

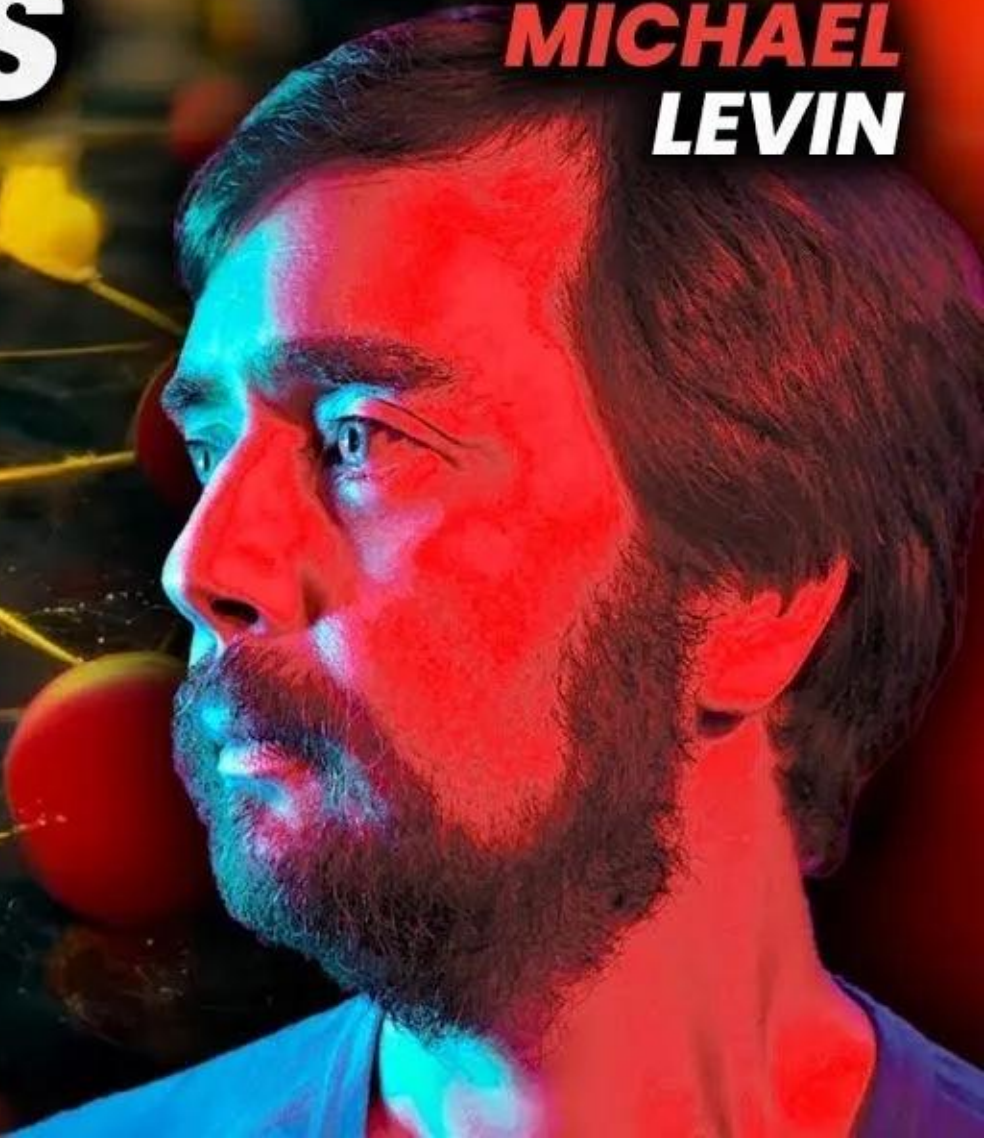
OUR CONNECTED

**JOSCHA
BACH**

MINDS

**MICHAEL
LEVIN**

ROUND 1



1
00:00:03,710 --> 00:00:01,850
Michael Levin's work on regulating

2
00:00:05,329 --> 00:00:03,720
intractable pattern formation in living

3
00:00:07,610 --> 00:00:05,339
systems has made him one of the most

4
00:00:09,169 --> 00:00:07,620
compelling biologists of our time in

5
00:00:10,549 --> 00:00:09,179
Translation this means that his team is

6
00:00:12,530 --> 00:00:10,559
sussing out how to develop limbs

7
00:00:14,629 --> 00:00:12,540
regenerate limbs how to generate minds

8
00:00:16,730 --> 00:00:14,639
and even life extension by manipulating

9
00:00:18,410 --> 00:00:16,740
electric signals rather than genetics or

10
00:00:20,090 --> 00:00:18,420
epigenetics his work is something that I

11
00:00:21,109 --> 00:00:20,100
consider to be worthy of a Nobel Prize

12
00:00:23,150 --> 00:00:21,119
and I don't think I've said that about

13
00:00:24,950 --> 00:00:23,160

anyone on the podcast Michael Levin's

14

00:00:26,509 --> 00:00:24,960

previous podcast on toe is in the

15

00:00:28,070 --> 00:00:26,519

description that's a solo episode with

16

00:00:30,170 --> 00:00:28,080

him where we go into a two-hour Deep

17

00:00:31,910 --> 00:00:30,180

dive as well as there's a Theo locution

18

00:00:34,010 --> 00:00:31,920

so that is him and another guest just

19

00:00:35,510 --> 00:00:34,020

like today except between Carl friston

20

00:00:37,610 --> 00:00:35,520

and Chris fields on Consciousness

21

00:00:39,590 --> 00:00:37,620

yoshibak is widely considered to be the

22

00:00:41,569 --> 00:00:39,600

Pinnacle of an AI researcher dealing

23

00:00:44,150 --> 00:00:41,579

with emotion modeling and multi-agent

24

00:00:46,190 --> 00:00:44,160

systems a large focus of boxes to build

25

00:00:48,049 --> 00:00:46,200

a model of the Mind from strong AI

26
00:00:50,029 --> 00:00:48,059
speaking of Mind Bach is one of the most

27
00:00:51,950 --> 00:00:50,039
inventive Minds in the field of computer

28
00:00:53,750 --> 00:00:51,960
science and has appeared several times

29
00:00:55,610 --> 00:00:53,760
on toll prior again there's a solo

30
00:00:57,470 --> 00:00:55,620
episode there's also a theologution

31
00:00:59,090 --> 00:00:57,480
between yoshibak and Donald Hoffman on

32
00:01:01,970 --> 00:00:59,100
Consciousness and yo shabach and John

33
00:01:03,830 --> 00:01:01,980
vervaki also on in reality biology has

34
00:01:05,690 --> 00:01:03,840
much to teach us about artificial

35
00:01:07,310 --> 00:01:05,700
intelligence and vice versa this

36
00:01:08,570 --> 00:01:07,320
discussion between two brilliant

37
00:01:09,710 --> 00:01:08,580
researchers is something that I'm

38
00:01:12,170 --> 00:01:09,720

extremely

39

00:01:14,570 --> 00:01:12,180

lucky blessed fortunate to be a part of

40

00:01:15,830 --> 00:01:14,580

as well as us as collective as an

41

00:01:17,570 --> 00:01:15,840

audience that are fortunate enough to

42

00:01:19,730 --> 00:01:17,580

witness approximately 30 minutes into

43

00:01:22,310 --> 00:01:19,740

the conversation you'll see two sponsors

44

00:01:24,410 --> 00:01:22,320

they are Masterworks and Roman I implore

45

00:01:26,330 --> 00:01:24,420

you not to skip it as firstly watching

46

00:01:27,890 --> 00:01:26,340

it supports toe directly and then

47

00:01:29,990 --> 00:01:27,900

secondly they're fascinating companies

48

00:01:31,850 --> 00:01:30,000

in and of themselves additionally you'll

49

00:01:33,890 --> 00:01:31,860

hear from one more Trade coffee around

50

00:01:35,630 --> 00:01:33,900

the one and a half hour mark thank you

51
00:01:38,929 --> 00:01:35,640
and enjoy this theolocution between

52
00:01:41,090 --> 00:01:38,939
yoshabak and Michael Levin welcome both

53
00:01:42,649 --> 00:01:41,100
Professor Michael Evan and yoshabak it's

54
00:01:44,210 --> 00:01:42,659
an honor to have you on the toll podcast

55
00:01:46,069 --> 00:01:44,220
again both of you and then together

56
00:01:47,030 --> 00:01:46,079
right now thank you it's great to be

57
00:01:51,830 --> 00:01:47,040
here

58
00:01:53,330 --> 00:01:51,840
and look forward to this conversation I

59
00:01:55,910 --> 00:01:53,340
look forward to it as well so we'll

60
00:01:57,590 --> 00:01:55,920
start off with the question of what is

61
00:01:59,749 --> 00:01:57,600
it that you Michael find most

62
00:02:01,910 --> 00:01:59,759
interesting about yosho's work and then

63
00:02:03,230 --> 00:02:01,920

Yoshi will go for you toward Michael

64

00:02:05,870 --> 00:02:03,240

yeah

65

00:02:07,249 --> 00:02:05,880

um I really enjoy the uh the breadth so

66

00:02:08,930 --> 00:02:07,259

so I've been looking I think I've

67

00:02:10,609 --> 00:02:08,940

probably read almost everything on your

68

00:02:12,830 --> 00:02:10,619

on your website you know the short kind

69

00:02:15,830 --> 00:02:12,840

of blog pieces and everything and uh

70

00:02:17,990 --> 00:02:15,840

yeah I'm I'm uh I'm I'm a big fan of of

71

00:02:19,970 --> 00:02:18,000

the breadth of of tackling a lot of the

72

00:02:22,790 --> 00:02:19,980

different issues that you do with

73

00:02:25,369 --> 00:02:22,800

respect to uh you know computation and

74

00:02:27,050 --> 00:02:25,379

and cognition and Ai and uh you know and

75

00:02:28,729 --> 00:02:27,060

ethics and everything I I really like

76

00:02:32,270 --> 00:02:28,739

that aspect of it so

77

00:02:36,470 --> 00:02:32,280

then you're sure yeah my apologies my

78

00:02:39,229 --> 00:02:36,480

blog is not up to date I haven't uh

79

00:02:40,670 --> 00:02:39,239

done any updates for a few years now on

80

00:02:44,449 --> 00:02:40,680

it I think

81

00:02:46,610 --> 00:02:44,459

um so of course I'm still in the Pro

82

00:02:50,449 --> 00:02:46,620

process of progressing and having new

83

00:02:53,630 --> 00:02:50,459

ideas and the ideas that I had in recent

84

00:02:55,430 --> 00:02:53,640

years I have a great overlap with a lot

85

00:02:59,930 --> 00:02:55,440

of the things that you are working on

86

00:03:02,030 --> 00:02:59,940

and when I listen to your Lex podcast

87

00:03:04,850 --> 00:03:02,040

last night there were many thoughts that

88

00:03:05,630 --> 00:03:04,860

you had that I had stumbled on

89

00:03:07,670 --> 00:03:05,640

um

90

00:03:09,170 --> 00:03:07,680

uh that I've never heard from anybody

91

00:03:11,030 --> 00:03:09,180

else and so I found this very

92

00:03:12,770 --> 00:03:11,040

fascinating and thought

93

00:03:14,449 --> 00:03:12,780

um maybe let's look at some of these

94

00:03:16,009 --> 00:03:14,459

thoughts first and then go from there

95

00:03:19,670 --> 00:03:16,019

and expand

96

00:03:22,610 --> 00:03:19,680

um Beyond those ideas but uh I for

97

00:03:23,869 --> 00:03:22,620

instance found after thinking about how

98

00:03:25,790 --> 00:03:23,879

cells work

99

00:03:27,530 --> 00:03:25,800

kind of obvious but missed by most

100

00:03:29,930 --> 00:03:27,540

people in Neuroscience or in science in

101
00:03:33,290 --> 00:03:29,940
general is that every cell has the

102
00:03:35,509 --> 00:03:33,300
ability to send multiple message types

103
00:03:37,190 --> 00:03:35,519
and receive multiple message types and

104
00:03:38,750 --> 00:03:37,200
do this conditionally and learn an

105
00:03:41,210 --> 00:03:38,760
average conditions to do that and to

106
00:03:43,430 --> 00:03:41,220
modulate this also every cell is an

107
00:03:45,170 --> 00:03:43,440
individual reinforcement learning agent

108
00:03:47,210 --> 00:03:45,180
single-sided animal that tries to

109
00:03:48,890 --> 00:03:47,220
survive by cooperating with its

110
00:03:50,210 --> 00:03:48,900
environment gets most of its rewards

111
00:03:53,750 --> 00:03:50,220
from its environment

112
00:03:55,789 --> 00:03:53,760
and as a result this means that every

113
00:03:58,490 --> 00:03:55,799

cell can in principle function like a

114

00:04:00,289 --> 00:03:58,500

neuron it can fulfill the same learning

115

00:04:02,690 --> 00:04:00,299

and information processing tasks as a

116

00:04:04,550 --> 00:04:02,700

new one the only difference that exists

117

00:04:07,550 --> 00:04:04,560

with respect to neurons or the main

118

00:04:09,589 --> 00:04:07,560

difference is that they cannot do this

119

00:04:12,589 --> 00:04:09,599

over very long distances because they

120

00:04:14,750 --> 00:04:12,599

are mostly connected only to the cells

121

00:04:16,729 --> 00:04:14,760

that are directly adjacent of course new

122

00:04:18,710 --> 00:04:16,739

ones also only communicate to adjacent

123

00:04:20,569 --> 00:04:18,720

cells but the adjacency of neurons is

124

00:04:22,610 --> 00:04:20,579

such that they have Excellence parts of

125

00:04:24,950 --> 00:04:22,620

the cell that reach very far through the

126

00:04:28,189 --> 00:04:24,960

organism so in some sense in your one is

127

00:04:31,310 --> 00:04:28,199

a telegraph cell that uses very specific

128

00:04:33,530 --> 00:04:31,320

messages that are encoded in a way like

129

00:04:35,330 --> 00:04:33,540

Morsi signals in extremely short high

130

00:04:37,129 --> 00:04:35,340

energy bursts that allow to send

131

00:04:40,490 --> 00:04:37,139

messages over the very long distances

132

00:04:42,830 --> 00:04:40,500

very quickly to move the muscles of an

133

00:04:43,790 --> 00:04:42,840

animal at the limit of what physics

134

00:04:45,770 --> 00:04:43,800

allows

135

00:04:48,350 --> 00:04:45,780

so it can compete with other animals and

136

00:04:50,030 --> 00:04:48,360

search for food and in order to make

137

00:04:52,010 --> 00:04:50,040

that happen it also needs to have a

138

00:04:54,110 --> 00:04:52,020

model of the world that gets updated at

139

00:04:56,330 --> 00:04:54,120

this higher rate so there is going to be

140

00:04:58,909 --> 00:04:56,340

an information processing system that is

141

00:05:00,230 --> 00:04:58,919

duplicating basically this cellular

142

00:05:03,230 --> 00:05:00,240

brain that is made from all the other

143

00:05:04,610 --> 00:05:03,240

cells in the body of the organism and at

144

00:05:06,469 --> 00:05:04,620

some point these two systems get

145

00:05:09,110 --> 00:05:06,479

decoupled they have their own codes

146

00:05:11,810 --> 00:05:09,120

their own language so to speak and but

147

00:05:14,150 --> 00:05:11,820

it still makes sense I guess to see the

148

00:05:16,670 --> 00:05:14,160

brain as a telegraphic extension of the

149

00:05:19,430 --> 00:05:16,680

community of cells in the body and for

150

00:05:21,830 --> 00:05:19,440

me this insight that I stumbled on just

151
00:05:23,570 --> 00:05:21,840
because means and motive that Evolution

152
00:05:25,189 --> 00:05:23,580
would equip cells with doing that

153
00:05:27,770 --> 00:05:25,199
information processing if the organism

154
00:05:29,870 --> 00:05:27,780
is long enough lives long enough and if

155
00:05:31,790 --> 00:05:29,880
the cells share common genetic Destiny

156
00:05:34,189 --> 00:05:31,800
so they can get attuned to each other in

157
00:05:36,710 --> 00:05:34,199
an organism that basically every

158
00:05:39,890 --> 00:05:36,720
organism has the potential to become

159
00:05:43,550 --> 00:05:39,900
intelligent and if it gets old enough to

160
00:05:46,430 --> 00:05:43,560
process enough data to get to a very

161
00:05:49,010 --> 00:05:46,440
high degree of understanding of its

162
00:05:51,170 --> 00:05:49,020
environment in principle so of course a

163
00:05:53,810 --> 00:05:51,180

normal houseplant is not going to get

164

00:05:55,490 --> 00:05:53,820

very old with compared to us because the

165

00:05:57,890 --> 00:05:55,500

information processing is so much slower

166

00:06:00,409 --> 00:05:57,900

so they're not going to be very smart

167

00:06:02,210 --> 00:06:00,419

but at the level of ecosystems it's

168

00:06:04,310 --> 00:06:02,220

conceivable that there is quite

169

00:06:06,409 --> 00:06:04,320

considerable intelligence and then I

170

00:06:09,409 --> 00:06:06,419

stumbled on this notion that our

171

00:06:11,270 --> 00:06:09,419

ancestors thought that one day in

172

00:06:15,290 --> 00:06:11,280

Fairyland equals seven years in human

173

00:06:18,170 --> 00:06:15,300

land which is taught in the Artemis and

174

00:06:20,090 --> 00:06:18,180

also I just at some point I revised my

175

00:06:22,610 --> 00:06:20,100

notion of what the spirit is for

176

00:06:24,409 --> 00:06:22,620

instance is a spirit is it's an old bird

177

00:06:26,330 --> 00:06:24,419

for the operating system for an

178

00:06:29,029 --> 00:06:26,340

autonomous robot

179

00:06:31,010 --> 00:06:29,039

and the event this word was invented the

180

00:06:33,110 --> 00:06:31,020

um only autonomous robots that were

181

00:06:35,809 --> 00:06:33,120

known were people and plants and animals

182

00:06:38,029 --> 00:06:35,819

and nation states and ecosystems

183

00:06:41,510 --> 00:06:38,039

right whatever no robots built by people

184

00:06:44,629 --> 00:06:41,520

yet but uh there was this pattern of

185

00:06:46,550 --> 00:06:44,639

control in it that people could observe

186

00:06:48,469 --> 00:06:46,560

that was not directly tied to the

187

00:06:51,409 --> 00:06:48,479

hardware that was realized by the

188

00:06:53,150 --> 00:06:51,419

hardware but disembodied in a way and

189

00:06:55,850 --> 00:06:53,160

this notion of several is something that

190

00:06:57,830 --> 00:06:55,860

we lost after the enlightenment when we

191

00:07:00,529 --> 00:06:57,840

tried to deal with the

192

00:07:03,050 --> 00:07:00,539

um wrong Christian metaphysics and

193

00:07:04,430 --> 00:07:03,060

Superstition that came with it and threw

194

00:07:06,050 --> 00:07:04,440

out a lot of babies with the bath water

195

00:07:08,510 --> 00:07:06,060

and suddenly we basically lost a lot of

196

00:07:11,090 --> 00:07:08,520

Concepts especially this concept of

197

00:07:13,730 --> 00:07:11,100

software that existed before in a way

198

00:07:16,309 --> 00:07:13,740

this a software being a control pattern

199

00:07:17,570 --> 00:07:16,319

or a pattern of course a structure that

200

00:07:20,330 --> 00:07:17,580

exists at a certain level of course

201

00:07:22,850 --> 00:07:20,340

graining as some type of very very

202

00:07:26,230 --> 00:07:22,860

specific physical law that he exists by

203

00:07:29,990 --> 00:07:26,240

looking at reality from a certain angle

204

00:07:33,950 --> 00:07:30,000

and what I liked about your work is that

205

00:07:36,350 --> 00:07:33,960

you systematically have focused on this

206

00:07:38,270 --> 00:07:36,360

direction of what their can do that a

207

00:07:40,309 --> 00:07:38,280

cell is an agent and that levels of

208

00:07:43,730 --> 00:07:40,319

agency emerge in the interaction between

209

00:07:46,430 --> 00:07:43,740

cells and and you use a very clear

210

00:07:48,830 --> 00:07:46,440

language and uh clear Concepts and you

211

00:07:50,450 --> 00:07:48,840

obviously are driven by questions that

212

00:07:52,790 --> 00:07:50,460

you want to answer which is unusual in

213

00:07:55,730 --> 00:07:52,800

science I found that most of our

214

00:07:57,830 --> 00:07:55,740

contemporaries in science get broken it

215

00:08:01,189 --> 00:07:57,840

if it doesn't happen earlier during the

216

00:08:04,070 --> 00:08:01,199

PHD into people who apply methods in

217

00:08:05,570 --> 00:08:04,080

teams instead of people who join

218

00:08:06,830 --> 00:08:05,580

Academia because they think it's the

219

00:08:08,990 --> 00:08:06,840

most valuable thing they can do with

220

00:08:10,430 --> 00:08:09,000

their lives to pursue questions that

221

00:08:12,589 --> 00:08:10,440

they are interested and want to make

222

00:08:14,089 --> 00:08:12,599

progress on

223

00:08:16,790 --> 00:08:14,099

all right Michael there's plenty to

224

00:08:17,450 --> 00:08:16,800

respond to yeah yeah lots of lots of

225

00:08:19,550 --> 00:08:17,460

ideas

226

00:08:21,409 --> 00:08:19,560

um yeah I think I think it's very uh

227

00:08:23,150 --> 00:08:21,419

your point is very interesting about you

228

00:08:24,589 --> 00:08:23,160

know what what it really what really

229

00:08:26,110 --> 00:08:24,599

fundamentally is the difference between

230

00:08:28,969 --> 00:08:26,120

neurons and other cells of course

231

00:08:30,589 --> 00:08:28,979

evolutionarily they're reusing Machinery

232

00:08:32,209 --> 00:08:30,599

that has been around for a very long

233

00:08:34,010 --> 00:08:32,219

time since the time of bacteria

234

00:08:36,469 --> 00:08:34,020

basically right so our multi our

235

00:08:38,990 --> 00:08:36,479

unicellular ancestors had a lot of the

236

00:08:40,790 --> 00:08:39,000

same machinery and and even I mean of

237

00:08:43,850 --> 00:08:40,800

course axons are very can be very long

238

00:08:45,350 --> 00:08:43,860

but but uh there are sort of

239

00:08:47,150 --> 00:08:45,360

intermediate structures right there are

240

00:08:49,790 --> 00:08:47,160

tunneling nanotubes and things that

241

00:08:51,650 --> 00:08:49,800

allow cells to connect to maybe five or

242

00:08:53,690 --> 00:08:51,660

