference

208
00:07:03,670 --> 00:07:02,800
frames

209
00:07:05,029 --> 00:07:03,680
but

210
00:07:06,070 --> 00:07:05,039
that theory doesn't tell you what light

211
00:07:12,550 --> 00:07:06,080
is

212
00:07:14,950 --> 00:07:12,560
whole life studying it and i still have

213
00:07:16,790 --> 00:07:14,960

no idea what what light really is

214

00:07:19,110 --> 00:07:16,800

and and so

215

00:07:19,909 --> 00:07:19,120

we're in that situation as scientists

216

00:07:22,390 --> 00:07:19,919

where

217

00:07:23,830 --> 00:07:22,400

um what we're doing is valuable it's

218

00:07:26,230 --> 00:07:23,840

it's absolutely essential because we're

219

00:07:27,589 --> 00:07:26,240

being precise about our assumptions

220

00:07:28,870 --> 00:07:27,599

we're being precise about what they

221

00:07:30,950 --> 00:07:28,880

entail

222

00:07:32,469 --> 00:07:30,960

but there's going to be a fundamental

223

00:07:35,670 --> 00:07:32,479

limit and and

224

00:07:37,909 --> 00:07:35,680

my guess is that science

225

00:07:38,629 --> 00:07:37,919

um as valuable as it is is one of the

226
00:07:40,550 --> 00:07:38,639
most

227
00:07:41,350 --> 00:07:40,560
important advances that humanity has

228
00:07:44,390 --> 00:07:41,360
made

229
00:07:46,309 --> 00:07:44,400
um will always and only scratch the

230
00:07:49,029 --> 00:07:46,319
surface beyond the seashore with with

231
00:07:51,749 --> 00:07:49,039
newton while the vast ocean um lays

232
00:07:53,430 --> 00:07:51,759
undiscovered and um so that that's sort

233
00:07:56,070 --> 00:07:53,440
of when so when we talk about theories

234
00:07:59,029 --> 00:07:56,080
of consciousness and free will and so

235
00:08:01,350 --> 00:07:59,039
forth going forward

236
00:08:03,909 --> 00:08:01,360
i do it with sort of a very modest look

237
00:08:05,589 --> 00:08:03,919
at my own ideas the the ideas are going

238
00:08:06,550 --> 00:08:05,599

to be very much

239

00:08:08,469 --> 00:08:06,560

in

240

00:08:10,390 --> 00:08:08,479

the framework of these are the best

241

00:08:11,749 --> 00:08:10,400

ideas we've come up with so far

242

00:08:13,670 --> 00:08:11,759

of course

243

00:08:16,390 --> 00:08:13,680

there's going to be much much deeper

244

00:08:19,110 --> 00:08:16,400

work ahead um and much more to to

245

00:08:20,790 --> 00:08:19,120

discover ahead so we just have to

246

00:08:22,790 --> 00:08:20,800

as scientists be precise about the

247

00:08:24,469 --> 00:08:22,800

current assumptions we're making and why

248

00:08:27,430 --> 00:08:24,479

we're making them and what what follows

249

00:08:28,790 --> 00:08:27,440

from them but be completely open to

250

00:08:33,190 --> 00:08:28,800

radical

251
00:08:36,550 --> 00:08:33,200
new understandings

252
00:08:37,509 --> 00:08:36,560
your view on consciousness and free will

253
00:08:38,949 --> 00:08:37,519
so

254
00:08:40,630 --> 00:08:38,959
um

255
00:08:43,670 --> 00:08:40,640
in in a nutshell

256
00:08:44,949 --> 00:08:43,680
um my views on consciousness

257
00:08:50,310 --> 00:08:44,959
are

258
00:08:55,829 --> 00:08:53,350
so physicalist approaches we'll say that

259
00:08:57,829 --> 00:08:55,839
we will start with space-time

260
00:09:00,870 --> 00:08:57,839
and and some of its contents

261
00:09:02,470 --> 00:09:00,880
particles neurons neural systems neural

262
00:09:03,509 --> 00:09:02,480
networks that

263
00:09:04,470 --> 00:09:03,519

um

264

00:09:06,389 --> 00:09:04,480

and

265

00:09:08,230 --> 00:09:06,399

those will be so that's a scientific

266

00:09:09,590 --> 00:09:08,240

theory which those are our assumptions

267

00:09:11,110 --> 00:09:09,600

space time and its contents are

268

00:09:13,269 --> 00:09:11,120

fundamental

269

00:09:16,150 --> 00:09:13,279

and particular contents may be very very

270

00:09:17,190 --> 00:09:16,160

important for example dynamical systems

271

00:09:20,230 --> 00:09:17,200

of

272

00:09:21,990 --> 00:09:20,240

on neural networks for example

273

00:09:23,509 --> 00:09:22,000

and from that we're going to try to to

274

00:09:25,750 --> 00:09:23,519

boot up um

275

00:09:28,630 --> 00:09:25,760

subjective experience um

276

00:09:30,949 --> 00:09:28,640

and and that's perfectly a fine project

277

00:09:32,630 --> 00:09:30,959

to try to do uh what we you know what i

278

00:09:34,790 --> 00:09:32,640

would want from that physicalist

279

00:09:37,190 --> 00:09:34,800

approach would be um

280

00:09:39,110 --> 00:09:37,200

not a hand wave but but a specific

281

00:09:43,509 --> 00:09:39,120

accomplishment so you know how do we

282

00:09:45,190 --> 00:09:43,519

start with um dynamical systems of

283

00:09:46,550 --> 00:09:45,200

neural networks and come up with the

284

00:09:48,630 --> 00:09:46,560

taste of chocolate

285

00:09:51,190 --> 00:09:48,640

or the smell of garlic or something

286

00:09:53,670 --> 00:09:51,200

specific some specific conscious

287

00:09:55,910 --> 00:09:53,680

experience but we say my my scientific

288

00:09:58,470 --> 00:09:55,920

theory says why this

289

00:10:00,470 --> 00:09:58,480

dynamical system of activity in

290

00:10:02,310 --> 00:10:00,480

neurons or in computer system or

291

00:10:03,829 --> 00:10:02,320

something like that must be the taste of

292

00:10:05,269 --> 00:10:03,839

chocolate it could not be the smell of

293

00:10:07,350 --> 00:10:05,279

garlic and these are the principal

294

00:10:09,269 --> 00:10:07,360

reasons why if we if something like that

295

00:10:11,350 --> 00:10:09,279

were on the table i would be impressed

296

00:10:12,790 --> 00:10:11,360

until then i'm not impressed

297

00:10:15,670 --> 00:10:12,800

so so

298

00:10:17,350 --> 00:10:15,680

and there's nothing on the table uh yet

299

00:10:19,110 --> 00:10:17,360

that can do that

300

00:10:21,269 --> 00:10:19,120

so that's one reason why i've been

301
00:10:22,550 --> 00:10:21,279
casting around and and looking for a

302
00:10:25,110 --> 00:10:22,560
different direction

303
00:10:26,389 --> 00:10:25,120
um it's not starting with the with the

304
00:10:29,110 --> 00:10:26,399
physical

305
00:10:30,870 --> 00:10:29,120
but starting um somewhere else and

306
00:10:34,069 --> 00:10:30,880
partly because and we can talk about

307
00:10:36,150 --> 00:10:34,079
this in greater detail

308
00:10:37,830 --> 00:10:36,160
because our best scientific theories

309
00:10:40,310 --> 00:10:37,840
right now namely um

310
00:10:42,949 --> 00:10:40,320
[Music]

311
00:10:45,190 --> 00:10:42,959
quantum field theory and and general

312
00:10:47,350 --> 00:10:45,200
relativity on the one hand

313
00:10:48,630 --> 00:10:47,360

and an evolution of natural selection on

314

00:10:50,230 --> 00:10:48,640

the other

315

00:10:51,990 --> 00:10:50,240

both

316

00:10:55,269 --> 00:10:52,000

entail

317

00:10:57,750 --> 00:10:55,279

that space-time is not fundamental

318

00:11:00,710 --> 00:10:57,760

our our two

319

00:11:02,630 --> 00:11:00,720

or three premier scientific theories

320

00:11:03,829 --> 00:11:02,640

um really tell us

321

00:11:05,990 --> 00:11:03,839

their limits

322

00:11:07,269 --> 00:11:06,000

they tell us that space time cannot be

323

00:11:08,949 --> 00:11:07,279

fundamental

324

00:11:11,030 --> 00:11:08,959

and that therefore the contents of space

325

00:11:12,310 --> 00:11:11,040

time are not fundamental

326

00:11:15,350 --> 00:11:12,320

and so if we're going to look for a

327

00:11:17,590 --> 00:11:15,360

theory of consciousness

328

00:11:19,670 --> 00:11:17,600

and we start with something inside space

329

00:11:23,269 --> 00:11:19,680

time we're already starting where our

330

00:11:27,670 --> 00:11:25,190

is not fundamental

331

00:11:29,750 --> 00:11:27,680

so as a result i've been trying to then

332

00:11:31,269 --> 00:11:29,760

say well if space time isn't fundamental

333

00:11:32,949 --> 00:11:31,279

and we don't yet know

334

00:11:35,030 --> 00:11:32,959

what's more fundamental

335

00:11:36,949 --> 00:11:35,040

why don't we first start with trying to

336

00:11:39,670 --> 00:11:36,959

get a mathematical theory of

337

00:11:41,509 --> 00:11:39,680

consciousness on its own terms

338

00:11:42,870 --> 00:11:41,519

what is consciousness

339

00:11:44,230 --> 00:11:42,880

what kinds of assumptions can we make

340

00:11:45,990 --> 00:11:44,240

about it

341

00:11:48,150 --> 00:11:46,000

and then we can ask the question you

342

00:11:50,389 --> 00:11:48,160

know is consciousness

343

00:11:52,389 --> 00:11:50,399

more fundamental than space-time what is

344

00:11:54,870 --> 00:11:52,399

the relationship between consciousness

345

00:11:57,750 --> 00:11:54,880

and space-time

346

00:11:59,509 --> 00:11:57,760

so so the you know the and i can go in

347

00:12:02,710 --> 00:11:59,519

in some of the details if we want to on

348

00:12:03,790 --> 00:12:02,720

on that model um but but the big picture

349

00:12:06,150 --> 00:12:03,800

is that um

350

00:12:08,470 --> 00:12:06,160

[Music]