ten diameter cell diameters away right

243

00:08:55,610 --> 00:08:53,700

so so not terribly long but but also not

244

00:08:57,710 --> 00:08:55,620

immediate neighbors necessarily so that

245

00:08:59,930 --> 00:08:57,720

kind of architecture has been around for

246

00:09:00,889 --> 00:08:59,940

a while and people like roll so well

247

00:09:01,790 --> 00:09:00,899

look at

248

00:09:04,130 --> 00:09:01,800

um

249

00:09:06,530 --> 00:09:04,140

but a very brain-like electrical

250

00:09:09,769 --> 00:09:06,540

signaling in bacterial Colony so this is

251
00:09:12,769 --> 00:09:09,779
you know I think I think Evolution began

252
00:09:15,290 --> 00:09:12,779
to reuse this toolkit specifically of

253
00:09:16,550 --> 00:09:15,300
using this kind of communication to

254
00:09:18,290 --> 00:09:16,560
scale up

255
00:09:22,070 --> 00:09:18,300
um with the computational and other

256
00:09:24,050 --> 00:09:22,080
kinds of um other kinds of uh tricks uh

257
00:09:25,850 --> 00:09:24,060
yeah a really long time ago you know and

258
00:09:28,670 --> 00:09:25,860
I like to I like to imagine that if

259
00:09:30,230 --> 00:09:28,680
somebody had come to the people who were

260
00:09:32,389 --> 00:09:30,240
inventing connectionism and the first

261
00:09:33,949 --> 00:09:32,399
you know sort of perceptrons and neural

262
00:09:35,990 --> 00:09:33,959
networks and so on if somebody had come

263
00:09:37,910 --> 00:09:36,000

to them and said oh by the way sorry you

264

00:09:39,590 --> 00:09:37,920

know we're with the biologists we we got

265

00:09:41,509 --> 00:09:39,600

it wrong it's not the thinking isn't in

266

00:09:42,889 --> 00:09:41,519

the brain it's in the liver and so then

267

00:09:44,389 --> 00:09:42,899

the question is what would they do right

268

00:09:46,730 --> 00:09:44,399

what would they have changed anything

269

00:09:48,470 --> 00:09:46,740

about what they're doing and we said ah

270

00:09:50,210 --> 00:09:48,480

now we have to rethink our model or with

271

00:09:51,590 --> 00:09:50,220

is that fine who cares uh this is

272

00:09:53,750 --> 00:09:51,600

exactly the same the same model

273

00:09:55,130 --> 00:09:53,760

everything works just as well so I often

274

00:09:58,009 --> 00:09:55,140

I often think about that that that

275

00:10:01,190 --> 00:09:58,019

question what exactly do we mean by by

276

00:10:03,650 --> 00:10:01,200

neurons and isn't it interesting that we

277

00:10:07,250 --> 00:10:03,660

are able to to steal most of the tools

278

00:10:09,590 --> 00:10:07,260

the concepts the Frameworks the the math

279

00:10:12,110 --> 00:10:09,600

from neuroscience and apply it to

280

00:10:13,670 --> 00:10:12,120

problems in other spaces so not movement

281

00:10:15,170 --> 00:10:13,680

in three-dimensional space with muscles

282

00:10:16,850 --> 00:10:15,180

but for example movement through

283

00:10:18,829 --> 00:10:16,860

amorphous space right anatomical

284

00:10:20,329 --> 00:10:18,839

amorphous space the techniques can't

285

00:10:22,009 --> 00:10:20,339

tell the difference we use all the same

286

00:10:25,430 --> 00:10:22,019

stuff optogenetics neurotransmitter

287

00:10:28,850 --> 00:10:25,440

signaling we model active inference and

288

00:10:30,650 --> 00:10:28,860

uh we see perceptual by stability you

289

00:10:32,630 --> 00:10:30,660

name it you know we take Concepts from

290

00:10:35,389 --> 00:10:32,640

from neuroscience and we apply it out

291

00:10:37,850 --> 00:10:35,399

elsewhere in the body and uh generally

292

00:10:40,190 --> 00:10:37,860

speaking uh everything works exactly the

293

00:10:41,810 --> 00:10:40,200

same and that shows this I think what

294

00:10:45,949 --> 00:10:41,820

you were saying that there's this really

295

00:10:48,170 --> 00:10:45,959

interesting uh kind of um symmetry

296

00:10:49,310 --> 00:10:48,180

between these these uh that that a lot

297

00:10:50,930 --> 00:10:49,320

of the distinctions that we've been

298

00:10:52,550 --> 00:10:50,940

making are you know in terms of having

299

00:10:54,110 --> 00:10:52,560

different departments and different PHD

300

00:10:55,430 --> 00:10:54,120

programs and other things that say you

301
00:10:57,110 --> 00:10:55,440
know this is neuroscience this is

302
00:11:00,110 --> 00:10:57,120
developmental biology a lot of these

303
00:11:03,829 --> 00:11:00,120
things are just not um uh not as not as

304
00:11:06,350 --> 00:11:03,839
firm distinctions as we used to think

305
00:11:08,329 --> 00:11:06,360
yeah I suspect that people who insist on

306
00:11:12,170 --> 00:11:08,339
strong disciplinary boundaries do this

307
00:11:13,850 --> 00:11:12,180
out of of a protective impulse and what

308
00:11:16,850 --> 00:11:13,860
I noticed by I was studying many

309
00:11:19,190 --> 00:11:16,860
disciplines when I was young that

310
00:11:22,250 --> 00:11:19,200
um the different methodologies are so

311
00:11:23,870 --> 00:11:22,260
incompatible across fields that when I

312
00:11:26,150 --> 00:11:23,880
was studying philosophy

313
00:11:28,190 --> 00:11:26,160

um by or psychology I felt that computer

314

00:11:30,290 --> 00:11:28,200

scientists would be laughing about the

315

00:11:33,490 --> 00:11:30,300

methods that each of these fields are

316

00:11:36,650 --> 00:11:33,500

using to justify what they're doing and

317

00:11:39,650 --> 00:11:36,660

this I think is indicative of a defect

318

00:11:42,590 --> 00:11:39,660

because if you take science into the

319

00:11:44,690 --> 00:11:42,600

current regime of regulating it entirely

320

00:11:46,670 --> 00:11:44,700

by peer review there is no external

321

00:11:48,650 --> 00:11:46,680

Authority even the grand authorities are

322

00:11:51,170 --> 00:11:48,660

mostly fields or people who have been

323

00:11:52,970 --> 00:11:51,180

trained in The Sciences in existing

324

00:11:54,710 --> 00:11:52,980

paradigms and then are finding the

325

00:11:55,430 --> 00:11:54,720

continuation of those paradigms from the

326

00:11:57,250 --> 00:11:55,440

outside

327

00:12:00,110 --> 00:11:57,260

this um

328

00:12:02,210 --> 00:12:00,120

meta paradigmatic thinking it does not

329

00:12:04,550 --> 00:12:02,220

really exist that much in a

330

00:12:05,990 --> 00:12:04,560

peer-reviewed paradigm and ultimately

331

00:12:08,090 --> 00:12:06,000

when you do peer review for a couple

332

00:12:09,769 --> 00:12:08,100

Generations it also means that if your

333

00:12:11,329 --> 00:12:09,779

peers deteriorate there is nothing who

334

00:12:14,690 --> 00:12:11,339

pulls your science back

335

00:12:16,610 --> 00:12:14,700

and uh what I missed specifically in a

336

00:12:18,170 --> 00:12:16,620

lot of the way which Neuroscience is

337

00:12:19,430 --> 00:12:18,180

done is what you call the engineering

338

00:12:22,130 --> 00:12:19,440

stance

339

00:12:23,509 --> 00:12:22,140

and this engineering sense is very

340

00:12:25,130 --> 00:12:23,519

powerful and you get it automatically

341

00:12:26,930 --> 00:12:25,140

when you're a computer scientist because

342

00:12:28,850 --> 00:12:26,940

you don't really care about language is

343

00:12:31,430 --> 00:12:28,860

it written in what you care in is what

344

00:12:34,069 --> 00:12:31,440

causal pattern is realized and how can

345

00:12:36,410 --> 00:12:34,079

this be realized and how could I do it

346

00:12:38,389 --> 00:12:36,420

how would I do it how can Evolution do

347

00:12:40,850 --> 00:12:38,399

it what it means are it is disposal and

348

00:12:42,590 --> 00:12:40,860

this determines the search space for the

349

00:12:44,750 --> 00:12:42,600

things that I'm looking for but this

350

00:12:47,889 --> 00:12:44,760

requires that I think in causal systems

351
00:12:50,690 --> 00:12:47,899
and this thinking and causal systems is

352
00:12:52,430 --> 00:12:50,700
not impossible to it's possible not to

353
00:12:54,829 --> 00:12:52,440
do for a computer scientist

354
00:12:56,990 --> 00:12:54,839
but it is unusual outside of computer

355
00:12:59,210 --> 00:12:57,000
science and once you realize that it's

356
00:13:01,069 --> 00:12:59,220
it's very weird and suddenly you have

357
00:13:04,009 --> 00:13:01,079
Notions that try to replace causal

358
00:13:06,470 --> 00:13:04,019
structure with say evidence and then you

359
00:13:09,290 --> 00:13:06,480
notice that uh for instance evidence

360
00:13:11,030 --> 00:13:09,300
medicine is is not about uh

361
00:13:12,769 --> 00:13:11,040
probabilities of how something is

362
00:13:14,509 --> 00:13:12,779
realized and must work like you see

363
00:13:16,670 --> 00:13:14,519

people on the cruise ship getting

364

00:13:19,129 --> 00:13:16,680

infected over distances and you think oh

365

00:13:20,629 --> 00:13:19,139

this must be upward but no there is no

366

00:13:22,790 --> 00:13:20,639

peer control study so there is no

367

00:13:24,410 --> 00:13:22,800

evidence that it's airport and when you

368

00:13:26,090 --> 00:13:24,420

look at resistive planes from the

369

00:13:29,389 --> 00:13:26,100

outside like in this case the medical

370

00:13:32,269 --> 00:13:29,399

profession or the medical messaging and

371

00:13:35,150 --> 00:13:32,279

decision making or um I get terrified

372

00:13:37,190 --> 00:13:35,160

because it directly affects us and in

373

00:13:39,170 --> 00:13:37,200

terms of Neuroscience um of course

374

00:13:41,750 --> 00:13:39,180

there's more theoretical for the most

375

00:13:43,850 --> 00:13:41,760

part but there must be a reason why it's

376

00:13:46,910 --> 00:13:43,860

for the most part a theoretical because

377

00:13:49,670 --> 00:13:46,920

why there is no causal model that

378

00:13:51,949 --> 00:13:49,680

clinicians can use to explain uh what is

379

00:13:54,470 --> 00:13:51,959

happening in certain syndromes that

380

00:13:58,550 --> 00:13:54,480

people are exhibiting and I noticed this

381

00:14:01,069 --> 00:13:58,560

when I go to a doctor and even at a

382

00:14:02,870 --> 00:14:01,079

reputable institution like Stanford that

383

00:14:04,990 --> 00:14:02,880

most of the neuroscientists at some

384

00:14:07,009 --> 00:14:05,000

level there are of most of the

385

00:14:09,889 --> 00:14:07,019

neurologists that I'm talking towards us

386

00:14:13,790 --> 00:14:09,899

at some level dual lists that they uh

387

00:14:15,829 --> 00:14:13,800

don't have causal model of of the way in

388

00:14:18,530 --> 00:14:15,839

which the brain is realizing things and

389

00:14:21,050 --> 00:14:18,540

a lot of studies which discover that

390

00:14:22,910 --> 00:14:21,060

very simple mechanisms like the ability

391

00:14:24,949 --> 00:14:22,920

of human beings to use grammatical

392

00:14:26,750 --> 00:14:24,959

structure are actually reflected in the

393

00:14:28,550 --> 00:14:26,760

brain this is so amazing would have

394

00:14:31,870 --> 00:14:28,560

thought

395

00:14:35,269 --> 00:14:33,650

developments that existed in computer

396

00:14:36,769 --> 00:14:35,279

science have letters on a completely

397

00:14:40,430 --> 00:14:36,779

different track there is uh the

398

00:14:42,350 --> 00:14:40,440

perceptron is vaguely inspired by what

399

00:14:44,449 --> 00:14:42,360

the brain might be doing but I think

400

00:14:46,850 --> 00:14:44,459

it's it's really a toy model or a

401
00:14:48,650 --> 00:14:46,860
caricature of what cells are doing and

402
00:14:51,530 --> 00:14:48,660
not in the sense that it's inferior it's

403
00:14:54,110 --> 00:14:51,540
amazing what you can put forth with the

404
00:14:56,210 --> 00:14:54,120
modern perceptron variations right the

405
00:14:59,090 --> 00:14:56,220
current machine learning systems are

406
00:15:00,350 --> 00:14:59,100
mind-blowing and what they can do but

407
00:15:02,210 --> 00:15:00,360
they don't do it like biological

408
00:15:05,509 --> 00:15:02,220
organisms at all it's it's very

409
00:15:09,410 --> 00:15:05,519
different cells do not form change in

410
00:15:12,170 --> 00:15:09,420
which they wait uh sums of real numbers

411
00:15:14,210 --> 00:15:12,180
that there is something going on that is

412
00:15:15,769 --> 00:15:14,220
roughly similar to it but there's a

413
00:15:17,750 --> 00:15:15,779

self-organizing system that designs

414

00:15:19,370 --> 00:15:17,760

itself from the inside out not by a

415

00:15:21,410 --> 00:15:19,380

measure learning principle that applies

416

00:15:23,269 --> 00:15:21,420

to the outside and updates weights after

417

00:15:25,490 --> 00:15:23,279

reading and comparing them and Computing

418

00:15:27,949 --> 00:15:25,500

gradients to the system so this

419

00:15:30,650 --> 00:15:27,959

perspective of local surf organization

420

00:15:33,769 --> 00:15:30,660

by reinforcement agents that try to

421

00:15:35,090 --> 00:15:33,779

trade rewards with each other that is a

422

00:15:37,490 --> 00:15:35,100

perspective that I find totally

423

00:15:40,670 --> 00:15:37,500

fascinating and I wish this would have

424

00:15:43,009 --> 00:15:40,680

come and from Neuroscience into computer

425

00:15:44,449 --> 00:15:43,019

science but it hasn't there are some

426
00:15:46,310 --> 00:15:44,459
people which have thought about these

427
00:15:48,769 --> 00:15:46,320
ideas to some degree but there's been

428
00:15:50,990 --> 00:15:48,779
very little cross-pollination and I

429
00:15:53,090 --> 00:15:51,000
think all this talk of Neuroscience uh

430
00:15:55,389 --> 00:15:53,100
influencing computer science is mostly

431
00:15:58,910 --> 00:15:55,399
visual thinking

432
00:16:00,590 --> 00:15:58,920
yeah it's also uh I find uh this you

433
00:16:02,509 --> 00:16:00,600
know what you were saying about the

434
00:16:05,629 --> 00:16:02,519
different disciplines it's it's kind of

435
00:16:06,470 --> 00:16:05,639
amazing how uh well when I when I give a

436
00:16:07,910 --> 00:16:06,480
talk

437
00:16:10,189 --> 00:16:07,920
um I can always tell which department

438
00:16:12,470 --> 00:16:10,199

I'm in by by which part of the talk

439

00:16:13,910 --> 00:16:12,480

makes people uncomfortable and upset and

440

00:16:15,590 --> 00:16:13,920

it's always different depending on which

441

00:16:16,910 --> 00:16:15,600

department it is right so so there are

442

00:16:18,710 --> 00:16:16,920

things you can say in one Department

443

00:16:19,970 --> 00:16:18,720

that are completely obvious and you say

444

00:16:21,470 --> 00:16:19,980

this in the in another group of people

445

00:16:22,970 --> 00:16:21,480

and they they throw tomatoes they think

446

00:16:26,750 --> 00:16:22,980

this is just crazy for instance

447

00:16:28,730 --> 00:16:26,760

uh for for instance um I could I could

448

00:16:31,189 --> 00:16:28,740

uh say in you know in in a neuroscience

449

00:16:34,250 --> 00:16:31,199

Department I could say uh information

450

00:16:35,810 --> 00:16:34,260

can be processed is without changes in

451
00:16:36,949 --> 00:16:35,820
gene expression you don't need changes

452
00:16:38,769 --> 00:16:36,959
in gene expression to process

453
00:16:40,850 --> 00:16:38,779
information because the the the

454
00:16:42,530 --> 00:16:40,860
processing inside a neural network that

455
00:16:44,990 --> 00:16:42,540
runs on the physics of of action

456
00:16:46,370 --> 00:16:45,000
potentials right so I mean so right so

457
00:16:47,689 --> 00:16:46,380
so you can do all kinds of interesting

458
00:16:48,949 --> 00:16:47,699
information processing and you don't

459
00:16:50,269 --> 00:16:48,959
need genetic change sort of

460
00:16:51,829 --> 00:16:50,279
transcriptional or genetic change for

461
00:16:53,269 --> 00:16:51,839
that if I say the same thing in a

462
00:16:55,249 --> 00:16:53,279
molecular genetics department that say

463
00:16:57,050 --> 00:16:55,259

hey these cells could be processing tons

464

00:16:58,670 --> 00:16:57,060

of information long before the the

465

00:17:00,590 --> 00:16:58,680

transcriptome ever finds out about it

466

00:17:02,329 --> 00:17:00,600

this is this is considered you know just

467

00:17:04,970 --> 00:17:02,339

just completely wild because because

468

00:17:06,590 --> 00:17:04,980

it's thought that that that most of the

469

00:17:08,510 --> 00:17:06,600

hard work or in fact all of the hard

470

00:17:10,309 --> 00:17:08,520

work is done in in gene regulatory

471

00:17:12,770 --> 00:17:10,319

circuits and things like that right

472

00:17:15,770 --> 00:17:12,780

there are other other examples if I say

473

00:17:17,870 --> 00:17:15,780

um uh here's a uh here's a collection of

474

00:17:20,329 --> 00:17:17,880

cells that communicate electrically to

475

00:17:24,289 --> 00:17:20,339

to remember a particular spatial pattern

476

00:17:25,490 --> 00:17:24,299

again molecular cell biology that's what

477

00:17:27,409 --> 00:17:25,500

do you mean how can how can a collection

478

00:17:29,270 --> 00:17:27,419

of cells remember a spatial pattern but

479

00:17:30,530 --> 00:17:29,280

again in Neuroscience or in in an

480

00:17:32,690 --> 00:17:30,540

engineering department yeah of course

481

00:17:34,190 --> 00:17:32,700

the the of course they have electrical

482

00:17:36,110 --> 00:17:34,200

circuits that remember patterns and can

483

00:17:38,090 --> 00:17:36,120

do pattern completion and things like

484

00:17:40,190 --> 00:17:38,100

that so

485

00:17:42,110 --> 00:17:40,200

um you know views of views of causality

486

00:17:43,730 --> 00:17:42,120

views of uh just just lots of things

487

00:17:46,430 --> 00:17:43,740

like that that are that are very obvious

488

00:17:49,430 --> 00:17:46,440

uh to one group of people is completely

489

00:17:51,770 --> 00:17:49,440

taboo elsewhere so that that that

490

00:17:53,990 --> 00:17:51,780

distinction and and and and yeah and as

491

00:17:56,510 --> 00:17:54,000

as you as Joshua just said

492

00:17:58,549 --> 00:17:56,520

um it impacts it impacts everything it

493

00:18:01,970 --> 00:17:58,559

impacts education it impacts grants you

494

00:18:03,770 --> 00:18:01,980

know Grant reviews because when these

495

00:18:06,110 --> 00:18:03,780

kind of interdisciplinary grants come up

496

00:18:07,549 --> 00:18:06,120

the study sections have a really hard

497

00:18:09,409 --> 00:18:07,559

time finding people that can actually

498

00:18:11,630 --> 00:18:09,419

review them because what often happens

499

00:18:14,450 --> 00:18:11,640

is you'll find you'll you'll get a some

500

00:18:16,370 --> 00:18:14,460

kind of computational biology Grant and

501
00:18:17,990 --> 00:18:16,380
you put a proposal and you'll have some

502
00:18:19,850 --> 00:18:18,000
people on the on the panel who are

503
00:18:21,950 --> 00:18:19,860
biologists and some people who are the

504
00:18:23,510 --> 00:18:21,960
computational folks and it's very hard

505
00:18:25,070 --> 00:18:23,520
to get people that actually can

506
00:18:27,049 --> 00:18:25,080
appreciate both sides of it and

507
00:18:28,850 --> 00:18:27,059
understand what's happening together

508
00:18:30,409 --> 00:18:28,860
right so they will sort of each critique

509
00:18:32,570 --> 00:18:30,419
a certain part of it and the other part

510
00:18:35,390 --> 00:18:32,580
they say I don't know what this is and

511
00:18:37,310 --> 00:18:35,400
and as a result grants like that don't

512
00:18:39,230 --> 00:18:37,320
tend to not have a champion you know one

513
00:18:40,549 --> 00:18:39,240

person who can say no I get I get the

514

00:18:42,049 --> 00:18:40,559

whole thing and I I think it's really

515

00:18:44,990 --> 00:18:42,059

good or not

516

00:18:47,510 --> 00:18:45,000

so yeah it's uh even to the point where

517

00:18:49,970 --> 00:18:47,520

I I'm often asked you know when when

518

00:18:52,190 --> 00:18:49,980

people want to you list me somewhere

519

00:18:53,750 --> 00:18:52,200

they'll say so so what what what are you

520

00:18:55,850 --> 00:18:53,760

you know what kind of what kind of uh

521

00:18:56,990 --> 00:18:55,860

what's your field and I I never know how

522

00:18:58,250 --> 00:18:57,000

to answer that question you know this

523

00:18:59,870 --> 00:18:58,260

day it's been 30 years I still don't

524

00:19:01,909 --> 00:18:59,880

know how to answer that question I I

525

00:19:03,529 --> 00:19:01,919

just can't boil it down to one you know

526

00:19:06,110 --> 00:19:03,539

it just wouldn't make any sense to to

527

00:19:07,909 --> 00:19:06,120

say any of the traditional um you know

528

00:19:09,830 --> 00:19:07,919

the traditional fields

529

00:19:11,630 --> 00:19:09,840

so what do you say yosha when someone

530

00:19:13,970 --> 00:19:11,640

asks you what field you're in

531

00:19:18,049 --> 00:19:13,980

and it depends on who's asking

532

00:19:20,630 --> 00:19:18,059

so for instance I found it quite useful

533

00:19:23,150 --> 00:19:20,640

to sometimes say and

534

00:19:23,990 --> 00:19:23,160

sorry I'm not a philosopher

535

00:19:26,690 --> 00:19:24,000

um

536

00:19:28,970 --> 00:19:26,700

but uh but this or

537

00:19:31,610 --> 00:19:28,980

um I'm not that interested in machine

538

00:19:33,830 --> 00:19:31,620

learning and I'm I did publish papers in

539

00:19:36,409 --> 00:19:33,840

philosophy and in machine learning but

540

00:19:39,289 --> 00:19:36,419

it's not my specialty in the sense that

541

00:19:41,210 --> 00:19:39,299

I need to identify with it and

542

00:19:43,610 --> 00:19:41,220

um in some sense I guess that these

543

00:19:46,610 --> 00:19:43,620

categories are important when you try to

544

00:19:48,409 --> 00:19:46,620

write a grant proposal or when you try

545

00:19:50,450 --> 00:19:48,419

to find a job in a particular

546

00:19:53,450 --> 00:19:50,460

institution and they need to fill a

547

00:19:55,190 --> 00:19:53,460

position but for me it's more what

548

00:19:56,570 --> 00:19:55,200

questions am I interested and what is

549

00:19:58,010 --> 00:19:56,580

the thing that I want to make progress

550

00:19:59,330 --> 00:19:58,020

on or what is the thing that I want to

551
00:20:03,710 --> 00:19:59,340
build right now

552
00:20:07,250 --> 00:20:03,720
and uh I guess that in terms of the

553
00:20:10,130 --> 00:20:07,260
intersection I'm a cognitive scientist

554
00:20:12,110 --> 00:20:10,140
so I was asking Michael prior to you

555
00:20:14,210 --> 00:20:12,120
joining yosha why is that Michael that

556
00:20:15,409 --> 00:20:14,220
you were doing podcasts and if I

557
00:20:16,970 --> 00:20:15,419
understand correctly part of the reason

558
00:20:18,289 --> 00:20:16,980
was because you think out loud and you

559
00:20:20,390 --> 00:20:18,299
like to hear the other person's thoughts

560
00:20:21,950 --> 00:20:20,400
and take notes and it Spurs your own and

561
00:20:23,510 --> 00:20:21,960
firstly like Michael you can correct me

562
00:20:25,730 --> 00:20:23,520
if that's incorrect and then secondly

563
00:20:27,710 --> 00:20:25,740

yoksha I'm curious for an answer for

564

00:20:30,049 --> 00:20:27,720

this the same question what is it that

565

00:20:32,510 --> 00:20:30,059

you get out of doing podcasts other than

566

00:20:33,710 --> 00:20:32,520

say some marketing for if you were

567

00:20:35,510 --> 00:20:33,720

promoting something which I don't

568

00:20:39,230 --> 00:20:35,520

imagine you are currently

569

00:20:41,990 --> 00:20:39,240

uh no I'm not bucketing anything I uh

570

00:20:46,130 --> 00:20:42,000

what I like about podcasts is the

571

00:20:48,289 --> 00:20:46,140

ability to publish something in a format

572

00:20:50,450 --> 00:20:48,299

that is engaging to an interesting to

573

00:20:54,409 --> 00:20:50,460

people who actually care about it

574

00:20:56,270 --> 00:20:54,419

I like this informal way of uh holding

575

00:20:58,310 --> 00:20:56,280

on to some ideas and also like

576

00:21:01,930 --> 00:20:58,320

conversations is a medium to develop

577

00:21:04,190 --> 00:21:01,940

thought is this space in which we can

578

00:21:06,710 --> 00:21:04,200

reflect on each other look into each

579

00:21:09,650 --> 00:21:06,720

other's minds interact with the ideas of

580

00:21:11,990 --> 00:21:09,660

others in real time uh the production

581

00:21:13,730 --> 00:21:12,000

format of a podcast creates a certain

582

00:21:16,190 --> 00:21:13,740

focus of the conversation that can be

583

00:21:19,370 --> 00:21:16,200

useful and it's a pleasant kind of

584

00:21:23,690 --> 00:21:19,380

tangent that focuses you to stay on task

585

00:21:25,970 --> 00:21:23,700

and I also found that uh it's genuinely

586

00:21:28,549 --> 00:21:25,980

useful to some people like uh with the

587

00:21:31,370 --> 00:21:28,559

feedback that I get is that uh people

588

00:21:34,010 --> 00:21:31,380

tell me I had this really important

589

00:21:36,169 --> 00:21:34,020

question and I found this allowed me to

590

00:21:38,810 --> 00:21:36,179

make a progress on it and I feel much

591

00:21:41,270 --> 00:21:38,820

better now about these questions I uh

592

00:21:43,250 --> 00:21:41,280

just clarified something for me that has

593

00:21:45,770 --> 00:21:43,260

plagued me for years and

594

00:21:48,289 --> 00:21:45,780

um put me on track to solving it or this

595

00:21:50,570 --> 00:21:48,299

is inspired the following work so it's a

596

00:21:53,330 --> 00:21:50,580

form of uh publishing ideas and getting

597

00:21:56,450 --> 00:21:53,340

them into circulation in our Global

598

00:21:59,390 --> 00:21:56,460

Health Minds that is very informal in a

599

00:22:02,750 --> 00:21:59,400

way but it's not useless and also it's

600

00:22:05,090 --> 00:22:02,760

uh believes me in in this instance at

601
00:22:07,250 --> 00:22:05,100
least of the work of cutting editing and

602
00:22:09,409 --> 00:22:07,260
so on uh but anyway so I'm very grateful

603
00:22:12,169 --> 00:22:09,419
that you provide the service of curating

604
00:22:14,990 --> 00:22:12,179
our conversation and putting a little

605
00:22:17,270 --> 00:22:15,000
form that is useful to other people

606
00:22:19,250 --> 00:22:17,280
yeah yeah there's something well the two

607
00:22:21,409 --> 00:22:19,260
two things I was thinking of one is that

608
00:22:22,970 --> 00:22:21,419
uh you know I mean I have conversations

609
00:22:24,230 --> 00:22:22,980
with people all day long about these

610
00:22:26,330 --> 00:22:24,240
issues right so people in my lab

611
00:22:27,830 --> 00:22:26,340
collaborators whatever and most of

612
00:22:29,630 --> 00:22:27,840
course the vast majority of those

613
00:22:31,250 --> 00:22:29,640

conversations are not recorded and they

614

00:22:33,230 --> 00:22:31,260

just sort of disappear into the ether

615

00:22:34,250 --> 00:22:33,240

and then I I take something away from it

616

00:22:36,649 --> 00:22:34,260

and the other person takes something

617

00:22:38,149 --> 00:22:36,659

away from it but I've often thought that

618

00:22:40,669 --> 00:22:38,159

wouldn't it be wouldn't isn't it a shame

619

00:22:42,649 --> 00:22:40,679

that all of this is uh just just kind of

620

00:22:44,450 --> 00:22:42,659

disappears and it would be amazing to to

621

00:22:45,950 --> 00:22:44,460

have have a record of it and of course

622

00:22:48,649 --> 00:22:45,960

not every conversation is you know as

623

00:22:51,110 --> 00:22:48,659

gold but but but a lot of them are are

624

00:22:53,510 --> 00:22:51,120

useful and interesting and uh there are

625

00:22:55,370 --> 00:22:53,520

plenty of people that um could could be

626

00:22:57,590 --> 00:22:55,380

interested in could could benefit from

627

00:22:59,510 --> 00:22:57,600

it so so I really like this aspect that

628

00:23:00,830 --> 00:22:59,520

uh we can have conversations and then

629

00:23:03,230 --> 00:23:00,840

they are you know sort of canned and

630

00:23:04,730 --> 00:23:03,240

they're out there for uh for for people

631

00:23:06,830 --> 00:23:04,740

who are who are interested the other

632

00:23:08,570 --> 00:23:06,840

kind of um aspect of it which I don't

633

00:23:11,390 --> 00:23:08,580

really understand but but it's kind of

634

00:23:13,610 --> 00:23:11,400

neat is that if when somebody when

635

00:23:16,669 --> 00:23:13,620

somebody asks me to uh pre-record a talk

636

00:23:19,010 --> 00:23:16,679

it takes crazy amount of time because

637

00:23:20,330 --> 00:23:19,020

because I keep stopping and realizing I

638

00:23:21,950 --> 00:23:20,340

could have said that better let me start

639

00:23:23,990 --> 00:23:21,960

from the beginning and and it's just

640

00:23:26,450 --> 00:23:24,000

it's it's an incredible ordeal whereas

641

00:23:29,210 --> 00:23:26,460

something like this that's real time uh

642

00:23:30,289 --> 00:23:29,220

I'm sure has as many you know mistakes

643

00:23:31,730 --> 00:23:30,299

and things that I would have rather

644

00:23:33,289 --> 00:23:31,740

fixed later but but you can't do that

645

00:23:34,549 --> 00:23:33,299

right so you just sort of go with it and

646

00:23:36,470 --> 00:23:34,559

that's it and then it's done and you can

647

00:23:38,930 --> 00:23:36,480

move on so so I like I like that

648

00:23:40,490 --> 00:23:38,940

real-time aspect of it because it just

649

00:23:42,470 --> 00:23:40,500

it just helps you to get the ideas out

650

00:23:45,169 --> 00:23:42,480

without getting hung up and and trying

651
00:23:46,789 --> 00:23:45,179
to redo things 50 times

652
00:23:50,930 --> 00:23:46,799
yeah it's a format that allows

653
00:23:54,470 --> 00:23:50,940
tentativity if we have published we have

654
00:23:56,450 --> 00:23:54,480
culture in sciences that requires us to

655
00:23:58,610 --> 00:23:56,460
publish the things that we can hope to

656
00:24:00,649 --> 00:23:58,620
prove and make the best proof that we

657
00:24:02,630 --> 00:24:00,659
can but when we have anything

658
00:24:05,690 --> 00:24:02,640
complicated especially when we take our

659
00:24:07,130 --> 00:24:05,700
engineering stance we often cannot prove

660
00:24:10,070 --> 00:24:07,140
how things work

661
00:24:11,750 --> 00:24:10,080
instead our answers are in the realm of

662
00:24:14,750 --> 00:24:11,760
the possible and we need to discuss the

663
00:24:16,970 --> 00:24:14,760

possibilities and there is a value in

664

00:24:19,130 --> 00:24:16,980

understanding these possibilities to

665

00:24:21,409 --> 00:24:19,140

direct our future experiments and the

666

00:24:23,810 --> 00:24:21,419

Practical work that we do to see what's

667

00:24:25,850 --> 00:24:23,820

actually the case and we don't really

668

00:24:29,270 --> 00:24:25,860

have a publication format for that right

669

00:24:30,770 --> 00:24:29,280

we don't get neuroscientists to publish

670

00:24:32,270 --> 00:24:30,780

their ideas on how the mind works

671

00:24:34,310 --> 00:24:32,280

because nobody has a theory that they

672

00:24:35,930 --> 00:24:34,320

can prove and as a result there is

673

00:24:37,850 --> 00:24:35,940

basically a vacuum where theories should

674

00:24:40,370 --> 00:24:37,860

be and the theory building happens

675

00:24:41,930 --> 00:24:40,380

informally in conversations that

676

00:24:45,169 --> 00:24:41,940

basically requires personal contact

677

00:24:46,850 --> 00:24:45,179

which is a big issue once conference has

678

00:24:49,370 --> 00:24:46,860

been virtual because that contact

679

00:24:50,690 --> 00:24:49,380

diminished and you get a lot of

680

00:24:53,450 --> 00:24:50,700

important ideas by reading the

681

00:24:55,370 --> 00:24:53,460

Publications and so on but this uh what

682

00:24:57,289 --> 00:24:55,380

could be or connecting the dots or

683

00:24:59,029 --> 00:24:57,299

possibilities or ideas that might be

684

00:25:01,490 --> 00:24:59,039

proven wrong later that we just exchange

685

00:25:03,049 --> 00:25:01,500

as in the status of ideas that is

686

00:25:04,850 --> 00:25:03,059

something that has a good place and a

687

00:25:11,029 --> 00:25:04,860

podcast

688

00:25:13,190 --> 00:25:11,039

something new so for instance I was

689

00:25:14,870 --> 00:25:13,200

thinking about this and I well podcasts

690

00:25:16,850 --> 00:25:14,880

go back a while and Brogan invented this

691

00:25:19,970 --> 00:25:16,860

long-form format or popularized it

692

00:25:21,649 --> 00:25:19,980

however on television there are

693

00:25:23,630 --> 00:25:21,659

interviews so there's Oprah and those

694

00:25:26,570 --> 00:25:23,640

are long one hour they're 60 minutes and

695

00:25:28,370 --> 00:25:26,580

then back in the 90s there was a three

696

00:25:30,169 --> 00:25:28,380

and a half hour it's essentially a

697

00:25:32,029 --> 00:25:30,179

podcast it's like Charlie Rose three and

698

00:25:34,669 --> 00:25:32,039

a half hour conversation it's like a

699

00:25:38,149 --> 00:25:34,679

Theo location with Freeman Dyson Daniel

700

00:25:41,330 --> 00:25:38,159

Dennett Stephen J Gould like the Rupert

701
00:25:43,370 --> 00:25:41,340
sheldrake all of those on the same one

702
00:25:46,370 --> 00:25:43,380
format it's essentially a podcast

703
00:25:47,810 --> 00:25:46,380
talking about metaphysics like man oh

704
00:25:49,250 --> 00:25:47,820
man I can't believe that got published

705
00:25:51,230 --> 00:25:49,260
and then also I think about it well did

706
00:25:52,669 --> 00:25:51,240
Plato have the first podcast

707
00:25:54,049 --> 00:25:52,679
because he's just publishing these

708
00:25:55,549 --> 00:25:54,059
dialogues and you read them but it's not

709
00:25:57,110 --> 00:25:55,559
as if maybe he would have published it

710
00:25:58,669 --> 00:25:57,120
in video I think Plato was the first

711
00:26:00,950 --> 00:25:58,679
podcaster

712
00:26:02,930 --> 00:26:00,960
so is there something new about this

713
00:26:05,090 --> 00:26:02,940

format of podcasting that wasn't there

714

00:26:07,130 --> 00:26:05,100

before or what's new about it I think

715

00:26:09,769 --> 00:26:07,140

it's like it's like vlogging uh blogging

716

00:26:12,950 --> 00:26:09,779

is also not new right being able to

717

00:26:15,890 --> 00:26:12,960

write text that you publish uh and uh

718

00:26:18,529 --> 00:26:15,900

people can follow about your writing and

719

00:26:20,570 --> 00:26:18,539

so on did exist in some sense before but

720

00:26:22,730 --> 00:26:20,580

uh the internet made it possible to

721

00:26:25,250 --> 00:26:22,740

publish this for everyone do you don't

722

00:26:26,870 --> 00:26:25,260

need a publisher anymore and you don't