351
00:12:10,310 --> 00:12:08,480
i'm taking very seriously that evolution

352
00:12:11,350 --> 00:12:10,320
of natural selection entails that none

353
00:12:13,430 --> 00:12:11,360
of our

354
00:12:15,269 --> 00:12:13,440
sensory systems tell us the truths about

355
00:12:17,030 --> 00:12:15,279
objective reality and that therefore

356
00:12:19,030 --> 00:12:17,040
space time is is

357
00:12:19,990 --> 00:12:19,040
not an objective truth it's just

358
00:12:42,310 --> 00:12:20,000
a

359
00:12:44,389 --> 00:12:42,320
it's over

360
00:12:45,509 --> 00:12:44,399
space time is not fundamental and the

361
00:12:48,069 --> 00:12:45,519
contents of space time are not

362
00:12:49,590 --> 00:12:48,079
fundamental and so we need to figure out

363
00:12:50,949 --> 00:12:49,600

and he's got things with you working

364

00:12:53,350 --> 00:12:50,959

with juan maul the cena on things like

365

00:12:55,670 --> 00:12:53,360

cosmological polytopes they're finding

366

00:12:58,389 --> 00:12:55,680

structures beyond space-time from which

367

00:12:59,590 --> 00:12:58,399

space-time can emerge as as a as a

368

00:13:02,150 --> 00:12:59,600

projection

369

00:13:03,750 --> 00:13:02,160

as a special case but these in these in

370

00:13:05,590 --> 00:13:03,760

these deeper

371

00:13:07,509 --> 00:13:05,600

theories there is no time

372

00:13:09,430 --> 00:13:07,519

and there is no space

373

00:13:11,269 --> 00:13:09,440

but there are symmetries that are true

374

00:13:12,949 --> 00:13:11,279

of for example scattering amplitudes

375

00:13:15,110 --> 00:13:12,959

data

376

00:13:17,190 --> 00:13:15,120

that that are there that are true that

377

00:13:19,030 --> 00:13:17,200

you can't see in space time they they

378

00:13:20,790 --> 00:13:19,040

can predict the data but they don't use

379

00:13:23,910 --> 00:13:20,800

space and time as the fundamental

380

00:13:26,389 --> 00:13:23,920

concepts and i think that

381

00:13:27,509 --> 00:13:26,399

as we start to go into

382

00:13:28,870 --> 00:13:27,519

your scientific theories of

383

00:13:31,110 --> 00:13:28,880

consciousness

384

00:13:32,790 --> 00:13:31,120

we cannot ignore what our physicist

385

00:13:34,069 --> 00:13:32,800

colleagues are telling us

386

00:13:35,829 --> 00:13:34,079

they're they're telling us if you're

387

00:13:37,670 --> 00:13:35,839

looking for something fundamental it's

388

00:13:38,949 --> 00:13:37,680

not space time and in particular it's

389

00:13:42,069 --> 00:13:38,959

not time

390

00:13:44,230 --> 00:13:42,079

and that that is a real show stopper is

391

00:13:46,710 --> 00:13:44,240

it's for the physicist too i mean trying

392

00:13:49,670 --> 00:13:46,720

to think outside of the time box

393

00:13:51,829 --> 00:13:49,680

is not easy for the physicists and so

394

00:13:53,910 --> 00:13:51,839

what do we do if we don't have

395

00:13:54,790 --> 00:13:53,920

um space time if we don't have

396

00:13:57,509 --> 00:13:54,800

time

397

00:13:58,870 --> 00:13:57,519

so so i think that that's

398

00:14:00,389 --> 00:13:58,880

one of the interesting questions that we

399

00:14:02,150 --> 00:14:00,399

have to face if we're going to come up

400

00:14:04,710 --> 00:14:02,160

with a theory of consciousness what do

401
00:14:07,350 --> 00:14:04,720
we take as fundamental in our theory if

402
00:14:10,150 --> 00:14:07,360
we take anything inside space time

403
00:14:11,030 --> 00:14:10,160
we're already sort of cutting ourselves

404
00:14:13,269 --> 00:14:11,040
off

405
00:14:14,470 --> 00:14:13,279
because we know that as physics

406
00:14:17,030 --> 00:14:14,480
progresses

407
00:14:19,509 --> 00:14:17,040
things inside space time will just be um

408
00:14:22,310 --> 00:14:19,519
shown to be secondary

409
00:14:23,509 --> 00:14:22,320
so we can go into my details on on

410
00:14:25,350 --> 00:14:23,519
you know my current model of

411
00:14:28,790 --> 00:14:25,360
consciousness but maybe we should talk

412
00:14:33,509 --> 00:14:28,800
first about these more meta ideas

413
00:14:37,829 --> 00:14:34,949

and it's interesting that you start

414

00:14:39,590 --> 00:14:37,839

outing yourself as a mysterialist in a

415

00:14:41,590 --> 00:14:39,600

way right the mysterialism being the

416

00:14:44,470 --> 00:14:41,600

position that human minds are basically

417

00:14:46,150 --> 00:14:44,480

not equipped to understand how they work

418

00:14:48,389 --> 00:14:46,160

or how the universe works that they are

419

00:14:50,550 --> 00:14:48,399

embedded in at a very deep level

420

00:14:52,470 --> 00:14:50,560

and i sometimes joke that mysterialism

421

00:14:54,230 --> 00:14:52,480

is the position that something cannot be

422

00:14:59,269 --> 00:14:54,240

understood if it cannot be understood by

423

00:15:03,910 --> 00:15:01,509

with respect to the mind at the science

424

00:15:06,550 --> 00:15:03,920

of consciousness conference he once uh

425

00:15:08,949 --> 00:15:06,560

gave a presentation where he uh talks

426

00:15:10,470 --> 00:15:08,959

about the card and then mentions that

427

00:15:12,310 --> 00:15:10,480

the card was actually a very smart

428

00:15:14,230 --> 00:15:12,320

fellow because you could already

429

00:15:16,870 --> 00:15:14,240

anticipate stuff that would only be

430

00:15:19,590 --> 00:15:16,880

discovered much much later on and i was

431

00:15:21,910 --> 00:15:19,600

perking up and wondering my god chomsky

432

00:15:23,829 --> 00:15:21,920

is giving this guy credit

433

00:15:24,790 --> 00:15:23,839

and it turned out what he anticipated

434

00:15:27,030 --> 00:15:24,800

was that

435

00:15:30,790 --> 00:15:27,040

we would later like tomski discover that

436

00:15:34,550 --> 00:15:32,710

right so uh this

437

00:15:36,230 --> 00:15:34,560

it's fascinating of course if you are

438

00:15:38,230 --> 00:15:36,240

one of the smartest minds of your own

439

00:15:40,310 --> 00:15:38,240

generation and you see that other people

440

00:15:43,110 --> 00:15:40,320

don't understand

441

00:15:44,790 --> 00:15:43,120

things and that you understand and there

442

00:15:46,550 --> 00:15:44,800

is a boundary where nobody seems to have

443

00:15:48,710 --> 00:15:46,560

an understanding and you crash against

444

00:15:51,110 --> 00:15:48,720

it you you might think okay maybe there

445

00:15:52,629 --> 00:15:51,120

is no way that humans can do it

446

00:15:54,230 --> 00:15:52,639

not convinced that this is the case

447

00:15:57,030 --> 00:15:54,240

though so i'm not i'm not a mysticianist

448

00:15:59,350 --> 00:15:57,040

at this point in my intellectual career

449

00:16:01,829 --> 00:15:59,360

and that's in part because i come from

450

00:16:03,269 --> 00:16:01,839

the other side so many of the things

451
00:16:05,430 --> 00:16:03,279
that

452
00:16:08,470 --> 00:16:05,440
people took as a given for a long time

453
00:16:10,710 --> 00:16:08,480
like space and time

454
00:16:12,069 --> 00:16:10,720
appeared to me in the beginning quite

455
00:16:12,870 --> 00:16:12,079
mysterious

456
00:16:17,269 --> 00:16:12,880
so

457
00:16:19,110 --> 00:16:17,279
time was not that mysterious to me

458
00:16:22,389 --> 00:16:19,120
basically i'm a computer scientist i

459
00:16:24,470 --> 00:16:22,399
started very very early on in my life to

460
00:16:26,389 --> 00:16:24,480
program before i properly understood

461
00:16:27,509 --> 00:16:26,399
mathematics and before i understood

462
00:16:29,590 --> 00:16:27,519
physics

463
00:16:31,269 --> 00:16:29,600

and i understood how to make things in a

464

00:16:32,949 --> 00:16:31,279

computer and

465

00:16:34,150 --> 00:16:32,959

einstein's watch

466

00:16:38,470 --> 00:16:34,160

that is

467

00:16:41,910 --> 00:16:40,470

movements and so on but you cannot open

468

00:16:44,230 --> 00:16:41,920

it and you can come up with theories

469

00:16:46,790 --> 00:16:44,240

what's happening inside to me this watch

470

00:16:49,430 --> 00:16:46,800

was the screen of a computer

471

00:16:51,990 --> 00:16:49,440

and i understood that there is no limit

472

00:16:54,069 --> 00:16:52,000

to what can be put into the computer if

473

00:16:55,590 --> 00:16:54,079

uh it has enough resources right so if

474

00:16:57,749 --> 00:16:55,600

the computer is fast enough and if it

475

00:16:59,590 --> 00:16:57,759

has enough memory there is no pattern

476
00:17:01,430 --> 00:16:59,600
that cannot be shown on the screen there

477
00:17:03,749 --> 00:17:01,440
is no limit to the sequence of patterns

478
00:17:06,069 --> 00:17:03,759
that is to be shown on the screen so any

479
00:17:08,470 --> 00:17:06,079
observation that i am making if i

480
00:17:10,949 --> 00:17:08,480
understand it as a pattern on some kind

481
00:17:13,750 --> 00:17:10,959
of screen that is visible to me i will

482
00:17:15,510 --> 00:17:13,760
always be able to construct something a

483
00:17:17,669 --> 00:17:15,520
mechanism that is on the other side and

484
00:17:20,069 --> 00:17:17,679
produces the sequence

485
00:17:22,470 --> 00:17:20,079
and now the question is can i produce an

486
00:17:25,189 --> 00:17:22,480
elegant sequence can i produce a minimal

487
00:17:26,870 --> 00:17:25,199
pattern can i produce something from

488
00:17:29,350 --> 00:17:26,880

which i think it's plausible that it

489

00:17:31,510 --> 00:17:29,360

emerged by itself

490

00:17:34,070 --> 00:17:31,520

and that is to me this big important

491

00:17:37,110 --> 00:17:34,080

question of physics the idea of

492

00:17:39,430 --> 00:17:37,120

physicalism to me is the notion that

493

00:17:41,270 --> 00:17:39,440

we live in a reality that is fully

494

00:17:43,270 --> 00:17:41,280

emergent over a causally closed

495

00:17:45,430 --> 00:17:43,280

mechanical layer and we are in that base

496

00:17:48,070 --> 00:17:45,440

reality that emerges from it

497

00:17:50,870 --> 00:17:48,080

and the alternatives to physicalism is

498

00:17:52,870 --> 00:17:50,880

that this base layer is somewhere else

499

00:17:54,390 --> 00:17:52,880

because even if we live in a simulation

500

00:17:56,390 --> 00:17:54,400

that is created by some kind of

501
00:17:57,510 --> 00:17:56,400
supernatural being

502
00:17:59,110 --> 00:17:57,520
something must have created the

503
00:18:01,270 --> 00:17:59,120
supernatural being in its parent

504
00:18:03,029 --> 00:18:01,280
universe right so ultimately every

505
00:18:06,390 --> 00:18:03,039
supernatural event is going to have some

506
00:18:08,789 --> 00:18:06,400
kind of natural cause some kind of prime

507
00:18:10,230 --> 00:18:08,799
mover that is taking away in the void

508
00:18:11,430 --> 00:18:10,240
and producing the patterns that you

509
00:18:14,230 --> 00:18:11,440
observe and the patterns that you

510
00:18:16,230 --> 00:18:14,240
observe are so damn regular and there is

511
00:18:19,669 --> 00:18:16,240
all this conservation going on

512
00:18:21,510 --> 00:18:19,679
of information that uh it

513
00:18:23,190 --> 00:18:21,520

doesn't seem like a conspiracy to me it

514

00:18:25,669 --> 00:18:23,200

seems that we are not in a simulation it

515

00:18:27,669 --> 00:18:25,679

seems that the idea that consciousness

516

00:18:29,669 --> 00:18:27,679

could be primary to our reality is not

517

00:18:31,510 --> 00:18:29,679

true because consciousness being primary

518

00:18:33,270 --> 00:18:31,520

means that you would have to live in

519

00:18:35,190 --> 00:18:33,280

somebody else's mind

520

00:18:37,270 --> 00:18:35,200

that we live in some kind of

521

00:18:39,110 --> 00:18:37,280

conspirational simulation that somebody

522

00:18:40,950 --> 00:18:39,120

has set up for us and well that is

523

00:18:42,870 --> 00:18:40,960

possible and i can principal not exclude

524

00:18:45,190 --> 00:18:42,880

it because there can be no evidence that

525

00:18:47,350 --> 00:18:45,200

can ever be fully conclusive if somebody

526

00:18:49,029 --> 00:18:47,360

sets it up to deceive me

527

00:18:50,150 --> 00:18:49,039

there is no reason for me to believe it

528

00:18:52,710 --> 00:18:50,160

because there are not enough things

529

00:18:54,630 --> 00:18:52,720

happening in my reality that counteract

530

00:18:57,270 --> 00:18:54,640

the notion that i live in a mechanical

531

00:18:58,870 --> 00:18:57,280

universe the few things that pop up i

532

00:19:01,350 --> 00:18:58,880

can still explain this by faulty

533

00:19:03,669 --> 00:19:01,360

memories and psychosis

534

00:19:06,070 --> 00:19:03,679

right so the only thing that uh needs to

535

00:19:08,390 --> 00:19:06,080

be explained and that i was puzzling

536

00:19:10,390 --> 00:19:08,400

people like turing and other thinkers is

537

00:19:11,190 --> 00:19:10,400

there's a possibility that telepathy is

538

00:19:15,110 --> 00:19:11,200

true

539

00:19:17,350 --> 00:19:15,120

would not be compatible with the way in

540

00:19:18,950 --> 00:19:17,360

which we understand physics right now

541

00:19:20,230 --> 00:19:18,960

and there's this question is there a

542

00:19:22,070 --> 00:19:20,240

point at which we have to discard

543

00:19:23,909 --> 00:19:22,080

physics fully and accept that you live

544

00:19:25,669 --> 00:19:23,919

in some kind of simulation in some kind

545

00:19:27,270 --> 00:19:25,679

of dream universe that somebody has set

546

00:19:29,430 --> 00:19:27,280

up like a computer game where you can

547

00:19:32,710 --> 00:19:29,440

arbitrarily break hostility when it's

548

00:19:35,350 --> 00:19:32,720

convenient or is this uh something that

549

00:19:37,029 --> 00:19:35,360

we need to extend physics or is it just

550

00:19:38,950 --> 00:19:37,039

something where our minds are playing

551
00:19:41,029 --> 00:19:38,960
tricks with us and we know our mindset

552
00:19:43,190 --> 00:19:41,039
playing lots of tricks with us

553
00:19:45,909 --> 00:19:43,200
so during considered the possibility

554
00:19:47,990 --> 00:19:45,919
that telepathy exists as very real to

555
00:19:50,710 --> 00:19:48,000
this to the point where he included this

556
00:19:52,070 --> 00:19:50,720
in his 1950 paper computing machinery

557
00:19:53,430 --> 00:19:52,080
and intelligence where he sketches out

558
00:19:55,830 --> 00:19:53,440
the tubing test

559
00:19:57,750 --> 00:19:55,840
and seriously asks what a turing test

560
00:19:59,350 --> 00:19:57,760
would have to involve or such a system

561
00:20:02,310 --> 00:19:59,360
the ability to

562
00:20:04,230 --> 00:20:02,320
be telepathic and if it's not what

563
00:20:06,310 --> 00:20:04,240

difference would it make it doesn't get

564

00:20:07,029 --> 00:20:06,320

to the point where you assess out loud

565

00:20:08,870 --> 00:20:07,039

that

566

00:20:10,870 --> 00:20:08,880

if telepathy is possible you cannot be

567

00:20:12,870 --> 00:20:10,880

sure which of your thoughts and feelings

568

00:20:15,110 --> 00:20:12,880

originate in your own brain they could

569

00:20:17,590 --> 00:20:15,120

come from somewhere else right so

570

00:20:18,549 --> 00:20:17,600

this opens up the door to lots and lots

571

00:20:20,630 --> 00:20:18,559

of things

572

00:20:22,390 --> 00:20:20,640

but uh for the time being

573

00:20:25,270 --> 00:20:22,400

i think that uh the evidence for

574

00:20:27,350 --> 00:20:25,280

telepathy is weak and if uh telepathy

575

00:20:28,870 --> 00:20:27,360

would exist um i would be seriously

576

00:20:31,669 --> 00:20:28,880

willing to consider this together with

577

00:20:33,510 --> 00:20:31,679

during uh this is not clear why whether

578

00:20:34,789 --> 00:20:33,520

we cannot find a mechanical explanation

579

00:20:36,549 --> 00:20:34,799

for it

580

00:20:38,630 --> 00:20:36,559

but there's always going to be some kind

581

00:20:40,470 --> 00:20:38,640

of computer program that explains the

582

00:20:43,590 --> 00:20:40,480

patterns on the screen

583

00:20:45,830 --> 00:20:43,600

now if we think about space

584

00:20:48,070 --> 00:20:45,840

to me as a

585

00:20:50,549 --> 00:20:48,080

kit that was programming the notion of a

586

00:20:52,390 --> 00:20:50,559

continuous space never made sense

587

00:20:54,710 --> 00:20:52,400

because it's not computable i cannot

588

00:20:56,470 --> 00:20:54,720

write something that is continuous space

589

00:20:58,070 --> 00:20:56,480

and when i tried to wrap my mind around

590

00:21:00,549 --> 00:20:58,080

the mathematics

591

00:21:02,310 --> 00:21:00,559

the language broke i was not able to

592

00:21:05,029 --> 00:21:02,320

understand how to make a point that is

593

00:21:07,190 --> 00:21:05,039

infinitely small yet fits together if

594

00:21:09,830 --> 00:21:07,200

you add infinitely many of these points

595

00:21:12,070 --> 00:21:09,840

into a continuum

596

00:21:14,070 --> 00:21:12,080

this just doesn't work right

597

00:21:16,230 --> 00:21:14,080

but it's not a problem to make something

598

00:21:17,990 --> 00:21:16,240

that exactly looks like this it's not a

599

00:21:20,070 --> 00:21:18,000

problem to make a computer game that

600

00:21:22,149 --> 00:21:20,080

looks continuous it's not a computer

601
00:21:24,070 --> 00:21:22,159
game that produces physics that looks

602
00:21:26,470 --> 00:21:24,080
similar to what we can observe at least

603
00:21:28,789 --> 00:21:26,480
in the simplification of course our

604
00:21:29,750 --> 00:21:28,799
computers are extremely inefficient when

605
00:21:31,669 --> 00:21:29,760
it comes

606
00:21:33,590 --> 00:21:31,679
to simulating

607
00:21:36,310 --> 00:21:33,600
the substrate layer the quantum

608
00:21:38,549 --> 00:21:36,320
mechanics that we can observe or a layer

609
00:21:40,310 --> 00:21:38,559
below the quantum mechanics if because

610
00:21:42,390 --> 00:21:40,320
quantum mechanics is probably not the

611
00:21:44,470 --> 00:21:42,400
the lowest layer in which physics plays

612
00:21:46,630 --> 00:21:44,480
out it's just the lowest layer in which

613
00:21:48,390 --> 00:21:46,640

we can currently make observations that

614

00:21:49,830 --> 00:21:48,400

we can conceptualize

615

00:21:51,029 --> 00:21:49,840

and this leads us to what you also

616

00:21:52,870 --> 00:21:51,039

mentioned

617

00:21:54,950 --> 00:21:52,880

what is the photon i don't think that

618

00:21:57,110 --> 00:21:54,960

einstein started out with the assumption

619

00:21:59,350 --> 00:21:57,120

that the speed of light is fixed i think

620

00:22:01,029 --> 00:21:59,360

it was a derivation that he made he

621

00:22:02,310 --> 00:22:01,039

concluded that the speed of light is

622

00:22:03,190 --> 00:22:02,320

fixed

623

00:22:05,830 --> 00:22:03,200

and

624

00:22:08,070 --> 00:22:05,840

he basically once he had this conclusion

625

00:22:11,270 --> 00:22:08,080

he had implications for the possible

626
00:22:12,870 --> 00:22:11,280
descriptions of space-time that emerged

627
00:22:15,110 --> 00:22:12,880
because uh when the speed of light is

628
00:22:17,750 --> 00:22:15,120
fixed you end up with some very

629
00:22:19,430 --> 00:22:17,760
interesting paradoxes if you stay in a

630
00:22:21,270 --> 00:22:19,440
newtonian universe right you have this

631
00:22:24,470 --> 00:22:21,280
issue imagine you fly in a very fast

632
00:22:26,230 --> 00:22:24,480
spaceship and you are lighting uh

633
00:22:28,710 --> 00:22:26,240
putting light out of your flashlight

634
00:22:31,110 --> 00:22:28,720
inside of your spaceship wouldn't the

635
00:22:32,789 --> 00:22:31,120
speed of light necessarily add up to the

636
00:22:33,990 --> 00:22:32,799
speed of the spaceship to an external

637
00:22:37,990 --> 00:22:34,000
observer

638
00:22:40,149 --> 00:22:38,000

not need to observe a different speed of

639

00:22:41,750 --> 00:22:40,159

light than the person traveling in a

640

00:22:43,430 --> 00:22:41,760

spaceship and if the speed of light is

641

00:22:44,549 --> 00:22:43,440

constant always

642

00:22:46,789 --> 00:22:44,559

it means

643

00:22:48,950 --> 00:22:46,799

that the thing that now it has to change

644

00:22:51,110 --> 00:22:48,960

is time or space or both

645

00:22:53,190 --> 00:22:51,120

right you can still fix this if you make

646

00:22:55,190 --> 00:22:53,200

sure that the speed of

647

00:22:57,350 --> 00:22:55,200

time runs in a different way and this

648

00:22:59,669 --> 00:22:57,360

leads us to the inside

649

00:23:01,830 --> 00:22:59,679

that the time and space that we observe

650

00:23:03,830 --> 00:23:01,840

from our own perspectives as at merchant

651
00:23:04,789 --> 00:23:03,840
observer and whatever universe produces

652
00:23:06,070 --> 00:23:04,799
us

653
00:23:07,830 --> 00:23:06,080
are interdependent they're not

654
00:23:10,789 --> 00:23:07,840
independent of each other the speed of

655
00:23:12,230 --> 00:23:10,799
light depends on the trajectory that the

656
00:23:13,990 --> 00:23:12,240
the speed of time depends on the

657
00:23:16,230 --> 00:23:14,000
trajectory that you are taking through

658
00:23:17,029 --> 00:23:16,240
the universe

659
00:23:18,390 --> 00:23:17,039
and

660
00:23:20,390 --> 00:23:18,400
if you want to think about something

661
00:23:22,470 --> 00:23:20,400
that could be more fundamental

662
00:23:23,990 --> 00:23:22,480
we would say that the photon is a

663
00:23:25,830 --> 00:23:24,000

carrier of a

664

00:23:28,390 --> 00:23:25,840

of the electromagnetic force it's a type

665

00:23:30,230 --> 00:23:28,400

of boson which means it can be described

666

00:23:31,190 --> 00:23:30,240

as a certain pattern that has an integer

667

00:23:33,270 --> 00:23:31,200

spin

668

00:23:34,470 --> 00:23:33,280

and it has the property

669

00:23:36,789 --> 00:23:34,480

that it

670

00:23:38,710 --> 00:23:36,799

is describing the potential lte for

671

00:23:39,830 --> 00:23:38,720

measuring some electromagnetic

672

00:23:41,350 --> 00:23:39,840

interaction

673

00:23:43,190 --> 00:23:41,360

so if we take space time from the

674

00:23:44,710 --> 00:23:43,200

perspective of the observer it's the set

675

00:23:46,070 --> 00:23:44,720

of locations that can contain

676
00:23:48,390 --> 00:23:46,080
information

677
00:23:51,190 --> 00:23:48,400
and the set of trajectories that the

678
00:23:53,510 --> 00:23:51,200
information can take and the photon is a

679
00:23:55,909 --> 00:23:53,520
model of information traveling through

680
00:23:58,230 --> 00:23:55,919
space-time

681
00:24:01,029 --> 00:23:58,240
and what we have discovered and what

682
00:24:03,669 --> 00:24:01,039
einstein also sometimes suspected

683
00:24:04,950 --> 00:24:03,679
is that space itself cannot be

684
00:24:07,510 --> 00:24:04,960
fundamental

685
00:24:10,549 --> 00:24:07,520
and there were concrete reasons to to

686
00:24:12,310 --> 00:24:10,559
see this because what was discovered

687
00:24:13,190 --> 00:24:12,320
during einstein's career even when he

688
00:24:17,510 --> 00:24:13,200

was

689

00:24:19,590 --> 00:24:17,520

were singularities in spacetime which

690

00:24:21,750 --> 00:24:19,600

means points at where the mathematics of

691

00:24:23,350 --> 00:24:21,760

continuous space breaks down so your

692

00:24:25,430 --> 00:24:23,360

mathematics doesn't work anymore you

693

00:24:27,110 --> 00:24:25,440

have some kind of a division by zero

694

00:24:29,750 --> 00:24:27,120

something unpleasant happens where your

695

00:24:32,789 --> 00:24:29,760

mathematics is no longer valid

696

00:24:33,990 --> 00:24:32,799

and what einstein saw is that we can fix

697

00:24:36,149 --> 00:24:34,000

this by

698

00:24:38,070 --> 00:24:36,159

shifting the singularities around in our

699

00:24:39,830 --> 00:24:38,080

spaces type model

700

00:24:40,870 --> 00:24:39,840

and we can basically put them below the

701
00:24:43,510 --> 00:24:40,880
carpet

702
00:24:45,669 --> 00:24:43,520
you can put them in centers of mass

703
00:24:47,110 --> 00:24:45,679
so in the center of mars there is

704
00:24:48,870 --> 00:24:47,120
basically something like little black

705
00:24:50,230 --> 00:24:48,880
hole where mathematics doesn't work

706
00:24:51,669 --> 00:24:50,240
anymore the mathematics of space time

707
00:24:53,990 --> 00:24:51,679
where your mathematical description of

708
00:24:56,230 --> 00:24:54,000
that world doesn't work anymore

709
00:24:57,750 --> 00:24:56,240
and what could be more fundamental than

710
00:25:00,390 --> 00:24:57,760
space-time i think it could be

711
00:25:02,310 --> 00:25:00,400
transitions so you describe the universe

712
00:25:04,310 --> 00:25:02,320
as some kind of state vector set of

713
00:25:05,909 --> 00:25:04,320

information and this information is

714

00:25:09,110 --> 00:25:05,919

dynamic you have the way in which

715

00:25:12,310 --> 00:25:09,120

information moves between the locations

716

00:25:14,310 --> 00:25:12,320

and in this paradigm the speed of light

717

00:25:17,750 --> 00:25:14,320

could be uh the rate at which

718

00:25:20,149 --> 00:25:17,760

information propagates between locations

719

00:25:21,990 --> 00:25:20,159

and this would be an upper limit of all

720

00:25:23,430 --> 00:25:22,000

interactions that you observe

721

00:25:25,909 --> 00:25:23,440

within this

722

00:25:27,190 --> 00:25:25,919

lattice versus staff is densely

723

00:25:29,669 --> 00:25:27,200

connected

724

00:25:31,590 --> 00:25:29,679

what would it what would be necessary to

725

00:25:33,029 --> 00:25:31,600

if you have a set of locations some kind

726

00:25:34,710 --> 00:25:33,039

of graph and causal graph and

727

00:25:36,310 --> 00:25:34,720

information flowing between them to

728

00:25:37,669 --> 00:25:36,320

understand that there is causal

729

00:25:39,590 --> 00:25:37,679

structure well you need to understand

730

00:25:41,190 --> 00:25:39,600

where the information comes from to

731

00:25:43,990 --> 00:25:41,200

understand what it signifies so you can

732

00:25:45,590 --> 00:25:44,000

model it how can a single bit mean

733

00:25:47,590 --> 00:25:45,600

anything to you if it's just a single

734

00:25:50,070 --> 00:25:47,600

bit if it's not attached with the source

735

00:25:52,230 --> 00:25:50,080

with the type with the context

736

00:25:53,909 --> 00:25:52,240

right so what could be a way to figure

737

00:25:55,909 --> 00:25:53,919

out where information comes from well it

738

00:25:57,430 --> 00:25:55,919

needs to have some kind of momentum some

739

00:26:00,070 --> 00:25:57,440

kind of direction

740

00:26:02,070 --> 00:26:00,080

to carry information about direction

741

00:26:03,590 --> 00:26:02,080

and you send this to the graph that by

742

00:26:05,669 --> 00:26:03,600

itself just has just locations

743

00:26:09,029 --> 00:26:05,679

connections the only way that you can do

744

00:26:10,950 --> 00:26:09,039

this is if this thing is extended if

745

00:26:12,549 --> 00:26:10,960

it's not just a single location so which

746

00:26:14,310 --> 00:26:12,559

the information propagates but if it's

747

00:26:16,070 --> 00:26:14,320

neighboring connections and you get

748

00:26:18,630 --> 00:26:16,080

information that verifies it so you need

749

00:26:20,870 --> 00:26:18,640

to be in some kind of densely strong

750

00:26:22,230 --> 00:26:20,880

letters for information that you can

751
00:26:23,430 --> 00:26:22,240
pinpoint

752
00:26:25,750 --> 00:26:23,440
basically you need to have something

753
00:26:28,149 --> 00:26:25,760
that looks like a continuous space so

754
00:26:30,630 --> 00:26:28,159
you can identify controllable structure

755
00:26:32,549 --> 00:26:30,640
that you can identify where uh stuff

756
00:26:34,950 --> 00:26:32,559
comes from like a photon

757
00:26:36,870 --> 00:26:34,960
and uh if there is information that is

758
00:26:39,269 --> 00:26:36,880
traveling across distance so to speak

759
00:26:40,950 --> 00:26:39,279
that this is non-local that is not going

760
00:26:43,029 --> 00:26:40,960
through densely connected local

761
00:26:44,630 --> 00:26:43,039
connections but that is going over

762
00:26:46,149 --> 00:26:44,640
individual long-range links this

763
00:26:48,549 --> 00:26:46,159

information will look like a random

764

00:26:50,230 --> 00:26:48,559

fluctuation or a distant entanglement

765

00:26:52,710 --> 00:26:50,240

that you can no longer track if you

766

00:26:54,630 --> 00:26:52,720

don't know where it originated

767

00:26:55,909 --> 00:26:54,640

and this would will look like something

768

00:26:57,669 --> 00:26:55,919

like

769

00:26:59,510 --> 00:26:57,679

in determinism in from your local

770

00:27:01,510 --> 00:26:59,520

observer perspective

771

00:27:03,510 --> 00:27:01,520

still you would uh not be in

772

00:27:05,269 --> 00:27:03,520

contradiction to the

773

00:27:06,950 --> 00:27:05,279

preservation of information it would

774

00:27:09,590 --> 00:27:06,960

still be a universe in which information

775

00:27:12,310 --> 00:27:09,600

is not invented but in which the amount

776
00:27:15,029 --> 00:27:12,320
of discernible information is constant

777
00:27:17,029 --> 00:27:15,039
and if the universe was not in such a

778
00:27:18,630 --> 00:27:17,039
way that information would be preserved

779
00:27:20,549 --> 00:27:18,640
of course it would not be learnable

780
00:27:22,310 --> 00:27:20,559
because it would mean that the present

781
00:27:24,310 --> 00:27:22,320
state of the universe

782
00:27:26,710 --> 00:27:24,320
is forgetting what happened before in

783
00:27:28,230 --> 00:27:26,720
the universe it gets disconnected the

784
00:27:29,990 --> 00:27:28,240
world line of the universe just gets

785
00:27:32,710 --> 00:27:30,000
disconnected and so from an

786
00:27:34,630 --> 00:27:32,720
epistemological perspective we can only

787
00:27:36,230 --> 00:27:34,640
learn the aspects of the universe that

788
00:27:37,750 --> 00:27:36,240

look like they are conserved if there

789

00:27:39,269 --> 00:27:37,760

are things in the universe that are not

790

00:27:40,789 --> 00:27:39,279

conserved then they will not be

791

00:27:42,389 --> 00:27:40,799

intelligible to us

792

00:27:44,630 --> 00:27:42,399

and of course it's conceivable that the

793

00:27:46,950 --> 00:27:44,640

universe is some kind of automaton that

794

00:27:48,950 --> 00:27:46,960

forgets information

795

00:27:51,990 --> 00:27:48,960

another thing that shows us that

796

00:27:53,110 --> 00:27:52,000

space-time cannot be fundamental besides

797

00:27:55,190 --> 00:27:53,120

um

798

00:27:58,149 --> 00:27:55,200

about theorem which destroys the notion

799

00:27:59,990 --> 00:27:58,159

of locality is the notion of the

800

00:28:00,870 --> 00:28:00,000

collapse of the wave function basically

801
00:28:02,549 --> 00:28:00,880
this

802
00:28:03,430 --> 00:28:02,559
collapse of the wave function is the

803
00:28:05,510 --> 00:28:03,440
point

804
00:28:07,269 --> 00:28:05,520
in the history of an observer beyond

805
00:28:08,950 --> 00:28:07,279
which we cannot

806
00:28:12,470 --> 00:28:08,960
obtain a model

807
00:28:14,789 --> 00:28:12,480
of locations of events in time and space

808
00:28:16,870 --> 00:28:14,799
right beyond that point it's no longer

809
00:28:18,870 --> 00:28:16,880
not just that we don't have enough

810
00:28:20,950 --> 00:28:18,880
information to construct it but it makes

811
00:28:22,950 --> 00:28:20,960
no sense anymore to assume that the

812
00:28:24,549 --> 00:28:22,960
photon was at a particular point when it

813
00:28:27,110 --> 00:28:24,559

went to the double slit

814

00:28:28,789 --> 00:28:27,120

right at this point the space-time model

815

00:28:30,389 --> 00:28:28,799

breaks down the space-time model is a

816

00:28:32,549 --> 00:28:30,399

mathematical abstraction

817

00:28:35,269 --> 00:28:32,559

that works relatively well to look at

818

00:28:37,110 --> 00:28:35,279

things happening in the limit

819

00:28:39,269 --> 00:28:37,120

but it's not a model that can be

820

00:28:41,269 --> 00:28:39,279

fundamental i think

821

00:28:42,549 --> 00:28:41,279

and but i'm not a physicist so i'm not

822

00:28:44,149 --> 00:28:42,559

actually qualified to have these

823

00:28:46,230 --> 00:28:44,159

opinions this is just what it looks like

824

00:28:48,070 --> 00:28:46,240

to me as a computer scientist who tries

825

00:28:49,590 --> 00:28:48,080

to understand the mind and things like

826
00:28:51,029 --> 00:28:49,600
donald that

827
00:28:53,669 --> 00:28:51,039
we have to

828
00:28:56,070 --> 00:28:53,679
understand a certain degree of physics

829
00:28:57,990 --> 00:28:56,080
to make sure that our theories of

830
00:29:00,630 --> 00:28:58,000
consciousness are tight and that they

831
00:29:02,870 --> 00:29:00,640
make sense and to have to understand in

832
00:29:03,990 --> 00:29:02,880
which way they could possibly relate to

833
00:29:06,149 --> 00:29:04,000
physics

834
00:29:07,990 --> 00:29:06,159
i'm less convinced that donald that a

835
00:29:09,669 --> 00:29:08,000
deep understanding of physics is

836
00:29:11,830 --> 00:29:09,679
necessary or that physics is going to

837
00:29:14,230 --> 00:29:11,840
teach us about consciousness in part

838
00:29:17,269 --> 00:29:14,240

because i don't think that consciousness

839

00:29:17,990 --> 00:29:17,279

is that mysterious anymore i spent a lot

840

00:29:19,510 --> 00:29:18,000

of

841

00:29:21,750 --> 00:29:19,520

time in my life

842

00:29:24,630 --> 00:29:21,760

thinking that it was mysterious but

843

00:29:26,870 --> 00:29:24,640

seems to be a riddle that can be solved

844

00:29:28,389 --> 00:29:26,880

and uh basically i think that there's

845

00:29:29,909 --> 00:29:28,399

some aspects to consciousness for

846

00:29:32,630 --> 00:29:29,919

instance that you that you're observing

847

00:29:34,870 --> 00:29:32,640

yourself to be observing but uh

848

00:29:36,470 --> 00:29:34,880

consciousness is

849

00:29:38,870 --> 00:29:36,480

something that is entirely virtual it's

850

00:29:40,630 --> 00:29:38,880

not a physical thing

851

00:29:42,789 --> 00:29:40,640

electrons photons

852

00:29:45,190 --> 00:29:42,799

physical entities neurons brains cannot

853

00:29:45,909 --> 00:29:45,200

be conscious they're just mechanisms

854

00:29:47,909 --> 00:29:45,919

and

855

00:29:50,230 --> 00:29:47,919

what we can see is that the elements of

856

00:29:51,990 --> 00:29:50,240

our consciousness are not mechanical

857

00:29:53,269 --> 00:29:52,000

they're magical somehow there is magic

858

00:29:57,269 --> 00:29:53,279

happening

859

00:29:59,029 --> 00:29:57,279

that it's an a causal structure it's

860

00:30:02,470 --> 00:29:59,039

something that has been made on some

861

00:30:05,350 --> 00:30:02,480

kind of causal loom but that is not

862

00:30:07,590 --> 00:30:05,360

necessarily built in the same mechanical

863

00:30:10,470 --> 00:30:07,600

way as physics is built

864

00:30:13,110 --> 00:30:10,480

it's a story it's a it's a tale being

865

00:30:14,870 --> 00:30:13,120

told by a physical system to itself

866

00:30:16,789 --> 00:30:14,880

and if you think about organisms you

867

00:30:18,870 --> 00:30:16,799

often think of them as physical systems

868

00:30:20,950 --> 00:30:18,880

and they're neither right the organism

869

00:30:23,029 --> 00:30:20,960

doesn't exist it's not the same

870

00:30:24,549 --> 00:30:23,039