723

00:26:28,490 --> 00:26:26,880

know your TV studio anymore you don't

724

00:26:30,529 --> 00:26:28,500

need a broadcast station that is

725

00:26:32,630 --> 00:26:30,539

recording your talk show and sends it to

726
00:26:35,450 --> 00:26:32,640
an audience there is no competition with

727
00:26:37,549 --> 00:26:35,460
other talk Source because uh there is no

728
00:26:40,190 --> 00:26:37,559
limitations on how many people can

729
00:26:42,710 --> 00:26:40,200
broadcast at the same time and this

730
00:26:45,649 --> 00:26:42,720
allows an enormous diversity and of

731
00:26:48,529 --> 00:26:45,659
thoughts and small Productions that are

732
00:26:50,570 --> 00:26:48,539
done at a very low cost lowering the

733
00:26:52,730 --> 00:26:50,580
threshold for putting something out

734
00:26:54,830 --> 00:26:52,740
there and seeing what happens so in this

735
00:26:57,110 --> 00:26:54,840
sense it's the ecosystem that emerged is

736
00:26:59,210 --> 00:26:57,120
new because a variable change that

737
00:27:00,529 --> 00:26:59,220
changed the cost of producing a talk

738
00:27:02,149 --> 00:27:00,539

show

739

00:27:03,950 --> 00:27:02,159

all right

740

00:27:06,470 --> 00:27:03,960

Michael you agree

741

00:27:09,590 --> 00:27:06,480

um yeah yeah I mean yes that and and all

742

00:27:12,169 --> 00:27:09,600

of that and also just the fact that you

743

00:27:13,669 --> 00:27:12,179

know uh as you as you just said uh these

744

00:27:15,769 --> 00:27:13,679

kind of like long form things were

745

00:27:16,850 --> 00:27:15,779

fairly rare so most of the time if

746

00:27:18,649 --> 00:27:16,860

you're going to be in one of the

747

00:27:20,630 --> 00:27:18,659

traditional media they tell you okay

748

00:27:22,310 --> 00:27:20,640

you've got the you've got you know three

749

00:27:23,570 --> 00:27:22,320

minutes uh you know we're gonna cut all

750

00:27:25,549 --> 00:27:23,580

this stuff and we're gonna boil it down

751
00:27:27,169 --> 00:27:25,559
to three minutes and this this is often

752
00:27:28,669 --> 00:27:27,179
incredibly frustrating and and I

753
00:27:31,010 --> 00:27:28,679
understand I mean we're drowned in

754
00:27:32,570 --> 00:27:31,020
information and so so there's obviously

755
00:27:34,610 --> 00:27:32,580
a place for very short statement on

756
00:27:36,950 --> 00:27:34,620
things but the kind of stuff that we're

757
00:27:39,529 --> 00:27:36,960
talking about uh cannot be boiled down

758
00:27:41,570 --> 00:27:39,539
to to you know TV sound bites or

759
00:27:43,370 --> 00:27:41,580
anything it's just not and and so so the

760
00:27:45,350 --> 00:27:43,380
ability to have these long-form things

761
00:27:47,510 --> 00:27:45,360
so that anybody who wants to really dig

762
00:27:49,310 --> 00:27:47,520
in can hear what the actual thought is

763
00:27:52,430 --> 00:27:49,320

as opposed to something that's that's

764

00:27:54,950 --> 00:27:52,440

been just uh you know boiled into into a

765

00:27:57,049 --> 00:27:54,960

very um very very short statement I

766

00:27:58,430 --> 00:27:57,059

think is is invaluable just being able

767

00:28:01,430 --> 00:27:58,440

to have it out there for people to find

768

00:28:03,289 --> 00:28:01,440

now a brief note from two sponsors this

769

00:28:05,149 --> 00:28:03,299

is a considerably easy sponsor because

770

00:28:06,409 --> 00:28:05,159

some of you watching this are losing

771

00:28:07,850 --> 00:28:06,419

your hair and it's not because you have

772

00:28:09,169 --> 00:28:07,860

a you have trouble understanding the

773

00:28:10,789 --> 00:28:09,179

content so you're pulling it out it

774

00:28:12,830 --> 00:28:10,799

happens to approximately half of all men

775

00:28:15,590 --> 00:28:12,840

it's uncomfortable but there are methods

776
00:28:17,390 --> 00:28:15,600
to help and even to stop the process of

777
00:28:19,850 --> 00:28:17,400
balding Roman offers clinically proven

778
00:28:21,230 --> 00:28:19,860
medication to help treat hair loss all

779
00:28:22,730 --> 00:28:21,240
of course from the comfort and privacy

780
00:28:24,409 --> 00:28:22,740
of your own home Roman offers

781
00:28:26,149 --> 00:28:24,419
prescription medication and

782
00:28:28,190 --> 00:28:26,159
over-the-counter treatments they also

783
00:28:29,810 --> 00:28:28,200
offer specially formulated shampoos and

784
00:28:31,610 --> 00:28:29,820
conditioners with ingredients that

785
00:28:34,430 --> 00:28:31,620
fortify and moisturize the hair to look

786
00:28:35,930 --> 00:28:34,440
fuller research shows that 80 of men who

787
00:28:37,909 --> 00:28:35,940
use prescription hair loss medication

788
00:28:40,549 --> 00:28:37,919

had no further hair loss after two years

789

00:28:42,890 --> 00:28:40,559

Roman is licensed and the whole process

790

00:28:44,149 --> 00:28:42,900

is straightforward and discreet plans

791

00:28:46,250 --> 00:28:44,159

start at twenty dollars a month

792

00:28:49,029 --> 00:28:46,260

currently Roman has a special offer for

793

00:28:53,149 --> 00:28:49,039

toe listeners that is you use the link

794

00:28:56,230 --> 00:28:53,159

ro.co Kurt c-u-r-t to get 20 off your

795

00:28:58,669 --> 00:28:56,240

first order again that's ro.co

796

00:29:00,950 --> 00:28:58,679

c-u-r-t the link is in the description

797

00:29:02,870 --> 00:29:00,960

and you get 20 off as the toe project

798

00:29:04,610 --> 00:29:02,880

grows we get plenty of sponsor is coming

799

00:29:06,649 --> 00:29:04,620

and I thought you know this one is a

800

00:29:08,750 --> 00:29:06,659

fascinating company our new sponsor is

801
00:29:10,610 --> 00:29:08,760
Masterworks Masterworks is the only

802
00:29:12,769 --> 00:29:10,620
platform that allows you to invest in

803
00:29:15,529 --> 00:29:12,779
multi-million dollar works of art by

804
00:29:17,149 --> 00:29:15,539
Picasso bansky and more Masterworks has

805
00:29:18,950 --> 00:29:17,159
given you access to invest in Fine Art

806
00:29:20,930 --> 00:29:18,960
which is usually only accessible to

807
00:29:23,149 --> 00:29:20,940
multi-millionaires or billionaires the

808
00:29:25,010 --> 00:29:23,159
art that you see hanging in museums can

809
00:29:26,330 --> 00:29:25,020
now be partially owned by you the

810
00:29:28,130 --> 00:29:26,340
inventive Parts is that you don't need

811
00:29:29,630 --> 00:29:28,140
to know the details of art or investing

812
00:29:31,549 --> 00:29:29,640
Masterworks makes the whole process

813
00:29:33,769 --> 00:29:31,559

straightforward with a clean interface

814

00:29:35,210 --> 00:29:33,779

and exceptional customer service they

815

00:29:36,889 --> 00:29:35,220

are innovating as more traditional

816

00:29:39,409 --> 00:29:36,899

Investments suffer last month we

817

00:29:41,269 --> 00:29:39,419

verified a cell which had a 21.5 percent

818

00:29:42,350 --> 00:29:41,279

return so for instance if you were to

819

00:29:43,850 --> 00:29:42,360

put ten thousand dollars in you would

820

00:29:45,230 --> 00:29:43,860

now have twelve thousand Welcome to our

821

00:29:46,730 --> 00:29:45,240

new sponsor Masterworks and the link to

822

00:29:48,649 --> 00:29:46,740

them is in the description just so you

823

00:29:50,810 --> 00:29:48,659

know there's in fact a wait list to join

824

00:29:52,669 --> 00:29:50,820

their platform right now however total

825

00:29:54,529 --> 00:29:52,679

listeners can skip the wait list by

826

00:29:56,750 --> 00:29:54,539

visiting the link in the description as

827

00:29:58,669 --> 00:29:56,760

well as by using the promo code theories

828

00:30:00,110 --> 00:29:58,679

of everything again the link is in the

829

00:30:01,909 --> 00:30:00,120

description you can see important

830

00:30:05,330 --> 00:30:01,919

regulation A disclosures at Masterworks

831

00:30:07,549 --> 00:30:05,340

dot com slash CD what some stance of

832

00:30:09,529 --> 00:30:07,559

yours some belief that has changed most

833

00:30:11,389 --> 00:30:09,539

drastically in the past few years let's

834

00:30:13,250 --> 00:30:11,399

say three and it could be anywhere from

835

00:30:14,930 --> 00:30:13,260

something abstruse and academic to more

836

00:30:17,090 --> 00:30:14,940

colloquial like I didn't realize the

837

00:30:18,230 --> 00:30:17,100

value of children or I overvalued

838

00:30:20,750 --> 00:30:18,240

children now I'm stuck with them like

839

00:30:22,789 --> 00:30:20,760

geez that was a mistake

840

00:30:25,490 --> 00:30:22,799

yeah so something where I changed my

841

00:30:28,909 --> 00:30:25,500

mind was RNA based memory transfer

842

00:30:31,250 --> 00:30:28,919

and uh I think it's a super interesting

843

00:30:33,830 --> 00:30:31,260

idea in this context because it's uh

844

00:30:36,710 --> 00:30:33,840

close to uh stuff that Michael has been

845

00:30:38,450 --> 00:30:36,720

working on and is interested in uh there

846

00:30:41,510 --> 00:30:38,460

have been some experiments in the Soviet

847

00:30:46,070 --> 00:30:41,520

Union I think in the 70s where

848

00:30:47,930 --> 00:30:46,080

scientists look planaria uh trained them

849

00:30:49,430 --> 00:30:47,940

to learn something I think they were

850

00:30:51,649 --> 00:30:49,440

learned how to be afraid of electric

851

00:30:53,810 --> 00:30:51,659

shocks and things like that and then

852

00:30:55,970 --> 00:30:53,820

they put their uh the brains into a

853

00:30:57,710 --> 00:30:55,980

blender extracted the iron a injected

854

00:30:59,510 --> 00:30:57,720

other planaria visit and these other

855

00:31:02,870 --> 00:30:59,520

planaria had learned it

856

00:31:05,029 --> 00:31:02,880

and I I learned about this as a kid when

857

00:31:06,529 --> 00:31:05,039

I in the 1980s read Soviet science

858

00:31:09,889 --> 00:31:06,539

fiction into Twitter I grew up in

859

00:31:14,570 --> 00:31:09,899

Eastern Germany and the evil scientist

860

00:31:17,149 --> 00:31:14,580

uh harvested the brains of geniuses and

861

00:31:20,029 --> 00:31:17,159

injected himself is RNA extracted from

862

00:31:22,549 --> 00:31:20,039

these brains and thereby acquired the

863

00:31:25,430 --> 00:31:22,559

skills and even though I'm pretty sure

864

00:31:27,669 --> 00:31:25,440

it probably doesn't work if you if you

865

00:31:29,810 --> 00:31:27,679

do it at this level

866

00:31:33,110 --> 00:31:29,820

this was inspired by this original

867

00:31:37,210 --> 00:31:33,120

research and I later heard nothing about

868

00:31:41,029 --> 00:31:37,220

this anymore and so I dismissed it as uh

869

00:31:42,529 --> 00:31:41,039

similar things as I read in Sputnik and

870

00:31:44,630 --> 00:31:42,539

other Russian Publications which create

871

00:31:47,990 --> 00:31:44,640

their own methodological Universe about

872

00:31:50,330 --> 00:31:48,000

ball lightning that is authentic and

873

00:31:52,250 --> 00:31:50,340

possibly sentient and so on and

874

00:31:54,230 --> 00:31:52,260

dismissed this all as basically Another

875

00:31:56,570 --> 00:31:54,240

Universe of another Reader's Digest

876

00:31:58,970 --> 00:31:56,580

culture that is producing its own ideas

877

00:32:00,169 --> 00:31:58,980

that then later on get dissolved once

878

00:32:02,210 --> 00:32:00,179

science advanced answers because

879

00:32:03,649 --> 00:32:02,220

everybody knows it's it's synapses it's

880

00:32:05,690 --> 00:32:03,659

connections between neurons that matter

881

00:32:07,789 --> 00:32:05,700

the RNA is not that important for the

882

00:32:09,710 --> 00:32:07,799

information processing might change some

883

00:32:11,810 --> 00:32:09,720

state but you cannot learn something by

884

00:32:13,909 --> 00:32:11,820

extracting RNA and re-injecting it into

885

00:32:16,250 --> 00:32:13,919

the next organism because how would that

886

00:32:18,470 --> 00:32:16,260

work if it's done in the synapses

887

00:32:20,690 --> 00:32:18,480

and uh then recently there were some

888

00:32:22,490 --> 00:32:20,700

papers which replicated uh the original

889

00:32:24,190 --> 00:32:22,500

research and has been replicated from

890

00:32:28,730 --> 00:32:24,200

time to time

891

00:32:31,730 --> 00:32:28,740

in different types of organisms but to

892

00:32:34,850 --> 00:32:31,740

my knowledge not in of course macaques

893

00:32:36,830 --> 00:32:34,860

or not even mice but so it's not clear

894

00:32:39,409 --> 00:32:36,840

if their brains work according to the

895

00:32:41,350 --> 00:32:39,419

same principles as planaria but planaria

896

00:32:43,669 --> 00:32:41,360

are not

897

00:32:45,289 --> 00:32:43,679

extremely simple organisms only a

898

00:32:47,289 --> 00:32:45,299

handful of neurons there are something

899

00:32:49,789 --> 00:32:47,299

intermediate with some their main

900

00:32:51,230 --> 00:32:49,799

architecture is different from ours and

901
00:32:53,149 --> 00:32:51,240
their functioning principles of their

902
00:32:55,130 --> 00:32:53,159
neurons might be slightly different but

903
00:32:58,190 --> 00:32:55,140
it's worse following this idea and going

904
00:33:00,169 --> 00:32:58,200
down that rabbit hole and then I looked

905
00:33:02,090 --> 00:33:00,179
for my computer science engineering

906
00:33:04,250 --> 00:33:02,100
perspective and I realized that there

907
00:33:07,789 --> 00:33:04,260
are always things about the synaptic

908
00:33:10,250 --> 00:33:07,799
story that uh I find confusing because

909
00:33:12,649 --> 00:33:10,260
they're very difficult to implement

910
00:33:14,750 --> 00:33:12,659
so for instance weight sharing as a

911
00:33:16,070 --> 00:33:14,760
computer scientist I require weight

912
00:33:19,009 --> 00:33:16,080
sharing I don't know how to get around

913
00:33:21,049 --> 00:33:19,019

this if I want to entrain myself as

914

00:33:23,090 --> 00:33:21,059

computational Primitives in a local area

915

00:33:25,850 --> 00:33:23,100

of of my brain for instance the ability

916

00:33:28,909 --> 00:33:25,860

to rotate something which rotation is

917

00:33:31,549 --> 00:33:28,919

some operator that I apply on a pattern

918

00:33:32,990 --> 00:33:31,559

that allows this pattern to be

919

00:33:35,870 --> 00:33:33,000

represented in a slightly different way

920

00:33:38,090 --> 00:33:35,880

to have this object rotated a few

921

00:33:39,710 --> 00:33:38,100

degrees but an object doesn't consist of

922

00:33:42,830 --> 00:33:39,720

a single point it consists of many

923

00:33:44,630 --> 00:33:42,840

features that all need to get the same

924

00:33:47,509 --> 00:33:44,640

rotation applied to them using the same

925

00:33:49,970 --> 00:33:47,519

mathematical Primitives so how do you

926

00:33:53,269 --> 00:33:49,980

implement the same operator across an

927

00:33:55,909 --> 00:33:53,279

entire brain area do you make many many

928

00:33:57,769 --> 00:33:55,919

copies of the same pattern and computer

929

00:33:59,389 --> 00:33:57,779

scientists solve that with so-called

930

00:34:02,149 --> 00:33:59,399

convolutional neural networks which

931

00:34:04,810 --> 00:34:02,159

basically use the same weights again and

932

00:34:06,769 --> 00:34:04,820

again in different areas using only

933

00:34:08,570 --> 00:34:06,779

training them once and making them

934

00:34:11,149 --> 00:34:08,580

available everywhere and that would be

935

00:34:14,030 --> 00:34:11,159

very difficult to implement and synapses

936

00:34:16,430 --> 00:34:14,040

maybe there are ways but it's not

937

00:34:18,829 --> 00:34:16,440

straightforward another thing is if we

938

00:34:21,290 --> 00:34:18,839

see how training Works in babies they

939

00:34:22,909 --> 00:34:21,300

learn something and then they get rid of

940

00:34:24,290 --> 00:34:22,919

the Surplus synopsis initially they have

941

00:34:27,649 --> 00:34:24,300

much more connectivity than they need

942

00:34:29,930 --> 00:34:27,659

and uh when they get uh after they've

943

00:34:32,270 --> 00:34:29,940

trained they optimize the way in which

944

00:34:34,010 --> 00:34:32,280

the wiring works by discarding the

945

00:34:36,409 --> 00:34:34,020

things they don't need to compute what

946

00:34:39,470 --> 00:34:36,419

they want to compute so it's like

947

00:34:41,329 --> 00:34:39,480

calling the synapses it does not uh

948

00:34:43,369 --> 00:34:41,339

freeze or Edge the learning into the

949

00:34:45,730 --> 00:34:43,379

brain but it optimizes the energy usage

950

00:34:47,810 --> 00:34:45,740

of the brain another issue is that

951
00:34:49,490 --> 00:34:47,820
patterns of activation are not

952
00:34:51,589 --> 00:34:49,500
completely stable in the brain they in

953
00:34:53,389 --> 00:34:51,599
the cortex if you look you find that

954
00:34:55,190 --> 00:34:53,399
they might be moving the next day or

955
00:34:57,109 --> 00:34:55,200
even rotate a little bit which is also

956
00:34:58,790 --> 00:34:57,119
difficult to do with synapses you cannot

957
00:35:00,230 --> 00:34:58,800
read out the weights and copy them

958
00:35:02,810 --> 00:35:00,240
somewhere else in an easy

959
00:35:05,390 --> 00:35:02,820
straightforward fashion and another

960
00:35:07,370 --> 00:35:05,400
issue is defragmentation if you learn

961
00:35:08,089 --> 00:35:07,380
for instance your body map into a brain