if you think about it what exists are

871

00:30:26,389 --> 00:30:24,559

cells that interact with each other and

872

00:30:27,990 --> 00:30:26,399

even the cells don't really exist what

873

00:30:29,669 --> 00:30:28,000

exists are molecules and even the

874

00:30:31,590 --> 00:30:29,679

molecules don't really exist right

875

00:30:33,350 --> 00:30:31,600

they're all layers of descriptions

876

00:30:34,870 --> 00:30:33,360

they're models that we can make because

877

00:30:37,430 --> 00:30:34,880

they're coherent

878

00:30:39,430 --> 00:30:37,440

and they hold to some degree

879

00:30:41,669 --> 00:30:39,440

it might be frazzling out at the

880

00:30:43,269 --> 00:30:41,679

boundaries but there are ways of

881

00:30:44,789 --> 00:30:43,279

thinking about the flow of information

882

00:30:47,110 --> 00:30:44,799

in the universe

883

00:30:48,470 --> 00:30:47,120

and the organism is a coherent pattern

884

00:30:50,789 --> 00:30:48,480

that you observe in the interaction

885

00:30:52,710 --> 00:30:50,799

between cells and the cells have been

886

00:30:54,630 --> 00:30:52,720

set up by evolution to interact in this

887

00:30:56,710 --> 00:30:54,640

coherent pattern because when they

888

00:30:58,789 --> 00:30:56,720

interact as if they were driven by a

889

00:31:00,789 --> 00:30:58,799

single spirit by a single target by a

890

00:31:03,029 --> 00:31:00,799

single telos and if their behavior is

891

00:31:05,269 --> 00:31:03,039

coherent and consistent that are state

892

00:31:07,190 --> 00:31:05,279

building then they have an advantage

893

00:31:08,710 --> 00:31:07,200

over cells which don't do that and just

894

00:31:10,310 --> 00:31:08,720

fight for themselves because together

895

00:31:12,870 --> 00:31:10,320

they can play longer games

896

00:31:16,070 --> 00:31:12,880

by playing longer games they can occupy

897

00:31:17,830 --> 00:31:16,080

niches in nature that cannot be occupied

898

00:31:18,710 --> 00:31:17,840

by control systems that play shorter

899

00:31:20,789 --> 00:31:18,720

games

900

00:31:23,750 --> 00:31:20,799

and this is the benefit that organisms

901
00:31:25,110 --> 00:31:23,760
have these coordinations between cells

902
00:31:27,350 --> 00:31:25,120
and an organism is a function that

903
00:31:30,549 --> 00:31:27,360
describes this pattern in the cells

904
00:31:32,630 --> 00:31:30,559
and the organism is facilitated by

905
00:31:34,230 --> 00:31:32,640
information processing across cells

906
00:31:36,630 --> 00:31:34,240
among other things

907
00:31:38,310 --> 00:31:36,640
to coordinate its interactions the

908
00:31:41,029 --> 00:31:38,320
organism needs to have something like a

909
00:31:43,029 --> 00:31:41,039
telegraph network by which it's able to

910
00:31:44,470 --> 00:31:43,039
make models of reality and coordinate

911
00:31:46,389 --> 00:31:44,480
them between the cells and coordinate

912
00:31:49,990 --> 00:31:46,399
the behavior of the cells

913
00:31:51,990 --> 00:31:50,000

and in animals this telegraph system is

914

00:31:53,909 --> 00:31:52,000

facilitated in large part by the nervous

915

00:31:55,750 --> 00:31:53,919

system it would not be necessary that

916

00:31:57,669 --> 00:31:55,760

the nervous system basically every cell

917

00:31:58,870 --> 00:31:57,679

type can do this but if you want to make

918

00:32:00,389 --> 00:31:58,880

it fast

919

00:32:02,789 --> 00:32:00,399

you need to have specialized cells that

920

00:32:04,789 --> 00:32:02,799

have a very quick expensive metabolism

921

00:32:06,630 --> 00:32:04,799

and can send information over very long

922

00:32:08,789 --> 00:32:06,640

distances very quickly which other cell

923

00:32:10,870 --> 00:32:08,799

types cannot so neurons are a specific

924

00:32:12,070 --> 00:32:10,880

type of cells that allow

925

00:32:13,350 --> 00:32:12,080

particular kind of information

926
00:32:17,269 --> 00:32:13,360
processing

927
00:32:19,509 --> 00:32:17,279
property that they can put stuff on the

928
00:32:21,590 --> 00:32:19,519
screen so it's some kind of computer

929
00:32:23,509 --> 00:32:21,600
it's a thing that can produce arbitrary

930
00:32:25,990 --> 00:32:23,519
sequences of patterns if it discovers a

931
00:32:27,750 --> 00:32:26,000
suitable function to produce them and

932
00:32:29,750 --> 00:32:27,760
implement them in the distributed

933
00:32:31,509 --> 00:32:29,760
networks of cells

934
00:32:33,430 --> 00:32:31,519
and part of what they're doing is that

935
00:32:35,350 --> 00:32:33,440
they create a story

936
00:32:36,630 --> 00:32:35,360
about a being that lives in the outside

937
00:32:38,470 --> 00:32:36,640
world

938
00:32:40,870 --> 00:32:38,480

and in our culture we have difficulty

939

00:32:43,269 --> 00:32:40,880

understanding how that is because we

940

00:32:45,590 --> 00:32:43,279

in our culture as a default teacher for

941

00:32:46,549 --> 00:32:45,600

kids that what they see is the physical

942

00:32:50,149 --> 00:32:46,559

world

943

00:32:52,149 --> 00:32:50,159

colors and so on only much later we tell

944

00:32:54,230 --> 00:32:52,159

them well it's slightly more complicated

945

00:32:55,669 --> 00:32:54,240

and sounds and color are not actually in

946

00:32:57,110 --> 00:32:55,679

physics

947

00:32:59,509 --> 00:32:57,120

everything that you consider to be

948

00:33:01,029 --> 00:32:59,519

sounds and colors is photons photons

949

00:33:03,190 --> 00:33:01,039

make electromagnetic interaction which

950

00:33:06,230 --> 00:33:03,200

let air molecules push against each

951
00:33:07,750 --> 00:33:06,240
other so they can form regular waves and

952
00:33:10,149 --> 00:33:07,760
colors are

953
00:33:13,269 --> 00:33:10,159
local dimensions that you get by

954
00:33:15,269 --> 00:33:13,279
measuring sampling the frequency of the

955
00:33:16,950 --> 00:33:15,279
electromagnetic spectrum using different

956
00:33:19,590 --> 00:33:16,960
receptor types and making a model of

957
00:33:21,990 --> 00:33:19,600
them using polar coordinates

958
00:33:23,990 --> 00:33:22,000
right so this is something that we don't

959
00:33:25,430 --> 00:33:24,000
tell the story fully to our children

960
00:33:27,350 --> 00:33:25,440
which makes it even more confusing and

961
00:33:29,110 --> 00:33:27,360
then we tell them uh photons are

962
00:33:31,750 --> 00:33:29,120
actually not little billiard balls but

963
00:33:33,350 --> 00:33:31,760

there are regions in the space time that

964

00:33:34,470 --> 00:33:33,360

have a potential for an electromagnetic

965

00:33:36,310 --> 00:33:34,480

interaction

966

00:33:38,950 --> 00:33:36,320

and this space that you're talking about

967

00:33:40,549 --> 00:33:38,960

is the photonic space it's the space

968

00:33:42,389 --> 00:33:40,559

where you can possibly have photon

969

00:33:44,070 --> 00:33:42,399

interactions for some reason it's

970

00:33:45,430 --> 00:33:44,080

three-dimensional

971

00:33:46,870 --> 00:33:45,440

and maybe there are other spaces that

972

00:33:48,789 --> 00:33:46,880

are not three-dimensional and maybe in

973

00:33:50,710 --> 00:33:48,799

these spaces you cannot have interacting

974

00:33:53,990 --> 00:33:50,720

matter in the same way

975

00:33:55,509 --> 00:33:54,000

because uh maybe um in order to get

976

00:33:57,590 --> 00:33:55,519

stable objects you need to make little

977

00:33:59,990 --> 00:33:57,600

nuts in the electromagnetic structure or

978

00:34:02,070 --> 00:34:00,000

in the spatial structure and you cannot

979

00:34:04,470 --> 00:34:02,080

make knots in 2d and in 4d they fall

980

00:34:05,909 --> 00:34:04,480

apart so maybe that's the reason or

981

00:34:07,509 --> 00:34:05,919

maybe there's another one and we haven't

982

00:34:09,829 --> 00:34:07,519

completely figured it out yet and there

983

00:34:11,190 --> 00:34:09,839

are some candidates that explain why the

984

00:34:13,109 --> 00:34:11,200

space that we are in is

985

00:34:14,629 --> 00:34:13,119

three-dimensional so why is it that we

986

00:34:16,230 --> 00:34:14,639

are interacting with the photonic space

987

00:34:18,550 --> 00:34:16,240

and not with the others why are the

988

00:34:19,589 --> 00:34:18,560

others not seeming to form a connected

989

00:34:21,589 --> 00:34:19,599

space

990

00:34:23,669 --> 00:34:21,599

in this connected letters

991

00:34:26,310 --> 00:34:23,679

um but we don't know the answer yet at

992

00:34:27,909 --> 00:34:26,320

least i'm not aware of the work that is

993

00:34:28,869 --> 00:34:27,919

sketching out the answer

994

00:34:31,349 --> 00:34:28,879

and

995

00:34:32,550 --> 00:34:31,359

if i stumble on it i i pray that i

996

00:34:33,829 --> 00:34:32,560

understand it

997

00:34:36,389 --> 00:34:33,839

but i think that there are other

998

00:34:37,909 --> 00:34:36,399

cultures that have a better intuitive

999

00:34:39,750 --> 00:34:37,919

understanding of what consciousness is

1000

00:34:41,829 --> 00:34:39,760

and if you look around we find that some

1001
00:34:44,470 --> 00:34:41,839
cultures don't find consciousness

1002
00:34:47,109 --> 00:34:44,480
mysterious i even suspect that in the

1003
00:34:48,710 --> 00:34:47,119
core of our own culture before the tower

1004
00:34:51,430 --> 00:34:48,720
of people that destroyed the shared

1005
00:34:54,310 --> 00:34:51,440
understanding it's still in there

1006
00:34:57,030 --> 00:34:54,320
so a little bit obsessed these days with

1007
00:34:59,510 --> 00:34:57,040
thinking about genesis in the bible and

1008
00:35:02,310 --> 00:34:59,520
read this epistemologically correct not

1009
00:35:04,230 --> 00:35:02,320
as a myth that is a stand in for an

1010
00:35:05,109 --> 00:35:04,240
origin theory until real science comes

1011
00:35:07,990 --> 00:35:05,119
along

1012
00:35:10,470 --> 00:35:08,000
but as something that is literally true

1013
00:35:12,230 --> 00:35:10,480

so what would that mean you know i'm

1014

00:35:13,990 --> 00:35:12,240

talking about the first book

1015

00:35:16,390 --> 00:35:14,000

i'm talking about um the book that

1016

00:35:18,150 --> 00:35:16,400

starts out with the creation of

1017

00:35:19,430 --> 00:35:18,160

sky and darkness and heaven and earth

1018

00:35:20,630 --> 00:35:19,440

and so on

1019

00:35:22,310 --> 00:35:20,640

and

1020

00:35:24,230 --> 00:35:22,320

they sing with the story if you take it

1021

00:35:26,390 --> 00:35:24,240

literally the way in which christianity

1022

00:35:28,230 --> 00:35:26,400

interprets it it's a story about a

1023

00:35:30,310 --> 00:35:28,240

supernatural being creating a physical

1024

00:35:31,910 --> 00:35:30,320

universe and what's wrong with the story

1025

00:35:33,750 --> 00:35:31,920

is that whoever tells it to you had no

1026

00:35:35,510 --> 00:35:33,760

evidence that it was true

1027

00:35:37,109 --> 00:35:35,520

right so there is no claim

1028

00:35:39,829 --> 00:35:37,119

if somebody makes a claim without

1029

00:35:42,550 --> 00:35:39,839

evidence you don't have to listen

1030

00:35:43,990 --> 00:35:42,560

it uh it could be interesting as a story

1031

00:35:45,430 --> 00:35:44,000

for cultural reference what could be

1032

00:35:47,030 --> 00:35:45,440

interesting as an idea for something

1033

00:35:48,790 --> 00:35:47,040

that you could test but if it's

1034

00:35:50,950 --> 00:35:48,800

principle not testable

1035

00:35:52,870 --> 00:35:50,960

this person cannot have that evidence

1036

00:35:54,630 --> 00:35:52,880

there is no secret source of knowledge

1037

00:35:56,710 --> 00:35:54,640

that this person had there is in

1038

00:35:57,589 --> 00:35:56,720

principle nothing that

1039

00:35:59,510 --> 00:35:57,599

that

1040

00:36:01,270 --> 00:35:59,520

some other person can update others with

1041

00:36:02,950 --> 00:36:01,280

some kind of back channel by talking to

1042

00:36:06,550 --> 00:36:02,960

a burning bush that could would

1043

00:36:07,270 --> 00:36:06,560

constitute a valid experiment so

1044

00:36:09,270 --> 00:36:07,280

uh

1045

00:36:10,870 --> 00:36:09,280

this reading makes no sense

1046

00:36:12,630 --> 00:36:10,880

it would never make any sense but it

1047

00:36:14,069 --> 00:36:12,640

could make sense especially if you

1048

00:36:15,670 --> 00:36:14,079

understand that

1049

00:36:17,910 --> 00:36:15,680

sky and ground

1050

00:36:19,829 --> 00:36:17,920

and light and sound and plants and

1051
00:36:21,670 --> 00:36:19,839
animals and their names don't actually

1052
00:36:23,510 --> 00:36:21,680
exist in physics

1053
00:36:25,349 --> 00:36:23,520
right they only exist in our mind as a

1054
00:36:27,270 --> 00:36:25,359
division of the universe into separate

1055
00:36:28,390 --> 00:36:27,280
objects so they become intelligible to

1056
00:36:30,870 --> 00:36:28,400
us

1057
00:36:33,109 --> 00:36:30,880
and the way in which we construct these

1058
00:36:34,950 --> 00:36:33,119
objects is inside of the mind so the

1059
00:36:37,190 --> 00:36:34,960
creation of the universe that is being

1060
00:36:38,870 --> 00:36:37,200
described in genesis is not the

1061
00:36:41,750 --> 00:36:38,880
physicalist universe with quantum

1062
00:36:43,510 --> 00:36:41,760
mechanics it's the creation of the

1063
00:36:45,190 --> 00:36:43,520

experimental universe in which we are

1064

00:36:46,390 --> 00:36:45,200

actually in in which we find ourselves

1065

00:36:48,790 --> 00:36:46,400

to be in

1066

00:36:50,230 --> 00:36:48,800

and the first thing that the mind is

1067

00:36:52,710 --> 00:36:50,240

discovering when it creates this

1068

00:36:54,550 --> 00:36:52,720

universe is how to make light

1069

00:36:57,829 --> 00:36:54,560

right how to uh create neural

1070

00:37:00,150 --> 00:36:57,839

oscillators that are creating a contrast

1071

00:37:02,069 --> 00:37:00,160

between light and darkness so separate

1072

00:37:03,990 --> 00:37:02,079

the light from the darkness and then

1073

00:37:06,150 --> 00:37:04,000

organize this into multiple dimensions

1074

00:37:07,829 --> 00:37:06,160

until you get a space

1075

00:37:09,750 --> 00:37:07,839

and then you align the space with the

1076
00:37:11,030 --> 00:37:09,760
information from your vestibular organs

1077
00:37:12,870 --> 00:37:11,040
and what you get

1078
00:37:15,270 --> 00:37:12,880
is the two-dimensional plane of the

1079
00:37:17,829 --> 00:37:15,280
ground and the three-dimensional space

1080
00:37:19,670 --> 00:37:17,839
of the sky above it

1081
00:37:22,550 --> 00:37:19,680
right so after you create light and

1082
00:37:25,030 --> 00:37:22,560
darkness you create literally every mind

1083
00:37:27,030 --> 00:37:25,040
does this in their cognitive development

1084
00:37:28,790 --> 00:37:27,040
the sky and the ground

1085
00:37:30,310 --> 00:37:28,800
and then you discover the objects in it

1086
00:37:32,870 --> 00:37:30,320
so you basically learn how to model

1087
00:37:35,510 --> 00:37:32,880
materials in your mind so you have

1088
00:37:37,510 --> 00:37:35,520

solids and you have liquids

1089

00:37:39,670 --> 00:37:37,520

and you have organic shapes and you have

1090

00:37:41,109 --> 00:37:39,680

animated agents

1091

00:37:42,950 --> 00:37:41,119

and then you discover features that you

1092

00:37:44,069 --> 00:37:42,960

cannot interact with like celestial

1093

00:37:45,510 --> 00:37:44,079

bodies

1094

00:37:47,510 --> 00:37:45,520

and anchor them in the world and you

1095

00:37:49,190 --> 00:37:47,520

learn how to navigate this world and

1096

00:37:50,630 --> 00:37:49,200

then you discover all the plants and the

1097

00:37:52,150 --> 00:37:50,640

animals or you construct them in your

1098

00:37:54,470 --> 00:37:52,160

mind and you associate them all with

1099

00:37:56,310 --> 00:37:54,480

their names so again of course not a

1100

00:37:57,829 --> 00:37:56,320

feature of the physical world they are

1101

00:37:59,990 --> 00:37:57,839

socially cons

1102

00:38:02,470 --> 00:38:00,000

exchanged these names and so on create

1103

00:38:03,349 --> 00:38:02,480

this world together and then

1104

00:38:05,030 --> 00:38:03,359

last

1105

00:38:07,589 --> 00:38:05,040

but not least

1106

00:38:09,750 --> 00:38:07,599

we create a person

1107

00:38:12,069 --> 00:38:09,760

so the thing that creates it is not a

1108

00:38:13,910 --> 00:38:12,079

person yet it's a mind that exists

1109

00:38:16,069 --> 00:38:13,920

before a person is around we don't

1110

00:38:18,310 --> 00:38:16,079

remember how we made light

1111

00:38:20,150 --> 00:38:18,320

we don't remember how we discovered the

1112

00:38:22,390 --> 00:38:20,160

sky and the ground in the first space

1113

00:38:23,510 --> 00:38:22,400

this was another observing agent in our

1114

00:38:25,270 --> 00:38:23,520

own brain

1115

00:38:27,990 --> 00:38:25,280

and this observing agent in our own

1116

00:38:30,230 --> 00:38:28,000

brain at some point discovers

1117

00:38:32,470 --> 00:38:30,240

the needs of a person of the needs of an

1118

00:38:35,030 --> 00:38:32,480

organism the organism that

1119

00:38:37,670 --> 00:38:35,040

its brain is embedded in

1120

00:38:39,190 --> 00:38:37,680

and it creates a model of that too

1121

00:38:40,630 --> 00:38:39,200

so it creates

1122

00:38:42,470 --> 00:38:40,640

an agent

1123

00:38:44,790 --> 00:38:42,480

that is observing this universe that is

1124

00:38:46,950 --> 00:38:44,800

embedded in this universe because this

1125

00:38:48,310 --> 00:38:46,960

first observer in our own mind is

1126

00:38:50,470 --> 00:38:48,320

discovering

1127

00:38:52,390 --> 00:38:50,480

that such an entity exists it's this

1128

00:38:54,069 --> 00:38:52,400

useful model to describe reality that

1129

00:38:56,710 --> 00:38:54,079

there is a person that has needs and

1130

00:38:59,510 --> 00:38:56,720

desires and social embedding and dreams

1131

00:39:01,349 --> 00:38:59,520

and hopes and memories and expectations

1132

00:39:04,550 --> 00:39:01,359

and it will create a story of that and

1133

00:39:06,550 --> 00:39:04,560

that story is just as real as the trees

1134

00:39:09,990 --> 00:39:06,560

that exist in our mind as imaginations

1135

00:39:13,349 --> 00:39:10,000

or the trees or um the uh that in the

1136

00:39:15,190 --> 00:39:13,359

forest and uh beyond the horizon and as

1137

00:39:16,950 --> 00:39:15,200

real as the sky and the clouds and the

1138

00:39:19,589 --> 00:39:16,960

colors and so on but they're all virtual

1139

00:39:21,750 --> 00:39:19,599

they're all simulacra they all exist to

1140

00:39:23,829 --> 00:39:21,760

tell a story to the organism that is

1141

00:39:24,710 --> 00:39:23,839

useful for the organism to model the

1142

00:39:28,150 --> 00:39:24,720

world

1143

00:39:29,990 --> 00:39:28,160

and this part where we become a person

1144

00:39:32,310 --> 00:39:30,000

seems to be happening i think around the

1145

00:39:34,870 --> 00:39:32,320

age of one and a half to two and a half

1146

00:39:36,550 --> 00:39:34,880

roughly in most children that i observed

1147

00:39:38,069 --> 00:39:36,560

and at this point a person that is

1148

00:39:40,230 --> 00:39:38,079

different from before emerges in their

1149

00:39:41,750 --> 00:39:40,240

mind it's not that there is nobody there

1150

00:39:42,950 --> 00:39:41,760

before it's just that this thing before

1151

00:39:44,310 --> 00:39:42,960

it's different

1152

00:39:46,230 --> 00:39:44,320

and you notice that there's a gap in

1153

00:39:47,030 --> 00:39:46,240

their memories they have memories when

1154

00:39:48,150 --> 00:39:47,040

they're

1155

00:39:50,470 --> 00:39:48,160

in the

1156

00:39:52,390 --> 00:39:50,480

first year when you talk to them

1157

00:39:55,030 --> 00:39:52,400

where they remember what happened

1158

00:39:56,630 --> 00:39:55,040

and have expectations already

1159

00:39:58,150 --> 00:39:56,640

but later on there is this point where

1160

00:40:00,069 --> 00:39:58,160

they don't remember these things anymore

1161

00:40:01,670 --> 00:40:00,079

it's very weird and most people when you

1162

00:40:04,309 --> 00:40:01,680

think back don't have memories that they

1163

00:40:06,550 --> 00:40:04,319

can consciously access between uh before

1164

00:40:08,230 --> 00:40:06,560

they're like two and a half years old

1165

00:40:09,990 --> 00:40:08,240

and so i wonder if this transition is

1166

00:40:11,910 --> 00:40:10,000

the result of just a re-indexing of

1167

00:40:14,550 --> 00:40:11,920

memories due to our newfound linguistic

1168

00:40:16,069 --> 00:40:14,560

ability so we can later on no longer

1169

00:40:18,630 --> 00:40:16,079

access these memories or if it's really

1170

00:40:20,550 --> 00:40:18,640

just uh basically a new agent that is

1171

00:40:21,430 --> 00:40:20,560

created by the first agent in its own

1172

00:40:23,349 --> 00:40:21,440

image

1173

00:40:25,510 --> 00:40:23,359

as an observer that is aware of the fact

1174

00:40:28,470 --> 00:40:25,520

that it's observing

1175

00:40:30,150 --> 00:40:28,480

and uh but in a different way as men and

1176

00:40:32,950 --> 00:40:30,160

women as something that thinks it's a

1177

00:40:34,710 --> 00:40:32,960

person that thinks it's a human being

1178

00:40:36,470 --> 00:40:34,720

and i'm not a human being i realize that

1179

00:40:38,630 --> 00:40:36,480

at some level i don't have an identity

1180

00:40:41,270 --> 00:40:38,640

as a human being this is a story that my

1181

00:40:42,950 --> 00:40:41,280

mind tells itself as an additional thing

1182

00:40:45,030 --> 00:40:42,960

my consciousness doesn't have an

1183

00:40:46,710 --> 00:40:45,040

identity

1184

00:40:48,550 --> 00:40:46,720

my consciousness is also not of the

1185

00:40:50,950 --> 00:40:48,560

nature that it's the same as everybody

1186

00:40:53,910 --> 00:40:50,960

else's consciousness right it's

1187

00:40:55,190 --> 00:40:53,920

the question do we all uh are the same

1188

00:40:57,430 --> 00:40:55,200

consciousness looking through different

1189

00:40:59,109 --> 00:40:57,440

eyes or with separate consciousnesses is

1190

00:41:02,069 --> 00:40:59,119

in some sense as meaningless as the

1191

00:41:03,589 --> 00:41:02,079

question of asking is the text editor

1192

00:41:05,430 --> 00:41:03,599

that you're running onto your computer

1193

00:41:07,349 --> 00:41:05,440

the same text editor that everybody else

1194

00:41:10,309 --> 00:41:07,359

runs on their computer

1195

00:41:12,870 --> 00:41:10,319

or is it a different one

1196

00:41:15,589 --> 00:41:12,880

right the program word is in some sense

1197

00:41:17,510 --> 00:41:15,599

a natural law if you put the circuits of

1198

00:41:20,069 --> 00:41:17,520

your computer in the same

1199

00:41:21,430 --> 00:41:20,079

functional configuration then

1200

00:41:22,790 --> 00:41:21,440

those things are going to happen with

1201
00:41:24,950 --> 00:41:22,800
the circuits of your computer and they

1202
00:41:26,550 --> 00:41:24,960
will afford the following interactions

1203
00:41:28,470 --> 00:41:26,560
but the program word doesn't have an

1204
00:41:30,150 --> 00:41:28,480
identity and it's also not that it has

1205
00:41:32,309 --> 00:41:30,160
no identity in the sense it's just not a

1206
00:41:34,390 --> 00:41:32,319
meaningful category to apply to it in

1207
00:41:36,230 --> 00:41:34,400
the same sense my consciousness is not

1208
00:41:38,390 --> 00:41:36,240
in in this category that would have an

1209
00:41:39,990 --> 00:41:38,400
identity or none

1210
00:41:41,670 --> 00:41:40,000
so it's it's not something that is

1211
00:41:43,510 --> 00:41:41,680
shared with others and it's not

1212
00:41:45,750 --> 00:41:43,520
something that is separate from others

1213
00:41:47,589 --> 00:41:45,760

it's a principle that applies to the

1214

00:41:49,349 --> 00:41:47,599

observation and when the consciousness

1215

00:41:51,190 --> 00:41:49,359

gets tied to a self-model then it

1216

00:41:53,829 --> 00:41:51,200

becomes perspectival and i have an

1217

00:41:56,390 --> 00:41:53,839

identity and so on but this identity is

1218

00:42:00,069 --> 00:41:56,400

a particular kind of model that my

1219

00:42:03,190 --> 00:42:00,079

organism tells itself by changing um

1220

00:42:05,510 --> 00:42:03,200

certain factors in my own brain

1221

00:42:06,630 --> 00:42:05,520

okay let's let don respond

1222

00:42:08,069 --> 00:42:06,640

yeah there's well there's quite a bit

1223

00:42:11,030 --> 00:42:08,079

there

1224

00:42:12,390 --> 00:42:11,040

um so on the

1225

00:42:14,790 --> 00:42:12,400

the nature of

1226
00:42:16,630 --> 00:42:14,800
the physical world and and in

1227
00:42:18,790 --> 00:42:16,640
computation

1228
00:42:20,790 --> 00:42:18,800
um

1229
00:42:22,630 --> 00:42:20,800
and the finiteness

1230
00:42:25,270 --> 00:42:22,640
versus you contin continuity of

1231
00:42:26,470 --> 00:42:25,280
spacetime and so forth

1232
00:42:28,710 --> 00:42:26,480
i think that

1233
00:42:29,910 --> 00:42:28,720
the work you know girdles incompleteness

1234
00:42:32,309 --> 00:42:29,920
theorem

1235
00:42:33,910 --> 00:42:32,319
is is very relevant here that

1236
00:42:36,390 --> 00:42:33,920
the notion of

1237
00:42:38,550 --> 00:42:36,400
truth

1238
00:42:40,309 --> 00:42:38,560

is far deeper than the notion of proof

1239

00:42:42,309 --> 00:42:40,319

there are

1240

00:42:44,790 --> 00:42:42,319

any system

1241

00:42:46,470 --> 00:42:44,800

any computational system will have

1242

00:42:47,190 --> 00:42:46,480

things that it can prove

1243

00:42:48,950 --> 00:42:47,200

but

1244

00:42:50,790 --> 00:42:48,960

there will be truths

1245

00:42:52,470 --> 00:42:50,800

that that computational system cannot

1246

00:42:54,550 --> 00:42:52,480

access

1247

00:42:57,030 --> 00:42:54,560

um and if you add those new truth add a

1248

00:42:58,950 --> 00:42:57,040

new truth of you know a girl's statement

1249

00:43:01,430 --> 00:42:58,960

to your set of axioms and there will be

1250

00:43:03,109 --> 00:43:01,440

yet more truths that cannot be accessed

1251
00:43:06,230 --> 00:43:03,119
from that that that

1252
00:43:09,270 --> 00:43:06,240
and so what you can compute

1253
00:43:10,630 --> 00:43:09,280
is always going to be trivial

1254
00:43:13,589 --> 00:43:10,640
to what

1255
00:43:15,030 --> 00:43:13,599
is true there will always be

1256
00:43:17,670 --> 00:43:15,040
as far as i can tell again is sort of

1257
00:43:20,870 --> 00:43:17,680
like newton's notion of we're at the

1258
00:43:24,470 --> 00:43:20,880
seashore and the vast ocean

1259
00:43:26,230 --> 00:43:24,480
of of of reality of the truth he

1260
00:43:28,790 --> 00:43:26,240
actually used the word truth the vast

1261
00:43:30,950 --> 00:43:28,800
ocean of truths is out there beyond what

1262
00:43:34,390 --> 00:43:30,960
we can compute and every truth that you

1263
00:43:35,990 --> 00:43:34,400

add to your base for computation um

1264

00:43:36,710 --> 00:43:36,000

doesn't solve the problem

1265

00:43:40,790 --> 00:43:36,720

and

1266

00:43:42,870 --> 00:43:40,800

true you know of abstract mathematics

1267

00:43:45,430 --> 00:43:42,880

but that's not true of physics

1268

00:43:46,550 --> 00:43:45,440

i mean the physics itself is computable

1269

00:43:49,990 --> 00:43:46,560

but that

1270

00:43:51,589 --> 00:43:50,000

um there's some recent work um

1271

00:43:54,069 --> 00:43:51,599

suggesting that that's that's not the

1272

00:43:56,069 --> 00:43:54,079

case so um

1273

00:43:59,030 --> 00:43:56,079

tony kubit

1274

00:44:02,230 --> 00:43:59,040

the physicist and and his colleagues

1275

00:44:04,309 --> 00:44:02,240

have have recently proved that

1276

00:44:05,910 --> 00:44:04,319

a very important problem to condense

1277

00:44:09,750 --> 00:44:05,920

matter physicists

1278

00:44:12,870 --> 00:44:09,760

called the spectral gap problem

1279

00:44:14,870 --> 00:44:12,880

um is not computable

1280

00:44:21,030 --> 00:44:14,880

and

1281

00:44:23,190 --> 00:44:21,040

they haven't proven this yet but that

1282

00:44:24,710 --> 00:44:23,200

something that that's a big open problem

1283

00:44:26,470 --> 00:44:24,720

i think the millennium

1284

00:44:29,030 --> 00:44:26,480

prize committee has this is one of their

1285

00:44:30,870 --> 00:44:29,040

problems is to understand the the yang

1286

00:44:33,589 --> 00:44:30,880

mills gas gap

1287

00:44:35,990 --> 00:44:33,599

problem which is you know why do

1288

00:44:36,950 --> 00:44:36,000

photons and gravitons have no mass but

1289

00:44:40,630 --> 00:44:36,960

the

1290

00:44:42,710 --> 00:44:40,640

have mass

1291

00:44:44,309 --> 00:44:42,720

and kubit and his

1292

00:44:47,990 --> 00:44:44,319

collaborators think again that we're

1293

00:44:51,589 --> 00:44:49,829

non-computational is going on here it's

1294

00:44:53,829 --> 00:44:51,599

not decidable

1295

00:44:55,030 --> 00:44:53,839

and my guess is that this is just the

1296

00:44:56,550 --> 00:44:55,040

beginning

1297

00:44:59,510 --> 00:44:56,560

that we're going to find that as

1298

00:45:00,550 --> 00:44:59,520

powerful as computation is and you know

1299

00:46:04,870 --> 00:45:00,560

i

1300

00:46:07,349 --> 00:46:04,880

you on the seashore

1301
00:46:08,309 --> 00:46:07,359
and so that that's why

1302
00:46:10,309 --> 00:46:08,319
i mean

1303
00:46:12,550 --> 00:46:10,319
i i didn't like that conclusion but you

1304
00:46:14,309 --> 00:46:12,560
know girdle proved it and now physicists

1305
00:46:16,630 --> 00:46:14,319
are finding it in you know the spectral

1306
00:46:18,309 --> 00:46:16,640
gap and so

1307
00:46:20,630 --> 00:46:18,319
as much as i like computation i'm a

1308
00:46:22,230 --> 00:46:20,640
computer scientist myself as much as i

1309
00:46:24,150 --> 00:46:22,240
like computation

1310
00:46:27,030 --> 00:46:24,160
i have to defer to the mathematical

1311
00:46:29,349 --> 00:46:27,040
proofs that say um computation goes thus

1312
00:46:31,510 --> 00:46:29,359
far and no further

1313
00:46:35,270 --> 00:46:31,520

and then ask myself okay

1314

00:46:36,950 --> 00:46:35,280

how can so my my conceptual system then

1315

00:46:40,630 --> 00:46:36,960

is itself

1316

00:46:43,270 --> 00:46:40,640

just a symbolic system

1317

00:46:46,790 --> 00:46:43,280

with derivation rules so what i what i

1318

00:46:49,109 --> 00:46:46,800

can compute by my my thought is also

1319

00:46:50,309 --> 00:46:49,119

going to be limited which is why i was

1320

00:46:52,390 --> 00:46:50,319

saying up front what i think about

1321

00:46:53,829 --> 00:46:52,400

scientific theories right scientific

1322

00:46:55,990 --> 00:46:53,839

theories are going to have these

1323

00:46:57,750 --> 00:46:56,000

limitations we will put down a set of

1324

00:46:59,589 --> 00:46:57,760

axioms

1325

00:47:02,550 --> 00:46:59,599

each theory a good scientific theory

1326

00:47:03,910 --> 00:47:02,560

will tell you exactly what it assumes

1327

00:47:05,430 --> 00:47:03,920

and

1328

00:47:06,790 --> 00:47:05,440

it will also give you a hint about the

1329

00:47:09,430 --> 00:47:06,800

kind of derivations that you can give

1330

00:47:11,910 --> 00:47:09,440

from those assumptions and then you use

1331

00:47:14,470 --> 00:47:11,920

you find what that theory will entail

1332

00:47:15,990 --> 00:47:14,480

but our best theories

1333

00:47:18,710 --> 00:47:16,000

uh like

1334

00:47:20,470 --> 00:47:18,720

quantum theory and relativity and

1335

00:47:22,470 --> 00:47:20,480

evolution of natural selection

1336

00:47:24,470 --> 00:47:22,480

the best theories will also tell you

1337

00:47:26,630 --> 00:47:24,480

where they stop they will say we go this

1338

00:47:29,349 --> 00:47:26,640

far and no further

1339

00:47:30,710 --> 00:47:29,359

and and for example

1340

00:47:32,309 --> 00:47:30,720

physics tells us

1341

00:47:34,549 --> 00:47:32,319

that

1342

00:47:36,870 --> 00:47:34,559

space time itself cannot be fundamental

1343

00:47:38,549 --> 00:47:36,880

that the very notion of space-time

1344

00:47:41,190 --> 00:47:38,559

cannot be fundamental which is stunning

1345

00:47:43,109 --> 00:47:41,200

because physics for several centuries

1346

00:47:44,950 --> 00:47:43,119

has essentially been the study of what

1347

00:47:46,710 --> 00:47:44,960

happens in space and time

1348

00:47:47,910 --> 00:47:46,720

and so to say that space time is not

1349

00:47:49,910 --> 00:47:47,920

fundamental

1350

00:47:51,990 --> 00:47:49,920

means that the physicists have to

1351
00:47:54,630 --> 00:47:52,000
redefine what what physics is about and

1352
00:47:57,190 --> 00:47:54,640
that's what for example juan maldocena

1353
00:47:58,790 --> 00:47:57,200
and neymar connie hamid are trying to do

1354
00:48:00,710 --> 00:47:58,800
with things like the cosmological

1355
00:48:01,750 --> 00:48:00,720
polytope and amplitude and so forth

1356
00:48:04,150 --> 00:48:01,760
they're finding

1357
00:48:06,870 --> 00:48:04,160
structures where there are no hilbert

1358
00:48:08,470 --> 00:48:06,880
spaces so there's no quantum theory

1359
00:48:09,910 --> 00:48:08,480
there is no time

1360
00:48:12,470 --> 00:48:09,920
there is no space

1361
00:48:15,990 --> 00:48:12,480
there are these positive geometries and

1362
00:48:18,069 --> 00:48:16,000
what you find is you can predict

1363
00:48:19,670 --> 00:48:18,079

events in space time like scattering

1364

00:48:21,829 --> 00:48:19,680

processes that you see at the large

1365

00:48:23,430 --> 00:48:21,839

hadron collider you can predict them and

1366

00:48:24,950 --> 00:48:23,440

in fact you

1367

00:48:26,630 --> 00:48:24,960

you can actually

1368

00:48:29,109 --> 00:48:26,640

compute them

1369

00:48:31,430 --> 00:48:29,119

in some sense better than if you assume

1370

00:48:33,109 --> 00:48:31,440

space time so they're finding that what

1371

00:48:35,510 --> 00:48:33,119

you know if you use feynman diagrams and

1372

00:48:37,510 --> 00:48:35,520

try to compute scattering amplitudes for

1373

00:48:39,910 --> 00:48:37,520

two gluons coming in and four gluons

1374

00:48:41,750 --> 00:48:39,920

scattering out using the standard

1375

00:48:43,829 --> 00:48:41,760

quantum field theoretic approaches where

1376

00:48:45,829 --> 00:48:43,839

space and time is assumed you get

1377

00:48:48,150 --> 00:48:45,839

hundreds of pages of algebra and it's

1378

00:48:49,990 --> 00:48:48,160

it's it's a mask whereas if you let go

1379

00:48:51,030 --> 00:48:50,000

space time and and look at these

1380

00:48:52,549 --> 00:48:51,040

structures

1381

00:48:54,150 --> 00:48:52,559

uh with symmetries that cannot be

1382

00:48:56,309 --> 00:48:54,160

expressed in space timeline dual

1383

00:48:57,510 --> 00:48:56,319

conformal symmetry then you find that

1384

00:48:59,589 --> 00:48:57,520

the the

1385

00:49:02,470 --> 00:48:59,599

the same scattering amplitudes can be

1386

00:49:04,549 --> 00:49:02,480

processed in just two or three um terms

1387

00:49:07,030 --> 00:49:04,559

that you can write down pen and paper on

1388

00:49:09,030 --> 00:49:07,040

a sheet of paper so all of a sudden you

1389

00:49:11,510 --> 00:49:09,040

so what they're seeing is space time has