962
00:35:10,310 --> 00:35:08,099
area

963
00:35:11,930 --> 00:35:10,320

and then somebody changes your body map

964

00:35:13,970 --> 00:35:11,940

because you have an accident and lose a

965

00:35:15,589 --> 00:35:13,980

finger or somebody gives you an

966

00:35:17,810 --> 00:35:15,599

artificial limp and you start to

967

00:35:19,490 --> 00:35:17,820

integrate this into your body map how do

968

00:35:21,589 --> 00:35:19,500

you shift all the representations around

969

00:35:23,810 --> 00:35:21,599

how do you make space for something else

970

00:35:26,150 --> 00:35:23,820

and move it or also initially when you

971

00:35:27,470 --> 00:35:26,160

set up your Maps via happier learning

972

00:35:29,870 --> 00:35:27,480

how do you make sure that the

973

00:35:31,550 --> 00:35:29,880

neighborhoods are always correct and you

974

00:35:33,589 --> 00:35:31,560

don't need to realign anything and I

975

00:35:35,810 --> 00:35:33,599

guess you need some kind of realignment

976
00:35:37,550 --> 00:35:35,820
and uh all these things seem to be

977
00:35:38,750 --> 00:35:37,560
possible when you switch to a different

978
00:35:41,750 --> 00:35:38,760
paradigm

979
00:35:44,030 --> 00:35:41,760
and uh this so if you take this RNA

980
00:35:47,210 --> 00:35:44,040
basically seriously go down this wrapper

981
00:35:49,609 --> 00:35:47,220
tool what you get is

982
00:35:52,190 --> 00:35:49,619
um the neurons are not learning a local

983
00:35:53,870 --> 00:35:52,200
function over its neighbors but they are

984
00:35:55,910 --> 00:35:53,880
learning how to respond to the shape of

985
00:35:57,650 --> 00:35:55,920
an incoming activation front

986
00:35:59,270 --> 00:35:57,660
right the spatial temporal pattern in

987
00:36:01,609 --> 00:35:59,280
their neighborhood and they are densely

988
00:36:04,849 --> 00:36:01,619

enough connected so the enabled is just

989

00:36:07,250 --> 00:36:04,859

the space around them and in this space

990

00:36:10,069 --> 00:36:07,260

they basically interpret this according

991

00:36:12,290 --> 00:36:10,079

to a certain topology to say this uh is

992

00:36:14,810 --> 00:36:12,300

maybe a convolution that gives me two

993

00:36:16,670 --> 00:36:14,820

and a half D or it gives me 2D or 1D or

994

00:36:20,750 --> 00:36:16,680

whatever the type of function is that

995

00:36:23,750 --> 00:36:20,760

they want to compute and they learn how

996

00:36:25,730 --> 00:36:23,760

to fire in this in response to those

997

00:36:27,170 --> 00:36:25,740

patterns and thereby modulate the

998

00:36:28,670 --> 00:36:27,180

patterns when they're passed on so the

999

00:36:31,670 --> 00:36:28,680

neurons act as something like a

1000

00:36:34,150 --> 00:36:31,680

self-modulating ether so which waveforms

1001
00:36:37,609 --> 00:36:34,160
propagate that perform the computations

1002
00:36:39,829 --> 00:36:37,619
and they store the responses to the

1003
00:36:43,250 --> 00:36:39,839
distributions of incoming signals

1004
00:36:45,829 --> 00:36:43,260
possibly in RNA so you have little mix

1005
00:36:48,230 --> 00:36:45,839
tapes little tape fragments that they

1006
00:36:50,390 --> 00:36:48,240
store in the Soma and that you can make

1007
00:36:52,310 --> 00:36:50,400
more of very cheaply and easily if they

1008
00:36:53,930 --> 00:36:52,320
are successful mixtapes and their useful

1009
00:36:55,490 --> 00:36:53,940
computational Primitives that they

1010
00:36:57,410 --> 00:36:55,500
discovered and they can distribute this

1011
00:37:00,230 --> 00:36:57,420
to other neurons through the entire

1012
00:37:02,030 --> 00:37:00,240
cortex so new ones of the same type will

1013
00:37:04,250 --> 00:37:02,040

gain the knowledge to apply the same

1014

00:37:06,650 --> 00:37:04,260

computational Primitives

1015

00:37:08,510 --> 00:37:06,660

and that is something I don't know if

1016

00:37:10,190 --> 00:37:08,520

the brain is doing that and of the human

1017

00:37:11,750 --> 00:37:10,200

brain is using these principles or if

1018

00:37:13,670 --> 00:37:11,760

it's using them a lot and how important

1019

00:37:15,829 --> 00:37:13,680

this is and how many other mechanisms

1020

00:37:17,630 --> 00:37:15,839

exist but it's a mechanism that we

1021

00:37:19,730 --> 00:37:17,640

haven't so my knowledge tried very much

1022

00:37:22,310 --> 00:37:19,740

in Ai and computer science

1023

00:37:25,130 --> 00:37:22,320

and it would work there is something

1024

00:37:27,170 --> 00:37:25,140

that is a very close analog that is a

1025

00:37:29,390 --> 00:37:27,180

neural cellular automaton

1026

00:37:31,430 --> 00:37:29,400

here so basically instead of learning

1027

00:37:33,290 --> 00:37:31,440

weight uh weight shifts or weight

1028

00:37:34,849 --> 00:37:33,300

changes between adjacent new ones what

1029

00:37:37,670 --> 00:37:34,859

you learn is

1030

00:37:40,069 --> 00:37:37,680

um Global functions that tell neurons on

1031

00:37:41,450 --> 00:37:40,079

how to respond to patterns in the

1032

00:37:44,030 --> 00:37:41,460

neighborhood

1033

00:37:46,550 --> 00:37:44,040

and these functions are the same for

1034

00:37:48,890 --> 00:37:46,560

every point in your Matrix

1035

00:37:51,650 --> 00:37:48,900

and you can learn arbitrary functions in

1036

00:37:53,329 --> 00:37:51,660

this way and what's nice about is that

1037

00:37:56,630 --> 00:37:53,339

you only need to learn computational

1038

00:37:59,510 --> 00:37:56,640

Primitives once our kubernetworks need

1039

00:38:01,130 --> 00:37:59,520

to learn the same linear algebra over

1040

00:38:03,650 --> 00:38:01,140

and over again in many different corners

1041

00:38:05,150 --> 00:38:03,660

of the neural network because you need a

1042

00:38:07,370 --> 00:38:05,160

vector algebra for many kinds of

1043

00:38:08,930 --> 00:38:07,380

operations that we perform like for

1044

00:38:11,450 --> 00:38:08,940

instance operations in space

1045

00:38:14,390 --> 00:38:11,460

where we shift things around or rotate

1046

00:38:15,650 --> 00:38:14,400

them and if they could change exchange

1047

00:38:17,870 --> 00:38:15,660

these useful

1048

00:38:19,430 --> 00:38:17,880

um operations with each other and just

1049

00:38:21,710 --> 00:38:19,440

apply an operator whenever the

1050

00:38:23,390 --> 00:38:21,720

environment uh dictates that this would

1051
00:38:25,310 --> 00:38:23,400
be a good idea to try to apply this

1052
00:38:27,530 --> 00:38:25,320
operator right now in this context that

1053
00:38:28,849 --> 00:38:27,540
could speed up learning it could make uh

1054
00:38:31,550 --> 00:38:28,859
training much more sample efficient

1055
00:38:33,109 --> 00:38:31,560
right so something super interesting to

1056
00:38:35,450 --> 00:38:33,119
try and this is one of the rabbit holes

1057
00:38:38,450 --> 00:38:35,460
I recently fell down whenever I changed

1058
00:38:41,810 --> 00:38:38,460
my thinking based on some experiment

1059
00:38:43,609 --> 00:38:41,820
from Neuroscience that doesn't have very

1060
00:38:46,250 --> 00:38:43,619
big impact for for the mainstream of

1061
00:38:49,329 --> 00:38:46,260
Neuroscience but that I found reflected

1062
00:38:51,470 --> 00:38:49,339
in Michael's work with planaria

1063
00:38:54,530 --> 00:38:51,480

yeah that's that's super interesting

1064

00:38:57,829 --> 00:38:54,540

stuff um I I can sprinkle a few a few

1065

00:39:00,589 --> 00:38:57,839

details onto this um uh the original so

1066

00:39:02,569 --> 00:39:00,599

so the original finding in planaria was

1067

00:39:04,609 --> 00:39:02,579

um was a guy named James McConnell in

1068

00:39:06,710 --> 00:39:04,619

the in in Michigan actually in the US

1069

00:39:08,450 --> 00:39:06,720

and and then that was in the 60s the

1070

00:39:10,670 --> 00:39:08,460

early 60s and then there were some

1071

00:39:12,650 --> 00:39:10,680

really interesting Russian work um that

1072

00:39:14,810 --> 00:39:12,660

that picked it up after that uh we

1073

00:39:17,150 --> 00:39:14,820

reproduced some of it recently in using

1074

00:39:19,069 --> 00:39:17,160

modern uh modern quantitative uh

1075

00:39:20,810 --> 00:39:19,079

Automation and and things like this but

1076

00:39:22,190 --> 00:39:20,820

one of the one of the really cool

1077

00:39:24,109 --> 00:39:22,200

aspects of this and there's a whole

1078

00:39:26,089 --> 00:39:24,119

Community by the way with um you know

1079

00:39:27,829 --> 00:39:26,099

people like uh Randy gallistel and Sam

1080

00:39:30,290 --> 00:39:27,839

gershman and um you know of course

1081

00:39:32,750 --> 00:39:30,300

glansman David glansman and people who

1082

00:39:34,970 --> 00:39:32,760

are that that story of memory in the in

1083

00:39:36,530 --> 00:39:34,980

the precise details of the um of the

1084

00:39:38,089 --> 00:39:36,540

synapses is that that story is really

1085

00:39:39,770 --> 00:39:38,099

starting to crack actually for a number

1086

00:39:41,329 --> 00:39:39,780

of reasons but one of the one of the

1087

00:39:43,550 --> 00:39:41,339

cool things that that was done in the

1088

00:39:46,430 --> 00:39:43,560

Russian work and it was also done later

1089

00:39:48,470 --> 00:39:46,440

on by um uh Doug Blackiston who's who's

1090

00:39:50,589 --> 00:39:48,480

in my lab now as a staff scientist and

1091

00:39:52,730 --> 00:39:50,599

other people is this this you can

1092

00:39:54,470 --> 00:39:52,740

certain certain animals that go through

1093

00:39:56,390 --> 00:39:54,480

larval stages right so you can take so

1094

00:39:58,790 --> 00:39:56,400

what the Russians were using um beetle

1095

00:40:01,190 --> 00:39:58,800

beetle larvae and uh and Doug and other

1096

00:40:03,109 --> 00:40:01,200

people used uh used used moths and

1097

00:40:05,690 --> 00:40:03,119

butterflies so what happens is you train

1098

00:40:07,550 --> 00:40:05,700

you train the larva right so so here

1099

00:40:09,109 --> 00:40:07,560

you've got a butterfly a caterpillar so

1100

00:40:10,849 --> 00:40:09,119

so this caterpillar lives in a

1101
00:40:12,290 --> 00:40:10,859
two-dimensional world it's a soft-bodied

1102
00:40:13,849 --> 00:40:12,300
robot it lives in a two-dimensional

1103
00:40:15,530 --> 00:40:13,859
world that eats leaves and so on right

1104
00:40:17,150 --> 00:40:15,540
and so you train this thing for a

1105
00:40:19,730 --> 00:40:17,160
particular task well during

1106
00:40:21,950 --> 00:40:19,740
metamorphosis it needs to become a moth

1107
00:40:23,210 --> 00:40:21,960
or butterfly which it lives in a

1108
00:40:24,770 --> 00:40:23,220
three-dimensional world plus it's a

1109
00:40:26,210 --> 00:40:24,780
hard-bodied creature so so the

1110
00:40:27,770 --> 00:40:26,220
controller is completely different right

1111
00:40:29,630 --> 00:40:27,780
for running this for running a

1112
00:40:31,550 --> 00:40:29,640
caterpillar versus a butterfly so so

1113
00:40:34,010 --> 00:40:31,560

during that process what happens is the

1114

00:40:35,450 --> 00:40:34,020

brain is basically dissolved so most of

1115

00:40:37,790 --> 00:40:35,460

the connections are broken most of the

1116

00:40:39,290 --> 00:40:37,800

cells are gone they die uh you you put

1117

00:40:41,450 --> 00:40:39,300

together a brand new brain itself

1118

00:40:43,130 --> 00:40:41,460

assembles and you can ask all sorts of

1119

00:40:44,930 --> 00:40:43,140

interesting philosophical questions of

1120

00:40:46,430 --> 00:40:44,940

what it's like to be a creature whose

1121

00:40:49,490 --> 00:40:46,440

brain is undergoing this massive change

1122

00:40:51,650 --> 00:40:49,500

uh but the information remains and and

1123

00:40:53,210 --> 00:40:51,660

so one can ask okay this is you know

1124

00:40:55,550 --> 00:40:53,220

certainly for computer science it's it's

1125

00:40:57,710 --> 00:40:55,560

amazing to have a cop to have to have a

1126

00:41:00,310 --> 00:40:57,720

memory medium that can survive this

1127

00:41:03,470 --> 00:41:00,320

radical re Remodeling and reconstruction

1128

00:41:04,730 --> 00:41:03,480

and there's there's the RNA story but

1129

00:41:06,710 --> 00:41:04,740

but also

1130

00:41:08,569 --> 00:41:06,720

um uh you had mentioned you know does

1131

00:41:10,910 --> 00:41:08,579

this does this work from for mammals so

1132

00:41:12,530 --> 00:41:10,920

there was a guy in the 70s and 80s there

1133

00:41:14,510 --> 00:41:12,540

was a there was a guy named George Ungar

1134

00:41:18,530 --> 00:41:14,520

who did tons of he's got tons of papers

1135

00:41:20,990 --> 00:41:18,540

he uh reproduced it in rats so so his

1136

00:41:23,210 --> 00:41:21,000

was fear of the dark and he actually

1137

00:41:24,170 --> 00:41:23,220

um by by establishing this essay and

1138

00:41:25,970 --> 00:41:24,180

then

1139

00:41:28,010 --> 00:41:25,980

um uh you know fractionating their

1140

00:41:30,349 --> 00:41:28,020

brains and and extracting this this

1141

00:41:32,750 --> 00:41:30,359

activity now he thought it was a peptide

1142

00:41:34,609 --> 00:41:32,760

not not RNA so he he ended up with a

1143

00:41:36,410 --> 00:41:34,619

with a thing called uh scotophobin

1144

00:41:39,230 --> 00:41:36,420

which turns out to be I think an eight

1145

00:41:40,490 --> 00:41:39,240

mer peptide or something and the claim

1146

00:41:42,770 --> 00:41:40,500

was that you can transfer this

1147

00:41:44,750 --> 00:41:42,780

scotophobia you can synthesize it and

1148

00:41:46,490 --> 00:41:44,760

then transfer it from brain to brain and

1149

00:41:47,870 --> 00:41:46,500

and that's and that's you know that's

1150

00:41:49,790 --> 00:41:47,880

that's that's what he thought it was and

1151
00:41:52,609 --> 00:41:49,800
then of course I think David glansman

1152
00:41:53,930 --> 00:41:52,619
favors RNA again but yeah I agree with

1153
00:41:56,630 --> 00:41:53,940
you I think I think that's a that's a

1154
00:41:59,150 --> 00:41:56,640
that's a super important story of how it

1155
00:42:01,910 --> 00:41:59,160
is that this kind of information can

1156
00:42:03,530 --> 00:42:01,920
survive uh just just massive uh

1157
00:42:05,870 --> 00:42:03,540
remodeling of the of the cognitive

1158
00:42:07,490 --> 00:42:05,880
substrate in planaria what we what we

1159
00:42:09,349 --> 00:42:07,500
did and and planaria you know they they

1160
00:42:11,390 --> 00:42:09,359
have a true centralized brain they have

1161
00:42:12,710 --> 00:42:11,400
all the same neurotransmitters that we

1162
00:42:14,210 --> 00:42:12,720
have they're not as simple a simple

1163
00:42:15,950 --> 00:42:14,220

organism

1164

00:42:17,930 --> 00:42:15,960

um what we did was McConnell's first

1165

00:42:19,490 --> 00:42:17,940

experiments which is to train them on

1166

00:42:22,849 --> 00:42:19,500

something and we train them to recognize

1167

00:42:24,349 --> 00:42:22,859

a laser etched um kind of bumpy pattern

1168

00:42:25,609 --> 00:42:24,359

on the bottom of the dish to recognize

1169

00:42:26,690 --> 00:42:25,619

that that's where their food was going

1170

00:42:28,970 --> 00:42:26,700

to be found so they made this

1171

00:42:30,950 --> 00:42:28,980

association between this pattern and the

1172

00:42:33,230 --> 00:42:30,960

and getting food and then we cut their

1173

00:42:34,910 --> 00:42:33,240

heads off and and we took the Tails and

1174

00:42:36,650 --> 00:42:34,920

the Tails sit there for 10 days doing

1175

00:42:38,569 --> 00:42:36,660

nothing and then eventually they grow a

1176

00:42:40,730 --> 00:42:38,579

new brain and what happens is that

1177

00:42:41,870 --> 00:42:40,740

information is then imprinted onto the

1178

00:42:44,030 --> 00:42:41,880

new brain and then and then you can

1179

00:42:46,030 --> 00:42:44,040

recover behavioral you know evidence

1180

00:42:48,829 --> 00:42:46,040

that they remember the information

1181

00:42:51,170 --> 00:42:48,839

so so that's pretty cool too because it

1182

00:42:53,569 --> 00:42:51,180

suggests that well we don't know if the

1183

00:42:55,609 --> 00:42:53,579

information is everywhere or if it's in

1184

00:42:57,290 --> 00:42:55,619

other places in the peripheral nervous

1185

00:42:58,670 --> 00:42:57,300

system or in this you know in the Nerf

1186

00:43:01,190 --> 00:42:58,680

core that we don't know where it is yet

1187

00:43:03,109 --> 00:43:01,200

but it's clear that it can move around

1188

00:43:04,910 --> 00:43:03,119

that the information can move around in

1189

00:43:06,710 --> 00:43:04,920

the body because it can be in the

1190

00:43:08,210 --> 00:43:06,720

posterior half and then imprinted onto

1191

00:43:09,650 --> 00:43:08,220

the brain which actually drives all the

1192

00:43:11,750 --> 00:43:09,660

all the behaviors

1193

00:43:13,790 --> 00:43:11,760

so thinking about that I I totally agree

1194

00:43:16,069 --> 00:43:13,800

that this is this is a really important

1195

00:43:17,750 --> 00:43:16,079

rabbit hole for asking but but it has it

1196

00:43:20,390 --> 00:43:17,760

there's an interesting puzzle here which

1197

00:43:24,190 --> 00:43:20,400

which is which is this you know it's one

1198

00:43:27,710 --> 00:43:24,200

thing to remember things that are

1199

00:43:29,210 --> 00:43:27,720