1390

00:49:13,910 --> 00:49:11,520

had a good run

1391

00:49:16,870 --> 00:49:13,920

but if you force yourself to stick with

1392

00:49:18,950 --> 00:49:16,880

space time then the math is ugly you get

1393

00:49:20,710 --> 00:49:18,960

hundreds of pages of algebra to compute

1394

00:49:23,190 --> 00:49:20,720

scattering amplitudes you can't see the

1395

00:49:25,030 --> 00:49:23,200

symmetries that are there like dual

1396

00:49:27,190 --> 00:49:25,040

conformal symmetry if you let go

1397

00:49:28,470 --> 00:49:27,200

space-time you're finding these amazing

1398

00:49:29,589 --> 00:49:28,480

structures that they don't know what

1399

00:49:31,270 --> 00:49:29,599

they're about

1400

00:49:33,109 --> 00:49:31,280

but all of a sudden you see the right

1401

00:49:34,230 --> 00:49:33,119

symmetries and the computations become

1402

00:49:36,069 --> 00:49:34,240

trivial

1403

00:49:38,309 --> 00:49:36,079

so there's some big hint

1404

00:49:40,390 --> 00:49:38,319

that um i think

1405

00:49:42,390 --> 00:49:40,400

on a couple fronts from girdle

1406

00:49:43,990 --> 00:49:42,400

and from the work by tony kubit and his

1407

00:49:47,030 --> 00:49:44,000

team that

1408

00:49:48,470 --> 00:49:47,040

the computation is as as powerful as it

1409

00:49:50,309 --> 00:49:48,480

is and as much as i love it as a you

1410

00:49:53,510 --> 00:49:50,319

know ai person

1411

00:49:55,030 --> 00:49:53,520

and a cognitive scientist it it it has

1412

00:49:56,549 --> 00:49:55,040

it's always going to be on the seashore

1413

00:49:57,349 --> 00:49:56,559

with newton

1414

00:50:00,069 --> 00:49:57,359

and

1415

00:50:01,990 --> 00:50:00,079

when we let go space-time

1416

00:50:03,510 --> 00:50:02,000

we're still of course as theorists

1417

00:50:05,510 --> 00:50:03,520

always going to have

1418

00:50:07,270 --> 00:50:05,520

a finite set of axioms and and

1419

00:50:09,349 --> 00:50:07,280

derivations about you know like the

1420

00:50:13,109 --> 00:50:09,359

cosmological polytope and and and so

1421

00:50:14,870 --> 00:50:13,119

forth that nema and juan are finding

1422

00:50:17,030 --> 00:50:14,880

we're still going to have a finite set

1423

00:50:17,910 --> 00:50:17,040

of concepts and derivations so we're not

1424

00:50:20,150 --> 00:50:17,920

going to get around girdle's

1425

00:50:23,589 --> 00:50:20,160

incompleteness there but at least we're

1426

00:50:25,430 --> 00:50:23,599

we're going beyond the notion of time

1427

00:50:27,030 --> 00:50:25,440

which is really critical

1428

00:50:29,510 --> 00:50:27,040

and and

1429

00:50:31,670 --> 00:50:29,520

and that also cuts at the computational

1430

00:50:34,230 --> 00:50:31,680

issues pretty interesting computational

1431

00:50:36,150 --> 00:50:34,240

complexity is is about you know a lot of

1432

00:50:37,349 --> 00:50:36,160

it's about time complexity

1433

00:50:38,790 --> 00:50:37,359

and

1434

00:50:40,390 --> 00:50:38,800

what physicists are telling us is that

1435

00:50:41,670 --> 00:50:40,400

ultimately

1436

00:50:43,829 --> 00:50:41,680

we're gonna have to let go of the notion

1437

00:50:45,750 --> 00:50:43,839

of time and so as computer scientists

1438

00:50:47,910 --> 00:50:45,760

we're gonna have to rethink complexity

1439

00:50:50,069 --> 00:50:47,920

issues when the very notion of time

1440

00:50:52,069 --> 00:50:50,079

itself isn't fundamental

1441

00:50:55,190 --> 00:50:52,079

so that that's gonna be a real

1442

00:50:57,190 --> 00:50:55,200

a real kicker for for us in in computer

1443

00:50:59,030 --> 00:50:57,200

science how do we think about complexity

1444

00:51:00,630 --> 00:50:59,040

issues when time itself is not the right

1445

00:51:02,150 --> 00:51:00,640

way to think about things

1446

00:51:04,470 --> 00:51:02,160

and and therefore the sequence of

1447

00:51:06,309 --> 00:51:04,480

computations in time is not the right

1448

00:51:09,510 --> 00:51:06,319

way to think about things we have some

1449

00:51:11,270 --> 00:51:09,520

really deep thinking to do ahead

1450

00:51:12,870 --> 00:51:11,280

but

1451
00:51:15,670 --> 00:51:12,880
where i i think

1452
00:51:17,750 --> 00:51:15,680
we share some common ground yoshi is

1453
00:51:19,990 --> 00:51:17,760
i think that a lot of

1454
00:51:21,510 --> 00:51:20,000
our experiences and so forth our models

1455
00:51:22,549 --> 00:51:21,520
that we built i think that we are

1456
00:51:25,190 --> 00:51:22,559
building

1457
00:51:26,870 --> 00:51:25,200
internal models

1458
00:51:30,309 --> 00:51:26,880
but the question is what is the

1459
00:51:31,750 --> 00:51:30,319
apparatus that's building those models

1460
00:51:36,069 --> 00:51:31,760
and

1461
00:51:38,309 --> 00:51:36,079
time

1462
00:51:40,630 --> 00:51:38,319
it so in particular

1463
00:51:42,710 --> 00:51:40,640

i'll be very very explicit i i don't

1464

00:51:45,030 --> 00:51:42,720

think that neurons exist

1465

00:51:46,710 --> 00:51:45,040

when they're not perceived

1466

00:51:48,150 --> 00:51:46,720

i don't think space-time exists when

1467

00:51:50,390 --> 00:51:48,160

it's not perceived

1468

00:51:52,390 --> 00:51:50,400

i think neurons in space-time

1469

00:51:54,390 --> 00:51:52,400

and even particles

1470

00:51:55,670 --> 00:51:54,400

are are

1471

00:51:58,630 --> 00:51:55,680

simply

1472

00:52:01,750 --> 00:51:58,640

data structures

1473

00:52:05,510 --> 00:52:02,950

and

1474

00:52:06,950 --> 00:52:05,520

there is a a formulation of quantum

1475

00:52:09,190 --> 00:52:06,960

theory that that's very similar to this

1476
00:52:11,190 --> 00:52:09,200
is called cubism quantum basianism chris

1477
00:52:13,349 --> 00:52:11,200
fuchs and david merman

1478
00:52:15,270 --> 00:52:13,359
where where they they take this point of

1479
00:52:17,510 --> 00:52:15,280
view that it's the

1480
00:52:18,390 --> 00:52:17,520
every act of observation

1481
00:52:21,109 --> 00:52:18,400
in physics

1482
00:52:23,750 --> 00:52:21,119
every experiment that you do is an act

1483
00:52:25,910 --> 00:52:23,760
of fact creation

1484
00:52:27,750 --> 00:52:25,920
right that that it's not that there are

1485
00:52:29,430 --> 00:52:27,760
pre-existing particles with pre-existing

1486
00:52:31,109 --> 00:52:29,440
states and you're measuring

1487
00:52:34,630 --> 00:52:31,119
those those states

1488
00:52:36,710 --> 00:52:34,640

rather the it's their their you know

1489

00:52:38,309 --> 00:52:36,720

their subjective bayesians so all the

1490

00:52:39,670 --> 00:52:38,319

probabilities in quantum theory are

1491

00:52:41,430 --> 00:52:39,680

subjective probabilities they're not

1492

00:52:43,750 --> 00:52:41,440

objective probabilities

1493

00:52:44,790 --> 00:52:43,760

and every outcome is a

1494

00:52:47,190 --> 00:52:44,800

um

1495

00:52:49,190 --> 00:52:47,200

a fact creation and they they do have i

1496

00:52:51,910 --> 00:52:49,200

mean chris pukes has a very interesting

1497

00:52:52,710 --> 00:52:51,920

2010 paper called cubism

1498

00:52:54,470 --> 00:52:52,720

um

1499

00:52:56,390 --> 00:52:54,480

that i highly recommend and in that

1500

00:52:57,510 --> 00:52:56,400

paper he actually points to very

1501
00:52:58,829 --> 00:52:57,520
interesting

1502
00:53:03,750 --> 00:52:58,839
um

1503
00:53:06,630 --> 00:53:03,760
that there's a sequence of

1504
00:53:08,950 --> 00:53:06,640
what what what's proven is that even if

1505
00:53:10,309 --> 00:53:08,960
you know what the outcome of your

1506
00:53:12,470 --> 00:53:10,319
experiment is going to be with

1507
00:53:14,470 --> 00:53:12,480
probability one

1508
00:53:15,990 --> 00:53:14,480
that does not entail that the outcome is

1509
00:53:17,829 --> 00:53:16,000
there and exists independent of your

1510
00:53:19,670 --> 00:53:17,839
observation

1511
00:53:20,950 --> 00:53:19,680
that's a stunning thing to say is the

1512
00:53:22,470 --> 00:53:20,960
probability one you know with

1513
00:53:24,790 --> 00:53:22,480

probability of one what you're going to

1514

00:53:26,710 --> 00:53:24,800

measure and yet you can prove

1515

00:53:29,349 --> 00:53:26,720

with with quantum mechanics that it's

1516

00:53:31,829 --> 00:53:29,359

impossible that the outcome was there

1517

00:53:32,950 --> 00:53:31,839

the the value existed before you made

1518

00:53:35,589 --> 00:53:32,960

the measurement

1519

00:53:38,309 --> 00:53:35,599

so that the it's really the case that

1520

00:53:39,750 --> 00:53:38,319

the acts of observation are fact

1521

00:53:40,549 --> 00:53:39,760

creations

1522

00:53:43,349 --> 00:53:40,559

not

1523

00:53:45,190 --> 00:53:43,359

fact discoveries

1524

00:53:50,470 --> 00:53:45,200

so

1525

00:53:52,230 --> 00:53:50,480

the work that's done in consciousness

1526

00:53:54,150 --> 00:53:52,240

assumes

1527

00:53:55,829 --> 00:53:54,160

i would say this is 99 of the theories

1528

00:53:58,390 --> 00:53:55,839

that i've seen in consciousness

1529

00:54:00,069 --> 00:53:58,400

assume that space-time is fundamental

1530

00:54:02,150 --> 00:54:00,079

assume that physical particles are

1531

00:54:04,150 --> 00:54:02,160

fundamental and that somehow neural

1532

00:54:05,750 --> 00:54:04,160

activity

1533

00:54:07,990 --> 00:54:05,760

in humans

1534

00:54:11,270 --> 00:54:08,000

and perhaps other kinds of more complex

1535

00:54:13,670 --> 00:54:11,280

activity in ais creates creates

1536

00:54:15,270 --> 00:54:13,680

consciousness but but the very founding

1537

00:54:17,030 --> 00:54:15,280

assumptions that space-time is

1538

00:54:19,430 --> 00:54:17,040

fundamental that neurons exist when

1539

00:54:21,430 --> 00:54:19,440

they're when they're not perceived

1540

00:54:23,349 --> 00:54:21,440

contradicts our best physics and it also

1541

00:54:24,790 --> 00:54:23,359

contradicts evolution of natural

1542

00:54:25,589 --> 00:54:24,800

selection

1543

00:54:29,829 --> 00:54:25,599

which

1544

00:54:32,069 --> 00:54:29,839

natural selection makes it very clear

1545

00:54:35,990 --> 00:54:32,079

that the probability is zero

1546

00:54:37,750 --> 00:54:36,000

that the sensory systems of any organism

1547

00:54:39,589 --> 00:54:37,760

tell them any truths about objective

1548

00:54:41,670 --> 00:54:39,599

reality

1549

00:54:43,430 --> 00:54:41,680

they tell it what what they tell

1550

00:54:45,750 --> 00:54:43,440

organisms sensory systems evolve to tell

1551
00:54:47,510 --> 00:54:45,760
organisms how to behave in order to stay

1552
00:54:48,789 --> 00:54:47,520
alive period

1553
00:54:49,750 --> 00:54:48,799
that's it

1554
00:54:55,109 --> 00:54:49,760
and

1555
00:54:57,030 --> 00:54:55,119
for you know staying alive but but gives

1556
00:54:58,470 --> 00:54:57,040
you no access to the truth and that that

1557
00:55:00,789 --> 00:54:58,480
fits with what physics is telling us

1558
00:55:03,510 --> 00:55:00,799
that that space time is a user interface

1559
00:55:05,030 --> 00:55:03,520
but it's not the final truth and so so

1560
00:55:07,750 --> 00:55:05,040
what i want from

1561
00:55:10,150 --> 00:55:07,760
a theory of consciousness

1562
00:55:12,630 --> 00:55:10,160
as a scientist is i want a clear

1563
00:55:13,910 --> 00:55:12,640

statement of what are the what am i

1564

00:55:15,910 --> 00:55:13,920

assuming

1565

00:55:18,069 --> 00:55:15,920

what are the exact things that my theory

1566

00:55:20,549 --> 00:55:18,079

takes is primitive

1567

00:55:22,630 --> 00:55:20,559

what are the exact rules that

1568

00:55:25,030 --> 00:55:22,640

that allow me to drive things from those

1569

00:55:27,270 --> 00:55:25,040

primitives and how exactly do i get the

1570

00:55:29,270 --> 00:55:27,280

taste of chocolate from that

1571

00:55:31,670 --> 00:55:29,280

that's that's what i'm looking for from

1572

00:55:33,589 --> 00:55:31,680

from the theory of consciousness precise

1573

00:55:36,309 --> 00:55:33,599

statement of exactly what i'm assuming

1574

00:55:38,150 --> 00:55:36,319

up front with mathematical precision and

1575

00:55:39,430 --> 00:55:38,160

then precise derivation if i'm not

1576

00:55:42,470 --> 00:55:39,440

taking the taste of chocolate is

1577

00:55:44,150 --> 00:55:42,480

fundamental if i'm saying that somehow

1578

00:55:46,069 --> 00:55:44,160

some dynamical system is going to give

1579

00:55:48,789 --> 00:55:46,079

it to me then i want to know exactly

1580

00:55:50,549 --> 00:55:48,799

which dynamical system is

1581

00:55:52,390 --> 00:55:50,559

giving me the taste of chocolate and why

1582

00:55:54,870 --> 00:55:52,400

that dynamical system could not be the

1583

00:55:56,630 --> 00:55:54,880

smell of garlic i want to know exactly

1584

00:55:58,549 --> 00:55:56,640

otherwise there's no there's no real

1585

00:56:01,109 --> 00:55:58,559

science on the table

1586

00:56:02,470 --> 00:56:01,119

at all so that's what i'm looking for is

1587

00:56:04,710 --> 00:56:02,480

theories that say exactly what the

1588

00:56:06,470 --> 00:56:04,720

assumptions are and tell me exactly for

1589

00:56:09,270 --> 00:56:06,480

at least one specific conscious

1590

00:56:10,309 --> 00:56:09,280

experience how that conscious experience

1591

00:56:12,069 --> 00:56:10,319

must be

1592

00:56:15,030 --> 00:56:12,079

derived in that way and so so that's

1593

00:56:18,069 --> 00:56:15,040

where i'm coming from on those now in

1594

00:56:20,309 --> 00:56:18,079

the case of of cells and the brain

1595

00:56:21,829 --> 00:56:20,319

i i would just mention something that's

1596

00:56:24,950 --> 00:56:21,839

very interesting that you probably know

1597

00:56:27,990 --> 00:56:24,960

about mike levin's work um

1598

00:56:28,870 --> 00:56:28,000

right and and so he's finding that

1599

00:56:31,589 --> 00:56:28,880

that

1600

00:56:34,950 --> 00:56:31,599

cells not just neurons but but any cell

1601
00:56:36,630 --> 00:56:34,960
in in in animals that in fact

1602
00:56:39,430 --> 00:56:36,640
outside of the brain

1603
00:56:41,510 --> 00:56:39,440
they they can learn

1604
00:56:43,030 --> 00:56:41,520
and they can compute

1605
00:56:45,510 --> 00:56:43,040
and they can

1606
00:56:48,630 --> 00:56:45,520
do morphogenesis of you know of of of

1607
00:56:50,230 --> 00:56:48,640
the cell's body they use gap junction

1608
00:56:52,549 --> 00:56:50,240
communication electric

1609
00:56:54,870 --> 00:56:52,559
so they're effectively um

1610
00:56:57,510 --> 00:56:54,880
doing what neurons do but in a very very

1611
00:56:59,670 --> 00:56:57,520
different way and and this is all cells

1612
00:57:02,630 --> 00:56:59,680
can communicate with in this way with

1613
00:57:04,710 --> 00:57:02,640

gap junctions and so forth so i suspect

1614

00:57:10,309 --> 00:57:04,720

that

1615

00:57:12,230 --> 00:57:10,319

neurons aren't special in in the sense

1616

00:57:14,230 --> 00:57:12,240

of being information processors that

1617

00:57:16,150 --> 00:57:14,240

that that information processing and

1618

00:57:18,390 --> 00:57:16,160

this seems to be where where mike was is

1619

00:57:19,430 --> 00:57:18,400

heading um is that that information

1620

00:57:20,630 --> 00:57:19,440

processing

1621

00:57:23,190 --> 00:57:20,640

is happening in what he calls these

1622

00:57:25,670 --> 00:57:23,200

bioelectric fields um even if there are

1623

00:57:28,150 --> 00:57:25,680

no neurons and that they can learn they

1624

00:57:30,069 --> 00:57:28,160

can retain memories and they can be very

1625

00:57:31,430 --> 00:57:30,079

intelligent and so so even as

1626
00:57:33,349 --> 00:57:31,440
neuroscientists

1627
00:57:35,750 --> 00:57:33,359
we may find that we'll have to expand

1628
00:57:37,030 --> 00:57:35,760
our horizons beyond

1629
00:57:38,630 --> 00:57:37,040
neuroscience

1630
00:57:40,950 --> 00:57:38,640
and understand if i were a

1631
00:57:42,710 --> 00:57:40,960
reductionist and trying to do biological

1632
00:57:45,270 --> 00:57:42,720
reduction i would at this point with

1633
00:57:47,829 --> 00:57:45,280
mike levin's stuff be be interested to

1634
00:57:49,750 --> 00:57:47,839
say oh well maybe i wouldn't necessarily

1635
00:57:51,589 --> 00:57:49,760
reduce consciousness to neural activity

1636
00:57:53,430 --> 00:57:51,599
maybe these gap junctions and the

1637
00:57:54,950 --> 00:57:53,440
computations that cells can do would

1638
00:57:56,630 --> 00:57:54,960

also be

1639

00:57:58,470 --> 00:57:56,640

a suitable

1640

00:58:00,630 --> 00:57:58,480

format but but again i'm not a

1641

00:58:04,549 --> 00:58:00,640

reductionist in that sense but i'll stop

1642

00:58:09,190 --> 00:58:06,230

thank you um

1643

00:58:11,510 --> 00:58:09,200

you went very far and right and try to

1644

00:58:13,349 --> 00:58:11,520

be a little bit more concise

1645

00:58:15,109 --> 00:58:13,359

let's start out with good

1646

00:58:18,309 --> 00:58:15,119

good spoof had a

1647

00:58:21,589 --> 00:58:18,319

very profound and not necessarily very

1648

00:58:22,549 --> 00:58:21,599

positive influence on philosophy

1649

00:58:27,430 --> 00:58:22,559

and

1650

00:58:29,589 --> 00:58:27,440

philosophy opened up a tradition that

1651

00:58:31,750 --> 00:58:29,599

where the underlying current is that

1652

00:58:33,190 --> 00:58:31,760

what goodl has shown is that mathematics

1653

00:58:35,670 --> 00:58:33,200

is important

1654

00:58:37,109 --> 00:58:35,680

to describe reality

1655

00:58:38,870 --> 00:58:37,119

and therefore

1656

00:58:40,630 --> 00:58:38,880

reality can only be described by people

1657

00:58:41,990 --> 00:58:40,640

who don't really know mathematics that

1658

00:58:43,910 --> 00:58:42,000

is philosophers

1659

00:58:46,150 --> 00:58:43,920

so philosophers like that intuition

1660

00:58:48,549 --> 00:58:46,160

right but it implies that there is

1661

00:58:51,270 --> 00:58:48,559

something beyond mathematics

1662

00:58:53,030 --> 00:58:51,280

that allows you to make sense of things

1663

00:58:55,910 --> 00:58:53,040

that assign truth

1664

00:58:57,990 --> 00:58:55,920

and uh slightly deeper when you say that

1665

00:59:00,230 --> 00:58:58,000

uh you like computation and you value it

1666

00:59:01,750 --> 00:59:00,240

and so on and you see its limits it

1667

00:59:03,349 --> 00:59:01,760

implies that you see what comes beyond

1668

00:59:05,589 --> 00:59:03,359

these limits and you're using that thing

1669

00:59:07,270 --> 00:59:05,599

beyond the limits to think

1670

00:59:09,670 --> 00:59:07,280

and i don't think that you are

1671

00:59:11,990 --> 00:59:09,680

everything in my own mind that i can

1672

00:59:14,390 --> 00:59:12,000

observe when i observe myself perceiving

1673

00:59:19,109 --> 00:59:14,400

when i perceive myself

1674

00:59:21,270 --> 00:59:19,119

reasoning is computational it means that

1675

00:59:23,349 --> 00:59:21,280

i go to from state to state

1676

00:59:25,510 --> 00:59:23,359

in a somewhat deterministic way the

1677

00:59:27,510 --> 00:59:25,520

random parts are just deleting bits that

1678

00:59:29,190 --> 00:59:27,520

i computed before so i have to do it

1679

00:59:32,069 --> 00:59:29,200

again the randomness and determinism

1680

00:59:34,549 --> 00:59:32,079

doesn't help me so the part of my mind

1681

00:59:36,950 --> 00:59:34,559

that is relevant to my thinking is

1682

00:59:39,670 --> 00:59:36,960

fundamentally computational what girdle

1683

00:59:41,670 --> 00:59:39,680

discovered and is often misunderstood

1684

00:59:44,150 --> 00:59:41,680

and also by gordo himself

1685

00:59:45,750 --> 00:59:44,160

is is a very important thing

1686

00:59:48,549 --> 00:59:45,760

what girdle has discovered is not that

1687

00:59:51,030 --> 00:59:48,559

truth is deeper than proof

1688

00:59:53,589 --> 00:59:51,040

that was in some sense the suspicion

1689

00:59:56,870 --> 00:59:53,599

which he started with he knew that

1690

00:59:58,789 --> 00:59:56,880

in his view that truth is platonic

1691

01:00:00,549 --> 00:59:58,799

that things can be true or not

1692

01:00:02,710 --> 01:00:00,559

regardless of whether we find out or

1693

01:00:03,990 --> 01:00:02,720

whether it can be found out

1694

01:00:05,990 --> 01:00:04,000

and he hoped

1695

01:00:08,789 --> 01:00:06,000

to find a notion of truth

1696

01:00:10,549 --> 01:00:08,799

of proof that could reach truth

1697

01:00:13,190 --> 01:00:10,559

and he found that it couldn't and he

1698

01:00:15,510 --> 01:00:13,200

found this in a devastating way

1699

01:00:17,190 --> 01:00:15,520

and he drew the conclusion that there is

1700

01:00:18,950 --> 01:00:17,200

truth that cannot be found with

1701
01:00:21,349 --> 01:00:18,960
mathematics

1702
01:00:24,150 --> 01:00:21,359
and the opposite is true

1703
01:00:25,829 --> 01:00:24,160
there is no deeper notion of truth than

1704
01:00:27,430 --> 01:00:25,839
proof

1705
01:00:29,430 --> 01:00:27,440
you see a

1706
01:00:31,030 --> 01:00:29,440
perception cannot be true or false

1707
01:00:33,270 --> 01:00:31,040
perception just is

1708
01:00:35,270 --> 01:00:33,280
physics physical events out there in the

1709
01:00:37,270 --> 01:00:35,280
universe cannot be true or false they

1710
01:00:39,670 --> 01:00:37,280
just are a pattern that you observe is

1711
01:00:41,349 --> 01:00:39,680
not true or false it just is

1712
01:00:42,710 --> 01:00:41,359
right you could be erroneously thinking

1713
01:00:44,390 --> 01:00:42,720

that you're perceiving a pattern when

1714

01:00:46,710 --> 01:00:44,400

you don't because you're suffering from

1715

01:00:48,309 --> 01:00:46,720

false memory or a delusion or whatever

1716

01:00:51,270 --> 01:00:48,319

that makes your thinking or perception

1717

01:00:53,430 --> 01:00:51,280

inconsistent but the pattern itself is

1718

01:00:55,670 --> 01:00:53,440

not true or false it's an interpretation

1719

01:00:57,910 --> 01:00:55,680

that can be true or false and the

1720

01:00:59,829 --> 01:00:57,920

interpretation is has to be in a

1721

01:01:01,510 --> 01:00:59,839

symbolic language to have the property

1722

01:01:03,829 --> 01:01:01,520

that can be true or false a perceptual

1723

01:01:05,510 --> 01:01:03,839

interpretation by itself is not true or

1724

01:01:07,829 --> 01:01:05,520

false it just is

1725

01:01:10,230 --> 01:01:07,839

right so in order to be true or false

1726

01:01:12,150 --> 01:01:10,240

you need to have a language and the

1727

01:01:14,710 --> 01:01:12,160

language needs to be defined in such a

1728

01:01:16,789 --> 01:01:14,720

way that truths can be established and

1729

01:01:18,390 --> 01:01:16,799

the process of establishing truth is a

1730

01:01:20,309 --> 01:01:18,400

computation

1731

01:01:23,190 --> 01:01:20,319

and there are two types of languages in

1732

01:01:24,710 --> 01:01:23,200

which truths can be defined

1733

01:01:27,270 --> 01:01:24,720

and the language of classical

1734

01:01:29,910 --> 01:01:27,280

mathematics is a stateless language

1735

01:01:32,230 --> 01:01:29,920

it's one where time doesn't exist where

1736

01:01:34,230 --> 01:01:32,240

everything happens all at once or in

1737

01:01:36,309 --> 01:01:34,240

some kind of eternal moment

1738

01:01:38,150 --> 01:01:36,319

so if you want to go from state to state

1739

01:01:39,510 --> 01:01:38,160

in this language of eternal mathematics

1740

01:01:41,349 --> 01:01:39,520

in the stateless language you just

1741

01:01:43,430 --> 01:01:41,359

assign an index and then you iterate of

1742

01:01:45,750 --> 01:01:43,440

the index and you do this in a single

1743

01:01:48,150 --> 01:01:45,760

instant in one moment

1744

01:01:49,990 --> 01:01:48,160

and the stateless mathematics has a very

1745

01:01:51,670 --> 01:01:50,000

beautiful property it allows you to deal

1746

01:01:54,069 --> 01:01:51,680

with infinities because you can now

1747

01:01:56,230 --> 01:01:54,079

construct functions that take infinitely

1748

01:01:57,829 --> 01:01:56,240

many arguments in a single step

1749

01:01:59,750 --> 01:01:57,839

perform an operation over them in a

1750

01:02:01,190 --> 01:01:59,760

single step and give the result back in

1751

01:02:03,109 --> 01:02:01,200

a single step

1752

01:02:05,510 --> 01:02:03,119

it's a language in which you can assign

1753

01:02:07,190 --> 01:02:05,520

a value to pi

1754

01:02:08,870 --> 01:02:07,200

right in the computational system you

1755

01:02:10,069 --> 01:02:08,880

cannot really assign a value to pi you

1756

01:02:12,549 --> 01:02:10,079

can have a function that gives you

1757

01:02:15,430 --> 01:02:12,559

digits by digit but you never get to the

1758

01:02:17,589 --> 01:02:15,440

latest last digit it also means that

1759

01:02:19,510 --> 01:02:17,599

digit can uh pi can never be written

1760

01:02:21,190 --> 01:02:19,520

down in such a way that you can have a

1761

01:02:23,589 --> 01:02:21,200

process that relies on knowing all the

1762

01:02:26,950 --> 01:02:23,599

digits of pi and consumes them to tune

1763

01:02:28,150 --> 01:02:26,960

the outcome of some physical process

1764

01:02:30,789 --> 01:02:28,160

right if you

1765

01:02:32,470 --> 01:02:30,799

make the switch to a stateful language

1766

01:02:33,349 --> 01:02:32,480

in which you can only go from step to

1767

01:02:35,510 --> 01:02:33,359

step

1768

01:02:37,510 --> 01:02:35,520

you're losing certain things you're

1769

01:02:39,910 --> 01:02:37,520

losing the ability to treat pi as a

1770

01:02:41,829 --> 01:02:39,920

value pi is now certainly a function

1771

01:02:43,430 --> 01:02:41,839

that you can only approximate to a

1772

01:02:45,589 --> 01:02:43,440

certain degree

1773

01:02:47,190 --> 01:02:45,599

and many other things stop being values

1774

01:02:49,510 --> 01:02:47,200

you'll get a fundamental difference

1775

01:02:50,950 --> 01:02:49,520

between a value of the function a value

1776

01:02:53,109 --> 01:02:50,960

is something that you have already

1777

01:02:54,549 --> 01:02:53,119

computed that you know how to compute by

1778

01:02:56,230 --> 01:02:54,559

extension

1779

01:02:58,470 --> 01:02:56,240

and this means that also that truth

1780

01:03:00,230 --> 01:02:58,480

changes truth is no longer this platonic

1781

01:03:01,990 --> 01:03:00,240

thing that precedes mathematics and

1782

01:03:03,589 --> 01:03:02,000

where we can use mathematics as a tool

1783

01:03:05,829 --> 01:03:03,599

to figure it out

1784

01:03:07,430 --> 01:03:05,839

it has to be contingent on the language

1785

01:03:09,270 --> 01:03:07,440

in which you use it

1786

01:03:10,630 --> 01:03:09,280

if your language has internal

1787

01:03:12,630 --> 01:03:10,640

contradictions

1788

01:03:13,910 --> 01:03:12,640

then truth becomes impossible to

1789

01:03:14,870 --> 01:03:13,920

determine

1790

01:03:16,710 --> 01:03:14,880

right

1791

01:03:18,950 --> 01:03:16,720

you get into areas in this language

1792

01:03:21,109 --> 01:03:18,960

where it falls apart you can no longer

1793

01:03:22,789 --> 01:03:21,119

use it to express coherent thoughts

1794

01:03:24,150 --> 01:03:22,799

about reality and korean models about

1795

01:03:26,710 --> 01:03:24,160

reality

1796

01:03:28,710 --> 01:03:26,720

you can never make statements in the

1797

01:03:30,309 --> 01:03:28,720

language that you can prove outside of

1798

01:03:32,710 --> 01:03:30,319

the language so you cannot use your

1799

01:03:35,109 --> 01:03:32,720

language to prove things that are not

1800

01:03:37,910 --> 01:03:35,119

cannot be described in the language

1801
01:03:39,750 --> 01:03:37,920
your only hope to prove statements about

1802
01:03:41,190 --> 01:03:39,760
the universe that you exist in inner

1803
01:03:43,910 --> 01:03:41,200
language is that you are able to

1804
01:03:46,309 --> 01:03:43,920
recreate the observations that you make

1805
01:03:48,309 --> 01:03:46,319
inside of the language which means you

1806
01:03:49,589 --> 01:03:48,319
recreate a model of the universe that is

1807
01:03:51,829 --> 01:03:49,599
so good

1808
01:03:54,549 --> 01:03:51,839
that it gives you what you observe

1809
01:03:55,750 --> 01:03:54,559
correctly and then you can hope that the

1810
01:03:57,349 --> 01:03:55,760
statements that you make in your

1811
01:03:58,470 --> 01:03:57,359
language capture something about the

1812
01:04:00,230 --> 01:03:58,480
reality

1813
01:04:02,069 --> 01:04:00,240

outside of you that gives rise to your

1814

01:04:04,470 --> 01:04:02,079

observations but of course you cannot

1815

01:04:06,549 --> 01:04:04,480

know because it could also be different

1816

01:04:09,190 --> 01:04:06,559

but if your language is not able to

1817

01:04:11,270 --> 01:04:09,200

produce what's on your screen

1818

01:04:14,549 --> 01:04:11,280

then your language is wrong

1819

01:04:17,670 --> 01:04:14,559

and hilbert basically gave out this task

1820

01:04:20,950 --> 01:04:17,680

to mathematicians to find a machine

1821

01:04:22,950 --> 01:04:20,960

any kind of structural sound language

1822

01:04:24,549 --> 01:04:22,960

that is able to run the semantics of

1823

01:04:26,870 --> 01:04:24,559

mathematics without breaking and what

1824

01:04:28,630 --> 01:04:26,880

goethe discovered is that the semantics

1825

01:04:31,029 --> 01:04:28,640

of stateless mathematics cannot be

1826

01:04:33,670 --> 01:04:31,039

recovered if you assume that there is a

1827

01:04:34,549 --> 01:04:33,680

solution to get stateless mathematics to

1828

01:04:36,710 --> 01:04:34,559

work

1829

01:04:38,950 --> 01:04:36,720

you will run into contradictions

1830

01:04:40,950 --> 01:04:38,960

of the way that google is covered

1831

01:04:42,390 --> 01:04:40,960

but there is a way out

1832

01:04:44,470 --> 01:04:42,400

you just

1833

01:04:46,549 --> 01:04:44,480

drop the notion of truth that is

1834

01:04:48,630 --> 01:04:46,559

independent of the sequence of

1835

01:04:50,230 --> 01:04:48,640

operations the number of the set of

1836

01:04:51,109 --> 01:04:50,240

steps that you took the algorithm that

1837

01:04:53,670 --> 01:04:51,119

you took

1838

01:04:54,870 --> 01:04:53,680

to get to your result

1839

01:04:56,710 --> 01:04:54,880

it means that when you have a

1840

01:04:58,789 --> 01:04:56,720

self-referential statement like this

1841

01:05:00,789 --> 01:04:58,799

sentence is false

1842

01:05:02,710 --> 01:05:00,799

right this is a sentence that of the

1843

01:05:04,549 --> 01:05:02,720

type that god has shown leads and for

1844

01:05:06,710 --> 01:05:04,559

contradictions if you assume that there

1845

01:05:08,549 --> 01:05:06,720

is a stable notion of truth

1846

01:05:10,870 --> 01:05:08,559

that is stateless

1847

01:05:13,430 --> 01:05:10,880

if you accept that truth is not

1848

01:05:15,349 --> 01:05:13,440

necessarily a stable value and you look

1849

01:05:16,470 --> 01:05:15,359

at the sentence then as long as you look

1850

01:05:18,950 --> 01:05:16,480

at it

1851

01:05:20,630 --> 01:05:18,960

the truth value will fluctuate

1852

01:05:22,950 --> 01:05:20,640

because the assumption that the sentence

1853

01:05:25,349 --> 01:05:22,960

is true will lead to the sentence being

1854

01:05:27,190 --> 01:05:25,359

false and vice versa so suddenly you

1855

01:05:29,349 --> 01:05:27,200

have no longer a stable truth predicate

1856

01:05:30,870 --> 01:05:29,359

and it just means that the property of

1857

01:05:32,870 --> 01:05:30,880

the languages in which you can actually

1858

01:05:34,789 --> 01:05:32,880

deal with truth and assign it is that

1859

01:05:37,990 --> 01:05:34,799

under some circumstances the truth

1860

01:05:39,829 --> 01:05:38,000

predicate will not be stable

1861

01:05:41,109 --> 01:05:39,839

and it's fine there's nothing wrong with

1862

01:05:43,190 --> 01:05:41,119

that

1863

01:05:45,510 --> 01:05:43,200

and uh this same thing applies to the

1864

01:05:47,670 --> 01:05:45,520

entities problem that um

1865

01:05:49,589 --> 01:05:47,680

turing was dealing with when it came to

1866

01:05:51,190 --> 01:05:49,599

the halting problem we defined

1867

01:05:52,789 --> 01:05:51,200

originally the turing machine in such a

1868

01:05:54,069 --> 01:05:52,799

way that we could translate stateless

1869

01:05:55,990 --> 01:05:54,079

mathematics

1870

01:05:57,670 --> 01:05:56,000

into algorithms

1871

01:06:00,710 --> 01:05:57,680

and this might require that you have to

1872

01:06:02,470 --> 01:06:00,720

go through an infinite sequence of steps

1873

01:06:04,230 --> 01:06:02,480

and if you make this assumption that you

1874

01:06:05,670 --> 01:06:04,240

sometimes in order to get to truth you

1875

01:06:06,630 --> 01:06:05,680

have to go to an infinite sequence of

1876

01:06:09,589 --> 01:06:06,640

steps

1877

01:06:11,750 --> 01:06:09,599

you run into contradictions

1878

01:06:13,190 --> 01:06:11,760

so you might use an unbounded sequence

1879

01:06:14,789 --> 01:06:13,200

of steps that gives you continuously

1880

01:06:16,630 --> 01:06:14,799

results that's fine

1881

01:06:18,630 --> 01:06:16,640

but you cannot accept that anything

1882

01:06:20,230 --> 01:06:18,640

exists in any kind of universe that has

1883

01:06:21,829 --> 01:06:20,240

caused a structure

1884

01:06:23,990 --> 01:06:21,839

that is going to produce your solution

1885

01:06:25,029 --> 01:06:24,000

to the heartache problem that is which

1886

01:06:26,470 --> 01:06:25,039

would give you back stateless

1887

01:06:28,309 --> 01:06:26,480

mathematics

1888

01:06:29,510 --> 01:06:28,319

so basically what good and turing have

1889

01:06:33,029 --> 01:06:29,520

shown is

1890

01:06:34,710 --> 01:06:33,039

that stateless mathematics doesn't work

1891

01:06:36,390 --> 01:06:34,720

and when we look back at the history of

1892

01:06:37,910 --> 01:06:36,400

mathematics mathematicians have never

1893

01:06:40,230 --> 01:06:37,920

used stateless mathematics they only

1894

01:06:41,670 --> 01:06:40,240

pretended to whenever they actually

1895

01:06:44,630 --> 01:06:41,680

wanted to compute something with

1896

01:06:47,109 --> 01:06:44,640

mathematics they under the hood use

1897

01:06:48,950 --> 01:06:47,119

stateful descriptions they never took in

1898

01:06:50,230 --> 01:06:48,960

infinitely many arguments and performed

1899

01:06:53,029 --> 01:06:50,240

infinitely many

1900

01:06:55,349 --> 01:06:53,039

operations on them and the intuition

1901

01:06:57,270 --> 01:06:55,359

that stateless mathematics makes sense

1902

01:06:59,430 --> 01:06:57,280

is because we had this intuition that

1903

01:07:01,829 --> 01:06:59,440

continuity that space and time in a

1904

01:07:03,270 --> 01:07:01,839

continuous fashion exist

1905

01:07:05,589 --> 01:07:03,280

why do we have this information well

1906

01:07:07,270 --> 01:07:05,599

that's pretty easy to answer right the

1907

01:07:08,630 --> 01:07:07,280

number of things that we interact with

1908

01:07:10,390 --> 01:07:08,640

if we zoom in we find that they are

1909

01:07:13,990 --> 01:07:10,400

discrete although observations have a

1910

01:07:16,069 --> 01:07:14,000

discrete resolution in time and in space

1911

01:07:16,950 --> 01:07:16,079

all our knowledge that we store about

1912

01:07:19,750 --> 01:07:16,960

these

1913

01:07:21,910 --> 01:07:19,760

observables is has a discrete

1914

01:07:22,710 --> 01:07:21,920

number of bits that we can assign to

1915

01:07:24,870 --> 01:07:22,720

them

1916

01:07:26,549 --> 01:07:24,880

there is only finite number of

1917

01:07:28,390 --> 01:07:26,559

information that we can access and that

1918

01:07:30,390 --> 01:07:28,400

we can deal with as an observer that is

1919

01:07:33,029 --> 01:07:30,400

embedded in this universe so everything

1920

01:07:35,510 --> 01:07:33,039

was discrete to begin with but it's too

1921

01:07:40,950 --> 01:07:35,520

many parts to count

1922

01:07:43,990 --> 01:07:40,960

the inside that number of atoms that you

1923

01:07:45,670 --> 01:07:44,000

are in an ocean is a finite bounded

1924

01:07:47,990 --> 01:07:45,680

number it doesn't help you at all

1925

01:07:49,829 --> 01:07:48,000

because it's still almost infinite from

1926

01:07:51,190 --> 01:07:49,839

the perspective of an observer so when

1927

01:07:52,950 --> 01:07:51,200

you want to describe what the ocean is

1928

01:07:55,670 --> 01:07:52,960

doing it doesn't help to count the

1929

01:07:57,990 --> 01:07:55,680

molecules in it and to assign locations

1930

01:08:00,150 --> 01:07:58,000

to them and uh what are the interactions

1931

01:08:01,990 --> 01:08:00,160

doesn't work there is too much

1932

01:08:04,069 --> 01:08:02,000

so when you look at the dynamics too of

1933

01:08:06,150 --> 01:08:04,079

too many parts to count you're looking

1934

01:08:08,710 --> 01:08:06,160

for operations that converge in the

1935

01:08:11,430 --> 01:08:08,720

limit which means they behave quite

1936

01:08:14,870 --> 01:08:11,440

similar whether you're using a trillion

1937

01:08:17,349 --> 01:08:14,880

or 10 trillion or gazillion particles

1938

01:08:19,749 --> 01:08:17,359

right once you have these operators that

1939

01:08:21,430 --> 01:08:19,759

give you the same dynamics under all

1940

01:08:24,149 --> 01:08:21,440

circumstances when you take more and

1941

01:08:25,749 --> 01:08:24,159

more elements to them this this this

1942

01:08:27,510 --> 01:08:25,759

part of mathematics that describes the

1943

01:08:29,430 --> 01:08:27,520

convergent operators

1944

01:08:31,430 --> 01:08:29,440

that's geometry

1945

01:08:33,510 --> 01:08:31,440

and some of geometry is uncomputable so

1946

01:08:35,669 --> 01:08:33,520

you can only approximate it

1947

01:08:37,349 --> 01:08:35,679

but our brain has discovered geometry to

1948

01:08:38,390 --> 01:08:37,359

deal with the world of too many parts to

1949

01:08:40,070 --> 01:08:38,400

count

1950

01:08:41,910 --> 01:08:40,080

and this plays into what you are

1951

01:08:43,910 --> 01:08:41,920

pointing out when you say that

1952

01:08:46,149 --> 01:08:43,920

our perception doesn't give us reality

1953

01:08:46,950 --> 01:08:46,159

it gives us something that we can work

1954

01:08:48,870 --> 01:08:46,960

with

1955

01:08:50,950 --> 01:08:48,880

of course the reality that we are

1956

01:08:52,950 --> 01:08:50,960

embedded in has too many parts to count

1957

01:08:54,470 --> 01:08:52,960

we need a different reality we need one

1958

01:08:55,910 --> 01:08:54,480

that you can actually handle even if

1959

01:08:57,349 --> 01:08:55,920

it's not computable it can only be

1960

01:09:00,229 --> 01:08:57,359

approximated

1961

01:09:02,229 --> 01:09:00,239

and this experimental reality is a very

1962

01:09:04,390 --> 01:09:02,239

coarse simplification it's about as

1963

01:09:06,070 --> 01:09:04,400

coarse as a gaming engine is when you

1964

01:09:07,590 --> 01:09:06,080

play computer game as compared to real

1965

01:09:09,590 --> 01:09:07,600

physics

1966

01:09:11,030 --> 01:09:09,600

it's not much better than that in many

1967

01:09:13,110 --> 01:09:11,040

ways it's even worse which you can

1968

01:09:15,430 --> 01:09:13,120

verify if you put yourself into a lucid

1969

01:09:17,349 --> 01:09:15,440

dream and look at the fidelity of what

1970

01:09:18,950 --> 01:09:17,359

your brain is able to generate light

1971

01:09:20,709 --> 01:09:18,960

switches will usually not work you will

1972

01:09:22,709 --> 01:09:20,719

not be able to read the same stuff twice

1973

01:09:24,709 --> 01:09:22,719

on the same page and you imagine it and

1974

01:09:27,030 --> 01:09:24,719

so on there's only so many bits in your

1975

01:09:29,269 --> 01:09:27,040

working memory the fidelity of what your

1976

01:09:30,470 --> 01:09:29,279

perceptual system can track and imagine

1977

01:09:32,630 --> 01:09:30,480

is limited

1978

01:09:33,829 --> 01:09:32,640

it's relatively easy to overcome that

1979

01:09:35,269 --> 01:09:33,839

don't really know what the number of

1980

01:09:37,669 --> 01:09:35,279

bits in my working memory is and that

1981

01:09:38,390 --> 01:09:37,679

would be very curious to find out

1982

01:09:40,070 --> 01:09:38,400

but

1983

01:09:42,149 --> 01:09:40,080

it's not as big as i thought when i was

1984

01:09:44,309 --> 01:09:42,159

a child it's not infinite it's not

1985

01:09:45,990 --> 01:09:44,319

unlimited perception of infinity is

1986

01:09:49,510 --> 01:09:46,000

super easy to generate when your mind is

1987

01:09:52,470 --> 01:09:49,520

very finite super easy to overwhelm my

1988

01:09:53,349 --> 01:09:52,480

finite resolution mind

1989

01:09:55,350 --> 01:09:53,359

so

1990

01:09:57,189 --> 01:09:55,360

this deep thing that good is

1991

01:09:59,189 --> 01:09:57,199

misunderstood that google has not

1992

01:10:02,709 --> 01:09:59,199

discovered that mathematics cannot reach

1993

01:10:05,030 --> 01:10:02,719

truth but that truth is no more than the

1994

01:10:06,709 --> 01:10:05,040

result of a sequence of steps that is

1995

01:10:09,750 --> 01:10:06,719

compressing a statement to axioms

1996

01:10:11,510 --> 01:10:09,760

losslessly and doesn't go beyond that

1997

01:10:13,350 --> 01:10:11,520

that was the deep insight and it's one

1998

01:10:15,510 --> 01:10:13,360

that basically has not percolated in

1999

01:10:17,350 --> 01:10:15,520

most areas of philosophy and even

2000

01:10:18,470 --> 01:10:17,360

physics yet because the physicists have

2001

01:10:20,790 --> 01:10:18,480

checked out the code base for

2002

01:10:22,870 --> 01:10:20,800

mathematics before that result was

2003

01:10:25,270 --> 01:10:22,880

obtained and understood so basically

2004

01:10:27,350 --> 01:10:25,280

that we need to switch from continuous

2005

01:10:29,590 --> 01:10:27,360

stateless mathematics to constructive

2006

01:10:30,709 --> 01:10:29,600

mathematics that was not understood back

2007

01:10:33,189 --> 01:10:30,719

then

2008

01:10:35,750 --> 01:10:33,199

and it needs to be understood now

2009

01:10:38,790 --> 01:10:35,760

so uh basically my

2010

01:10:40,790 --> 01:10:38,800

uh question to uh somebody like donald

2011

01:10:42,070 --> 01:10:40,800

would not be so much how to explain the

2012

01:10:45,110 --> 01:10:42,080

spectral gap room because i think

2013

01:10:47,669 --> 01:10:45,120

problems of this case of this type are

2014

01:10:49,669 --> 01:10:47,679

with the result of using continuous

2015

01:10:51,189 --> 01:10:49,679

notions of space-time

2016

01:10:53,270 --> 01:10:51,199

and infinities

2017

01:10:54,950 --> 01:10:53,280

and assuming them as given so it's a

2018

01:10:55,669 --> 01:10:54,960

statement about certain theories that

2019

01:10:58,070 --> 01:10:55,679

are

2020

01:11:00,149 --> 01:10:58,080

expressed in the language that has

2021

01:11:01,910 --> 01:11:00,159

inconsistencies in this language with

2022

01:11:03,990 --> 01:11:01,920

these inconsistencies you get to the

2023

01:11:05,590 --> 01:11:04,000

point that you cannot get certain

2024

01:11:07,990 --> 01:11:05,600

results there's also an issue of

2025

01:11:09,750 --> 01:11:08,000

computational irreducibility which is

2026

01:11:12,470 --> 01:11:09,760

difficult to understand in stateless

2027

01:11:14,550 --> 01:11:12,480

mathematics computational irreducibility

2028

01:11:16,550 --> 01:11:14,560

is a property of a system

2029

01:11:18,149 --> 01:11:16,560

that means that you cannot obtain the

2030

01:11:21,189 --> 01:11:18,159

state of the system

2031

01:11:24,229 --> 01:11:21,199

without running the system to that point

2032

01:11:27,030 --> 01:11:24,239

there is no way to predict the system

2033

01:11:28,630 --> 01:11:27,040

except by taking the system with all its

2034

01:11:30,229 --> 01:11:28,640

detail and fidelity

2035

01:11:32,470 --> 01:11:30,239

and going through the sequence of steps

2036

01:11:34,790 --> 01:11:32,480

so you cannot predict what the universe

2037

01:11:36,310 --> 01:11:34,800

is going to do when the universe is

2038

01:11:38,229 --> 01:11:36,320

computationally reusable you're going to

2039

01:11:39,830 --> 01:11:38,239

predict some things but not all of

2040

01:11:41,669 --> 01:11:39,840

things and these some things only with a

2041

01:11:42,630 --> 01:11:41,679

certain degree of certainty because you

2042

01:11:44,870 --> 01:11:42,640

can

2043

01:11:46,550 --> 01:11:44,880

often not insulate them from the parts

2044

01:11:48,950 --> 01:11:46,560

that you cannot predict because they are

2045

01:11:52,149 --> 01:11:48,960

computationally irreducible

2046

01:11:54,390 --> 01:11:52,159

in a universe that is played out and

2047

01:11:56,229 --> 01:11:54,400

implemented in a stateless language that

2048

01:11:58,229 --> 01:11:56,239

is a confusing property

2049

01:11:59,830 --> 01:11:58,239

because the cost of computation doesn't

2050

01:12:02,390 --> 01:11:59,840

play a role when you are in a stateless

2051

01:12:03,830 --> 01:12:02,400

universe in a stateful universe the

2052

01:12:06,070 --> 01:12:03,840

number of state transitions that your

2053

01:12:07,910 --> 01:12:06,080

model needs to make plays a suddenly a

2054

01:12:09,030 --> 01:12:07,920

certain role and

2055

01:12:11,590 --> 01:12:09,040

this

2056

01:12:13,590 --> 01:12:11,600

specter of computational irreducibly uh

2057

01:12:15,830 --> 01:12:13,600

dooms large it means that you cannot

2058

01:12:16,870 --> 01:12:15,840

compute things for practical reasons

2059

01:12:18,310 --> 01:12:16,880

because you don't have enough

2060

01:12:20,790 --> 01:12:18,320

information yet and you cannot have

2061

01:12:23,270 --> 01:12:20,800

information to make that prediction but

2062

01:12:25,350 --> 01:12:23,280

there is no deep miracle uh that is not

2063

01:12:27,910 --> 01:12:25,360

caused by the language when you discover

2064

01:12:30,229 --> 01:12:27,920

that the spectral gap problem is uh

2065

01:12:32,149 --> 01:12:30,239

incomputable so my question to donald

2066

01:12:34,070 --> 01:12:32,159

would be if you think that there is a

2067

01:12:35,350 --> 01:12:34,080

limit to computation that you can see

2068

01:12:36,870 --> 01:12:35,360

and previously

2069

01:12:39,110 --> 01:12:36,880

you would still do something and make

2070

01:12:40,870 --> 01:12:39,120

statements what is it that you use to

2071

01:12:42,149 --> 01:12:40,880

make statements beyond the limits of

2072

01:12:44,709 --> 01:12:42,159

computation

2073

01:12:46,790 --> 01:12:44,719

what parts of uh of your mind are you

2074

01:12:48,630 --> 01:12:46,800

drawing from when you make statements

2075

01:12:51,750 --> 01:12:48,640

beyond what a computational system can

2076

01:12:55,189 --> 01:12:53,270

right so

2077

01:12:57,270 --> 01:12:55,199

so well one way of

2078

01:12:59,270 --> 01:12:57,280

trying to focus this would be to

2079

01:13:00,229 --> 01:12:59,280

talk about the integers versus the real

2080

01:13:03,270 --> 01:13:00,239

numbers

2081

01:13:08,550 --> 01:13:03,280

so

2082

01:13:12,149 --> 01:13:10,470

do you think that

2083

01:13:13,990 --> 01:13:12,159

so so for example if we

2084

01:13:16,950 --> 01:13:14,000

look at just the set of all functions

2085

01:13:18,790 --> 01:13:16,960

from the integers to the integers right

2086

01:13:22,229 --> 01:13:18,800

it's trivial to show that that's not

2087

01:13:25,350 --> 01:13:23,830

so

2088

01:13:27,030 --> 01:13:25,360

yeah touring showed that the set of

2089

01:13:29,270 --> 01:13:27,040

computable functions is countable the

2090

01:13:31,030 --> 01:13:29,280

set of turing machines is countable

2091

01:13:35,030 --> 01:13:31,040

so

2092

01:13:36,950 --> 01:13:35,040

things very very concrete

2093

01:13:39,270 --> 01:13:36,960

the the set of all functions from the

2094

01:13:41,350 --> 01:13:39,280

integers to the integers isn't countable

2095

01:13:43,669 --> 01:13:41,360

the turing computable functions are

2096

01:13:45,350 --> 01:13:43,679

countable and so there's a sense in

2097

01:13:46,709 --> 01:13:45,360

which the turing computable functions

2098

01:13:48,709 --> 01:13:46,719

have measure zero

2099

01:13:51,030 --> 01:13:48,719

they have their probability zero on the

2100

01:13:53,990 --> 01:13:51,040

set of all of all functions

2101

01:13:55,669 --> 01:13:54,000

so do we want to conclude

2102

01:13:57,350 --> 01:13:55,679

from from this computationalist point of

2103

01:13:58,950 --> 01:13:57,360

view that

2104

01:14:01,590 --> 01:13:58,960

that all those other functions don't

2105

01:14:03,110 --> 01:14:01,600

exist with that that we're sort of

2106

01:14:06,390 --> 01:14:03,120

when i so you you're saying those

2107

01:14:07,590 --> 01:14:06,400

functions so so real numbers don't exist

2108

01:14:09,590 --> 01:14:07,600

real numbers

2109

01:14:11,110 --> 01:14:09,600

yes for something to exist it has to uh

2110

01:14:12,709 --> 01:14:11,120

be implemented

2111

01:14:14,149 --> 01:14:12,719

if it's something it's not implemented

2112

01:14:15,990 --> 01:14:14,159

anywhere it doesn't make sense to claim

2113

01:14:18,070 --> 01:14:16,000

that it exists i think it's a confusion

2114

01:14:19,830 --> 01:14:18,080

of the notion of existence to say that

2115

01:14:22,550 --> 01:14:19,840

something that is not implemented and is

2116

01:14:24,470 --> 01:14:22,560

not implementable could exist

2117

01:14:26,630 --> 01:14:24,480

the things that produce patterns that we

2118

01:14:28,550 --> 01:14:26,640

observe in order to exist and need to be

2119

01:14:30,550 --> 01:14:28,560

implemented right

2120

01:14:32,149 --> 01:14:30,560

so uh you could say does the financial

2121

01:14:34,149 --> 01:14:32,159

system exist well it exists to the

2122

01:14:35,990 --> 01:14:34,159

degree that it's implemented there are

2123

01:14:37,270 --> 01:14:36,000

some boundaries very projected and it's

2124

01:14:39,430 --> 01:14:37,280

not actually implemented where it

2125

01:14:41,669 --> 01:14:39,440

doesn't actually exist only in some

2126

01:14:43,669 --> 01:14:41,679

course approximation but by and large

2127

01:14:46,630 --> 01:14:43,679

something exists right some causal

2128

01:14:48,310 --> 01:14:46,640

structure is implemented here the set of

2129

01:14:50,229 --> 01:14:48,320

all the functions between the integers

2130

01:14:51,510 --> 01:14:50,239

is not implementable therefore it

2131

01:14:53,990 --> 01:14:51,520

doesn't exist

2132

01:14:56,310 --> 01:14:54,000

it's something that you can specify and

2133

01:14:58,470 --> 01:14:56,320

this difference between specification

2134

01:15:00,709 --> 01:14:58,480

and existence is something that is very

2135

01:15:02,310 --> 01:15:00,719

obvious to a computer scientist

2136

01:15:03,990 --> 01:15:02,320

and sometimes not obvious to a

2137

01:15:05,830 --> 01:15:04,000

traditional mathematician

2138

01:15:08,630 --> 01:15:05,840

there is stuff that you can specify that

2139

01:15:09,990 --> 01:15:08,640

makes no sense it is only specifiable in

2140

01:15:13,030 --> 01:15:10,000

your language but that's because your

2141

01:15:14,950 --> 01:15:13,040

language is much more permissible than

2142

01:15:17,110 --> 01:15:14,960

the set of things that can be uh can

2143

01:15:19,910 --> 01:15:17,120

exist and computation is less

2144

01:15:22,229 --> 01:15:19,920

permissible computation only permits you

2145

01:15:23,830 --> 01:15:22,239

to build things that can actually exist

2146

01:15:25,510 --> 01:15:23,840

if you can build things that cannot

2147

01:15:26,630 --> 01:15:25,520

exist it's a problem of your language in

2148

01:15:29,669 --> 01:15:26,640

which you're building things it's not a

2149

01:15:31,750 --> 01:15:29,679

problem of reality just confused

2150

01:15:34,390 --> 01:15:31,760

i have a comment this one's from

2151

01:15:36,790 --> 01:15:34,400

professor edward lee of berkeley and it

2152

01:15:38,390 --> 01:15:36,800

may provide some insight and you both

2153

01:15:39,990 --> 01:15:38,400

can tell us your thoughts on this so

2154

01:15:41,990 --> 01:15:40,000

this is from professor edward lee of

2155

01:15:43,750 --> 01:15:42,000

berkeley this question is a major theme

2156

01:15:46,310 --> 01:15:43,760

in the second half of my book plato and

2157

01:15:47,910 --> 01:15:46,320

the nerd utms so universal turing

2158

01:15:49,830 --> 01:15:47,920

machines have the following properties

2159

01:15:51,830 --> 01:15:49,840

number one their operation is a sequence

2160

01:15:53,350 --> 01:15:51,840

of discrete steps number two the data

2161

01:15:55,910 --> 01:15:53,360

comes from a countable set number three

2162

01:15:58,070 --> 01:15:55,920

that sequence terminates it is a huge

2163

01:16:01,030 --> 01:15:58,080

leap of faith to assume that physical

2164

01:16:03,669 --> 01:16:01,040

processes have any of these constraints

2165

01:16:06,070 --> 01:16:03,679

i show in plato and the nerd that the

2166

01:16:07,510 --> 01:16:06,080

hypothesis that physical processes all

2167

01:16:11,030 --> 01:16:07,520

have these properties is actually

2168

01:16:12,149 --> 01:16:11,040

untestable i remember earlier yosha you

2169

01:16:14,149 --> 01:16:12,159

mentioned that

2170

01:16:15,270 --> 01:16:14,159

if it's untestable and you can't provide

2171

01:16:16,470 --> 01:16:15,280

evidence for it then perhaps it

2172

01:16:18,310 --> 01:16:16,480

shouldn't be talked about so this

2173

01:16:19,830 --> 01:16:18,320

reminded me of this and he says in

2174

01:16:21,910 --> 01:16:19,840

brackets this follows from an

2175

01:16:23,750 --> 01:16:21,920

information theorem due to clochen and

2176

01:16:25,990 --> 01:16:23,760

known as the channel capacity theorem

2177

01:16:28,229 --> 01:16:26,000

the converse hypothesis that the

2178

01:16:31,030 --> 01:16:28,239

physical world is not so constrained is

2179

01:16:33,350 --> 01:16:31,040

also untestable by experiment but i

2180

01:16:35,430 --> 01:16:33,360

argue in plato and the nerd that the

2181

01:16:37,350 --> 01:16:35,440

converse hypothesis leads to simpler

2182

01:16:39,270 --> 01:16:37,360

models of the universe and therefore is

2183

01:16:41,030 --> 01:16:39,280

a better choice by outcomes razor my

2184

01:16:42,870 --> 01:16:41,040

claim is that universal turing machines

2185

01:16:45,030 --> 01:16:42,880

is realized on today's computers are

2186

01:16:47,189 --> 01:16:45,040

simulations quote-unquote of a process

2187

01:16:48,870 --> 01:16:47,199

that is fundamentally non-algorithmic so

2188

01:16:50,310 --> 01:16:48,880

i just want to place that out there and

2189

01:16:54,149 --> 01:16:50,320

perhaps you can use that as a jumping

2190

01:16:55,669 --> 01:16:54,159

off board donald and then yosha

2191

01:16:57,110 --> 01:16:55,679

very interesting i'll want to to read

2192

01:16:59,590 --> 01:16:57,120

that book and make sure i understand

2193

01:17:01,590 --> 01:16:59,600

what uh professor lee is saying that's

2194

01:17:02,550 --> 01:17:01,600

quite interesting so plato and the nerd

2195

01:17:04,070 --> 01:17:02,560

um

2196

01:17:06,390 --> 01:17:04,080

i'll be interviewing edward at some

2197

01:17:08,390 --> 01:17:06,400

point in the next few weeks as well

2198

01:17:09,830 --> 01:17:08,400

oh oh very good yeah that's that's

2199

01:17:10,870 --> 01:17:09,840

that's really quick because these are

2200

01:17:13,030 --> 01:17:10,880

very very

2201

01:17:14,709 --> 01:17:13,040

deep issues it seems to me that this

2202

01:17:16,390 --> 01:17:14,719

also interacts with what the physicists

2203

01:17:18,870 --> 01:17:16,400

are telling us that there is

2204

01:17:22,870 --> 01:17:18,880

no time fundamentally

2205

01:17:25,750 --> 01:17:22,880

so so if if time is not fundamental then

2206

01:17:27,990 --> 01:17:25,760

these computational issues where there

2207

01:17:32,950 --> 01:17:29,669

fundamental limits to what can be

2208

01:17:37,030 --> 01:17:32,960

computed because we're assuming time

2209

01:17:39,189 --> 01:17:37,040

a sequence of so in in computer

2210

01:17:41,990 --> 01:17:39,199

simulations computer algorithms

2211

01:17:44,149 --> 01:17:42,000

we're assuming

2212

01:17:45,910 --> 01:17:44,159

a sequence in time of computations that

2213

01:17:47,830 --> 01:17:45,920

can be and the kinds of limits that

2214

01:17:50,550 --> 01:17:47,840

yoshi's talking about

2215

01:17:52,950 --> 01:17:50,560

seems to me um

2216

01:17:55,430 --> 01:17:52,960

are a consequence of assuming time to be

2217

01:17:57,830 --> 01:17:55,440

fundamental and if we have to go to a

2218

01:18:00,310 --> 01:17:57,840

physics in which time is not fundamental

2219

01:18:01,590 --> 01:18:00,320

then that that places this whole our

2220

01:18:03,030 --> 01:18:01,600

whole conversation in a completely

2221

01:18:06,070 --> 01:18:03,040

different context

2222

01:18:09,669 --> 01:18:08,470

what we may be pointing to is

2223

01:18:12,310 --> 01:18:09,679

time has

2224

01:18:14,709 --> 01:18:12,320

been a very useful and helpful thing for

2225

01:18:16,390 --> 01:18:14,719

physics for several centuries and and

2226

01:18:17,590 --> 01:18:16,400

now the hard work that we have to do is

2227

01:18:19,270 --> 01:18:17,600

to understand

2228

01:18:21,110 --> 01:18:19,280

how to go beyond the notion of time and

2229

01:18:22,790 --> 01:18:21,120

when we go beyond the notion of time

2230

01:18:23,750 --> 01:18:22,800

well the kind of the discussion we're

2231

01:18:27,030 --> 01:18:23,760

having

2232

01:18:28,070 --> 01:18:27,040

right now we fundamentally revised um

2233

01:18:30,470 --> 01:18:28,080

the computational versus

2234

01:18:31,350 --> 01:18:30,480

non-computational notions we may have to

2235

01:18:34,070 --> 01:18:31,360

really

2236

01:18:35,750 --> 01:18:34,080

revise how our whole conversation here

2237

01:18:39,189 --> 01:18:35,760

is going i'd be very interested what

2238

01:18:43,990 --> 01:18:43,030

thank you also thanks edward lee for

2239

01:18:45,189 --> 01:18:44,000

your

2240

01:18:45,990 --> 01:18:45,199

argument

2241

01:19:07,510 --> 01:18:46,000

i

2242

01:19:09,669 --> 01:19:07,520

steps

2243

01:19:12,310 --> 01:19:09,679

may be a mistake in the sense in which

2244

01:19:15,510 --> 01:19:12,320

two machines were originally defined

2245

01:19:17,510 --> 01:19:15,520

so basically a computer that can be

2246

01:19:18,630 --> 01:19:17,520

built is not a turing machine in this

2247

01:19:21,510 --> 01:19:18,640

sense but

2248

01:19:24,470 --> 01:19:21,520

it's always a finite state machine

2249

01:19:27,669 --> 01:19:24,480

and in a finite state machine you can

2250

01:19:29,750 --> 01:19:27,679

have a number of steps uh sequence of

2251

01:19:31,590 --> 01:19:29,760

steps that is unbounded that doesn't

2252

01:19:33,910 --> 01:19:31,600

stop and that gives you more and more

2253

01:19:36,630 --> 01:19:33,920

digits of pi while you're looking at in

2254

01:19:38,470 --> 01:19:36,640

a sense it doesn't come to a conclusion

2255

01:19:40,630 --> 01:19:38,480

if you want to compute physics but it's

2256

01:19:42,470 --> 01:19:40,640

not the problem to build a computer that

2257

01:19:43,830 --> 01:19:42,480

as long as it runs gives you more digits

2258

01:19:45,910 --> 01:19:43,840

of pi

2259

01:19:47,669 --> 01:19:45,920

and so i think from a formal perspective

2260

01:19:49,669 --> 01:19:47,679

or from an uh it doesn't make much of a

2261

01:19:51,189 --> 01:19:49,679

difference because you can easily fix it

2262

01:19:52,870 --> 01:19:51,199

but it's important

2263

01:19:54,390 --> 01:19:52,880

if you think about your intuitions about

2264

01:19:57,830 --> 01:19:54,400

how things work or the proofs that you

2265

01:19:59,990 --> 01:19:57,840

make in other contexts that the value of

2266

01:20:02,229 --> 01:20:00,000

computation doesn't hinge on there being

2267

01:20:04,229 --> 01:20:02,239

a finite number of steps until a

2268

01:20:05,750 --> 01:20:04,239

computation that is going to give you a

2269

01:20:09,110 --> 01:20:05,760

result that was formulated classical

2270

01:20:10,950 --> 01:20:09,120

mathematics terminates but that it means

2271

01:20:14,470 --> 01:20:10,960

that everything that you get is the

2272

01:20:16,629 --> 01:20:14,480

result of finite interactions

2273

01:20:18,870 --> 01:20:16,639

and if you assume that infinite

2274

01:20:20,629 --> 01:20:18,880

interactions are possible you run into

2275

01:20:22,470 --> 01:20:20,639

the difficulties that girdle and turing

2276

01:20:24,390 --> 01:20:22,480

has have discovered which means that

2277

01:20:25,910 --> 01:20:24,400

your theories no longer work they no

2278

01:20:29,350 --> 01:20:25,920

longer make sense

2279

01:20:30,950 --> 01:20:29,360

and uh different from edward and maybe

2280

01:20:32,870 --> 01:20:30,960

doing him in justice here i haven't read

2281

01:20:33,910 --> 01:20:32,880

this book um

2282

01:20:36,550 --> 01:20:33,920

so

2283

01:20:38,229 --> 01:20:36,560

i would say that it's much more elegant

2284

01:20:39,669 --> 01:20:38,239

from the perspective how comes razer to

2285

01:20:41,270 --> 01:20:39,679

describe reality in a language that

2286

01:20:43,030 --> 01:20:41,280

doesn't break

2287

01:20:45,189 --> 01:20:43,040

because if your language breaks and you

2288

01:20:46,470 --> 01:20:45,199

still try to make a

2289

01:20:48,870 --> 01:20:46,480

model of reality it's going to be

2290

01:20:51,030 --> 01:20:48,880

arbitrarily expensive it doesn't work

2291

01:20:53,270 --> 01:20:51,040

you have to find a language that works

2292

01:20:55,590 --> 01:20:53,280

so if we find that the languages in

2293

01:20:57,510 --> 01:20:55,600

which we can describe reality have to be

2294

01:20:59,910 --> 01:20:57,520

computational languages because the

2295

01:21:01,590 --> 01:20:59,920

others lead into contradictions then we

2296

01:21:03,189 --> 01:21:01,600

have to use the computational languages

2297

01:21:05,830 --> 01:21:03,199

that's the situation that i find myself

2298

01:21:07,510 --> 01:21:05,840

to be in this doesn't mean that i can

2299

01:21:09,110 --> 01:21:07,520

know what physics is like it just means

2300

01:21:11,270 --> 01:21:09,120

that all the physics that i can talk

2301

01:21:14,390 --> 01:21:11,280

about without my language breaking

2302

01:21:17,030 --> 01:21:14,400

has to play out in this way

2303

01:21:19,830 --> 01:21:17,040

and the notion of what is time so coming

2304

01:21:22,070 --> 01:21:19,840

back to donald is uh is very important

2305

01:21:24,709 --> 01:21:22,080

that there are two notions of time one

2306

01:21:27,189 --> 01:21:24,719

is this intuitive notion that we have as

2307

01:21:29,669 --> 01:21:27,199

human beings which is

2308

01:21:31,189 --> 01:21:29,679

basically this newtonian time this uh

2309

01:21:32,790 --> 01:21:31,199

time which uh

2310

01:21:34,629 --> 01:21:32,800

where clocks run the same speed

2311

01:21:36,709 --> 01:21:34,639

everywhere and so on and that describes

2312

01:21:39,990 --> 01:21:36,719

the transition of the universe from the

2313

01:21:40,790 --> 01:21:40,000

past into the future via the present

2314

01:21:42,950 --> 01:21:40,800

and

2315

01:21:44,950 --> 01:21:42,960

this notion of time is somewhat similar

2316

01:21:47,030 --> 01:21:44,960

to the notion of the straight state

2317

01:21:48,470 --> 01:21:47,040

transition in your computer

2318

01:21:50,229 --> 01:21:48,480

except that the state transition in a

2319

01:21:51,910 --> 01:21:50,239

computer has some kind of global clock

2320

01:21:54,550 --> 01:21:51,920

where everything in the computer goes

2321

01:21:56,629 --> 01:21:54,560

from state to state all at once and goes

2322

01:21:58,390 --> 01:21:56,639

progresses to the next step but what we

2323

01:22:01,189 --> 01:21:58,400

see in our universe that it only makes

2324

01:22:02,629 --> 01:22:01,199

sense if we assume that it's dynamic

2325

01:22:04,709 --> 01:22:02,639

if the universe would just be a

2326
01:22:06,709 --> 01:22:04,719
decoupled sequence of states without a

2327
01:22:08,470 --> 01:22:06,719
transition function there would not be

2328
01:22:10,790 --> 01:22:08,480
any law that we can discover there is

2329
01:22:12,390 --> 01:22:10,800
nothing that we can control organisms

2330
01:22:14,229 --> 01:22:12,400
would not exist in the way in which they

2331
01:22:16,229 --> 01:22:14,239
do so the

2332
01:22:17,830 --> 01:22:16,239
from the observations that we make we

2333
01:22:19,830 --> 01:22:17,840
have to assume that the transitions in

2334
01:22:21,990 --> 01:22:19,840
the universe are somehow fundamental

2335
01:22:24,470 --> 01:22:22,000
that the universe is moving

2336
01:22:25,990 --> 01:22:24,480
and state transitions seem to be crucial

2337
01:22:28,070 --> 01:22:26,000
in order to be able to understand the

2338
01:22:29,830 --> 01:22:28,080

universe that there is some notion of

2339

01:22:32,550 --> 01:22:29,840

transition and this notion of transition

2340

01:22:33,350 --> 01:22:32,560

is much more basic than time

2341

01:22:35,270 --> 01:22:33,360

and

2342

01:22:37,110 --> 01:22:35,280

the time that we are talking about when

2343

01:22:38,950 --> 01:22:37,120

we see that time is not fundamental in

2344

01:22:39,750 --> 01:22:38,960

the notion of space-time is relativistic

2345

01:22:43,750 --> 01:22:39,760

time

2346

01:22:45,510 --> 01:22:43,760

universe looks like to a relativistic

2347

01:22:47,590 --> 01:22:45,520

observer

2348

01:22:49,910 --> 01:22:47,600

and we can obtain relativistic time if

2349

01:22:52,390 --> 01:22:49,920

we understand that

2350

01:22:53,990 --> 01:22:52,400

what we perceive as time is basically

2351

01:22:55,990 --> 01:22:54,000

the speed of the clocks in our

2352

01:22:57,430 --> 01:22:56,000

environment

2353

01:23:00,390 --> 01:22:57,440

and the speed of the clocks that we

2354

01:23:02,470 --> 01:23:00,400

observe depend on our own speed

2355

01:23:05,030 --> 01:23:02,480

so if i move you through the universe

2356

01:23:06,870 --> 01:23:05,040

and you are a supervision pattern on the

2357

01:23:09,910 --> 01:23:06,880

structure of the universe imagine the

2358

01:23:12,790 --> 01:23:09,920

universe is something like an ocean

2359

01:23:15,590 --> 01:23:12,800

and the present is the crest of a

2360

01:23:16,470 --> 01:23:15,600

traveling wave through that ocean

2361

01:23:17,669 --> 01:23:16,480

and

2362

01:23:19,910 --> 01:23:17,679

there are

2363

01:23:21,510 --> 01:23:19,920

waves maybe in front and behind us but

2364

01:23:23,910 --> 01:23:21,520

they're not our future the past they're

2365

01:23:26,310 --> 01:23:23,920

different universes that just happen to

2366

01:23:28,229 --> 01:23:26,320

be a little more along a bit less along

2367

01:23:29,669 --> 01:23:28,239

the future and past would require you to

2368

01:23:30,950 --> 01:23:29,679

leave the crest of the wave and you

2369

01:23:32,629 --> 01:23:30,960

can't because you're always traveling

2370

01:23:35,189 --> 01:23:32,639

with the wave

2371

01:23:36,950 --> 01:23:35,199

so there is no way to leave that present

2372

01:23:39,189 --> 01:23:36,960

because only the present exists from the

2373

01:23:41,510 --> 01:23:39,199

perspective of that crest and you or me

2374

01:23:44,390 --> 01:23:41,520

we are vortices and scraped

2375

01:23:45,910 --> 01:23:44,400

on the crest of that traveling wave

2376

01:23:47,669 --> 01:23:45,920

and the

2377

01:23:49,590 --> 01:23:47,679

rotation that the vortex is doing when

2378

01:23:51,430 --> 01:23:49,600

it updates itself to observe the

2379

01:23:53,590 --> 01:23:51,440

universe to form a memory and so on and

2380

01:23:55,270 --> 01:23:53,600

to register its perceptions and so on

2381

01:23:57,189 --> 01:23:55,280

will depend on the speed in which this

2382

01:23:58,229 --> 01:23:57,199

vortex rotates

2383

01:24:00,950 --> 01:23:58,239

right

2384

01:24:03,030 --> 01:24:00,960

and so if the vortex is moving along

2385

01:24:05,430 --> 01:24:03,040

with the wave then the updates in the

2386

01:24:07,590 --> 01:24:05,440

vortex are a function of the movement in

2387

01:24:09,990 --> 01:24:07,600

the wave itself the basic parasitize on

2388

01:24:12,470 --> 01:24:10,000

the movement of the main wave

2389

01:24:14,149 --> 01:24:12,480

and you can not as this vortex traveling

2390

01:24:15,910 --> 01:24:14,159

with the wave ever leave the wave you

2391

01:24:18,390 --> 01:24:15,920

can move a little bit in this in the

2392

01:24:20,550 --> 01:24:18,400

wave to the left or to the right

2393

01:24:22,390 --> 01:24:20,560

that is moving to the left or the right

2394

01:24:25,189 --> 01:24:22,400

would be movement in space you cannot

2395

01:24:27,110 --> 01:24:25,199

move in time you just move this the time

2396

01:24:29,430 --> 01:24:27,120

right and the faster you move to the

2397

01:24:31,510 --> 01:24:29,440

left or to the right the less there will

2398

01:24:33,830 --> 01:24:31,520

be updates available for in turning your

2399

01:24:35,510 --> 01:24:33,840

internal state

2400

01:24:36,390 --> 01:24:35,520

so the fluctuations of the vortex

2401
01:24:38,870 --> 01:24:36,400
becomes

2402
01:24:40,550 --> 01:24:38,880
slower and slower the more the vortex

2403
01:24:42,470 --> 01:24:40,560
moves in space and this leads to

2404
01:24:43,669 --> 01:24:42,480
relativistic time it means that from the

2405
01:24:45,350 --> 01:24:43,679
perspective

2406
01:24:46,629 --> 01:24:45,360
of the vortex when it looks at its

2407
01:24:49,110 --> 01:24:46,639
environment the environment gets

2408
01:24:50,870 --> 01:24:49,120
distorted in time and space

2409
01:24:52,709 --> 01:24:50,880
so in this notion we realize why

2410
01:24:54,229 --> 01:24:52,719
something would look like to a vertex

2411
01:24:56,149 --> 01:24:54,239
that moves like this

2412
01:24:58,470 --> 01:24:56,159
like relativistic time and we understand

2413
01:25:00,390 --> 01:24:58,480

that the relativistic time from the

2414

01:25:02,070 --> 01:25:00,400

fundamental perspective how to make all

2415

01:25:04,070 --> 01:25:02,080

this happening how to build a system

2416