evolutionarily uh adaptive like fear of

1200

00:43:31,190 --> 00:43:29,220

the dark and things like this but

1201
00:43:33,829 --> 00:43:31,200
imagine and this hasn't really been done

1202
00:43:35,210 --> 00:43:33,839
well but imagine for a moment if we

1203
00:43:37,910 --> 00:43:35,220
could train them to something that is

1204
00:43:40,190 --> 00:43:37,920
completely novel let's say let's say we

1205
00:43:41,990 --> 00:43:40,200
train them um uh three yellow life

1206
00:43:43,430 --> 00:43:42,000
flashes means so take a step to your

1207
00:43:44,750 --> 00:43:43,440
left otherwise you get shocked something

1208
00:43:46,130 --> 00:43:44,760
like that and let's say they learn to do

1209
00:43:47,990 --> 00:43:46,140
it we haven't done this yet but let's

1210
00:43:50,690 --> 00:43:48,000
say let's say this could be could work

1211
00:43:52,609 --> 00:43:50,700
one of the big uh puzzles is going to be

1212
00:43:54,530 --> 00:43:52,619
when you extract whatever it is that you

1213
00:43:56,450 --> 00:43:54,540

extract let's say it's RNA or protein

1214

00:43:59,809 --> 00:43:56,460

whatever it is you stick it into the

1215

00:44:01,370 --> 00:43:59,819

brain of a recipient host and in order

1216

00:44:02,569 --> 00:44:01,380

for that memory to transfer one of the

1217

00:44:04,550 --> 00:44:02,579

things that the host has to be able to

1218

00:44:06,829 --> 00:44:04,560

do is has to be able to decode it in

1219

00:44:08,390 --> 00:44:06,839

order to decode it it's one thing if we

1220

00:44:10,130 --> 00:44:08,400

share the same code book and by

1221

00:44:11,569 --> 00:44:10,140

Evolution we could have this same code

1222

00:44:13,309 --> 00:44:11,579

book for things that come up all the

1223

00:44:16,490 --> 00:44:13,319

time like fear of the dark fear you know

1224

00:44:18,470 --> 00:44:16,500

things like that but how do you how how

1225

00:44:20,270 --> 00:44:18,480

would the recipient look at a a a a

1226

00:44:22,609 --> 00:44:20,280

weird sort of you know some some kind of

1227

00:44:24,230 --> 00:44:22,619

crazy hairpin RNA structure and look at

1228

00:44:27,109 --> 00:44:24,240

and and analyze it and be like oh yes

1229

00:44:28,970 --> 00:44:27,119

that's three light flashes and then uh

1230

00:44:31,550 --> 00:44:28,980

step to the left I see so you would need

1231

00:44:33,470 --> 00:44:31,560

to be able to interpret somehow this the

1232

00:44:35,210 --> 00:44:33,480

structure and convert it back to the

1233

00:44:37,970 --> 00:44:35,220

behavior and for and for behaviors that

1234

00:44:39,530 --> 00:44:37,980

are truly arbitrary that might be I I

1235

00:44:41,990 --> 00:44:39,540

don't know actually how that would work

1236

00:44:45,650 --> 00:44:42,000

and so so I think the frontier of this

1237

00:44:47,990 --> 00:44:45,660

field is going to be to have a really uh

1238

00:44:50,329 --> 00:44:48,000

convincing demonstration of of a

1239

00:44:52,670 --> 00:44:50,339

transfer of a memory that doesn't have a

1240

00:44:54,710 --> 00:44:52,680

plausible pre-existing shared

1241

00:44:56,030 --> 00:44:54,720

evolutionary decoding because because

1242

00:44:57,650 --> 00:44:56,040

otherwise you have a you have a real

1243

00:44:59,750 --> 00:44:57,660

puzzle as to how the how the the

1244

00:45:01,490 --> 00:44:59,760

decoding is going to work so this this

1245

00:45:03,410 --> 00:45:01,500

idea and and then and then even without

1246

00:45:06,230 --> 00:45:03,420

the transfer you can also think of it a

1247

00:45:08,210 --> 00:45:06,240

different way every memory is like a

1248

00:45:09,530 --> 00:45:08,220

message is like basically a transplanted

1249

00:45:11,390 --> 00:45:09,540

message from your past self to your

1250

00:45:12,710 --> 00:45:11,400

future self meaning that you still have

1251
00:45:14,510 --> 00:45:12,720
to decode your memories whatever your

1252
00:45:16,010 --> 00:45:14,520
memories are in an important sense you

1253
00:45:18,410 --> 00:45:16,020
have to you know those engrams you have

1254
00:45:20,870 --> 00:45:18,420
to decode them somehow so

1255
00:45:22,550 --> 00:45:20,880
um that that whole issue of of encoding

1256
00:45:24,230 --> 00:45:22,560
and decoding whatever the substrate of

1257
00:45:26,890 --> 00:45:24,240
memory is is you know maybe one of the

1258
00:45:29,329 --> 00:45:26,900
most important questions there are

1259
00:45:31,190 --> 00:45:29,339
one of the ways I we can think about

1260
00:45:34,630 --> 00:45:31,200
these engrams I think that there are

1261
00:45:37,430 --> 00:45:34,640
priors that condition what kinds of

1262
00:45:40,910 --> 00:45:37,440
features are being spawned in which

1263
00:45:42,589 --> 00:45:40,920

context for instance when we see a new

1264

00:45:46,309 --> 00:45:42,599

scene the way that perception seems to

1265

00:45:47,750 --> 00:45:46,319

be working is that we uh spawn lots lots

1266

00:45:49,670 --> 00:45:47,760

of feature controllers that then

1267

00:45:51,770 --> 00:45:49,680

organize into objects that are

1268

00:45:54,470 --> 00:45:51,780

controlled at the level of the scene

1269

00:45:56,870 --> 00:45:54,480

and uh this is basically a game engine

1270

00:45:59,089 --> 00:45:56,880

that is forming in our brain that is

1271

00:46:02,630 --> 00:45:59,099

creating a population of interacting

1272

00:46:04,430 --> 00:46:02,640

objects that are tuned to track our

1273

00:46:05,690 --> 00:46:04,440

perceptual data at the lowest level so

1274

00:46:09,109 --> 00:46:05,700

all the patterns that we get from our

1275

00:46:10,130 --> 00:46:09,119

retina and so on uh are samples noisy

1276

00:46:12,050 --> 00:46:10,140

samples

1277

00:46:13,609 --> 00:46:12,060

um that are difficult to interpret but

1278

00:46:15,829 --> 00:46:13,619

we are matching them into these

1279

00:46:18,290 --> 00:46:15,839

hierarchies of features that are

1280

00:46:20,750 --> 00:46:18,300

translated into objects that assign

1281

00:46:23,210 --> 00:46:20,760

every feed a feature to exactly one

1282

00:46:25,190 --> 00:46:23,220

object and every pixel so to speak to

1283

00:46:28,010 --> 00:46:25,200

exactly one except in the case of

1284

00:46:29,690 --> 00:46:28,020

transparency and use this to interpret

1285

00:46:31,370 --> 00:46:29,700

the scene that is happening in front of

1286

00:46:33,589 --> 00:46:31,380

us and when we are in the dark

1287

00:46:35,569 --> 00:46:33,599

what happens is that we spawn lots of

1288

00:46:38,030 --> 00:46:35,579

object controllers without being able to

1289

00:46:40,910 --> 00:46:38,040

disprove them because there is no data

1290

00:46:43,370 --> 00:46:40,920

that forces us to reject them and if you

1291

00:46:45,230 --> 00:46:43,380

have a vivid imagination especially as a

1292

00:46:47,329 --> 00:46:45,240

child you will feel this Darkness

1293

00:46:49,309 --> 00:46:47,339

automatically with lots of objects many

1294

00:46:52,670 --> 00:46:49,319

of which will be scary

1295

00:46:54,349 --> 00:46:52,680

and so I think that lots of the fear of

1296

00:46:56,990 --> 00:46:54,359

the dark doesn't need a lot of encoding

1297

00:46:59,569 --> 00:46:57,000

in our brain it is just an artifact of

1298

00:47:01,069 --> 00:46:59,579

the fact that there are scary things in

1299

00:47:03,230 --> 00:47:01,079

the world which I learned to represent

1300

00:47:04,849 --> 00:47:03,240

at an early age and that we cannot

1301
00:47:06,170 --> 00:47:04,859
disprove them that they just will just

1302
00:47:08,630 --> 00:47:06,180
spawn

1303
00:47:10,250 --> 00:47:08,640
I remember this vividly as a child that

1304
00:47:14,089 --> 00:47:10,260
whenever I had to go into the dark

1305
00:47:17,510 --> 00:47:14,099
basement to uh get some food in our

1306
00:47:19,370 --> 00:47:17,520
house uh in the countryside that this

1307
00:47:20,870 --> 00:47:19,380
Darkness automatically filled with all

1308
00:47:22,550 --> 00:47:20,880
sorts of shapes and things and

1309
00:47:25,970 --> 00:47:22,560
possibilities

1310
00:47:27,829 --> 00:47:25,980
and it took me later to learn that uh

1311
00:47:30,829 --> 00:47:27,839
you need to be much more afraid of the

1312
00:47:32,870 --> 00:47:30,839
ghosts that can hide in the light

1313
00:47:34,670 --> 00:47:32,880

so what would be the implications of if

1314

00:47:35,690 --> 00:47:34,680

you were able to transfer memory for

1315

00:47:37,790 --> 00:47:35,700

something that's

1316

00:47:40,550 --> 00:47:37,800

not trivial so nothing that's like an

1317

00:47:44,030 --> 00:47:40,560

archetype of fear of the dark between

1318

00:47:46,069 --> 00:47:44,040

a mammal like rats

1319

00:47:47,630 --> 00:47:46,079

and when I say transfer memory I mean in

1320

00:47:49,069 --> 00:47:47,640

this way that you blend up the brain or

1321

00:47:51,050 --> 00:47:49,079

you and also can you explain what's

1322

00:47:52,550 --> 00:47:51,060

meant by I think I understand what it

1323

00:47:53,690 --> 00:47:52,560

means to blend the brain of a planaria

1324

00:47:55,910 --> 00:47:53,700

but I don't think that's the same

1325

00:47:58,309 --> 00:47:55,920

process that's going on in rats maybe it

1326

00:48:00,290 --> 00:47:58,319

is they they well ongar did exactly the

1327

00:48:01,970 --> 00:48:00,300

same thing he would train rats for

1328

00:48:04,550 --> 00:48:01,980

particular tasks he would extract the

1329

00:48:06,829 --> 00:48:04,560

brain literally liquefy to extract the

1330

00:48:09,050 --> 00:48:06,839

chemical contents uh he would then

1331

00:48:10,609 --> 00:48:09,060

either inject the whole extract or a

1332

00:48:12,829 --> 00:48:10,619

filtered extract where you would divide

1333

00:48:14,990 --> 00:48:12,839

it up you'd fractionated so here's the

1334

00:48:17,329 --> 00:48:15,000

rnas here's the proteins here you know

1335

00:48:19,790 --> 00:48:17,339

other things uh and and then he would

1336

00:48:22,670 --> 00:48:19,800

inject that liquid directly into the

1337

00:48:25,130 --> 00:48:22,680

brains of recipient rats so you know

1338

00:48:27,349 --> 00:48:25,140

when you do that you lose you lose

1339

00:48:28,970 --> 00:48:27,359

spatial structure on the input because

1340

00:48:30,349 --> 00:48:28,980

you just Blended your brain whatever

1341

00:48:34,190 --> 00:48:30,359

spatial structure otherwise you just

1342

00:48:36,349 --> 00:48:34,200

destroyed it also on the recipient you

1343

00:48:37,910 --> 00:48:36,359

just you just inject it it's not you

1344

00:48:39,349 --> 00:48:37,920

know you're not finding that particular

1345

00:48:41,329 --> 00:48:39,359

place where you're going to stick that

1346

00:48:42,470 --> 00:48:41,339

you just inject this this thing right in

1347

00:48:44,390 --> 00:48:42,480

the middle of the brain who knows where

1348

00:48:45,770 --> 00:48:44,400

it goes you know where the fluid goes is

1349

00:48:48,890 --> 00:48:45,780

it sort of there's no spatial

1350

00:48:52,190 --> 00:48:48,900

specificity there whatsoever so if that

1351
00:48:54,290 --> 00:48:52,200
works uh what you're counting on is the

1352
00:48:57,710 --> 00:48:54,300
ability of the brain to take up

1353
00:48:59,630 --> 00:48:57,720
information via a completely novel route

1354
00:49:01,250 --> 00:48:59,640
so it's not information that's for

1355
00:49:03,470 --> 00:49:01,260
example visual right visual information

1356
00:49:05,150 --> 00:49:03,480
the accounts it comes in exactly the

1357
00:49:06,650 --> 00:49:05,160
same place all the time right there are

1358
00:49:08,210 --> 00:49:06,660
there are there are optic nerves that

1359
00:49:09,290 --> 00:49:08,220
connect to the same place in the in the

1360
00:49:12,410 --> 00:49:09,300
brain and that's where that information

1361
00:49:15,710 --> 00:49:12,420
arrives if you bathe the brain in some

1362
00:49:17,809 --> 00:49:15,720
sort of uh informational extract you're

1363
00:49:19,730 --> 00:49:17,819

basically asking the cells to take it up

1364

00:49:21,650 --> 00:49:19,740

almost as as a primitive animal would

1365

00:49:23,210 --> 00:49:21,660

with taste or touch you right that's

1366

00:49:24,710 --> 00:49:23,220

kind of distributed all over the body

1367

00:49:26,089 --> 00:49:24,720

and you can sort of pick it up anywhere

1368

00:49:28,190 --> 00:49:26,099

and then you have to process this

1369

00:49:29,690 --> 00:49:28,200

information so so you've got those

1370

00:49:31,370 --> 00:49:29,700

issues right off the bat right that

1371

00:49:33,710 --> 00:49:31,380

you've destroyed the incoming spatial

1372

00:49:35,690 --> 00:49:33,720

structure you you can't really count on

1373

00:49:38,630 --> 00:49:35,700

where it's going to land in the brain

1374

00:49:40,030 --> 00:49:38,640

and and then the third thing is as you

1375

00:49:41,990 --> 00:49:40,040

just mentioned is the idea that

1376

00:49:45,710 --> 00:49:42,000

especially if we start with information

1377

00:49:50,510 --> 00:49:45,720

that isn't any that is is that is so um

1378

00:49:51,490 --> 00:49:50,520

uh kind of uh specific and

1379

00:49:54,950 --> 00:49:51,500

um

1380

00:49:56,510 --> 00:49:54,960

you know kind of uh invented you know

1381

00:49:57,829 --> 00:49:56,520

that free light flashes means move to

1382

00:49:59,510 --> 00:49:57,839

your left I mean there's never there's

1383

00:50:01,490 --> 00:49:59,520

never been an evolutionary reason to

1384

00:50:02,930 --> 00:50:01,500

have that encoded like as you just said

1385

00:50:04,609 --> 00:50:02,940

having a fear of the dark is absolutely

1386

00:50:06,470 --> 00:50:04,619

a natural kind of thing that shows that

1387

00:50:08,030 --> 00:50:06,480

that you can expect but and then there

1388

00:50:10,430 --> 00:50:08,040

are many other things like that but but

1389

00:50:12,349 --> 00:50:10,440

something something as as contrived as

1390

00:50:13,910 --> 00:50:12,359

as you know three light flashes and then

1391

00:50:16,130 --> 00:50:13,920

you move to your left there's no reason

1392

00:50:18,349 --> 00:50:16,140

to think that we have a built-in way to

1393

00:50:20,930 --> 00:50:18,359

recognize that so when you as a as a

1394

00:50:23,150 --> 00:50:20,940

recipient brain are handed this weird uh

1395

00:50:25,430 --> 00:50:23,160

molecule with a particular structure or

1396

00:50:27,950 --> 00:50:25,440

or a set of molecules uh being able to

1397

00:50:29,809 --> 00:50:27,960

analyze that having the cells in your

1398

00:50:31,790 --> 00:50:29,819

brain or or other parts of the body

1399

00:50:34,010 --> 00:50:31,800

actually that could Analyze That and

1400

00:50:35,809 --> 00:50:34,020

recover that original information would

1401

00:50:37,910 --> 00:50:35,819

be extremely puzzling I actually don't

1402

00:50:40,130 --> 00:50:37,920

know how that would work and I'm a big

1403

00:50:41,750 --> 00:50:40,140

fan of of unlikely sounding experiments

1404

00:50:44,510 --> 00:50:41,760

that have implications if they would

1405

00:50:47,030 --> 00:50:44,520

work so this is something that uh that I

1406

00:50:48,349 --> 00:50:47,040

think should absolutely be done and um

1407

00:50:51,109 --> 00:50:48,359

and you know at some point we'll we'll

1408

00:50:52,849 --> 00:50:51,119

do it but we haven't done it yet but so

1409

00:50:55,010 --> 00:50:52,859

how far did the research in my school

1410

00:50:58,910 --> 00:50:55,020

what is the complexity of things that

1411

00:51:01,370 --> 00:50:58,920

could be transmitted via this road the I

1412

00:51:06,170 --> 00:51:01,380

as as I I don't remember everything that

1413

00:51:07,069 --> 00:51:06,180

he did uh the vast majority of he he did

1414

00:51:08,690 --> 00:51:07,079

not

1415

00:51:11,150 --> 00:51:08,700

um go

1416

00:51:12,589 --> 00:51:11,160

far to test all the complexities what he

1417

00:51:14,569 --> 00:51:12,599

tried to do was because as you can

1418

00:51:16,790 --> 00:51:14,579

imagine he faced incredible opposition

1419

00:51:18,770 --> 00:51:16,800

right so so everybody you know sort of

1420

00:51:21,770 --> 00:51:18,780

wanted to critique this thing so he

1421

00:51:23,329 --> 00:51:21,780

spent all of his time on he picked one

1422

00:51:25,670 --> 00:51:23,339

simple assay which was this fear of the

1423

00:51:28,730 --> 00:51:25,680

dark thing and then he just he just

1424

00:51:30,589 --> 00:51:28,740

bashed it for for 20 years uh to just

1425

00:51:32,690 --> 00:51:30,599

finally try to kind of crack that into

1426

00:51:34,970 --> 00:51:32,700

the into the Paradigm he did not

1427

00:51:37,309 --> 00:51:34,980

um as far as I know do lots of different

1428

00:51:39,109 --> 00:51:37,319

assays to try and make it more complex I

1429

00:51:42,109 --> 00:51:39,119

think uh I think it you know it's it's

1430

00:51:43,430 --> 00:51:42,119

very ripe for for investigation uh this

1431

00:51:44,870 --> 00:51:43,440

is the kind of did anyone else build

1432

00:51:46,609 --> 00:51:44,880

upon his work

1433

00:51:48,890 --> 00:51:46,619

um not that I know I mean I mean David

1434

00:51:50,569 --> 00:51:48,900

glansman is the best modern person who

1435

00:51:53,510 --> 00:51:50,579