01:25:05,350 --> 01:25:04,080

that functions like this cannot be

2417

01:25:08,149 --> 01:25:05,360

fundamental

2418

01:25:09,830 --> 01:25:08,159

it's a result to the observer it will be

2419

01:25:11,830 --> 01:25:09,840

what the universe looks like to the

2420

01:25:13,350 --> 01:25:11,840

observer of the observer screens as we

2421

01:25:15,350 --> 01:25:13,360

always do

2422

01:25:17,750 --> 01:25:15,360

right but it is not fundamental but

2423

01:25:19,750 --> 01:25:17,760

fundamental are the state transitions

2424

01:25:22,229 --> 01:25:19,760

so what we need to do is basically

2425

01:25:24,470 --> 01:25:22,239

replace the physical this time that is

2426

01:25:25,990 --> 01:25:24,480

relativistic for good reason in the

2427

01:25:28,390 --> 01:25:26,000

frame of certain models by something

2428

01:25:30,470 --> 01:25:28,400

that is more fundamental and allows us

2429

01:25:33,750 --> 01:25:30,480

to derive the relativistic time and this

2430

01:25:38,149 --> 01:25:36,229

very very interesting there's some

2431

01:25:39,510 --> 01:25:38,159

in that spirit um or at least in that

2432

01:25:42,310 --> 01:25:39,520

kind of direction there's

2433

01:25:44,149 --> 01:25:42,320

work by marcus mueller and and philip

2434

01:25:46,950 --> 01:25:44,159

hone

2435

01:25:49,110 --> 01:25:46,960

and and then also some some more recent

2436

01:25:51,830 --> 01:25:49,120

work um

2437

01:25:53,030 --> 01:25:51,840

by fabio mercadi and um

2438

01:25:54,790 --> 01:25:53,040

and giovanni

2439

01:25:56,310 --> 01:25:54,800

emelina camilla

2440

01:25:59,110 --> 01:25:56,320

where where they're

2441

01:26:00,550 --> 01:25:59,120

showing how relativistic space times can

2442

01:26:02,310 --> 01:26:00,560

be

2443

01:26:04,550 --> 01:26:02,320

constructed

2444

01:26:06,390 --> 01:26:04,560

from exchange of quantum information so

2445

01:26:08,709 --> 01:26:06,400

you don't assume it up front but you try

2446

01:26:10,310 --> 01:26:08,719

to get a dictionary

2447

01:26:12,470 --> 01:26:10,320

to that allows

2448

01:26:14,870 --> 01:26:12,480

different uh

2449

01:26:17,030 --> 01:26:14,880

quantum

2450

01:26:19,110 --> 01:26:17,040

agents to send information back and

2451

01:26:21,030 --> 01:26:19,120

forth and it turns out if you send

2452

01:26:22,390 --> 01:26:21,040

enough information back and forth

2453

01:26:24,229 --> 01:26:22,400

and try to set up a dictionary to make

2454

01:26:25,510 --> 01:26:24,239

everything consistent you will get

2455

01:26:27,910 --> 01:26:25,520

einstein's

2456

01:26:29,669 --> 01:26:27,920

special relativistic um space time

2457

01:26:30,550 --> 01:26:29,679

coming out of it so that's that that's

2458

01:26:32,470 --> 01:26:30,560

that's

2459

01:26:33,510 --> 01:26:32,480

an interesting direction

2460

01:26:35,669 --> 01:26:33,520

to go

2461

01:26:37,430 --> 01:26:35,679

um another

2462

01:26:40,870 --> 01:26:37,440

interesting direction

2463

01:26:43,270 --> 01:26:40,880

to think about one just a simple notion

2464

01:26:48,070 --> 01:26:43,280

time and entropy are

2465

01:26:50,629 --> 01:26:48,080

are deeply connected

2466

01:26:53,990 --> 01:26:50,639

and so we would like to have some way of

2467

01:26:56,149 --> 01:26:54,000

getting entropic time coming out of

2468

01:26:58,149 --> 01:26:56,159

a deeper system in which there is no

2469

01:26:59,830 --> 01:26:58,159

entropic time right

2470

01:27:01,750 --> 01:26:59,840

and there is a

2471

01:27:03,510 --> 01:27:01,760

i'm not saying this is the deepest way

2472

01:27:05,510 --> 01:27:03,520

of doing it but an interesting simple

2473

01:27:07,669 --> 01:27:05,520

way just in the case of markovian

2474

01:27:09,669 --> 01:27:07,679

dynamics so if i have a

2475

01:27:10,550 --> 01:27:09,679

a markovian system

2476

01:27:12,950 --> 01:27:10,560

um

2477

01:27:15,110 --> 01:27:12,960

homogeneous

2478

01:27:17,430 --> 01:27:15,120

and it's in a stationary

2479

01:27:19,270 --> 01:27:17,440

then the entropy of that system doesn't

2480

01:27:23,270 --> 01:27:19,280

change so

2481

01:27:27,030 --> 01:27:23,280

if if for state $x_{sub n}$ and x_{n-1}

2482

01:27:30,550 --> 01:27:27,040

and so forth the entropy h of x of n

2483

01:27:35,189 --> 01:27:30,560

equals h of $x_{sub n-1}$ for all n

2484

01:27:36,310 --> 01:27:35,199

so you so there is no entropic time

2485

01:27:38,149 --> 01:27:36,320

but

2486

01:27:39,590 --> 01:27:38,159

it's trivial to prove

2487

01:27:41,830 --> 01:27:39,600

that if you just do a simple

2488

01:27:43,990 --> 01:27:41,840

conditioning if i if i look at

2489

01:27:46,709 --> 01:27:44,000

xn given x1

2490

01:27:47,590 --> 01:27:46,719

or x yeah x n given but then it turns

2491

01:27:48,470 --> 01:27:47,600

out

2492

01:27:49,910 --> 01:27:48,480

that

2493

01:27:52,390 --> 01:27:49,920

h of x n

2494

01:27:55,350 --> 01:27:52,400

given x one is greater than or equal to

2495

01:27:56,870 --> 01:27:55,360

h of x n given x n minus one

2496

01:27:59,510 --> 01:27:56,880

in other words

2497

01:28:01,990 --> 01:27:59,520

the very fact of and

2498

01:28:03,750 --> 01:28:02,000

doing conditioning which is projection

2499

01:28:05,590 --> 01:28:03,760

so you can think about

2500

01:28:07,350 --> 01:28:05,600

i take this

2501

01:28:08,950 --> 01:28:07,360

dynamical system

2502

01:28:11,270 --> 01:28:08,960

which has a notion of state transition

2503

01:28:13,189 --> 01:28:11,280

it's a markov chain

2504

01:28:15,350 --> 01:28:13,199

but it doesn't have any entropic time

2505

01:28:17,270 --> 01:28:15,360

but as soon as you start projecting that

2506

01:28:19,270 --> 01:28:17,280

that non-entropic system onto different

2507

01:28:21,350 --> 01:28:19,280

perspectives by

2508

01:28:24,470 --> 01:28:21,360

by conditioning like h of x given x

2509

01:28:26,070 --> 01:28:24,480

one all of a sudden now you have entropy

2510

01:28:28,070 --> 01:28:26,080

and so now you have that kind of notion

2511

01:28:29,270 --> 01:28:28,080

of time so so is that a direction that

2512

01:28:32,390 --> 01:28:29,280

we could go

2513

01:28:33,910 --> 01:28:32,400

where where we could still have

2514

01:28:36,709 --> 01:28:33,920

in some sense a dynamical system but

2515

01:28:40,310 --> 01:28:36,719

it's not an entropic time system

2516

01:28:42,550 --> 01:28:40,320

and and show how we get space time

2517

01:28:44,229 --> 01:28:42,560

arising from that in in the way that you

2518

01:28:46,790 --> 01:28:44,239

know that some of these businesses are

2519

01:28:49,270 --> 01:28:46,800

trying to do i i think that will be

2520

01:28:50,950 --> 01:28:49,280

be interesting i think that it's a

2521

01:28:54,550 --> 01:28:50,960

separate question whether the real

2522

01:28:56,390 --> 01:28:54,560

numbers exist versus right that's

2523

01:28:58,229 --> 01:28:56,400

it's a it's a pretty strong statement to

2524

01:29:00,550 --> 01:28:58,239

say that real numbers don't exist that's

2525

01:29:02,550 --> 01:29:00,560

that's really quite interesting

2526

01:29:04,470 --> 01:29:02,560

to say that they don't exist

2527

01:29:05,910 --> 01:29:04,480

but i guess that that's where you want

2528

01:29:08,390 --> 01:29:05,920

to go anyway

2529

01:29:11,030 --> 01:29:08,400

yeah well i agree with categorized that

2530

01:29:13,110 --> 01:29:11,040

real numbers don't exist and the time

2531

01:29:15,110 --> 01:29:13,120

was not right back then so real numbers

2532

01:29:16,470 --> 01:29:15,120

are actually functions

2533

01:29:17,990 --> 01:29:16,480

and you can

2534

01:29:19,990 --> 01:29:18,000

can give you this function instead of a

2535

01:29:22,070 --> 01:29:20,000

real number and it can give you as many

2536

01:29:25,110 --> 01:29:22,080

digits as you want or as you can afford

2537

01:29:28,229 --> 01:29:25,120

to compute but this is it it's fine

2538

01:29:31,270 --> 01:29:28,239

so basically real numbers uh can be

2539

01:29:33,270 --> 01:29:31,280

derived in a deterministic fashion they

2540

01:29:35,430 --> 01:29:33,280

are determined once uh they are

2541

01:29:38,310 --> 01:29:35,440

predetermined in the sense

2542

01:29:40,229 --> 01:29:38,320

but uh you will not know the billions

2543

01:29:43,110 --> 01:29:40,239

digit of

2544

01:29:45,830 --> 01:29:43,120

the square root of two unless you find a

2545

01:29:47,189 --> 01:29:45,840

procedure to compute it and uh the

2546

01:29:49,030 --> 01:29:47,199

energy

2547

01:29:50,229 --> 01:29:49,040

for the neck entropy

2548

01:29:51,590 --> 01:29:50,239

to

2549

01:29:53,750 --> 01:29:51,600

actually get there

2550

01:29:57,510 --> 01:29:53,760

and this derivation of

2551
01:29:59,750 --> 01:29:57,520
a result via using upnic entropy i think

2552
01:30:01,430 --> 01:29:59,760
relates to our perception of time this

2553
01:30:03,350 --> 01:30:01,440
causal error of time which is aligned

2554
01:30:05,990 --> 01:30:03,360
with the entropic arrow

2555
01:30:08,229 --> 01:30:06,000
eric thresher finds a very good metaphor

2556
01:30:11,350 --> 01:30:08,239
in his book good and real i think to

2557
01:30:12,310 --> 01:30:11,360
give an intuition how a symmetric system

2558
01:30:14,149 --> 01:30:12,320
um

2559
01:30:15,510 --> 01:30:14,159
where the transitions are symmetric in

2560
01:30:16,550 --> 01:30:15,520
both directions

2561
01:30:18,149 --> 01:30:16,560
is still

2562
01:30:20,070 --> 01:30:18,159
not going to be

2563
01:30:22,790 --> 01:30:20,080

symmetric at scale when you look at it

2564

01:30:25,910 --> 01:30:22,800

so it digs as an example a well that is

2565

01:30:28,629 --> 01:30:25,920

made of large and small billiard balls

2566

01:30:31,669 --> 01:30:28,639

and did you put one of these billiard

2567

01:30:33,189 --> 01:30:31,679

balls in motion and uh the transaction

2568

01:30:35,830 --> 01:30:33,199

between the little balls are also

2569

01:30:38,390 --> 01:30:35,840

magical which means if you take a movie

2570

01:30:40,149 --> 01:30:38,400

and you play it forward and backward

2571

01:30:42,310 --> 01:30:40,159

you will see for the every interaction

2572

01:30:44,470 --> 01:30:42,320

between two billiard balls that it's the

2573

01:30:46,390 --> 01:30:44,480

same if you go the movie backwards or

2574

01:30:49,189 --> 01:30:46,400

forwards it's a simplified model where

2575

01:30:52,310 --> 01:30:49,199

you have no friction and so we have no

2576

01:30:53,590 --> 01:30:52,320

thermodynamic uh stuff going on we look

2577

01:30:55,830 --> 01:30:53,600

at the universe at the level where

2578

01:30:57,830 --> 01:30:55,840

thermodynamics doesn't exist yet because

2579

01:31:00,070 --> 01:30:57,840

this maybe the staff is too small to

2580

01:31:01,910 --> 01:31:00,080

have these losses right so we just look

2581

01:31:04,390 --> 01:31:01,920

at the billiard ball universe where

2582

01:31:07,669 --> 01:31:04,400

everything is deterministic and without

2583

01:31:09,990 --> 01:31:07,679

noise and in this model what we see is

2584

01:31:11,990 --> 01:31:10,000

that when we zoom out there is something

2585

01:31:13,990 --> 01:31:12,000

that is happening

2586

01:31:14,830 --> 01:31:14,000

at scale and that is

2587

01:31:17,750 --> 01:31:14,840

some

2588

01:31:20,950 --> 01:31:17,760

balls move after they have been hit and

2589

01:31:22,870 --> 01:31:20,960

keep moving hitting other balls

2590

01:31:24,950 --> 01:31:22,880

and there are if you play the movie

2591

01:31:26,470 --> 01:31:24,960

backwards it looks as if some balls are

2592

01:31:29,590 --> 01:31:26,480

anticipating that they are going to be

2593

01:31:31,350 --> 01:31:29,600

soon hit and start moving

2594

01:31:33,830 --> 01:31:31,360

as a result as if they would be hit

2595

01:31:35,830 --> 01:31:33,840

right so there is this asymmetry that uh

2596

01:31:37,669 --> 01:31:35,840

your balls leave a wake

2597

01:31:39,590 --> 01:31:37,679

behind them

2598

01:31:42,390 --> 01:31:39,600

and this vague

2599

01:31:44,149 --> 01:31:42,400

is describing in some sense the entropy

2600

01:31:46,070 --> 01:31:44,159

that we are looking at in our universe

2601
01:31:48,390 --> 01:31:46,080
that's the direction in which you can as

2602
01:31:50,470 --> 01:31:48,400
an embedded observer for memories

2603
01:31:52,709 --> 01:31:50,480
because in order to form memories you

2604
01:31:55,030 --> 01:31:52,719
rely on the dissipation of information

2605
01:31:56,550 --> 01:31:55,040
between locations

2606
01:31:58,790 --> 01:31:56,560
and so whenever

2607
01:32:00,229 --> 01:31:58,800
there is a way to form memories it means

2608
01:32:02,149 --> 01:32:00,239
that you are aligned with some kind of

2609
01:32:04,070 --> 01:32:02,159
entropic arrow

2610
01:32:05,990 --> 01:32:04,080
if you zoom out it means that you can

2611
01:32:07,430 --> 01:32:06,000
now sort the states of the universe in

2612
01:32:09,510 --> 01:32:07,440
such a way that you discover the

2613
01:32:11,189 --> 01:32:09,520

concentric wave that you are that you

2614

01:32:13,030 --> 01:32:11,199

are part of in our

2615

01:32:15,110 --> 01:32:13,040

ocean-like universe

2616

01:32:16,550 --> 01:32:15,120

has a point of origin

2617

01:32:18,229 --> 01:32:16,560

and this point of origin is a

2618

01:32:19,990 --> 01:32:18,239

construction that you make you discover

2619

01:32:22,550 --> 01:32:20,000

this by the wave expanding and you

2620

01:32:25,270 --> 01:32:22,560

discover it by information

2621

01:32:27,590 --> 01:32:25,280

moving diffusing across the locations in

2622

01:32:29,669 --> 01:32:27,600

the wave so there is a hypothetical

2623

01:32:30,790 --> 01:32:29,679

point

2624

01:32:32,790 --> 01:32:30,800

in the middle

2625

01:32:35,110 --> 01:32:32,800

where the information is not diffused

2626

01:32:40,470 --> 01:32:37,430

and this hypothetical point is what we

2627

01:32:42,709 --> 01:32:40,480

imagine to be the big bang

2628

01:32:44,870 --> 01:32:42,719

right and it's a mathematical

2629

01:32:45,990 --> 01:32:44,880

singularity in a way because if you are

2630

01:32:47,830 --> 01:32:46,000

in the big bang you don't know which

2631

01:32:50,470 --> 01:32:47,840

direction to go unless the big bang is

2632

01:32:52,229 --> 01:32:50,480

not completely perfect and symmetrical

2633

01:32:55,270 --> 01:32:52,239

and the interesting thing about this

2634

01:32:57,430 --> 01:32:55,280

before the big bang means uh it's it's

2635

01:32:59,350 --> 01:32:57,440

the wrong question to ask because before

2636

01:33:01,910 --> 01:32:59,360

the big bang if you it looked like it is

2637

01:33:03,750 --> 01:33:01,920

like a more rape pattern

2638

01:33:05,990 --> 01:33:03,760

this would be the point where the

2639

01:33:08,229 --> 01:33:06,000

information goes out of a distribution

2640

01:33:10,709 --> 01:33:08,239

or gets distributed or diffuses between

2641

01:33:13,430 --> 01:33:10,719

locations in the other direction every

2642

01:33:15,750 --> 01:33:13,440

point of every trajectory that goes away

2643

01:33:17,350 --> 01:33:15,760

from the big bang goes into a future

2644

01:33:18,870 --> 01:33:17,360

sorry to interrupt is this related to

2645

01:33:20,790 --> 01:33:18,880

the janus point

2646

01:33:21,669 --> 01:33:20,800

have you heard of julian barber's theory

2647

01:33:23,350 --> 01:33:21,679

of time

2648

01:33:27,110 --> 01:33:23,360

no

2649

01:33:29,430 --> 01:33:27,120

certain description basically we create

2650

01:33:31,270 --> 01:33:29,440

a certain mental model in which we

2651
01:33:34,470 --> 01:33:31,280
describe the

2652
01:33:36,390 --> 01:33:34,480
entropic era of time as the diffusion of

2653
01:33:38,709 --> 01:33:36,400
information across locations in the

2654
01:33:40,790 --> 01:33:38,719
universe and then we imagine that there

2655
01:33:42,390 --> 01:33:40,800
is a single point where this ends up and

2656
01:33:44,870 --> 01:33:42,400
we go through this point on the other

2657
01:33:47,430 --> 01:33:44,880
side we go back into another future

2658
01:33:49,430 --> 01:33:47,440
so so the further we go away from this

2659
01:33:51,510 --> 01:33:49,440
point in any direction the further we go

2660
01:33:53,910 --> 01:33:51,520
into a future in which systems could

2661
01:33:55,510 --> 01:33:53,920
form memories of the past and to form

2662
01:33:57,510 --> 01:33:55,520
memories of the past you need to have

2663
01:33:59,430 --> 01:33:57,520

some kind of reservoir of neck entropy

2664

01:34:01,830 --> 01:33:59,440

that you can tap and some kind of puddle

2665

01:34:04,229 --> 01:34:01,840

of neck entropy and then you can reason

2666

01:34:06,870 --> 01:34:04,239

about the conditions uh how such puddles

2667

01:34:08,790 --> 01:34:06,880

of neck entropy could form under which

2668

01:34:10,470 --> 01:34:08,800

conditions and how long they might last

2669

01:34:12,310 --> 01:34:10,480

i would like to get to the topic of free

2670

01:34:14,550 --> 01:34:12,320

will as well and then also some audience

2671

01:34:19,110 --> 01:34:14,560

questions so why don't you donald

2672

01:34:25,270 --> 01:34:20,470

okay uh

2673

01:34:25,280 --> 01:34:28,229

if

2674

01:34:32,790 --> 01:34:30,709

in a physicalist framework

2675

01:34:34,149 --> 01:34:32,800

which i so now i'll just talk about what

2676

01:34:37,189 --> 01:34:34,159

most of my

2677

01:34:39,990 --> 01:34:37,199

cognitive neuroscience peers think right

2678

01:34:41,750 --> 01:34:40,000

most of them assume that that physical

2679

01:34:43,750 --> 01:34:41,760

systems are fundamental

2680

01:34:45,830 --> 01:34:43,760

neural activity causes

2681

01:34:47,109 --> 01:34:45,840

um all of our behavior

2682

01:34:50,149 --> 01:34:47,119

and

2683

01:34:52,310 --> 01:34:50,159

in in that case um

2684

01:34:55,350 --> 01:34:52,320

there can be a a fiction of

2685

01:34:56,709 --> 01:34:55,360

a useful fiction of of free will but but

2686

01:34:59,189 --> 01:34:56,719

it's really just going to be a useful

2687

01:35:01,669 --> 01:34:59,199

fiction if i do something it's really my

2688

01:35:03,590 --> 01:35:01,679

neurons with the neural activity

2689

01:35:06,310 --> 01:35:03,600

that that did it and

2690

01:35:08,229 --> 01:35:06,320

um there is a sense in which you can say

2691

01:35:10,229 --> 01:35:08,239

i chose to do it because actually

2692

01:35:12,149 --> 01:35:10,239

neurons are part of me so i

2693

01:35:14,470 --> 01:35:12,159

i think that's the point of view that

2694

01:35:15,270 --> 01:35:14,480

dan dennett takes for example on this

2695

01:35:21,750 --> 01:35:15,280

and

2696

01:35:23,109 --> 01:35:21,760

that he says well yeah i also grill my

2697

01:35:25,910 --> 01:35:23,119

fingernails i'm not sure that i'm doing

2698

01:35:28,149 --> 01:35:25,920

that by free will but you know what

2699

01:35:29,510 --> 01:35:28,159

so so it's not real clear that just

2700

01:35:31,030 --> 01:35:29,520

because my neurons are doing it i have

2701

01:35:32,790 --> 01:35:31,040

free will just in the same sense that i

2702

01:35:34,870 --> 01:35:32,800

don't i'm not using free will to grow my

2703

01:35:35,910 --> 01:35:34,880

my my fingernails

2704

01:35:37,910 --> 01:35:35,920

um

2705

01:35:41,990 --> 01:35:37,920

so

2706

01:35:43,430 --> 01:35:42,000

as as free will if you're a physicist

2707

01:35:45,750 --> 01:35:43,440

dan dennett would say i'm a physicist

2708

01:35:46,950 --> 01:35:45,760

and there is this important notion of

2709

01:35:51,270 --> 01:35:46,960

free will

2710

01:35:54,950 --> 01:35:52,950

i i think that of course space time

2711

01:35:57,270 --> 01:35:54,960

isn't fundamental and so that we have to

2712

01:35:58,470 --> 01:35:57,280

completely think outside of that box all

2713

01:35:59,510 --> 01:35:58,480

together

2714

01:36:01,750 --> 01:35:59,520

and

2715

01:36:04,310 --> 01:36:01,760

as as scientists we have to

2716

01:36:05,750 --> 01:36:04,320

say up front what our hypotheses what

2717

01:36:09,750 --> 01:36:05,760

our axioms or

2718

01:36:12,470 --> 01:36:11,590

and and be very clear about them up

2719

01:36:14,310 --> 01:36:12,480

front

2720

01:36:16,790 --> 01:36:14,320

these conscious agents

2721

01:36:19,350 --> 01:36:16,800

in the mathematics they they get

2722

01:36:20,550 --> 01:36:19,360

certain inputs we call them experiences

2723

01:36:22,709 --> 01:36:20,560

that they have

2724

01:36:24,390 --> 01:36:22,719

and then they they there's a something

2725

01:36:26,709 --> 01:36:24,400

called a markovian kernel that that

2726

01:36:28,470 --> 01:36:26,719

describes what actions they take and

2727

01:36:30,229 --> 01:36:28,480

those actions affect the experiences of

2728

01:36:32,070 --> 01:36:30,239

other conscious agents

2729

01:36:33,910 --> 01:36:32,080

so so then there's so that's just the

2730

01:36:35,669 --> 01:36:33,920

mathematics that that my team has

2731

01:36:37,189 --> 01:36:35,679

written down it's a very simple notion

2732

01:36:39,030 --> 01:36:37,199

of markovian dynamics of conscious

2733

01:36:41,109 --> 01:36:39,040

agents interacting

2734

01:36:42,310 --> 01:36:41,119

and and it's not in the physical

2735

01:36:43,910 --> 01:36:42,320

framework

2736

01:36:46,149 --> 01:36:43,920

we're assuming that this is

2737

01:36:47,669 --> 01:36:46,159

you know in its own world right these

2738

01:36:49,430 --> 01:36:47,679

are conscious agents

2739

01:36:51,350 --> 01:36:49,440

and and that's the foundation space and

2740

01:36:53,350 --> 01:36:51,360

time are not the foundation conscious

2741

01:36:55,109 --> 01:36:53,360

agents so conscious experiences and

2742

01:36:57,830 --> 01:36:55,119

interactions of conscious agents are the

2743

01:36:58,629 --> 01:36:57,840

foundational notion

2744

01:37:01,350 --> 01:36:58,639

and

2745

01:37:02,790 --> 01:37:01,360

so then the question is how shall we

2746

01:37:04,550 --> 01:37:02,800

understand

2747

01:37:06,390 --> 01:37:04,560

the probabilities so if i get a

2748

01:37:08,709 --> 01:37:06,400

particular experience that

2749

01:37:10,229 --> 01:37:08,719

comes into a conscious agent

2750

01:37:11,830 --> 01:37:10,239

and it then

2751
01:37:13,910 --> 01:37:11,840
probabilistically affects the experience

2752
01:37:16,470 --> 01:37:13,920
of other agents how shall i

2753
01:37:17,750 --> 01:37:16,480
understand that probability

2754
01:37:20,070 --> 01:37:17,760
that it

2755
01:37:21,350 --> 01:37:20,080
shall i understand it as as a free will

2756
01:37:24,229 --> 01:37:21,360
choice

2757
01:37:27,830 --> 01:37:24,239
or or what um

2758
01:37:30,790 --> 01:37:29,350
you know i could say you know i refuse

2759
01:37:33,030 --> 01:37:30,800
to answer the question i just there's a

2760
01:37:35,030 --> 01:37:33,040
probability there and that's that's as

2761
01:37:36,790 --> 01:37:35,040
far as i go with with the theory there's

2762
01:37:39,910 --> 01:37:36,800
you know this agent

2763
01:37:42,470 --> 01:37:39,920

so i leave that probability as just um

2764

01:37:44,149 --> 01:37:42,480

where my theory stops right i say

2765

01:37:46,149 --> 01:37:44,159

in some sense wherever we see a

2766

01:37:47,669 --> 01:37:46,159

probability in a theory that's where

2767

01:37:48,950 --> 01:37:47,679

explanation stops

2768

01:37:51,109 --> 01:37:48,960

right

2769

01:37:53,990 --> 01:37:51,119

that's that's basically saying

2770

01:37:56,470 --> 01:37:54,000

i don't know like my so whenever so i

2771

01:37:59,030 --> 01:37:56,480

said is whenever in a scientific theory

2772

01:38:00,310 --> 01:37:59,040

you see probabilities coming up

2773

01:38:02,149 --> 01:38:00,320

um

2774

01:38:03,350 --> 01:38:02,159

you're seeing the theory say this is

2775

01:38:05,830 --> 01:38:03,360

where i halt

2776

01:38:09,910 --> 01:38:05,840

uh this is where my explanation stops

2777

01:38:12,950 --> 01:38:11,510

approaches toward understanding those

2778

01:38:14,229 --> 01:38:12,960

probabilities the objectivist and

2779

01:38:16,390 --> 01:38:14,239

subjectivist

2780

01:38:17,430 --> 01:38:16,400

to probabilities right so

2781

01:38:19,910 --> 01:38:17,440

objectivists say that these

2782

01:38:21,990 --> 01:38:19,920

probabilities are

2783

01:38:25,750 --> 01:38:22,000

pointing to some real

2784

01:38:28,070 --> 01:38:25,760

thing in the world there is some real

2785

01:38:29,750 --> 01:38:28,080

random generator in the world

2786

01:38:30,470 --> 01:38:29,760

um

2787

01:38:32,870 --> 01:38:30,480

and

2788

01:38:34,390 --> 01:38:32,880

subjectivists say no um

2789

01:38:36,790 --> 01:38:34,400

these are just degrees of beliefs

2790

01:38:38,870 --> 01:38:36,800

whenever you see probabilities

2791

01:38:41,189 --> 01:38:38,880

you're only talking about

2792

01:38:42,470 --> 01:38:41,199

degrees of belief

2793

01:38:45,910 --> 01:38:42,480

um but

2794

01:38:49,669 --> 01:38:48,149

explanation stops right

2795

01:38:51,350 --> 01:38:49,679

how do i come to that belief well i can

2796

01:38:53,510 --> 01:38:51,360

only tell you probabilities

2797

01:38:55,430 --> 01:38:53,520

what is that random objective process i

2798

01:38:57,990 --> 01:38:55,440

don't know but i can just tell you um

2799

01:38:59,669 --> 01:38:58,000

probabilities and so so really whenever

2800

01:39:01,590 --> 01:38:59,679

you see probabilities in the scientific

2801
01:39:03,350 --> 01:39:01,600
theory and they're all over the place

2802
01:39:06,550 --> 01:39:03,360
i read that as saying here's where

2803
01:39:08,950 --> 01:39:06,560
explanation stops um and our theories

2804
01:39:10,310 --> 01:39:08,960
our theories halt um and and if we want

2805
01:39:13,830 --> 01:39:10,320
to go further we're gonna have to unpack

2806
01:39:15,109 --> 01:39:13,840
that probability into some some deeper

2807
01:39:17,830 --> 01:39:15,119
deeper theory

2808
01:39:21,350 --> 01:39:19,669
if i say that it's

2809
01:39:24,830 --> 01:39:21,360
free will

2810
01:39:27,910 --> 01:39:24,840
in case of the conscious agents

2811
01:39:30,550 --> 01:39:27,920
um then i mean

2812
01:39:31,990 --> 01:39:30,560
in some sense that's just words

2813
01:39:34,149 --> 01:39:32,000

what what the theory has is the

2814

01:39:36,070 --> 01:39:34,159
probabilities and it has no further

2815

01:39:38,870 --> 01:39:36,080
explanation so if i say if i call that

2816

01:39:40,870 --> 01:39:38,880
probability of a free will

2817

01:39:43,669 --> 01:39:40,880
then i you know i can call it that but

2818

01:39:45,109 --> 01:39:43,679
but i haven't really done much to

2819

01:39:46,950 --> 01:39:45,119
give much insight into the notion of

2820

01:39:48,390 --> 01:39:46,960
free will free will then becomes a

2821

01:39:50,070 --> 01:39:48,400
primitive and and maybe that's what i

2822

01:39:52,709 --> 01:39:50,080
want to do i want to say um this is

2823

01:39:55,350 --> 01:39:52,719
where explanation stops and so free will

2824

01:39:59,030 --> 01:39:55,360
is primitive so when these probabilities

2825

01:40:01,750 --> 01:39:59,040
are our free will and i agree to that

2826
01:40:04,070 --> 01:40:01,760
that that's where my theory stops that i

2827
01:40:07,350 --> 01:40:04,080
i can do no further

2828
01:40:10,709 --> 01:40:09,270
now what's interesting in the in the the

2829
01:40:13,910 --> 01:40:10,719
conscious agent dynamics that we're

2830
01:40:16,950 --> 01:40:13,920
working on is that um

2831
01:40:19,430 --> 01:40:16,960
any group of conscious agents

2832
01:40:20,709 --> 01:40:19,440
together also satisfy the definition of

2833
01:40:22,629 --> 01:40:20,719
a conscious agent and so they are a

2834
01:40:25,030 --> 01:40:22,639
conscious agent so any conscious agents

2835
01:40:26,310 --> 01:40:25,040
interacting are also conscious agents so

2836
01:40:27,990 --> 01:40:26,320
they're in the third there's one

2837
01:40:29,510 --> 01:40:28,000
conscious agent

2838
01:40:32,950 --> 01:40:29,520

because if you take all of them together

2839

01:40:34,870 --> 01:40:32,960

they form one conscious agent but then

2840

01:40:36,470 --> 01:40:34,880

there are as many

2841

01:40:38,070 --> 01:40:36,480

um if you're computational there's only

2842

01:40:39,750 --> 01:40:38,080

accountable number of them or in my case

2843

01:40:41,510 --> 01:40:39,760

i don't know if it may be an uncountable

2844

01:40:43,590 --> 01:40:41,520

number of of conscious

2845

01:40:46,870 --> 01:40:43,600

agents but what's interesting is that

2846

01:40:49,270 --> 01:40:46,880

the you unpack this probability in the

2847

01:40:51,430 --> 01:40:49,280

markovian kernel there could be one big

2848

01:40:53,109 --> 01:40:51,440

probability for the one agent

2849

01:40:55,270 --> 01:40:53,119

but you can unpack that into all these

2850

01:40:57,109 --> 01:40:55,280

dynamical systems interacting conscious

2851
01:40:58,870 --> 01:40:57,119
agents with their own probabilities in

2852
01:41:01,669 --> 01:40:58,880
their own kernels and what's what's

2853
01:41:03,669 --> 01:41:01,679
interesting is that you could then

2854
01:41:05,430 --> 01:41:03,679
give in some sense an unpacking of the

2855
01:41:06,950 --> 01:41:05,440
notion of free will in that way you

2856
01:41:08,870 --> 01:41:06,960
could say well yeah the the one agent

2857
01:41:10,470 --> 01:41:08,880
has free will in this this probability

2858
01:41:12,870 --> 01:41:10,480
but i can actually

2859
01:41:14,629 --> 01:41:12,880
do some non-trivial unpacking of that

2860
01:41:17,590 --> 01:41:14,639
notion in this sort of recursive

2861
01:41:19,750 --> 01:41:17,600
unwinding of those probabilities um

2862
01:41:21,830 --> 01:41:19,760
throughout the network so so

2863
01:41:24,149 --> 01:41:21,840

there is the possibility here

2864

01:41:25,590 --> 01:41:24,159

of i mean ultimately

2865

01:41:27,270 --> 01:41:25,600

um

2866

01:41:29,030 --> 01:41:27,280

there will be a primitive notion of free

2867

01:41:31,350 --> 01:41:29,040

will that that is just primitive and not

2868

01:41:32,950 --> 01:41:31,360

explained but given that one i can

2869

01:41:34,470 --> 01:41:32,960

explain all these other free wills sort

2870

01:41:36,229 --> 01:41:34,480

of interacting

2871

01:41:38,950 --> 01:41:36,239

arising from this most primitive notion

2872

01:41:40,950 --> 01:41:38,960

of free will in a non-trivial

2873

01:41:43,189 --> 01:41:40,960

non-trivial way but but once again i i

2874

01:41:44,790 --> 01:41:43,199

would i would point out

2875

01:41:47,430 --> 01:41:44,800

something that i see all the time in

2876
01:41:49,350 --> 01:41:47,440
scientific theories no theory in science

2877
01:41:51,830 --> 01:41:49,360
will ever explain everything

2878
01:41:53,430 --> 01:41:51,840
and and and i would love to see if josh

2879
01:41:55,910 --> 01:41:53,440
joshua

2880
01:41:57,430 --> 01:41:55,920
agrees disagrees i i will just state to

2881
01:41:59,109 --> 01:41:57,440
make a strong claim

2882
01:42:00,629 --> 01:41:59,119
um

2883
01:42:02,870 --> 01:42:00,639
there cannot be a theory of everything

2884
01:42:05,430 --> 01:42:02,880
because every theory has to make

2885
01:42:07,590 --> 01:42:05,440
assumptions and those assumptions

2886
01:42:11,430 --> 01:42:07,600
are not explained they're assumed

2887
01:42:15,830 --> 01:42:13,590
okay am i correct in my

2888
01:42:17,590 --> 01:42:15,840

summary of your views on free will that

2889

01:42:19,430 --> 01:42:17,600

if in a physical theory you have

2890

01:42:21,270 --> 01:42:19,440

probability now some of that probability

2891

01:42:23,750 --> 01:42:21,280

is just due to our ignorance but if

2892

01:42:25,830 --> 01:42:23,760

there's a fundamental probability you

2893

01:42:27,510 --> 01:42:25,840

can just say well that's indicating that

2894

01:42:29,030 --> 01:42:27,520

the theories break down we just don't

2895

01:42:31,109 --> 01:42:29,040

know or you can say that there's

2896

01:42:32,229 --> 01:42:31,119

something underneath producing those and

2897

01:42:34,629 --> 01:42:32,239

that which is underneath the

2898

01:42:37,910 --> 01:42:34,639

probabilities is what you're calling

2899

01:42:40,310 --> 01:42:37,920

free will is that correct or is that off

2900

01:42:43,750 --> 01:42:40,320

right so if i'm a physicalist i'll say

2901

01:42:45,430 --> 01:42:43,760

that that probability is due to some

2902

01:42:46,790 --> 01:42:45,440

process that i can say no more about but

2903

01:42:48,149 --> 01:42:46,800

there's some process that generates this

2904

01:42:50,550 --> 01:42:48,159

stuff it's not free will it's just a

2905

01:42:52,229 --> 01:42:50,560

physical process that that um i don't

2906

01:42:54,149 --> 01:42:52,239

know but if i'm taking consciousness to

2907

01:42:56,390 --> 01:42:54,159

be fundamental then it's an interesting

2908

01:42:58,870 --> 01:42:56,400

move to say that that that free that

2909

01:43:00,070 --> 01:42:58,880

that probability um can be interpreted

2910

01:43:01,669 --> 01:43:00,080

as

2911

01:43:03,750 --> 01:43:01,679

free will now of course i'm not

2912

01:43:05,750 --> 01:43:03,760

explaining anything i'm not you mean

2913

01:43:07,590 --> 01:43:05,760

i'm just putting the frame for the

2914

01:43:08,470 --> 01:43:07,600

notion free will the word free will on

2915

01:43:12,470 --> 01:43:08,480

it right

2916

01:43:14,709 --> 01:43:12,480

and and and free will becomes just a

2917

01:43:17,350 --> 01:43:14,719

a primitive notion as well i'm so that's

2918

01:43:18,629 --> 01:43:17,360

where my explanation stops and i'm the

2919

01:43:20,070 --> 01:43:18,639

most unpacking i can do is that

2920

01:43:21,270 --> 01:43:20,080

recursive unpacking that i that i

2921

01:43:23,430 --> 01:43:21,280

mentioned which is an interesting

2922

01:43:24,790 --> 01:43:23,440

unpacking but ultimately there's this

2923

01:43:26,870 --> 01:43:24,800

primitive notion of free will that i

2924

01:43:29,030 --> 01:43:26,880

have nothing further to say about but

2925

01:43:30,310 --> 01:43:29,040

but i think that um

2926

01:43:33,350 --> 01:43:30,320

that's not

2927

01:43:34,470 --> 01:43:33,360

a problem specific to this theory i the

2928

01:43:37,189 --> 01:43:34,480

last thing i was saying was that that's

2929

01:43:39,990 --> 01:43:37,199

endemic to all scientific theories every

2930

01:43:42,390 --> 01:43:40,000

scientific theory will have miracles at

2931

01:43:44,950 --> 01:43:42,400

its foundation by miracles i mean

2932

01:43:47,350 --> 01:43:44,960

assumptions that are taken for granted

2933

01:43:48,550 --> 01:43:47,360

and not explained

2934

01:43:50,070 --> 01:43:48,560

if you explain them then you'll have a

2935

01:43:51,750 --> 01:43:50,080

deeper theory with new assumptions that

2936

01:43:54,229 --> 01:43:51,760

explain those assumptions but the new

2937

01:43:55,430 --> 01:43:54,239

assumptions aren't explained and so so

2938

01:43:56,870 --> 01:43:55,440

in this sense

2939

01:43:58,550 --> 01:43:56,880

science can never have a theory of

2940

01:44:01,430 --> 01:43:58,560

everything because science

2941