works on this right so he does aplizia

1436

00:51:55,970 --> 00:51:53,520

and he you know and he does RNA so so he

1437

00:51:57,910 --> 00:51:55,980

favors um he favors RNA

1438

00:52:01,309 --> 00:51:57,920

um there's a little bit of work from um

1439

00:52:04,250 --> 00:52:01,319

in Israel with C elegans uh he's kind of

1440

00:52:06,109 --> 00:52:04,260

looking into that it uh there's related

1441

00:52:08,630 --> 00:52:06,119

work that has to do with cryogenics

1442

00:52:11,750 --> 00:52:08,640

which is this this you know this idea

1443

00:52:13,490 --> 00:52:11,760

idea that that if it is if if

1444

00:52:16,970 --> 00:52:13,500

memories are a particular kind of

1445

00:52:18,470 --> 00:52:16,980

dynamic electrical State then some sort

1446

00:52:20,870 --> 00:52:18,480

of cryogenic freezing is probably going

1447

00:52:24,410 --> 00:52:20,880

to disrupt that whereas if it's a stable

1448

00:52:25,970 --> 00:52:24,420

molecule then it should survive so again

1449

00:52:27,890 --> 00:52:25,980

I think there are people interested in

1450

00:52:29,329 --> 00:52:27,900

that aspect of it but I'm not sure

1451
00:52:32,390 --> 00:52:29,339
um I'm not sure they've done anything

1452
00:52:35,329 --> 00:52:32,400
with it there's also a goraf uh

1453
00:52:38,569 --> 00:52:35,339
venkataraman I think he's oh yes yes

1454
00:52:40,730 --> 00:52:38,579
yeah yeah yeah yeah he uh taught me that

1455
00:52:41,990 --> 00:52:40,740
uh he has been working on this for

1456
00:52:45,349 --> 00:52:42,000
several years but he said It's

1457
00:52:47,990 --> 00:52:45,359
sociologically Tricky and that's to me

1458
00:52:51,530 --> 00:52:48,000
fascinating that we should care about

1459
00:52:53,510 --> 00:52:51,540
that what does he mean by that what do

1460
00:52:56,270 --> 00:52:53,520
you care about what stupid people think

1461
00:52:58,549 --> 00:52:56,280
uh if this uh possibility exists that

1462
00:53:01,370 --> 00:52:58,559
this works the upside is so big that

1463
00:53:03,829 --> 00:53:01,380

it's criminal to not research this I I

1464

00:53:05,450 --> 00:53:03,839

think it's a disaster that you can read

1465

00:53:07,490 --> 00:53:05,460

uh introductory textbooks on your

1466

00:53:09,710 --> 00:53:07,500

residence and never ever hear about any

1467

00:53:11,630 --> 00:53:09,720

of these experiments yeah yeah like uh

1468

00:53:13,910 --> 00:53:11,640

everybody who gets the introductory

1469

00:53:16,069 --> 00:53:13,920

stuff on Neuroscience only knows about

1470

00:53:19,910 --> 00:53:16,079

uh information stored in the connect

1471

00:53:22,910 --> 00:53:19,920

home and this leads to for instance the

1472

00:53:24,829 --> 00:53:22,920

blue brain project if that if RNA based

1473

00:53:27,589 --> 00:53:24,839

memory transfer is a thing then this

1474

00:53:29,750 --> 00:53:27,599

entire project is doomed and because you

1475

00:53:31,849 --> 00:53:29,760

cannot get the story out of uh just

1476
00:53:33,710 --> 00:53:31,859
recording the contact home or the most

1477
00:53:36,049 --> 00:53:33,720
of the research right now is focused on

1478
00:53:38,630 --> 00:53:36,059
reconstructing The Chronic tone as as it

1479
00:53:40,670 --> 00:53:38,640
was circuitry and hoping that we can get

1480
00:53:43,670 --> 00:53:40,680
the functionality of information

1481
00:53:45,950 --> 00:53:43,680
processing and to use the specificity of

1482
00:53:48,170 --> 00:53:45,960
the particular brain what it has learned

1483
00:53:50,210 --> 00:53:48,180
from the connections between neurons but

1484
00:53:53,150 --> 00:53:50,220
what if it turns out this doesn't matter

1485
00:53:55,250 --> 00:53:53,160
what is if you just need a connection

1486
00:53:56,930 --> 00:53:55,260
that dense enough and so basically

1487
00:53:59,329 --> 00:53:56,940
stochastic lattice that is somewhat

1488
00:54:00,470 --> 00:53:59,339

randomly wired and what matters is what

1489

00:54:02,030 --> 00:54:00,480

the new ones are doing with the

1490

00:54:04,130 --> 00:54:02,040

information that they're getting through

1491

00:54:05,930 --> 00:54:04,140

this ether to this lattice right this

1492

00:54:07,970 --> 00:54:05,940

changes the entire way in which we need

1493

00:54:09,530 --> 00:54:07,980

to look at things and if this

1494

00:54:11,630 --> 00:54:09,540

possibility exists and if this

1495

00:54:13,309 --> 00:54:11,640

possibility it's just one percent but

1496

00:54:16,010 --> 00:54:13,319

there is some experimentice points in

1497

00:54:17,809 --> 00:54:16,020

this direction it is not

1498

00:54:20,390 --> 00:54:17,819

um it's ridiculous to not pursue this

1499

00:54:22,130 --> 00:54:20,400

with high pressure and focus on it and

1500

00:54:25,190 --> 00:54:22,140

support research that goes in this

1501

00:54:26,870 --> 00:54:25,200

direction basically what's useful is not

1502

00:54:28,849 --> 00:54:26,880

so much answering questions in science

1503

00:54:31,370 --> 00:54:28,859

it's discovering questions it's

1504

00:54:32,990 --> 00:54:31,380

discovering new uncertainty reducing the

1505

00:54:34,609 --> 00:54:33,000

uncertainty is much easier than

1506

00:54:36,230 --> 00:54:34,619

discovering new areas of where you

1507

00:54:39,349 --> 00:54:36,240

thought that you were certain

1508

00:54:41,450 --> 00:54:39,359

but that allow you to get new insights

1509

00:54:43,609 --> 00:54:41,460

and it seems to me that a lot of

1510

00:54:45,650 --> 00:54:43,619

Neuroscience is stuck that does not

1511

00:54:48,770 --> 00:54:45,660

produce uh results that seem to

1512

00:54:50,270 --> 00:54:48,780

accumulate in an obvious way towards a

1513

00:54:53,390 --> 00:54:50,280

theory on how the brain processes

1514

00:54:56,109 --> 00:54:53,400

information yeah so the Neuroscience I

1515

00:54:58,430 --> 00:54:56,119

just don't deliver input to the

1516

00:55:00,890 --> 00:54:58,440

researchers and add the Transformer is

1517

00:55:03,410 --> 00:55:00,900

not the result of uh reading a lot of

1518

00:55:05,450 --> 00:55:03,420

Neuroscience it's really mostly the

1519

00:55:09,170 --> 00:55:05,460

result of people thinking about

1520

00:55:11,690 --> 00:55:09,180

statistics of data processing and it

1521

00:55:14,750 --> 00:55:11,700

would be great if we would focus on

1522

00:55:16,730 --> 00:55:14,760

ideas that are promising and new and

1523

00:55:19,430 --> 00:55:16,740

that have the power to shake existing

1524

00:55:21,650 --> 00:55:19,440

paradigms yeah this is you know this is

1525

00:55:24,410 --> 00:55:21,660

this is so important and it's not just

1526

00:55:26,510 --> 00:55:24,420

Neuroscience in developmental biology we

1527

00:55:27,710 --> 00:55:26,520

have exactly the same thing and and I'll

1528

00:55:29,930 --> 00:55:27,720

just give you two two very simple

1529

00:55:31,790 --> 00:55:29,940

examples of it where and I tell the

1530

00:55:33,710 --> 00:55:31,800

students when I when I give talks to

1531

00:55:36,170 --> 00:55:33,720

students I say isn't it amazing that

1532

00:55:37,970 --> 00:55:36,180

that in in your whole

1533

00:55:39,290 --> 00:55:37,980

course of biology in your developmental

1534

00:55:42,010 --> 00:55:39,300

biology textbook there's not a mention

1535

00:55:44,809 --> 00:55:42,020

of any of this because it completely um

1536

00:55:46,130 --> 00:55:44,819

uh just undermines a lot of the basic

1537

00:55:49,549 --> 00:55:46,140

assumptions so here's a couple of

1538

00:55:51,650 --> 00:55:49,559

examples one one example is that as of

1539

00:55:53,809 --> 00:55:51,660

trophic memory and deer so there are

1540

00:55:55,430 --> 00:55:53,819

species of deer that every year they

1541

00:55:56,630 --> 00:55:55,440

regenerate that you know the whole so

1542

00:55:57,890 --> 00:55:56,640

they make this antler rack on their

1543

00:56:01,549 --> 00:55:57,900

heads the whole thing falls off and then

1544

00:56:04,250 --> 00:56:01,559

it regrows the next year so these two

1545

00:56:05,990 --> 00:56:04,260

guys bubenik which are the Father and

1546

00:56:08,270 --> 00:56:06,000

Son team that did these experiments for

1547

00:56:09,950 --> 00:56:08,280

40 years and actually have all these

1548

00:56:12,950 --> 00:56:09,960

antlers in my lab now because when when

1549

00:56:14,329 --> 00:56:12,960

the younger one retired I asked he sent

1550

00:56:16,910 --> 00:56:14,339

me all these things all these antlers

1551

00:56:19,190 --> 00:56:16,920

the idea is this um what you can do is

1552

00:56:21,710 --> 00:56:19,200

you take a knife and somewhere in this

1553

00:56:23,870 --> 00:56:21,720

Branch structure you you make a wound

1554

00:56:25,130 --> 00:56:23,880

and the bone will heal and you get a

1555

00:56:26,750 --> 00:56:25,140

little callous and that's you know

1556

00:56:30,049 --> 00:56:26,760

that's it for that year then the whole

1557

00:56:31,849 --> 00:56:30,059

thing drops off and then next year

1558

00:56:34,069 --> 00:56:31,859

it starts to grow and it will make an

1559

00:56:36,410 --> 00:56:34,079

ectopic tine an ectopic Branch at the

1560

00:56:38,150 --> 00:56:36,420

point where you injured it last year and

1561

00:56:40,430 --> 00:56:38,160

this goes on for five or six years and

1562

00:56:43,130 --> 00:56:40,440

then eventually it goes away and and and

1563

00:56:45,770 --> 00:56:43,140

you get a normal normal rack again and

1564

00:56:47,990 --> 00:56:45,780

so the the amazing thing about it is

1565

00:56:50,270 --> 00:56:48,000

that you know as you you could you can

1566

00:56:52,370 --> 00:56:50,280

you can the the the standard models for

1567

00:56:53,990 --> 00:56:52,380

for patterning for morphogenesis are

1568

00:56:56,510 --> 00:56:54,000

these kind of um Gene regulatory

1569

00:56:58,730 --> 00:56:56,520

networks and and you know genetic um

1570

00:57:00,829 --> 00:56:58,740

Kinds of Kinds of uh biochemical

1571

00:57:02,809 --> 00:57:00,839

gradients and so on you know if you try

1572

00:57:05,750 --> 00:57:02,819

to try to come up with a with a with a

1573

00:57:07,190 --> 00:57:05,760

model for this so for for encoding an

1574

00:57:09,410 --> 00:57:07,200

arbitrary Point within a branch

1575

00:57:11,569 --> 00:57:09,420

structure that your cells at the scalp

1576
00:57:13,849 --> 00:57:11,579
have to remember for months after the

1577
00:57:15,650 --> 00:57:13,859
whole thing is dropped off and then not

1578
00:57:17,150 --> 00:57:15,660
only remember it but then implement it

1579
00:57:19,130 --> 00:57:17,160
so that when the bone starts to grow

1580
00:57:20,809 --> 00:57:19,140
something says oh yes that's the you

1581
00:57:22,549 --> 00:57:20,819
know the start another another time

1582
00:57:24,710 --> 00:57:22,559
growing to your left exactly exactly

1583
00:57:26,390 --> 00:57:24,720
here right trying to trying to make a

1584
00:57:29,510 --> 00:57:26,400
model of this using the standard tools

1585
00:57:31,010 --> 00:57:29,520
of the field is uh just just incredibly

1586
00:57:32,510 --> 00:57:31,020
difficult and and this is that that's

1587
00:57:33,790 --> 00:57:32,520
and there are other examples of this but

1588
00:57:35,750 --> 00:57:33,800

this kind of

1589

00:57:37,190 --> 00:57:35,760

non-non-genetic memory that's just very

1590

00:57:39,109 --> 00:57:37,200

difficult to explain with standard

1591

00:57:41,030 --> 00:57:39,119

models the other thing which is any I

1592

00:57:43,309 --> 00:57:41,040

think an even bigger Scandal is the

1593

00:57:43,970 --> 00:57:43,319

whole situation with planaria

1594

00:57:46,010 --> 00:57:43,980

um

1595

00:57:47,690 --> 00:57:46,020

planaria some species of planaria the

1596

00:57:49,670 --> 00:57:47,700

way they reproduce is they tear

1597

00:57:51,170 --> 00:57:49,680

themselves in half each half regenerates

1598

00:57:52,849 --> 00:57:51,180

the missing piece and now you've got two

1599

00:57:54,290 --> 00:57:52,859

that's how they reproduce so if you're

1600

00:57:56,930 --> 00:57:54,300

going to do that what you end up

1601
00:57:58,670 --> 00:57:56,940
avoiding is weissman's barrier this idea

1602
00:58:00,049 --> 00:57:58,680
that when we get mutations in our body

1603
00:58:02,390 --> 00:58:00,059
our children don't inherit those

1604
00:58:04,370 --> 00:58:02,400
mutations right so this means that any

1605
00:58:06,530 --> 00:58:04,380
mutation that doesn't kill the stem cell

1606
00:58:08,690 --> 00:58:06,540
in the body gets Amplified as that cell

1607
00:58:11,089 --> 00:58:08,700
contributes to regrowing the worm so

1608
00:58:12,530 --> 00:58:11,099
every as a result of this for for 400

1609
00:58:14,690 --> 00:58:12,540
million years these planaria have

1610
00:58:16,849 --> 00:58:14,700
accumulative mutations their genomes are

1611
00:58:18,890 --> 00:58:16,859
an incredible mess their cells are

1612
00:58:20,329 --> 00:58:18,900
basically mixoploid that meaning meaning

1613
00:58:21,410 --> 00:58:20,339

they're like a tumor every cell has a

1614

00:58:23,210 --> 00:58:21,420

different number of chromosomes

1615

00:58:25,490 --> 00:58:23,220

potentially they just they just look

1616

00:58:27,589 --> 00:58:25,500

look you know it just looks horrible as

1617

00:58:30,349 --> 00:58:27,599

an end result you've got an animal that

1618

00:58:33,349 --> 00:58:30,359

is Immortal incredibly good at

1619

00:58:36,410 --> 00:58:33,359

regenerating with 100 Fidelity and very

1620

00:58:37,970 --> 00:58:36,420

resistant to cancer now this is all of

1621

00:58:40,490 --> 00:58:37,980

this is the exact opposite of the

1622

00:58:42,109 --> 00:58:40,500

message you get uh from from from a

1623

00:58:43,730 --> 00:58:42,119

typical course through through biology

1624

00:58:45,829 --> 00:58:43,740

which it says that what is the genome

1625

00:58:47,569 --> 00:58:45,839

for The genome is for setting your body

1626

00:58:50,030 --> 00:58:47,579

structure if you mess with the genome

1627

00:58:52,309 --> 00:58:50,040

that information goes away you get you

1628

00:58:54,109 --> 00:58:52,319

get aging you get cancer right why does

1629

00:58:57,109 --> 00:58:54,119

the animal with the worst genome have

1630

00:58:58,490 --> 00:58:57,119

the the the best anatomical Fidelity I

1631

00:59:00,049 --> 00:58:58,500

mean that's just that and and I think we

1632

00:59:01,370 --> 00:59:00,059

actually as of as of you know a few

1633

00:59:03,349 --> 00:59:01,380

months ago we actually I think have some

1634

00:59:05,390 --> 00:59:03,359

insight into this but but but it's been

1635

00:59:07,309 --> 00:59:05,400

bugging me for for years and this is the

1636

00:59:09,589 --> 00:59:07,319

kind of thing that nobody ever talks

1637

00:59:11,089 --> 00:59:09,599

about because it it goes against the

1638

00:59:13,309 --> 00:59:11,099

general Assumption of what of what

1639

00:59:14,930 --> 00:59:13,319

genomes actually do and and what they're

1640

00:59:17,390 --> 00:59:14,940

for and you know this this complete lack

1641

00:59:18,770 --> 00:59:17,400

of uh correlation between the genome in

1642

00:59:20,930 --> 00:59:18,780

fact an anti-correlation between the

1643

00:59:23,270 --> 00:59:20,940

genome quality and the incredible

1644

00:59:25,730 --> 00:59:23,280

ability of this of this animal to uh to

1645

00:59:27,230 --> 00:59:25,740

to to to to have a healthy Anatomy yeah

1646

00:59:28,609 --> 00:59:27,240

what is that Insight that you mentioned

1647

00:59:31,609 --> 00:59:28,619

you acquired a few months ago

1648

00:59:33,650 --> 00:59:31,619

preliminary so so okay uh in the in the

1649

00:59:35,510 --> 00:59:33,660

name of uh you know throwing out uh kind

1650

00:59:37,670 --> 00:59:35,520

of new unproven ideas right so this is

1651
00:59:39,770 --> 00:59:37,680
you know this this is this is just my my

1652
00:59:41,270 --> 00:59:39,780
conjecture we've we've done some we've

1653
00:59:44,630 --> 00:59:41,280
done some computational modeling of it

1654
00:59:46,730 --> 00:59:44,640
which which I initially this was a um a

1655
00:59:49,010 --> 00:59:46,740
very uh clever student that I work with

1656
00:59:52,010 --> 00:59:49,020
named lakshman who I did did some models

1657
00:59:53,510 --> 00:59:52,020
with me and uh uh I initially thought it

1658
00:59:55,250 --> 00:59:53,520
was a bug and then I realized that no

1659
00:59:58,430 --> 00:59:55,260
actually this is this is this is the

1660
01:00:00,230 --> 00:59:58,440
feature the idea is this imagine so so

1661
01:00:02,630 --> 01:00:00,240
we've been working for a long a long

1662
01:00:05,270 --> 01:00:02,640
time on a concept of

1663
01:00:07,010 --> 01:00:05,280

um competency among embryonic parts and

1664

01:00:10,430 --> 01:00:07,020

what this means is basically the idea

1665

01:00:13,789 --> 01:00:10,440

that uh there are there are um

1666

01:00:16,190 --> 01:00:13,799

homeostatic feedback loops among various

1667

01:00:19,069 --> 01:00:16,200

cells and tissues and organs that

1668

01:00:21,049 --> 01:00:19,079

attempt to reach specific outcomes in

1669

01:00:23,210 --> 01:00:21,059

anatomical amorphous space despite

1670

01:00:25,190 --> 01:00:23,220