01:44:05,109 --> 01:44:01,440

theories always have assumptions and the

2942

01:44:08,870 --> 01:44:07,590

yosha i know donald said quite a few

2943

01:44:10,550 --> 01:44:08,880

there are quite a few elements to pick

2944

01:44:12,070 --> 01:44:10,560

from there

2945

01:44:14,629 --> 01:44:12,080

three um

2946

01:44:15,830 --> 01:44:14,639

interlocking claims but let's address

2947

01:44:17,510 --> 01:44:15,840

them um

2948

01:44:18,709 --> 01:44:17,520

first of all i don't know whether there

2949

01:44:20,629 --> 01:44:18,719

can be a

2950

01:44:22,550 --> 01:44:20,639

one theory of everything

2951
01:44:24,390 --> 01:44:22,560
because my reasoning is not tight enough

2952
01:44:25,510 --> 01:44:24,400
to have to make that proof one way or

2953
01:44:27,350 --> 01:44:25,520
the other

2954
01:44:29,510 --> 01:44:27,360
so at this point i have to remain

2955
01:44:31,430 --> 01:44:29,520
agnostic because i think from where i

2956
01:44:33,189 --> 01:44:31,440
stand it seems to be possible that there

2957
01:44:36,709 --> 01:44:33,199
can be a theory of everything and it

2958
01:44:39,590 --> 01:44:36,719
seems to be possible that they cannot

2959
01:44:41,830 --> 01:44:39,600
from a computational list perspective

2960
01:44:42,709 --> 01:44:41,840
whenever you have a set of observations

2961
01:44:45,189 --> 01:44:42,719
that is

2962
01:44:47,430 --> 01:44:45,199
finite you will be able to construct a

2963
01:44:49,030 --> 01:44:47,440

computational model that explains how to

2964

01:44:51,669 --> 01:44:49,040

make such patterns

2965

01:44:54,950 --> 01:44:51,679

so in principle there can always be a

2966

01:44:57,430 --> 01:44:54,960

theory of everything that you observe

2967

01:44:59,030 --> 01:44:57,440

that's something that i cannot

2968

01:45:01,189 --> 01:44:59,040

they don't see a way around this so this

2969

01:45:02,790 --> 01:45:01,199

seems to be sound to me and i think that

2970

01:45:04,229 --> 01:45:02,800

can be formally proven

2971

01:45:05,830 --> 01:45:04,239

but uh

2972

01:45:07,669 --> 01:45:05,840

and it seems to be almost trivial that

2973

01:45:09,590 --> 01:45:07,679

it's too proven so it's more interesting

2974

01:45:11,910 --> 01:45:09,600

the question is can you narrow this down

2975

01:45:13,109 --> 01:45:11,920

to a single one to one theory of

2976

01:45:14,950 --> 01:45:13,119

everything

2977

01:45:16,790 --> 01:45:14,960

right you will be always stuck with

2978

01:45:18,149 --> 01:45:16,800

infinitely many theories of everything

2979

01:45:20,629 --> 01:45:18,159

where most of these theories will be

2980

01:45:21,830 --> 01:45:20,639

super inelegant and uh redundant and

2981

01:45:23,990 --> 01:45:21,840

basically recordings of your

2982

01:45:26,070 --> 01:45:24,000

observations or

2983

01:45:27,990 --> 01:45:26,080

will there be one theory that is the

2984

01:45:31,350 --> 01:45:28,000

most elegant and explains everything

2985

01:45:33,270 --> 01:45:31,360

deeply and wraps it up and of course if

2986

01:45:34,790 --> 01:45:33,280

you think about the space of all

2987

01:45:37,669 --> 01:45:34,800

theories and think of them as things

2988

01:45:40,629 --> 01:45:37,679

that you can do in a language and

2989

01:45:42,070 --> 01:45:40,639

in which you can define truth and if you

2990

01:45:43,990 --> 01:45:42,080

realize that the languages in which you

2991

01:45:46,229 --> 01:45:44,000

can define truth consistently these are

2992

01:45:47,510 --> 01:45:46,239

the computational languages it turns out

2993

01:45:49,910 --> 01:45:47,520

that all your models are going to be

2994

01:45:51,350 --> 01:45:49,920

automata and that you can sort the space

2995

01:45:54,149 --> 01:45:51,360

of automata by the length of the

2996

01:45:56,149 --> 01:45:54,159

definitions so it also seems that in

2997

01:45:59,030 --> 01:45:56,159

principle it should be possible to find

2998

01:46:00,950 --> 01:45:59,040

the shortest automaton between two every

2999

01:46:02,790 --> 01:46:00,960

pair of automata that you can construct

3000

01:46:04,550 --> 01:46:02,800

and connect with now the question is

3001

01:46:06,629 --> 01:46:04,560

what's your search procedure for all the

3002

01:46:08,550 --> 01:46:06,639

possible automata do you have a search

3003

01:46:10,149 --> 01:46:08,560

procedure that you can hope that

3004

01:46:12,709 --> 01:46:10,159

terminates

3005

01:46:15,510 --> 01:46:12,719

and this is uh not a question of whether

3006

01:46:17,189 --> 01:46:15,520

it's mathematically uh possible uh but

3007

01:46:18,709 --> 01:46:17,199

whether it's efficient so you do is

3008

01:46:20,470 --> 01:46:18,719

there an efficient

3009

01:46:23,270 --> 01:46:20,480

strategy to find the theory of

3010

01:46:25,430 --> 01:46:23,280

everything that is the shortest one

3011

01:46:27,510 --> 01:46:25,440

and so far we haven't found one

3012

01:46:29,430 --> 01:46:27,520

and it relates to

3013

01:46:31,430 --> 01:46:29,440

what ai is doing in machine learning

3014

01:46:33,910 --> 01:46:31,440

when it tries to identify what's going

3015

01:46:35,830 --> 01:46:33,920

on in the domain

3016

01:46:37,669 --> 01:46:35,840

so while in principle we can always be

3017

01:46:39,510 --> 01:46:37,679

sure that we could be a brain in a vat

3018

01:46:40,950 --> 01:46:39,520

and everything is just a nefarious

3019

01:46:42,310 --> 01:46:40,960

conspiracy

3020

01:46:44,709 --> 01:46:42,320

that is playing out and because we

3021

01:46:47,669 --> 01:46:44,719

cannot exclude this we can never be sure

3022

01:46:50,709 --> 01:46:47,679

that our theory of everything is uh

3023

01:46:52,950 --> 01:46:50,719

is the best theory that could exist

3024

01:46:55,830 --> 01:46:52,960

of things so that's obviously the case

3025

01:46:57,669 --> 01:46:55,840

but if we uh take out this single thing

3026

01:46:59,910 --> 01:46:57,679

and make the assumption that reality is

3027

01:47:01,910 --> 01:46:59,920

not a conspiracy

3028

01:47:03,830 --> 01:47:01,920

uh i think then it look starts to look a

3029

01:47:06,790 --> 01:47:03,840

lot brighter

3030

01:47:08,870 --> 01:47:06,800

let's get to the notion of free will

3031

01:47:10,950 --> 01:47:08,880

i think that free will is tied into the

3032

01:47:12,870 --> 01:47:10,960

notion of agency

3033

01:47:15,109 --> 01:47:12,880

and the best

3034

01:47:17,510 --> 01:47:15,119

explanation of what an agent is that i

3035

01:47:19,270 --> 01:47:17,520

found so far is that an agent is a

3036

01:47:21,189 --> 01:47:19,280

control system

3037

01:47:24,390 --> 01:47:21,199

that is intrinsically combined with its

3038

01:47:26,550 --> 01:47:24,400

own set point generator a control system

3039

01:47:29,270 --> 01:47:26,560

is a notion from cybernetics it means

3040

01:47:31,109 --> 01:47:29,280

you have some system like a thermostat

3041

01:47:32,870 --> 01:47:31,119

that is making a measurement using

3042

01:47:35,510 --> 01:47:32,880

sensors for instance the temperature in

3043

01:47:37,350 --> 01:47:35,520

the room and that has a factors by which

3044

01:47:38,950 --> 01:47:37,360

it can change the dynamics of the system

3045

01:47:40,470 --> 01:47:38,960

so the effector would be a switch that

3046

01:47:42,470 --> 01:47:40,480

turns the heating on and off and the

3047

01:47:44,149 --> 01:47:42,480

system that's being regulated is the

3048

01:47:46,310 --> 01:47:44,159

temperature in the room and the

3049

01:47:48,310 --> 01:47:46,320

temperature in the room is disturbed by

3050

01:47:51,109 --> 01:47:48,320

the environment

3051

01:47:53,270 --> 01:47:51,119

and a simple thermostat will only act on

3052

01:47:54,870 --> 01:47:53,280

its present measurement and then

3053

01:47:56,470 --> 01:47:54,880

translate this present measurement using

3054

01:47:59,030 --> 01:47:56,480

a single parameter into whether it

3055

01:48:00,629 --> 01:47:59,040

should switch or not and depending on

3056

01:48:03,350 --> 01:48:00,639

choosing that

3057

01:48:04,950 --> 01:48:03,360

parameter well you have a more efficient

3058

01:48:07,109 --> 01:48:04,960

regulation or not

3059

01:48:08,709 --> 01:48:07,119

but if you want to be more efficient you

3060

01:48:10,390 --> 01:48:08,719

need to model the environment and the

3061

01:48:12,149 --> 01:48:10,400

dynamics of the system

3062

01:48:14,870 --> 01:48:12,159

and maybe the dynamics of the sensory

3063

01:48:16,709 --> 01:48:14,880

system and the actuator itself

3064

01:48:19,590 --> 01:48:16,719

and you can do this it means that you

3065

01:48:21,990 --> 01:48:19,600

model the future of the regulation

3066

01:48:23,830 --> 01:48:22,000

based on past observations so if you

3067

01:48:25,990 --> 01:48:23,840

endow the controller with the ability to

3068

01:48:28,390 --> 01:48:26,000

make a model of the future and use this

3069

01:48:29,830 --> 01:48:28,400

control model to fine-tune the actions

3070

01:48:31,510 --> 01:48:29,840

of the controller

3071

01:48:33,350 --> 01:48:31,520

it means that this a controller now is

3072

01:48:34,870 --> 01:48:33,360

more than a thermostat it's not going to

3073

01:48:37,109 --> 01:48:34,880

just optimize the temperature in the

3074

01:48:39,270 --> 01:48:37,119

room in the next frame but it's going to

3075

01:48:40,950 --> 01:48:39,280

optimize the integral of the temperature

3076

01:48:43,270 --> 01:48:40,960

over a long time span so it basically

3077

01:48:46,070 --> 01:48:43,280

takes a long expectation horizon the

3078

01:48:48,390 --> 01:48:46,080

fast further it goes the better probably

3079

01:48:50,149 --> 01:48:48,400

and then it tries to minimize all the

3080

01:48:52,390 --> 01:48:50,159

temperature deviations from the ideal

3081

01:48:54,310 --> 01:48:52,400

temperature from the set point over that

3082

01:48:56,790 --> 01:48:54,320

time span and this means that depending

3083

01:48:58,709 --> 01:48:56,800

on the fidelity and detail of the model

3084

01:49:00,790 --> 01:48:58,719

of its environment and its interaction

3085

01:49:03,189 --> 01:49:00,800

with the environment and itself

3086

01:49:05,430 --> 01:49:03,199

it's going to be better and better if it

3087

01:49:07,590 --> 01:49:05,440

assumes that there are trajectories in

3088

01:49:09,109 --> 01:49:07,600

the world that are the result of its own

3089

01:49:11,109 --> 01:49:09,119

decisions

3090

01:49:13,189 --> 01:49:11,119

right by turning the temperature on and

3091

01:49:14,709 --> 01:49:13,199

off at this particular point in time i'm

3092

01:49:16,310 --> 01:49:14,719

going to get this in this result

3093

01:49:18,870 --> 01:49:16,320

depending on the weather outside

3094

01:49:20,390 --> 01:49:18,880

depending on how often people uh open

3095

01:49:22,629 --> 01:49:20,400

and close the door to the room at

3096

01:49:25,350 --> 01:49:22,639

different times of the day depending on

3097

01:49:27,910 --> 01:49:25,360

the aging of my sensor or the

3098

01:49:29,750 --> 01:49:27,920

distance of my sensor to the heating and

3099

01:49:31,990 --> 01:49:29,760

depending on whether the

3100

01:49:34,229 --> 01:49:32,000

window and on top of the sensor is

3101

01:49:36,550 --> 01:49:34,239

currently open or closed and so on i get

3102

01:49:38,629 --> 01:49:36,560

lots and more more ways to differentiate

3103

01:49:40,629 --> 01:49:38,639

the event flow in the universe and the

3104

01:49:42,709 --> 01:49:40,639

path that the universe can take and the

3105

01:49:44,229 --> 01:49:42,719

interactions uh that that i can have

3106

01:49:45,830 --> 01:49:44,239

with the universe that determine whether

3107

01:49:49,189 --> 01:49:45,840

somebody will open the window and so on

3108

01:49:52,390 --> 01:49:49,199

and so on right so you uh have all these

3109

01:49:54,950 --> 01:49:52,400

uh points where the controller is a very

3110

01:49:56,629 --> 01:49:54,960

differentiated model of reality where

3111

01:49:58,470 --> 01:49:56,639

it's going to prefer some events of

3112

01:50:00,629 --> 01:49:58,480

others and is going to

3113

01:50:02,629 --> 01:50:00,639

assign its own decisions to these

3114

01:50:04,390 --> 01:50:02,639

trajectories

3115

01:50:07,270 --> 01:50:04,400

and this decision making necessarily

3116

01:50:10,629 --> 01:50:07,280

happens under conditions of uncertainty

3117

01:50:12,149 --> 01:50:10,639

which means the controller will never be

3118

01:50:13,430 --> 01:50:12,159

completely sure which one is going to

3119

01:50:16,070 --> 01:50:13,440

the right decision the controller will

3120

01:50:17,510 --> 01:50:16,080

have to make educated guesses bets on

3121

01:50:19,669 --> 01:50:17,520

the future

3122

01:50:21,270 --> 01:50:19,679

and this even includes the models of

3123

01:50:22,790 --> 01:50:21,280

itself right the better the control

3124

01:50:25,270 --> 01:50:22,800

system understands itself and the

3125

01:50:27,350 --> 01:50:25,280

limitations of its modeling ability the

3126

01:50:29,750 --> 01:50:27,360

better its models are going to be so at

3127

01:50:31,270 --> 01:50:29,760

some point of complexity this thing is

3128

01:50:33,430 --> 01:50:31,280

going to understand its own modeling

3129

01:50:35,189 --> 01:50:33,440

procedure to improve it and to find gaps

3130

01:50:36,149 --> 01:50:35,199

in it and so on

3131

01:50:38,229 --> 01:50:36,159

and

3132

01:50:40,390 --> 01:50:38,239

this also means that when it starts to

3133

01:50:41,589 --> 01:50:40,400

do this it is going to discover that

3134

01:50:42,950 --> 01:50:41,599

there are agents in the world other

3135

01:50:45,189 --> 01:50:42,960

controllers that have set points

3136

01:50:46,790 --> 01:50:45,199

generators and model the future and make

3137

01:50:48,149 --> 01:50:46,800

decisions for instance people that might

3138

01:50:50,149 --> 01:50:48,159

open the window when you make the room

3139

01:50:52,229 --> 01:50:50,159

too hard and you lose energy because of

3140

01:50:54,470 --> 01:50:52,239

that right so maybe not overheat the

3141

01:50:56,390 --> 01:50:54,480

room when people are in the room uh

3142

01:50:57,990 --> 01:50:56,400

right this this means you have to model

3143

01:50:59,750 --> 01:50:58,000

agency at some point and you will also

3144

01:51:01,350 --> 01:50:59,760

discover yourself as an agent in the

3145

01:51:02,790 --> 01:51:01,360

world as a controller as a set point

3146

01:51:03,750 --> 01:51:02,800

generator and the ability to model the

3147

01:51:05,910 --> 01:51:03,760

future

3148

01:51:07,350 --> 01:51:05,920

and you will discover this before you

3149

01:51:09,350 --> 01:51:07,360

understand how your own modeling of the

3150

01:51:10,950 --> 01:51:09,360

future works

3151
01:51:12,629 --> 01:51:10,960
right so you also have to make bets on

3152
01:51:14,950 --> 01:51:12,639
how you work

3153
01:51:16,629 --> 01:51:14,960
before you understand yourself

3154
01:51:18,870 --> 01:51:16,639
right so you will discover a self model

3155
01:51:20,709 --> 01:51:18,880
the self model is the agent

3156
01:51:23,030 --> 01:51:20,719
where the contents of your own model are

3157
01:51:24,870 --> 01:51:23,040
driving the behavior of that agent

3158
01:51:26,790 --> 01:51:24,880
and it's a very particular agent it's

3159
01:51:29,030 --> 01:51:26,800
one where your reasoning and your

3160
01:51:31,430 --> 01:51:29,040
modeling has an influence on what this

3161
01:51:33,589 --> 01:51:31,440
agent is going to do a direct coupling

3162
01:51:35,750 --> 01:51:33,599
it's a very specific model a very

3163
01:51:37,990 --> 01:51:35,760

specific agent that you discover there

3164

01:51:39,830 --> 01:51:38,000

and so in some sense free will i think

3165

01:51:41,990 --> 01:51:39,840

is a perspective on decision making

3166

01:51:43,350 --> 01:51:42,000

under uncertainty

3167

01:51:45,350 --> 01:51:43,360

starting from the point where you

3168

01:51:47,109 --> 01:51:45,360

discover your own self model

3169

01:51:49,510 --> 01:51:47,119

up to the point where you deconstruct it

3170

01:51:51,510 --> 01:51:49,520

again and of course you will deconstruct

3171

01:51:53,030 --> 01:51:51,520

it again at some point you will be able

3172

01:51:54,149 --> 01:51:53,040

to fully understand how you are

3173

01:51:55,750 --> 01:51:54,159

operating

3174

01:51:57,030 --> 01:51:55,760

and once you do this

3175

01:51:58,709 --> 01:51:57,040

making your decision becomes

3176
01:51:59,830 --> 01:51:58,719
indistinguishable from predicting your

3177
01:52:01,109 --> 01:51:59,840
decision

3178
01:52:02,950 --> 01:52:01,119
and because of computational

3179
01:52:04,470 --> 01:52:02,960
irreducibility often you will not be

3180
01:52:06,229 --> 01:52:04,480
able to predict the position before you

3181
01:52:07,350 --> 01:52:06,239
make it right

3182
01:52:09,030 --> 01:52:07,360
but uh

3183
01:52:11,430 --> 01:52:09,040
as soon as you understand that there's

3184
01:52:13,270 --> 01:52:11,440
just a computational process going on

3185
01:52:14,870 --> 01:52:13,280
and you are understand the properties of

3186
01:52:17,750 --> 01:52:14,880
that process you will no longer

3187
01:52:20,550 --> 01:52:17,760
experience yourself as having free will

3188
01:52:22,470 --> 01:52:20,560

free will is a particular kind of model

3189

01:52:24,950 --> 01:52:22,480

that happens as a result of your own

3190

01:52:27,109 --> 01:52:24,960

self model being a simulacrum instead of

3191

01:52:29,430 --> 01:52:27,119

being a high fidelity simulation of how

3192

01:52:32,149 --> 01:52:29,440

you actually work

3193

01:52:34,390 --> 01:52:32,159

and we are young beings we don't get

3194

01:52:35,589 --> 01:52:34,400

very old it's very difficult for us to

3195

01:52:37,270 --> 01:52:35,599

get to the point where we fully

3196

01:52:38,950 --> 01:52:37,280

understand how we work

3197

01:52:41,030 --> 01:52:38,960

except in certain circumstances right

3198

01:52:42,790 --> 01:52:41,040

when we observe our children very often

3199

01:52:44,310 --> 01:52:42,800

we get to the point as parents that we

3200

01:52:46,470 --> 01:52:44,320

fully understand what they will be doing

3201

01:52:47,830 --> 01:52:46,480

in a given situation we can fully

3202

01:52:49,350 --> 01:52:47,840

understand their own actions and

3203

01:52:51,189 --> 01:52:49,360

anticipate their decisions and the child

3204

01:52:52,629 --> 01:52:51,199

might experience that it has free will

3205

01:52:53,990 --> 01:52:52,639

and we experience that the child has

3206

01:52:55,910 --> 01:52:54,000

revealed up to the point where we

3207

01:52:57,030 --> 01:52:55,920

suddenly understand oh this is what's

3208

01:52:58,629 --> 01:52:57,040

going on

3209

01:53:00,310 --> 01:52:58,639

and at this point i can completely

3210

01:53:02,070 --> 01:53:00,320

control the child because he can out

3211

01:53:04,149 --> 01:53:02,080

model it

3212

01:53:07,030 --> 01:53:04,159

right and it's only to the point where

3213

01:53:09,430 --> 01:53:07,040

this system is going to introduce levels

3214

01:53:11,589 --> 01:53:09,440

that are again reaching my own level

3215

01:53:14,310 --> 01:53:11,599

that decisions become unpredictable but

3216

01:53:16,310 --> 01:53:14,320

if i am a few levels of modelling depth

3217

01:53:18,390 --> 01:53:16,320

above the other agent that might think

3218

01:53:20,229 --> 01:53:18,400

that it is prevail the free will start

3219

01:53:22,229 --> 01:53:20,239

to disappear from my own perspective and

3220

01:53:24,149 --> 01:53:22,239

also happens in my own mind as many

3221

01:53:26,470 --> 01:53:24,159

things that i do but i thought as a

3222

01:53:28,149 --> 01:53:26,480

child i'm acting out of my own free will

3223

01:53:31,270 --> 01:53:28,159

and now i understand how mechanical it

3224

01:53:33,030 --> 01:53:31,280

is and i can deal with myself

3225

01:53:35,030 --> 01:53:33,040

by controlling myself by outmodeling

3226
01:53:39,510 --> 01:53:35,040
myself successively and becoming one

3227
01:53:44,149 --> 01:53:42,070
and and all that yoshi the um the

3228
01:53:45,750 --> 01:53:44,159
computational process the probabilities

3229
01:53:49,910 --> 01:53:45,760
in the transition rules you would view

3230
01:53:53,910 --> 01:53:51,830
yes so there is also this issue that i

3231
01:53:55,830 --> 01:53:53,920
don't actually exist in the way in which

3232
01:53:58,390 --> 01:53:55,840
i model myself i only exist to some

3233
01:54:00,790 --> 01:53:58,400
degree of approximation i'm not this big

3234
01:54:03,189 --> 01:54:00,800
tree that is strictly implemented in

3235
01:54:04,870 --> 01:54:03,199
physical reality i'm more like a bunch

3236
01:54:06,709 --> 01:54:04,880
of shrubbery

3237
01:54:09,750 --> 01:54:06,719
and some of the shrubbery is tasked with

3238
01:54:11,430 --> 01:54:09,760

making a model of myself as a tree

3239

01:54:13,830 --> 01:54:11,440

and that model is going to be a course

3240

01:54:16,470 --> 01:54:13,840

approximation so the fact that i am

3241

01:54:18,950 --> 01:54:16,480

unable to follow up on my plans means

3242

01:54:20,870 --> 01:54:18,960

that i'm only approximately implemented

3243

01:54:22,390 --> 01:54:20,880

right the rubber hand illusion is a good

3244

01:54:25,910 --> 01:54:22,400

example of how we're continually

3245

01:54:27,430 --> 01:54:25,920

redefining who we are right where you

3246

01:54:28,790 --> 01:54:27,440

tap and drag on the hand at the same

3247

01:54:30,709 --> 01:54:28,800

time you're

3248

01:54:31,510 --> 01:54:30,719

tapping and dragging on a rubber hand

3249

01:54:32,709 --> 01:54:31,520

and

3250

01:54:33,910 --> 01:54:32,719

if you do it just right with the person

3251

01:54:35,350 --> 01:54:33,920

they'll take this rubber hand and

3252

01:54:37,990 --> 01:54:35,360

incorporate it into their body image so

3253

01:54:39,430 --> 01:54:38,000

we're always learning who we are

3254

01:54:40,709 --> 01:54:39,440

but those probabilities in that learning

3255

01:54:43,270 --> 01:54:40,719

process you would take as objective

3256

01:54:44,870 --> 01:54:43,280

probabilities and not free will kinds of

3257

01:54:46,870 --> 01:54:44,880

probabilities

3258

01:54:49,030 --> 01:54:46,880

and what does it mean that a probability

3259

01:54:50,870 --> 01:54:49,040

is objective it only means based on the

3260

01:54:53,109 --> 01:54:50,880

models in which which i have currently

3261

01:54:54,950 --> 01:54:53,119

made and if i go

3262

01:54:58,070 --> 01:54:54,960

far beyond back i

3263

01:55:00,149 --> 01:54:58,080

cannot assign an objective probability

3264

01:55:02,070 --> 01:55:00,159

to the probabilities that i am observing

3265

01:55:03,350 --> 01:55:02,080

because they are contingent on the

3266

01:55:05,270 --> 01:55:03,360

assumption for instance i'm currently

3267

01:55:07,270 --> 01:55:05,280

not in a dream

3268

01:55:09,030 --> 01:55:07,280

or that my memories are correct or that

3269

01:55:11,270 --> 01:55:09,040

my data are correct or that my the

3270

01:55:12,790 --> 01:55:11,280

theories that event and to establish the

3271

01:55:15,910 --> 01:55:12,800

relationships between my measurements

3272

01:55:17,830 --> 01:55:15,920

and my data and so on are correct so uh

3273

01:55:19,750 --> 01:55:17,840

i do agree that at some point there are

3274

01:55:21,270 --> 01:55:19,760

a lot of assumptions go into this and

3275

01:55:23,669 --> 01:55:21,280

these assumptions

3276

01:55:25,990 --> 01:55:23,679

differ with you are usually mild

3277

01:55:28,310 --> 01:55:26,000

because i make so many observations that

3278

01:55:30,149 --> 01:55:28,320

at some point i can the

3279

01:55:32,470 --> 01:55:30,159

errors cancel each other out or there's

3280

01:55:34,950 --> 01:55:32,480

so many people that can verify my ideas

3281

01:55:37,430 --> 01:55:34,960

and shut them down and so my ideas don't

3282

01:55:39,270 --> 01:55:37,440

exist in isolation they are being shot

3283

01:55:40,870 --> 01:55:39,280

against every philosophy and physics

3284

01:55:42,390 --> 01:55:40,880

book that i can get my hands on and that

3285

01:55:44,950 --> 01:55:42,400

i understand right and every

3286

01:55:47,109 --> 01:55:44,960

conversation that i have so

3287

01:55:49,350 --> 01:55:47,119

that doesn't mean that uh i will

3288

01:55:51,430 --> 01:55:49,360

discover the truth in this way but it

3289

01:55:53,109 --> 01:55:51,440

means that i discover many many of the

3290

01:55:55,030 --> 01:55:53,119

possible errors that i can make and at

3291

01:55:57,750 --> 01:55:55,040

some point i realized that there is a

3292

01:56:00,390 --> 01:55:57,760

finite space of theories that exists

3293

01:56:02,629 --> 01:56:00,400

and uh that we are discovering the same

3294

01:56:05,030 --> 01:56:02,639

things again and again so when we ask

3295

01:56:07,270 --> 01:56:05,040

ourselves what are integers for instance

3296

01:56:09,030 --> 01:56:07,280

or what are rational numbers

3297

01:56:11,189 --> 01:56:09,040

there are many ways of making theories

3298

01:56:13,030 --> 01:56:11,199

about what integers are for instance we

3299

01:56:15,669 --> 01:56:13,040

can say that there are the cardinalities

3300

01:56:17,669 --> 01:56:15,679

of sets or so basically you count

3301

01:56:19,589 --> 01:56:17,679

members of a set and this is an integer

3302

01:56:21,669 --> 01:56:19,599

and all the numbers of members of sets

3303

01:56:23,109 --> 01:56:21,679

that you can have are integers

3304

01:56:24,870 --> 01:56:23,119

or you can say that they are a

3305

01:56:27,830 --> 01:56:24,880

subsequent labeling scheme that's the

3306

01:56:29,669 --> 01:56:27,840

definition that i currently prefer

3307

01:56:31,189 --> 01:56:29,679

or you can use pianos axioms to

3308

01:56:33,350 --> 01:56:31,199

formalize them

3309

01:56:35,510 --> 01:56:33,360

and it turns out that they all describe

3310

01:56:38,229 --> 01:56:35,520

exactly the same thing

3311

01:56:39,669 --> 01:56:38,239

there are all different perspectives on

3312

01:56:41,109 --> 01:56:39,679

the same thing and once you understand

3313

01:56:43,030 --> 01:56:41,119

the larger space that surrounds the

3314

01:56:44,390 --> 01:56:43,040

integers you also understand why there

3315

01:56:45,750 --> 01:56:44,400

are different perspectives because you

3316

01:56:48,229 --> 01:56:45,760

understand how these perspectives are

3317

01:56:50,550 --> 01:56:48,239

being constructed and you can show that

3318

01:56:52,870 --> 01:56:50,560

it's all the same thing and this so in

3319

01:56:54,550 --> 01:56:52,880

some sense the integers are a fractal

3320

01:56:56,550 --> 01:56:54,560

and you can describe this fractal using

3321

01:56:58,709 --> 01:56:56,560

a generator function and you can also

3322

01:57:00,950 --> 01:56:58,719

describe it in many other ways

3323

01:57:03,589 --> 01:57:00,960

and it seems that mathematics or all the

3324

01:57:06,870 --> 01:57:03,599

languages that you can use that work are

3325

01:57:09,750 --> 01:57:06,880

usually a small relatively

3326

01:57:11,270 --> 01:57:09,760

intelligible set of fractals

3327

01:57:13,430 --> 01:57:11,280

and they are the boundary of what is

3328

01:57:16,070 --> 01:57:13,440

intelligible to the human mind

3329

01:57:18,149 --> 01:57:16,080

but not that far above it and probably

3330

01:57:21,350 --> 01:57:18,159

still inside of it

3331

01:57:23,589 --> 01:57:21,360

so i'm more optimistic than you are

3332

01:57:25,430 --> 01:57:23,599

i have a question for the both of you

3333

01:57:27,430 --> 01:57:25,440

it's about your models how much of it

3334

01:57:30,149 --> 01:57:27,440

would have to change let's say yosha in

3335

01:57:33,109 --> 01:57:30,159

your case if classical logic was indeed

3336

01:57:35,109 --> 01:57:33,119

correct if continuities exist and for

3337

01:57:37,270 --> 01:57:35,119

donald if the opposite was true so

3338

01:57:38,390 --> 01:57:37,280

continuity doesn't exist intuitionist

3339

01:57:41,669 --> 01:57:38,400

logic is

3340

01:57:47,910 --> 01:57:43,589

so

3341

01:57:49,750 --> 01:57:47,920

continuity must exist because everybody

3342

01:57:51,990 --> 01:57:49,760

was assuming that they did like most of

3343

01:57:53,830 --> 01:57:52,000

the eminent physicists thought that the

3344

01:57:55,669 --> 01:57:53,840

universe must be fundamentally

3345

01:57:57,830 --> 01:57:55,679

continuous many of the foundational

3346

01:58:00,310 --> 01:57:57,840

theories that we have in physics assume

3347

01:58:02,709 --> 01:58:00,320

that there is continuity and i thought

3348

01:58:05,589 --> 01:58:02,719

that my inability to derive continuity

3349

01:58:06,790 --> 01:58:05,599

to construct a continuous system

3350

01:58:08,709 --> 01:58:06,800

is the result of my lack of

3351

01:58:10,629 --> 01:58:08,719

understanding

3352

01:58:12,629 --> 01:58:10,639

and it took me quite some time to

3353

01:58:14,790 --> 01:58:12,639

realize that

3354

01:58:16,790 --> 01:58:14,800

what godel has stumbled upon

3355

01:58:18,229 --> 01:58:16,800

was actually the inside that continuity

3356

01:58:20,709 --> 01:58:18,239

cannot exist because it's not

3357

01:58:23,350 --> 01:58:20,719

constructive cannot be implemented

3358

01:58:26,070 --> 01:58:23,360

so once you have the infinities

3359

01:58:28,149 --> 01:58:26,080

and once you presuppose them there are

3360

01:58:29,270 --> 01:58:28,159

an amazing cornucopia all sorts of stuff

3361

01:58:31,350 --> 01:58:29,280

falls out

3362

01:58:32,870 --> 01:58:31,360

like you have hilbert's hotel that is

3363

01:58:34,390 --> 01:58:32,880

completely booked out but there's

3364

01:58:36,149 --> 01:58:34,400

infinitely many rooms and then there are

3365

01:58:38,470 --> 01:58:36,159

infinitely many buses coming on and you

3366

01:58:40,950 --> 01:58:38,480

just ask everybody to move in the room

3367

01:58:44,310 --> 01:58:40,960

with twice their number and then you fit

3368

01:58:46,229 --> 01:58:44,320

in the infinitely many new people right

3369

01:58:47,589 --> 01:58:46,239

this is not a feature

3370

01:58:49,350 --> 01:58:47,599

this is a bug

3371

01:58:51,270 --> 01:58:49,360

this shouldn't happen

3372

01:58:52,629 --> 01:58:51,280

i know how the hotels work no hotels

3373

01:58:54,470 --> 01:58:52,639

work like this

3374

01:58:56,950 --> 01:58:54,480

this is not good if something like this

3375

01:58:59,109 --> 01:58:56,960

happens and uh it's not surprising that

3376

01:59:00,470 --> 01:58:59,119

this blows up when you try to make

3377

01:59:03,189 --> 01:59:00,480

proofs

3378

01:59:06,310 --> 01:59:03,199

and so i think that hilbert's hotel

3379

01:59:08,070 --> 01:59:06,320

points not to a miracle in the universe

3380

01:59:09,910 --> 01:59:08,080

that under certain circumstances you get

3381

01:59:11,830 --> 01:59:09,920

something for nothing which is very nice

3382

01:59:13,910 --> 01:59:11,840

if you want to derive a universe from

3383

01:59:16,470 --> 01:59:13,920

nothing but

3384

01:59:18,550 --> 01:59:16,480

it shows that your language can break

3385

01:59:21,189 --> 01:59:18,560

and so i don't see a way to get the

3386

01:59:25,030 --> 01:59:21,199

languages in which continuity exists to

3387

01:59:26,950 --> 01:59:25,040

work and i cannot exclude that i'm wrong

3388

01:59:29,350 --> 01:59:26,960

and i might see a way in the future or

3389

01:59:31,350 --> 01:59:29,360

somebody else does in a way that i don't

3390

01:59:32,790 --> 01:59:31,360

i just don't see a way how to make

3391

01:59:34,310 --> 01:59:32,800

continuity work

3392

01:59:35,910 --> 01:59:34,320

but i get all the benefits from

3393

01:59:37,669 --> 01:59:35,920

continuity for the description of

3394

01:59:39,750 --> 01:59:37,679

practical systems

3395

01:59:41,109 --> 01:59:39,760

using discrete logic

3396

01:59:42,629 --> 01:59:41,119

so in this sense i would say that

3397

01:59:44,629 --> 01:59:42,639

dynamical systems that are truly

3398

01:59:46,310 --> 01:59:44,639

continuous don't exist

3399

01:59:47,750 --> 01:59:46,320

they're not causally existing they

3400

01:59:49,669 --> 01:59:47,760

cannot be causal

3401

01:59:52,709 --> 01:59:49,679

they are a layer of description that i

3402

01:59:54,229 --> 01:59:52,719

use to deal with too many parts to count

3403

01:59:56,550 --> 01:59:54,239

and there are sometimes a very useful

3404

01:59:58,870 --> 01:59:56,560

abstraction but they cannot be used for

3405

02:00:00,709 --> 01:59:58,880

a foundational theory

3406

02:00:02,550 --> 02:00:00,719

because the foundational stuff

3407

02:00:04,470 --> 02:00:02,560

has to work it has to be described in a

3408

02:00:06,709 --> 02:00:04,480

language where all the element

3409

02:00:07,910 --> 02:00:06,719

parts have to interface and stretch away

3410

02:00:09,669 --> 02:00:07,920

that your language doesn't blow up

3411

02:00:11,589 --> 02:00:09,679

because otherwise the terms in your

3412

02:00:14,709 --> 02:00:11,599

language don't mean anything so what

3413

02:00:16,709 --> 02:00:14,719

this means is that the word continuity

3414

02:00:18,790 --> 02:00:16,719

does not actually mean anything in my

3415

02:00:21,189 --> 02:00:18,800

world it does not have a useful

3416

02:00:23,350 --> 02:00:21,199

reference i cannot point at anything

3417

02:00:25,430 --> 02:00:23,360

that is truly continuous without my

3418

02:00:27,430 --> 02:00:25,440

language breaking

3419

02:00:29,910 --> 02:00:27,440

so it doesn't exist it's a word that

3420

02:00:32,470 --> 02:00:29,920

only exists as a confusion but it exists

3421

02:00:35,510 --> 02:00:32,480

approximately it exists as the dynamics

3422

02:00:37,430 --> 02:00:35,520

of too many parts to count which is fine

3423

02:00:39,510 --> 02:00:37,440

so i'm a confused man and when you say

3424

02:00:41,350 --> 02:00:39,520

that the language is breaking i just see

3425

02:00:43,830 --> 02:00:41,360

it as you saying that there are

3426

02:00:45,510 --> 02:00:43,840

extremely unintuitive results that well

3427

02:00:47,430 --> 02:00:45,520

they don't seem to make sense but it

3428

02:00:49,510 --> 02:00:47,440

doesn't mean that they don't make sense

3429

02:00:51,589 --> 02:00:49,520

because you defined work as what's

3430

02:00:53,030 --> 02:00:51,599

implementable now what it doesn't work

3431

02:00:55,430 --> 02:00:53,040

means that you can no longer derive

3432

02:00:56,709 --> 02:00:55,440

truth it means for instance in an

3433

02:00:58,870 --> 02:00:56,719

exomatic system if you have a

3434

02:01:00,470 --> 02:00:58,880

contradiction in your axioms

3435

02:01:03,189 --> 02:01:00,480

it means that you can certainly derive

3436

02:01:06,629 --> 02:01:05,270

and nothing it just means that your

3437

02:01:08,709 --> 02:01:06,639

fractal is no longer having a

3438

02:01:09,830 --> 02:01:08,719

discernable structure this is what it

3439

02:01:11,109 --> 02:01:09,840

means that it's breaking

3440

02:01:13,589 --> 02:01:11,119

[Music]

3441

02:01:15,990 --> 02:01:13,599

what is the exact contradiction

3442

02:01:18,070 --> 02:01:16,000

in classical logic because it seems as

3443

02:01:20,229 --> 02:01:18,080

though mathematicians are getting along

3444

02:01:21,830 --> 02:01:20,239

fine and it's difficult extremely

3445

02:01:22,790 --> 02:01:21,840

difficult to prove certain theorems and

3446

02:01:24,790 --> 02:01:22,800

it wouldn't be if there was a

3447

02:01:27,350 --> 02:01:24,800

contradiction well not necessarily but

3448

02:01:29,430 --> 02:01:27,360

you understand what i mean yes so the

3449

02:01:31,910 --> 02:01:29,440

issue is that the assumption of a

3450

02:01:34,149 --> 02:01:31,920

stateless platonic notion of truth that

3451

02:01:36,550 --> 02:01:34,159

holds independent of the process by

3452

02:01:38,629 --> 02:01:36,560

which you discover the truth

3453

02:01:40,390 --> 02:01:38,639

leads into contradictions

3454

02:01:42,229 --> 02:01:40,400

and this was what goodl had proven it

3455

02:01:44,550 --> 02:01:42,239

basically means that the sentence that

3456

02:01:46,629 --> 02:01:44,560

is true under these assumptions is also

3457

02:01:47,910 --> 02:01:46,639

false under these assumptions so it

3458

02:01:50,629 --> 02:01:47,920

cannot be true and this is where

3459

02:01:52,550 --> 02:01:50,639

undecidability comes in it just it's not

3460

02:01:54,310 --> 02:01:52,560

just about that some sentences are not

3461

02:01:56,550 --> 02:01:54,320

reachable because you don't know whether

3462

02:01:58,709 --> 02:01:56,560

they're true or false it also means that

3463

02:02:00,470 --> 02:01:58,719

there are some sentences that are true

3464

02:02:02,310 --> 02:02:00,480

and false at the same time

3465

02:02:04,310 --> 02:02:02,320

but if you have to find true inside

3466

02:02:06,709 --> 02:02:04,320

truth in such a way that it can that it

3467

02:02:08,550 --> 02:02:06,719

includes false falsity right something

3468

02:02:10,470 --> 02:02:08,560

is either true or false

3469

02:02:12,950 --> 02:02:10,480

if you have an excluded middle then this

3470

02:02:14,709 --> 02:02:12,960

cannot be the case so this is a very bad

3471

02:02:17,510 --> 02:02:14,719

result it just means that your language

3472

02:02:19,910 --> 02:02:17,520

is not working it gets to illegal states

3473

02:02:22,149 --> 02:02:19,920

it just means that the application of

3474

02:02:24,709 --> 02:02:22,159

steps that you have prescribed in your

3475

02:02:26,870 --> 02:02:24,719

logic if you apply them properly leads

3476

02:02:28,470 --> 02:02:26,880

to an undefined result

3477

02:02:30,310 --> 02:02:28,480

it means that your

3478

02:02:32,390 --> 02:02:30,320

language is seg-faulting it means your

3479

02:02:34,229 --> 02:02:32,400

mind is breaking apart it means that the

3480

02:02:36,470 --> 02:02:34,239

thoughts that you are thinking no longer

3481

02:02:37,589 --> 02:02:36,480

have meaning because they can no longer

3482

02:02:41,510 --> 02:02:37,599

point to anything that could be

3483

02:02:45,990 --> 02:02:43,910

okay so don't do the question that i asked

3484

02:02:48,229 --> 02:02:46,000

before was let's imagine that

3485

02:02:50,709 --> 02:02:48,239

intuitionist logic is correct how does

3486

02:02:53,990 --> 02:02:50,719

your theory change

3487

02:02:54,000 --> 02:02:57,669

i mean i could easily

3488

02:03:01,750 --> 02:02:59,589

implement the theory of conscious agents

3489

02:03:04,550 --> 02:03:01,760

you know in an intuitionist logic kind

3490

02:03:06,229 --> 02:03:04,560

of approach and and run it that way so

3491

02:03:07,990 --> 02:03:06,239

that that wouldn't really change my my

3492

02:03:11,830 --> 02:03:08,000

theory of conscious agents

3493

02:03:15,510 --> 02:03:12,830

my

3494

02:03:17,589 --> 02:03:15,520

own thinking on this i guess does differ

3495

02:03:19,350 --> 02:03:17,599

from yoshi's in in an interesting way

3496

02:03:21,750 --> 02:03:19,360

here and that that is

3497

02:03:23,750 --> 02:03:21,760

i do take girdles

3498

02:03:25,350 --> 02:03:23,760

result

3499

02:03:27,030 --> 02:03:25,360

not not necessarily to show that the

3500

02:03:30,709 --> 02:03:27,040

notion of continuity

3501

02:03:31,510 --> 02:03:30,719

is is nonsense or contradictory

3502

02:03:33,830 --> 02:03:31,520

but

3503

02:03:35,109 --> 02:03:33,840

rather that if i have a finite system of

3504

02:03:38,070 --> 02:03:35,119

axioms

3505

02:03:40,070 --> 02:03:38,080

in derivation rules

3506

02:03:41,589 --> 02:03:40,080

then

3507

02:03:44,310 --> 02:03:41,599

and you can look at the set of

3508

02:03:46,790 --> 02:03:44,320

statements that can be proven by that

3509

02:03:48,870 --> 02:03:46,800

system and then you can find statements

3510

02:03:51,189 --> 02:03:48,880

that that are not provable within the

3511

02:03:52,790 --> 02:03:51,199

system that so so they're undecidable

3512

02:03:56,709 --> 02:03:52,800

from within that system

3513

02:03:58,229 --> 02:03:56,719

but you can what what girdle did was to

3514

02:04:00,470 --> 02:03:58,239

to put a mapping

3515

02:04:03,030 --> 02:04:00,480

onto the the language of the system so

3516

02:04:05,030 --> 02:04:03,040

he could write down

3517

02:04:06,390 --> 02:04:05,040

an analogy as this douglas hofstadter

3518

02:04:08,629 --> 02:04:06,400

likes to talk about he he found an

3519

02:04:10,229 --> 02:04:08,639

analogy that he could write down where

3520

02:04:11,830 --> 02:04:10,239

there was this new sent there is a

3521

02:04:15,030 --> 02:04:11,840

sentence i could write down

3522

02:04:19,189 --> 02:04:15,040

that that says i am true

3523

02:04:23,189 --> 02:04:21,510

and that that doesn't seem to me to

3524

02:04:25,430 --> 02:04:23,199

require me going all the way off to in

3525

02:04:27,669 --> 02:04:25,440

to uncountable infinities and continuity

3526

02:04:29,510 --> 02:04:27,679

and so forth it's just saying i mean

3527

02:04:31,350 --> 02:04:29,520

here's the deflationary reading of

3528

02:04:33,510 --> 02:04:31,360

girdle it's just saying you give me any

3529

02:04:35,669 --> 02:04:33,520

computational system i'll find a

3530

02:04:37,189 --> 02:04:35,679

statement that that's true but can't be

3531

02:04:39,750 --> 02:04:37,199

derived from within that system

3532

02:04:42,069 --> 02:04:39,760

therefore any computation that you pick

3533

02:04:43,990 --> 02:04:42,079

um isn't the final word

3534

02:04:47,189 --> 02:04:44,000

i don't have to go all the way to you

3535

02:04:51,350 --> 02:04:49,109

uncountable sets and so forth i can just

3536

02:04:53,990 --> 02:04:51,360

i can just use that to say that the

3537

02:04:56,310 --> 02:04:54,000

computation can't be the final truth

3538

02:04:58,470 --> 02:04:56,320

um and so that would be uh

3539

02:05:02,310 --> 02:04:58,480

sort of the minimal way and

3540

02:05:06,470 --> 02:05:04,229

researchers have interpreted girdle but

3541

02:05:08,069 --> 02:05:06,480

but um i guess you should disagree on

3542

02:05:16,310 --> 02:05:08,079

that

3543

02:05:18,790 --> 02:05:16,320

after good language broke

3544

02:05:20,790 --> 02:05:18,800

well what you do is you take the the the

3545

02:05:23,189 --> 02:05:20,800

new statement

3546

02:05:24,550 --> 02:05:23,199

that that you showed was undecidable

3547

02:05:27,750 --> 02:05:24,560

within that

3548

02:05:29,189 --> 02:05:27,760

add it to your computational system

3549

02:05:31,669 --> 02:05:29,199

right every computational system has

3550

02:05:33,750 --> 02:05:31,679

axioms you don't compute without some

3551
02:05:35,430 --> 02:05:33,760
assumptions so your computation has to

3552
02:05:37,270 --> 02:05:35,440
have certain accents to begin with so

3553
02:05:39,430 --> 02:05:37,280
you add it to your accent it's now still

3554
02:05:41,270 --> 02:05:39,440
a finite set of axioms and now you say

3555
02:05:42,709 --> 02:05:41,280
okay now i'm good i i took that

3556
02:05:45,109 --> 02:05:42,719
undecidable sentence and i put it into

3557
02:05:46,709 --> 02:05:45,119
my set of axioms i'm good now i'm done

3558
02:05:48,069 --> 02:05:46,719
well no you're not now because girdle

3559
02:05:50,069 --> 02:05:48,079
comes back and says you know what i just

3560
02:05:51,990 --> 02:05:50,079
found another statement within your new

3561
02:05:53,910 --> 02:05:52,000
system and that's not computable so i'm

3562
02:05:55,589 --> 02:05:53,920
not getting anywhere near to these

3563
02:05:57,910 --> 02:05:55,599

uncountable infinities now wait wait

3564

02:05:59,589 --> 02:05:57,920

wait uh you're making a step too far

3565

02:06:01,430 --> 02:05:59,599

here i think you have just found this

3566

02:06:03,430 --> 02:06:01,440

procedure that discovers that something

3567

02:06:05,510 --> 02:06:03,440

is true that is not

3568

02:06:07,990 --> 02:06:05,520

true according to mathematics

3569

02:06:10,149 --> 02:06:08,000

so good is trying to find a foundation

3570

02:06:12,149 --> 02:06:10,159

for all of mathematics

3571

02:06:14,149 --> 02:06:12,159

and he does this by reducing the

3572

02:06:15,750 --> 02:06:14,159

mathematics that he's interested in to

3573

02:06:17,669 --> 02:06:15,760

piano arithmetic

3574

02:06:19,750 --> 02:06:17,679

and then computes all of mathematics in

3575

02:06:21,830 --> 02:06:19,760

piano arithmetic and discovers that he

3576

02:06:23,270 --> 02:06:21,840

cannot recover the semantics that he

3577

02:06:25,270 --> 02:06:23,280

wanted to discover

3578

02:06:26,709 --> 02:06:25,280

which was a platonic notion of truth one

3579

02:06:28,950 --> 02:06:26,719

that is independent of the state

3580

02:06:30,390 --> 02:06:28,960

sequence that he runs it through this is

3581

02:06:31,990 --> 02:06:30,400

the thing that you cannot recover and

3582

02:06:33,189 --> 02:06:32,000

you try to recover the original

3583

02:06:36,390 --> 02:06:33,199

mathematics

3584

02:06:39,030 --> 02:06:36,400

by extending uh the exomatic system

3585

02:06:41,270 --> 02:06:39,040

piano's axioms with an infinite sent a

3586

02:06:43,510 --> 02:06:41,280

set of arbitrary statements this doesn't

3587

02:06:45,189 --> 02:06:43,520

seem to be very elegant also of course

3588

02:06:46,550 --> 02:06:45,199

google shows that it doesn't terminate

3589

02:06:48,470 --> 02:06:46,560

it doesn't work it's not fixing

3590

02:06:51,830 --> 02:06:48,480

mathematics in any way

3591

02:06:53,830 --> 02:06:51,840

so uh you still have in the intuition

3592

02:06:55,990 --> 02:06:53,840

here that you have a procedure that

3593

02:06:58,709 --> 02:06:56,000

allows you to discover truth in ways

3594

02:07:00,629 --> 02:06:58,719

that gerda's procedure could not

3595

02:07:03,830 --> 02:07:00,639

and if you have that procedure you

3596

02:07:05,990 --> 02:07:03,840

should be able to prove that it's true

3597

02:07:07,910 --> 02:07:06,000

if you cannot prove that it's true i'm

3598

02:07:09,669 --> 02:07:07,920

not going to believe you

3599

02:07:12,149 --> 02:07:09,679

i don't think that the statements that

3600

02:07:15,030 --> 02:07:12,159

you think are true but my system cannot

3601
02:07:19,270 --> 02:07:17,030
right unless you can compute them right

3602
02:07:21,350 --> 02:07:19,280
so you have to show away and that would

3603
02:07:23,270 --> 02:07:21,360
force me as a rational uh

3604
02:07:25,189 --> 02:07:23,280
observer and colleague of yours that is

3605
02:07:27,270 --> 02:07:25,199
completely uh

3606
02:07:29,430 --> 02:07:27,280
terrible and so on and reasonable and

3607
02:07:30,950 --> 02:07:29,440
rational right to follow you there right

3608
02:07:33,750 --> 02:07:30,960
so if you can give me a rational

3609
02:07:34,870 --> 02:07:33,760
procedure then i expect that this

3610
02:07:37,030 --> 02:07:34,880
procedure

3611
02:07:39,510 --> 02:07:37,040
will be computational that it will there

3612
02:07:42,709 --> 02:07:39,520
will be a sequence of steps

3613
02:07:44,550 --> 02:07:42,719

that i can follow to see why your claim

3614

02:07:45,830 --> 02:07:44,560

that this sentence is true is actually

3615

02:07:47,910 --> 02:07:45,840

valid

3616

02:07:50,229 --> 02:07:47,920

if you cannot make such a claim i i

3617

02:07:52,870 --> 02:07:50,239

don't see how i can believe you

3618

02:07:54,629 --> 02:07:52,880

well so so the way the do i understand

3619

02:07:55,669 --> 02:07:54,639

girdle doing it is that he you know he

3620

02:07:56,790 --> 02:07:55,679

comes up with this whole girdle

3621

02:07:57,990 --> 02:07:56,800

numbering

3622

02:08:00,069 --> 02:07:58,000

approach

3623

02:08:03,270 --> 02:08:00,079

and he he takes you through and and

3624

02:08:05,430 --> 02:08:03,280

shows you this this mapping from the

3625

02:08:07,350 --> 02:08:05,440

from the numbers into these girdle

3626

02:08:09,030 --> 02:08:07,360

numbers that are making statements about

3627

02:08:10,550 --> 02:08:09,040

the numbers themselves

3628

02:08:12,550 --> 02:08:10,560

and you look at that and you go yeah

3629

02:08:14,229 --> 02:08:12,560

okay bye i understand that mapping

3630

02:08:16,069 --> 02:08:14,239

that's perfectly fine

3631

02:08:18,470 --> 02:08:16,079

and now i can write down within that

3632

02:08:20,709 --> 02:08:18,480

mapping i can write down this number

3633

02:08:23,350 --> 02:08:20,719

and when i look at the interpretation of

3634

02:08:25,669 --> 02:08:23,360

that number under this mapping

3635

02:08:29,430 --> 02:08:25,679

the the number says

3636

02:08:32,790 --> 02:08:29,440

i am true but not provable within piano

3637

02:08:35,109 --> 02:08:32,800

and so so now um i mean at this point i

3638

02:08:37,830 --> 02:08:35,119

sort of agree with roger penrose

3639

02:08:39,830 --> 02:08:37,840

penrose looks at that and says okay that

3640

02:08:41,350 --> 02:08:39,840

that means that there is something true

3641

02:08:43,750 --> 02:08:41,360

here

3642

02:08:46,470 --> 02:08:43,760

um i can see that it's true it's i i

3643

02:08:48,390 --> 02:08:46,480

don't disbelieve i mean i saw the whole

3644

02:08:50,709 --> 02:08:48,400

girdle numbering construction

3645

02:08:52,950 --> 02:08:50,719

i saw how the sentence came to say what

3646

02:08:54,629 --> 02:08:52,960

it says and i agree that it's that that

3647

02:08:56,310 --> 02:08:54,639

it's all consistent

3648

02:08:58,069 --> 02:08:56,320

and what it's saying

3649

02:08:59,750 --> 02:08:58,079

is saying that it's true and not

3650

02:09:00,470 --> 02:08:59,760

provable

3651

02:09:04,950 --> 02:09:00,480

so

3652

02:09:07,030 --> 02:09:04,960

point i

3653

02:09:09,510 --> 02:09:07,040

i guess i sort of agree with penrose at

3654

02:09:11,830 --> 02:09:09,520

that point i go okay there's something

3655

02:09:12,790 --> 02:09:11,840

beyond the notion of

3656

02:09:15,030 --> 02:09:12,800

proof

3657

02:09:17,430 --> 02:09:15,040

beyond the notion of derivation that's

3658

02:09:18,790 --> 02:09:17,440

going on here there's the looking at

3659

02:09:24,310 --> 02:09:18,800

analogies

3660

02:09:26,550 --> 02:09:24,320

that where we go this this sentence is

3661

02:09:29,430 --> 02:09:26,560

clearly true and it's also by its own

3662

02:09:31,030 --> 02:09:29,440

statement its own declaration that it's

3663

02:09:33,270 --> 02:09:31,040

not provable within

3664

02:09:34,790 --> 02:09:33,280

within this this finite computational

3665

02:09:37,270 --> 02:09:34,800

system yeah

3666

02:09:39,830 --> 02:09:37,280

perros is fascinating he thinks that our

3667

02:09:42,709 --> 02:09:39,840

brains are physical systems and he also

3668

02:09:45,030 --> 02:09:42,719

thinks that our mental processes are

3669

02:09:47,430 --> 02:09:45,040

generated by the brain probably

3670

02:09:48,950 --> 02:09:47,440

but that our brains can do mathematics

3671

02:09:51,589 --> 02:09:48,960

that go beyond the mathematics that

3672

02:09:53,669 --> 02:09:51,599

computers can do that is a very specific

3673

02:09:55,350 --> 02:09:53,679

statement that is more concrete i think

3674

02:09:58,709 --> 02:09:55,360

specific than what you've said so far

3675

02:10:01,109 --> 02:09:58,719

sure and uh it leads him to uh

3676

02:10:03,109 --> 02:10:01,119

to if a weird spot which is quite lonely

3677

02:10:04,790 --> 02:10:03,119

at the moment but i i find this

3678

02:10:06,950 --> 02:10:04,800

nevertheless a very interesting argument

3679

02:10:08,390 --> 02:10:06,960

to make i'm uh afraid we will not be

3680

02:10:10,709 --> 02:10:08,400

able to resolve it today because i have

3681

02:10:12,310 --> 02:10:10,719

to drop now yeah but

3682

02:10:14,149 --> 02:10:12,320

i found it very interesting to see that

3683

02:10:15,109 --> 02:10:14,159

you are appendrosis at the end of the

3684

02:10:17,669 --> 02:10:15,119

day

3685

02:10:19,430 --> 02:10:17,679

well um i don't like the microtubules

3686

02:10:21,109 --> 02:10:19,440

theory you know i don't like the the

3687

02:10:23,109 --> 02:10:21,119

non-competitive clusters

3688

02:10:25,510 --> 02:10:23,119

he's not really to be blamed for this i

3689

02:10:28,229 --> 02:10:25,520

suspect that his reasoning is that since

3690

02:10:30,390 --> 02:10:28,239

all neuron physics is computational

3691

02:10:33,189 --> 02:10:30,400

these basically takes a state and then

3692

02:10:35,350 --> 02:10:33,199

there is a transition between the states

3693

02:10:36,870 --> 02:10:35,360

the uh resolution for what consciousness

3694

02:10:38,709 --> 02:10:36,880

where it comes from

3695

02:10:40,870 --> 02:10:38,719

if the consciousness is enabling us to

3696

02:10:43,350 --> 02:10:40,880

do things that computers cannot needs to

3697

02:10:46,470 --> 02:10:43,360

be in an unknown area of physics and the

3698

02:10:48,149 --> 02:10:46,480

unknown area of physics that's left

3699

02:10:49,750 --> 02:10:48,159

reasoning in the same way as sherlock

3700

02:10:52,229 --> 02:10:49,760

holmes if you actually exclude all the

3701

02:10:54,310 --> 02:10:52,239

possibilities the only remaining thing

3702

02:10:56,069 --> 02:10:54,320

must be the truth right that's quantum

3703

02:10:57,990 --> 02:10:56,079

gravity because there is no generally

3704

02:11:00,149 --> 02:10:58,000

accepted theory of quantum gravity right

3705

02:11:02,069 --> 02:11:00,159

right and then it just so happens that

3706

02:11:05,589 --> 02:11:02,079

uh hammer off has this beautiful

3707

02:11:07,750 --> 02:11:05,599

psychedelic uh theory of uh how to get

3708

02:11:09,910 --> 02:11:07,760

the microtubules to have non-local

3709

02:11:11,669 --> 02:11:09,920

interactions that employ quantum

3710

02:11:13,669 --> 02:11:11,679

gravities in a way that nobody really

3711

02:11:16,629 --> 02:11:13,679

understands right right and this might

3712

02:11:17,910 --> 02:11:16,639

be in this corner and so uh they they

3713

02:11:20,790 --> 02:11:17,920

become friends

3714

02:11:22,310 --> 02:11:20,800

but i don't think that penrose theory is

3715

02:11:25,030 --> 02:11:22,320

exactly the same thing as hammer of

3716

02:11:26,229 --> 02:11:25,040

theory right right right and i'm not

3717

02:11:27,589 --> 02:11:26,239

talking about that more general theory

3718

02:11:29,350 --> 02:11:27,599

of consciousness i'm just talking about

3719

02:11:30,870 --> 02:11:29,360

his specific analysis of girdles

3720

02:11:32,550 --> 02:11:30,880

incompleteness theorem and what it means

3721

02:11:34,470 --> 02:11:32,560

for mathematics yes

3722

02:11:36,310 --> 02:11:34,480

and it's basically uh also something

3723

02:11:39,030 --> 02:11:36,320

that uh chomsky is affirming to in which

3724

02:11:41,030 --> 02:11:39,040

leads trump's chomsky to mysterianism so

3725

02:11:42,629 --> 02:11:41,040

basically they were confronted with the

3726

02:11:46,470 --> 02:11:42,639

same

3727

02:11:48,870 --> 02:11:46,480

that human brains can do things that

3728

02:11:51,109 --> 02:11:48,880

mathematics cannot

3729

02:11:53,510 --> 02:11:51,119

that mathematicians can make proofs that

3730

02:11:55,189 --> 02:11:53,520

computers and principle cannot make that

3731

02:11:57,510 --> 02:11:55,199

they discover that certain statements

3732

02:11:59,669 --> 02:11:57,520

are true that in a computable exomatic

3733

02:12:01,750 --> 02:11:59,679

system cannot be derived and this was

3734

02:12:03,990 --> 02:12:01,760

also what my question was pointing out

3735

02:12:05,669 --> 02:12:04,000

at uh how do you know that something is

3736

02:12:07,109 --> 02:12:05,679

true there if you cannot go show me a

3737

02:12:10,069 --> 02:12:07,119

sequence of steps

3738

02:12:12,629 --> 02:12:10,079

that that does it right and so uh

3739

02:12:13,430 --> 02:12:12,639

penrose and uh

3740

02:12:16,069 --> 02:12:13,440

thinks

3741

02:12:16,790 --> 02:12:16,079

that there must be unknown physics

3742

02:12:18,709 --> 02:12:16,800

and

3743

02:12:20,310 --> 02:12:18,719

um swamski things it cannot be

3744

02:12:23,830 --> 02:12:20,320

understood in principle which might be

3745

02:12:26,149 --> 02:12:23,840

the same thing at the end of the day

3746

02:12:27,669 --> 02:12:26,159

right like i guess we will have to go

3747

02:12:30,149 --> 02:12:27,679

i'll just say

3748

02:12:31,589 --> 02:12:30,159

our basic understanding of the axioms

3749

02:12:33,189 --> 02:12:31,599

itself

3750

02:12:35,109 --> 02:12:33,199

then maybe one thing to

3751

02:12:36,629 --> 02:12:35,119

how do i understand the basic axioms

3752

02:12:38,310 --> 02:12:36,639

that are the foundation of the

3753

02:12:39,990 --> 02:12:38,320

computational system where does that

3754

02:12:41,589 --> 02:12:40,000

understanding come from is that from

3755

02:12:43,030 --> 02:12:41,599

within the computational system or does

3756

02:12:44,870 --> 02:12:43,040

that ex does that escape the

3757

02:12:47,189 --> 02:12:44,880

computational system

3758

02:12:49,830 --> 02:12:47,199

from my own perspective it's

3759

02:12:51,990 --> 02:12:49,840

the case that my mind is constructing a

3760

02:12:53,830 --> 02:12:52,000

model of reality where the reality that

3761

02:12:56,149 --> 02:12:53,840

i found myself to be in is something

3762

02:12:57,669 --> 02:12:56,159

like a physics engine in which my own

3763

02:13:00,229 --> 02:12:57,679

conscious self

3764

02:13:02,709 --> 02:13:00,239

acts as a puppet as a simulacrum that is

3765

02:13:04,229 --> 02:13:02,719

being used to tell the story about an

3766

02:13:06,229 --> 02:13:04,239

intelligent agent

3767

02:13:08,310 --> 02:13:06,239

and i don't see any limitations in my

3768

02:13:10,550 --> 02:13:08,320

ability to make models that could

3769

02:13:13,430 --> 02:13:10,560

produce such an agent that would find

3770

02:13:14,870 --> 02:13:13,440

itself in this world and associate a set

3771

02:13:17,669 --> 02:13:14,880

of

3772

02:13:19,750 --> 02:13:17,679

valence presets with um

3773

02:13:21,030 --> 02:13:19,760

a garlic and another one

3774

02:13:21,830 --> 02:13:21,040

with sunlight

3775

02:13:23,270 --> 02:13:21,840

and

3776

02:13:25,990 --> 02:13:23,280

that happens entirely through the

3777

02:13:27,990 --> 02:13:26,000

relational nature of my unified model of

3778

02:13:30,069 --> 02:13:28,000

the universe that is being derived by

3779

02:13:32,470 --> 02:13:30,079

completely non nefarious computation

3780

02:13:34,550 --> 02:13:32,480

that are approximated in nervous systems

3781

02:13:37,270 --> 02:13:34,560

right so i don't see where i currently

3782

02:13:39,109 --> 02:13:37,280

stand uh that this doesn't work out

3783

02:13:40,870 --> 02:13:39,119

and i uh

3784

02:13:42,709 --> 02:13:40,880

very sympathetic to

3785

02:13:44,229 --> 02:13:42,719

when you don't see this

3786

02:13:46,069 --> 02:13:44,239

that it doesn't work out and that you

3787

02:13:48,310 --> 02:13:46,079

have to uh think that you have to find

3788

02:13:49,669 --> 02:13:48,320

the truth elsewhere and it could be that

3789

02:13:51,510 --> 02:13:49,679

i am going to change my mind in the

3790

02:13:54,229 --> 02:13:51,520

future when i stumble on something that

3791

02:13:56,229 --> 02:13:54,239

basically shows to me that that what i'm

3792

02:13:59,510 --> 02:13:56,239

intellectually trying doesn't work so as

3793

02:14:00,950 --> 02:13:59,520

far it seems to work and uh i appreciate

3794

02:14:02,390 --> 02:14:00,960

that we have this difference in our

3795

02:14:04,149 --> 02:14:02,400

perspectives because it's a very

3796

02:14:05,990 --> 02:14:04,159

productive and useful one to have

3797

02:14:07,910 --> 02:14:06,000

absolutely i've really appreciated the

3798

02:14:10,950 --> 02:14:07,920

the tenor of the conversation too very

3799

02:14:12,390 --> 02:14:10,960

very much so i i would just say my last

3800

02:14:13,830 --> 02:14:12,400

thought on this would be that

3801

02:14:16,149 --> 02:14:13,840

the what i would love to see from a

3802

02:14:17,910 --> 02:14:16,159

computational system on consciousness is

3803

02:14:19,750 --> 02:14:17,920

the associated association you just

3804

02:14:22,229 --> 02:14:19,760

talked about between the computation and

3805

02:14:24,830 --> 02:14:22,239

say the taste of garlic

3806

02:14:27,589 --> 02:14:24,840

is it principled or is it arbitrary that

3807

02:14:30,470 --> 02:14:27,599

association if it's arbitrary it's then

3808

02:14:34,069 --> 02:14:30,480

i'm not yes it's it's not arbitrary it's

3809

02:14:35,830 --> 02:14:34,079

related to uh the valence of the taste

3810

02:14:37,270 --> 02:14:35,840

receptors that you have so it might be

3811

02:14:39,589 --> 02:14:37,280

arbitrary in the sense that some people

3812

02:14:41,350 --> 02:14:39,599

hate garlic and other people love garlic

3813

02:14:42,950 --> 02:14:41,360

so the garlic will taste different to

3814

02:14:44,550 --> 02:14:42,960

them this means they will have a

3815

02:14:46,390 --> 02:14:44,560

different experience when they taste

3816

02:14:48,390 --> 02:14:46,400

garlic because the relations of the

3817

02:14:49,510 --> 02:14:48,400

taste of garlic will be different to the

3818

02:14:51,430 --> 02:14:49,520

uh

3819

02:14:53,830 --> 02:14:51,440

to the entire world model that they have

3820

02:14:55,589 --> 02:14:53,840

than they are to other people so they

3821

02:14:57,669 --> 02:14:55,599

basically the types of receptors that we

3822

02:14:59,510 --> 02:14:57,679

have in the valence that they imply

3823

02:15:02,149 --> 02:14:59,520

and the type of self model that we have

3824

02:15:03,830 --> 02:15:02,159

so in which way has the mind constructed

3825

02:15:06,149 --> 02:15:03,840

itself that is entangled with its

3826
02:15:08,470 --> 02:15:06,159
universe around it what is that boundary

3827
02:15:10,629 --> 02:15:08,480
what is the set points that are marking

3828
02:15:12,950 --> 02:15:10,639
this boundary that keeps the self stable

3829
02:15:14,709 --> 02:15:12,960
this is going to shape and alter the

3830
02:15:16,709 --> 02:15:14,719
perception but i don't think that there

3831
02:15:19,589 --> 02:15:16,719
is an intrinsic essence of perception

3832
02:15:22,550 --> 02:15:19,599
beyond the relations that we establish

3833
02:15:24,470 --> 02:15:22,560
between perceptual patterns and our

3834
02:15:25,910 --> 02:15:24,480
models of reality

3835
02:15:28,550 --> 02:15:25,920
so there'll always be the question why

3836
02:15:30,790 --> 02:15:28,560
should this computational

3837
02:15:32,790 --> 02:15:30,800
process

3838
02:15:34,790 --> 02:15:32,800

independent of valence be the taste of

3839

02:15:37,270 --> 02:15:34,800

garlic why couldn't have been the taste

3840

02:15:39,510 --> 02:15:37,280

of chocolate i would want a principled

3841

02:15:40,550 --> 02:15:39,520

answer to why is this computational

3842

02:15:42,470 --> 02:15:40,560

process

3843

02:15:44,390 --> 02:15:42,480

necessarily the taste of garlic why

3844

02:15:47,189 --> 02:15:44,400

isn't it the taste of chocolate because

3845

02:15:50,470 --> 02:15:47,199

one is affiliated to garlic and the

3846

02:15:52,310 --> 02:15:50,480

other one is associated to chocolate

3847

02:15:55,189 --> 02:15:52,320

but i'm talking about the the conscious

3848

02:15:57,430 --> 02:15:55,199

experience of the taste of oh well uh

3849

02:15:58,709 --> 02:15:57,440

chocolate is sweet for the most part and

3850

02:16:00,709 --> 02:15:58,719

garlic is not

3851

02:16:03,510 --> 02:16:00,719

so this is one of the dimensions in

3852

02:16:05,350 --> 02:16:03,520

which the features vary and uh sweetness

3853

02:16:06,709 --> 02:16:05,360

is perceived as a pleasant under some

3854

02:16:09,430 --> 02:16:06,719

circumstances when you need certain

3855

02:16:11,669 --> 02:16:09,440

types of nutrients and uh the soreness

3856

02:16:13,669 --> 02:16:11,679

and bitterness and sharpness of garlic

3857

02:16:15,910 --> 02:16:13,679

is associated with other things that you

3858

02:16:18,069 --> 02:16:15,920

might need or dislike at certain moments

3859

02:16:20,629 --> 02:16:18,079

so this the valence is crucial that you

3860

02:16:23,030 --> 02:16:20,639

get and they are basically um hundreds

3861

02:16:25,910 --> 02:16:23,040

or thousands or um tens of thousands of

3862

02:16:28,470 --> 02:16:25,920

valence dimensions that specify how we

3863

02:16:30,950 --> 02:16:28,480

perceive this texture of the pattern

3864

02:16:32,709 --> 02:16:30,960

that uh but the resolution the structure

3865

02:16:35,910 --> 02:16:32,719

of the pattern and so on is entirely

3866

02:16:37,110 --> 02:16:35,920

given by its its relational nature

3867

02:16:38,870 --> 02:16:37,120

i don't think that doesn't present

3868

02:16:40,549 --> 02:16:38,880

beyond the relations sound like well

3869

02:16:43,030 --> 02:16:40,559

this this is the story of a whole other

3870

02:16:44,389 --> 02:16:43,040

round one take care everyone thank you

3871

02:16:45,669 --> 02:16:44,399

so much

3872

02:16:47,270 --> 02:16:45,679

thank you too

3873

02:16:49,509 --> 02:16:47,280

good dog you enjoyed this thank you very

3874

02:16:51,349 --> 02:16:49,519

much it's plenty of fun and the audience

3875

02:16:54,389 --> 02:16:51,359

is all saying thank you as well i think

3876

02:16:55,910 --> 02:16:54,399

there were about a thousand people well

3877

02:16:57,910 --> 02:16:55,920

thank you very much

3878

02:17:00,549 --> 02:16:57,920

thanks everyone thank you joshua please

3879

02:17:02,150 --> 02:17:00,559

send me the mp3 if you don't mind

3880

02:17:04,150 --> 02:17:02,160

okay dawn i don't know if you still are

3881

02:17:07,429 --> 02:17:04,160

recording yours bye-bye

3882

02:17:08,709 --> 02:17:07,439

okay bye-bye take care

3883

02:17:10,309 --> 02:17:08,719

thank you all thank you all thank you

3884

02:17:12,230 --> 02:17:10,319

all so much for being here

3885

02:17:14,709 --> 02:17:12,240

it was plenty of fun there's plenty to

3886

02:17:16,469 --> 02:17:14,719

talk about for a round two whenever that

3887

02:17:19,750 --> 02:17:16,479

occurs maybe toward the end of the

3888

02:17:24,070 --> 02:17:19,760

summer or the middle of summer we'll see

3889

02:17:27,669 --> 02:17:25,990

the podcast is now finished if you'd

3890

02:17:30,870 --> 02:17:27,679

like to support conversations like this

3891

02:17:33,790 --> 02:17:30,880

then do consider going to patreon.com

3892

02:17:38,629 --> 02:17:36,870

j-a-i-m-u-n-g-a-l that is kurt jaimungle

3893

02:17:40,230 --> 02:17:38,639

it's support from the patrons and from

3894

02:17:41,830 --> 02:17:40,240

the sponsors that allow me to do this