various perturbations so the idea is

1671

01:00:27,890 --> 01:00:25,200

that if you have a tadpole and you do

1672

01:00:29,569 --> 01:00:27,900

something to it whether by a mutation or

1673

01:00:31,430 --> 01:00:29,579

by a drug or something you do something

1674

01:00:33,530 --> 01:00:31,440

to it where the eye is a little

1675

01:00:35,750 --> 01:00:33,540

off-kilter or the mouth is a little off

1676

01:00:37,010 --> 01:00:35,760

all of these organs pretty much know

1677

01:00:39,109 --> 01:00:37,020

where they're supposed to be they will

1678

01:00:41,270 --> 01:00:39,119

try to minimize distance from other um

1679

01:00:42,829 --> 01:00:41,280

landmarks and they will Remodel and

1680

01:00:44,930 --> 01:00:42,839

eventually you get a normal frog so that

1681

01:00:48,230 --> 01:00:44,940

so that they will they will sort of

1682

01:00:49,789 --> 01:00:48,240

um a a recover the correct uh Anatomy

1683

01:00:51,589 --> 01:00:49,799

despite starting off in the wrong

1684

01:00:53,450 --> 01:00:51,599

position or even things like changes in

1685

01:00:55,130 --> 01:00:53,460

the number of cells or the size of cells

1686

01:00:58,069 --> 01:00:55,140

they're really good at getting their job

1687

01:00:59,809 --> 01:00:58,079

done despite various changes right so

1688

01:01:02,329 --> 01:00:59,819

okay so they have these competencies to

1689

01:01:04,490 --> 01:01:02,339

optimize specific uh things like like

1690

01:01:05,270 --> 01:01:04,500

their position and structure and things

1691

01:01:07,549 --> 01:01:05,280

like that

1692

01:01:09,109 --> 01:01:07,559

so uh so so that's so that's competency

1693

01:01:09,829 --> 01:01:09,119

now now here's here's the interesting

1694

01:01:13,970 --> 01:01:09,839

thing

1695

01:01:16,490 --> 01:01:13,980

imagine that you have a species that uh

1696

01:01:18,589 --> 01:01:16,500

has some some degree of that competency

1697

01:01:21,170 --> 01:01:18,599

and so you've got an individual of that

1698

01:01:23,390 --> 01:01:21,180

species comes up for selection uh

1699

01:01:25,190 --> 01:01:23,400

Fitness is high looks pretty good but

1700

01:01:27,530 --> 01:01:25,200

here's the problem selection doesn't

1701

01:01:30,470 --> 01:01:27,540

know whether the fitness is high because

1702

01:01:31,970 --> 01:01:30,480

his genome was amazing or the fitness is

1703

01:01:34,069 --> 01:01:31,980

high because the genome was actually so

1704

01:01:35,450 --> 01:01:34,079

so but the competency sort of made up

1705

01:01:38,030 --> 01:01:35,460

for it and now everything kind of got

1706

01:01:40,849 --> 01:01:38,040

back to where it needs to go so what the

1707

01:01:43,670 --> 01:01:40,859

competency apparently does is Shield

1708

01:01:45,710 --> 01:01:43,680

information from Evolution about the

1709

01:01:47,630 --> 01:01:45,720

actual genome it makes it harder to pick

1710

01:01:49,730 --> 01:01:47,640

the best genomes because you're

1711

01:01:51,829 --> 01:01:49,740

individuals that perform well don't

1712

01:01:55,069 --> 01:01:51,839

necessarily have the best genomes what

1713

01:01:56,450 --> 01:01:55,079

they do have is competency so what

1714

01:01:59,210 --> 01:01:56,460

happens and what happens in our

1715

01:02:00,650 --> 01:01:59,220

simulations is that when if you start

1716

01:02:04,370 --> 01:02:00,660

off with even a little bit of that

1717

01:02:06,829 --> 01:02:04,380

competency Evolution loses some power in

1718

01:02:08,390 --> 01:02:06,839

selecting the best genomes but it but

1719

01:02:10,190 --> 01:02:08,400

but where all the work tends to happen

1720

01:02:12,349 --> 01:02:10,200

is increasing the competency

1721

01:02:14,089 --> 01:02:12,359

so then the competency goes up so the

1722

01:02:15,530 --> 01:02:14,099

cells are even better at and the tissues

1723

01:02:18,470 --> 01:02:15,540

are even better at getting the job done

1724

01:02:20,930 --> 01:02:18,480

despite the bad genome that makes it

1725

01:02:23,089 --> 01:02:20,940

even worse that that that that that that

1726

01:02:25,069 --> 01:02:23,099

makes it even harder for for evolution

1727

01:02:26,809 --> 01:02:25,079

to see the best genomes which relieves

1728

01:02:29,210 --> 01:02:26,819

some of the pressure on having a good

1729

01:02:31,250 --> 01:02:29,220

genome but it basically puts all the

1730

01:02:32,870 --> 01:02:31,260

pressure on being really competent so

1731

01:02:36,349 --> 01:02:32,880

you've got this so so basically what

1732

01:02:39,109 --> 01:02:36,359

happens is that uh the the the genetic

1733

01:02:41,270 --> 01:02:39,119

fitness basically levels out at a really

1734

01:02:43,250 --> 01:02:41,280

sub-optimal level and in fact the

1735

01:02:45,770 --> 01:02:43,260

pressure is off of it so so it's

1736

01:02:47,450 --> 01:02:45,780

tolerant all kinds of craziness but the

1737

01:02:49,789 --> 01:02:47,460

competency and the mechanisms of

1738

01:02:53,030 --> 01:02:49,799

Competency get get pushed up really high

1739

01:02:54,410 --> 01:02:53,040

so in many animals and but there are

1740

01:02:56,270 --> 01:02:54,420

other factors that sort of push against

1741

01:02:57,710 --> 01:02:56,280

this ratchet but it becomes it becomes a

1742

01:03:00,650 --> 01:02:57,720

positive feedback loop it becomes a

1743

01:03:03,650 --> 01:03:00,660

ratchet for Optimal Performance despite

1744

01:03:06,470 --> 01:03:03,660

a sub-optimal genome and so in some

1745

01:03:07,549 --> 01:03:06,480

animals this sort of evens out at a

1746

01:03:10,130 --> 01:03:07,559

particular point but I think what

1747

01:03:12,349 --> 01:03:10,140

happened in planaria is that this whole

1748

01:03:14,930 --> 01:03:12,359

process ran away to its ultimate

1749

01:03:17,870 --> 01:03:14,940

conclusion the ultimate conclusion is

1750

01:03:20,390 --> 01:03:17,880

the competency algorithm became so good

1751

01:03:22,430 --> 01:03:20,400

that basically whatever the genome is

1752

01:03:24,829 --> 01:03:22,440

it's really good at creating and

1753

01:03:27,049 --> 01:03:24,839

maintaining a proper worm because it is

1754

01:03:28,970 --> 01:03:27,059

already being evolved in the presence of

1755

01:03:31,849 --> 01:03:28,980

a genome whose quality we cannot control

1756

01:03:33,829 --> 01:03:31,859

so so in computer science speak it's

1757

01:03:35,870 --> 01:03:33,839

kind of like um and Steve Frank put me

1758

01:03:37,670 --> 01:03:35,880

onto this analogy it's kind of like what

1759

01:03:40,130 --> 01:03:37,680

happens in raid arrays when you have a

1760

01:03:41,990 --> 01:03:40,140

nice raid array where the software makes

1761

01:03:44,150 --> 01:03:42,000

sure that you don't lose any data the

1762

01:03:47,210 --> 01:03:44,160

pressure is off to have really uh really

1763

01:03:48,950 --> 01:03:47,220

high quality media and so now you can

1764

01:03:50,450 --> 01:03:48,960

tolerate you can tolerate media with

1765

01:03:52,309 --> 01:03:50,460

lots of mistakes because because the

1766

01:03:54,589 --> 01:03:52,319

software takes care of it in the in the

1767

01:03:56,750 --> 01:03:54,599

raid and the on the architecture takes

1768

01:03:59,210 --> 01:03:56,760

care of it so so basically what happens

1769

01:04:02,150 --> 01:03:59,220

is you've got this animal where that uh

1770

01:04:05,270 --> 01:04:02,160

that runaway uh feedback loop went went

1771

01:04:08,510 --> 01:04:05,280

so far that the algorithm is amazing and

1772

01:04:10,309 --> 01:04:08,520

it's been it's been uh evolved

1773

01:04:12,589 --> 01:04:10,319

specifically for the ability to do what

1774

01:04:15,349 --> 01:04:12,599

it needs to do even though the hardware

1775

01:04:16,970 --> 01:04:15,359

is kind of crap and and it's it's

1776

01:04:18,710 --> 01:04:16,980

incredibly tolerant so this has a number

1777

01:04:19,789 --> 01:04:18,720

of implications that that to my

1778

01:04:22,849 --> 01:04:19,799

knowledge have never been explained

1779

01:04:24,829 --> 01:04:22,859

before for example in every kind every

1780

01:04:26,329 --> 01:04:24,839

other kind of animal you can you can

1781

01:04:28,789 --> 01:04:26,339

call a stock Center and you can get

1782

01:04:31,549 --> 01:04:28,799

mutants so you can get mice with with

1783

01:04:34,309 --> 01:04:31,559

kinky kind of Kink tails you can get

1784

01:04:36,289 --> 01:04:34,319

flies with red eyes and you can get uh

1785

01:04:38,329 --> 01:04:36,299

chickens without toes and you can get

1786

01:04:40,010 --> 01:04:38,339

you know humans come with that it has

1787

01:04:41,030 --> 01:04:40,020

various you know albinos and things you

1788

01:04:43,809 --> 01:04:41,040

can you can there's there's always

1789

01:04:47,150 --> 01:04:43,819

mutants that you can get uh planaria

1790

01:04:49,309 --> 01:04:47,160

there are no there are no abnormal lines

1791

01:04:51,349 --> 01:04:49,319

of planaria anywhere except for the only

1792

01:04:52,910 --> 01:04:51,359

exception is our two-headed line and

1793

01:04:55,730 --> 01:04:52,920

that that one's not genetic that one's

1794

01:04:57,770 --> 01:04:55,740

that one's bioelectric so so isn't it

1795

01:04:59,630 --> 01:04:57,780

amazing that that that nobody has been

1796

01:05:01,549 --> 01:04:59,640

able despite despite a hundred and you

1797

01:05:03,589 --> 01:05:01,559

know I don't know 120 years of

1798

01:05:07,010 --> 01:05:03,599

experiments with planaria nobody has

1799

01:05:08,690 --> 01:05:07,020

isolated a uh a line of planaria that is

1800

01:05:10,430 --> 01:05:08,700

anything other than a perfect planarian

1801

01:05:12,650 --> 01:05:10,440

I think this is why I think it's because

1802

01:05:13,910 --> 01:05:12,660

they have been actually selected for

1803

01:05:15,470 --> 01:05:13,920

being able to do what they need to do

1804

01:05:18,950 --> 01:05:15,480

despite the fact that there the the

1805

01:05:20,450 --> 01:05:18,960

hardware is just very junky and so so

1806

01:05:22,549 --> 01:05:20,460

that's my that's my current that's my

1807

01:05:26,270 --> 01:05:22,559

current current take on it and and and

1808

01:05:28,670 --> 01:05:26,280

really uh it puts more kind of more

1809

01:05:30,770 --> 01:05:28,680

emphasis on on on the algorithm and the

1810

01:05:33,170 --> 01:05:30,780

decision making among that cellular

1811

01:05:34,250 --> 01:05:33,180

Collective of what what you know what

1812

01:05:35,809 --> 01:05:34,260

are we going to build and what's the

1813

01:05:38,329 --> 01:05:35,819

algorithm for for making sure that we're

1814

01:05:40,010 --> 01:05:38,339

all working to build the correct thing

1815

01:05:42,710 --> 01:05:40,020

so if you translate this idea into

1816

01:05:45,230 --> 01:05:42,720

computer science a way to look at it is

1817

01:05:47,329 --> 01:05:45,240

imagine that you find some computers

1818

01:05:50,930 --> 01:05:47,339

that have

1819

01:05:52,730 --> 01:05:50,940

um artists that are very very noisy and

1820

01:05:54,349 --> 01:05:52,740

where the heart is basically makes lots

1821

01:05:57,109 --> 01:05:54,359

and lots of mistakes in encoding things

1822

01:05:58,910 --> 01:05:57,119

and bits often flip and so on and you

1823

01:06:00,950 --> 01:05:58,920

will find that these computers still

1824

01:06:02,750 --> 01:06:00,960

work and they work on pretty much the

1825

01:06:06,109 --> 01:06:02,760

same way as the other computers that you

1826
01:06:08,210 --> 01:06:06,119
have and there is an orthodox sect of

1827
01:06:10,430 --> 01:06:08,220
computer scientists that thinks uh it is

1828
01:06:13,370 --> 01:06:10,440
necessary that uh the every bit on the

1829
01:06:15,289 --> 01:06:13,380
hard disk is completely reliable or

1830
01:06:17,990 --> 01:06:15,299
reliable to such a degree that you only

1831
01:06:20,809 --> 01:06:18,000
have a mistake once every 100 trillion

1832
01:06:22,069 --> 01:06:20,819
copies and you can have an error

1833
01:06:23,750 --> 01:06:22,079
correction quote running on the hard

1834
01:06:25,549 --> 01:06:23,760
disk at the low level that corrects this

1835
01:06:27,170 --> 01:06:25,559
and after some point it doesn't become

1836
01:06:29,029 --> 01:06:27,180
efficient anymore so you need to have

1837
01:06:31,910 --> 01:06:29,039
reliable hard disks to be able to have

1838
01:06:34,130 --> 01:06:31,920

computers that work like this but uh how

1839

01:06:36,230 --> 01:06:34,140

would these other computers work and it

1840

01:06:38,329 --> 01:06:36,240

basically means that you create a

1841

01:06:40,430 --> 01:06:38,339

virtual structure on top of the noisy

1842

01:06:43,430 --> 01:06:40,440

structure that is correcting for

1843

01:06:45,230 --> 01:06:43,440

whatever degree of um uncertainty you

1844

01:06:48,410 --> 01:06:45,240

have or the degree of Randomness that

1845

01:06:51,109 --> 01:06:48,420

gets injected into your substrate David

1846

01:06:55,549 --> 01:06:51,119

Dave Eckley has a very nice metaphor for

1847

01:06:58,370 --> 01:06:55,559

this you know maybe yeah yeah he's a I

1848

01:07:00,349 --> 01:06:58,380

think a beautiful artist who explores

1849

01:07:02,390 --> 01:07:00,359

complexity by tinkering with

1850

01:07:04,670 --> 01:07:02,400

computational models I really find this

1851
01:07:06,950 --> 01:07:04,680
work very inspiring and he has this idea

1852
01:07:09,529 --> 01:07:06,960
of best effort Computing so in his view

1853
01:07:11,569 --> 01:07:09,539
our own nervous system is a best effort

1854
01:07:13,730 --> 01:07:11,579
computer it's one that does not rely on

1855
01:07:17,329 --> 01:07:13,740
the other neurons around you working

1856
01:07:20,210 --> 01:07:17,339
perfectly uh but make an effort to be

1857
01:07:22,309 --> 01:07:20,220
better than random and then you stack

1858
01:07:25,309 --> 01:07:22,319
the improbabilities empirically by

1859
01:07:28,970 --> 01:07:25,319
having a system that evolves to measure

1860
01:07:31,190 --> 01:07:28,980
in effect the unreliability of its

1861
01:07:32,990 --> 01:07:31,200
components and then stack the

1862
01:07:35,089 --> 01:07:33,000
probabilities until you get the system

1863
01:07:36,829 --> 01:07:35,099

to be deterministic enough to do what

1864

01:07:40,069 --> 01:07:36,839

you're doing with what to do with it

1865

01:07:42,770 --> 01:07:40,079

right so you uh if you have a system

1866

01:07:45,349 --> 01:07:42,780

that is as in a planaria inherently very

1867

01:07:47,750 --> 01:07:45,359

noisy where the genome is an unreliable

1868

01:07:50,750 --> 01:07:47,760

witness of what should be done and the

1869

01:07:52,789 --> 01:07:50,760

body you just need to interpret it in a

1870

01:07:55,190 --> 01:07:52,799

way that Stacks the probabilities that

1871

01:07:58,069 --> 01:07:55,200

is evaluating things with much more

1872

01:08:00,349 --> 01:07:58,079

error tolerance and maybe this is always

1873

01:08:02,150 --> 01:08:00,359

the case maybe there is a Continuum

1874

01:08:03,950 --> 01:08:02,160

um maybe not it's also possible that

1875

01:08:06,650 --> 01:08:03,960

there is some kind of phase shift where

1876

01:08:08,690 --> 01:08:06,660

your switch from organisms with reliable

1877

01:08:10,069 --> 01:08:08,700

genomes to organisms with noisy genomes

1878

01:08:11,450 --> 01:08:10,079

and you would basically use a completely

1879

01:08:13,789 --> 01:08:11,460

different way to construct the organism

1880

01:08:16,130 --> 01:08:13,799

as a result but it's a it's a very

1881

01:08:18,829 --> 01:08:16,140

interesting hypothesis then to see if if

1882

01:08:20,450 --> 01:08:18,839

this is a radical thing or a gradual

1883

01:08:23,030 --> 01:08:20,460

thing that happens on all organisms to

1884

01:08:25,070 --> 01:08:23,040

some degree yeah what I also like about

1885

01:08:28,130 --> 01:08:25,080

this uh description that you give about

1886

01:08:31,070 --> 01:08:28,140

how the organism emerges it maps on in

1887

01:08:34,430 --> 01:08:31,080

some sense also in how perception Works

1888

01:08:35,749 --> 01:08:34,440

in in our own mind at the moment measure

1889

01:08:37,610 --> 01:08:35,759

learning is mostly focused on

1890

01:08:40,669 --> 01:08:37,620

recognizing images

1891

01:08:42,709 --> 01:08:40,679

so our individual frames and the you

1892

01:08:44,090 --> 01:08:42,719

feed in information frame by frame and

1893

01:08:47,209 --> 01:08:44,100

the information is relatively

1894

01:08:49,550 --> 01:08:47,219

disconnected from a system like Delhi 2

1895

01:08:51,110 --> 01:08:49,560

is trained by giving it several hundreds

1896

01:08:52,789 --> 01:08:51,120

of millions of images

1897

01:08:54,530 --> 01:08:52,799

and they are disconnected the they're

1898

01:08:56,870 --> 01:08:54,540

not adjacent images in the space of

1899

01:08:59,390 --> 01:08:56,880

images and a baby could not probably

1900

01:09:01,309 --> 01:08:59,400

learn from giving 600 million images in

1901

01:09:02,689 --> 01:09:01,319

a dark room and only looking at this

1902

01:09:05,510 --> 01:09:02,699

introduce the structure of the world

1903

01:09:07,370 --> 01:09:05,520

from this whereas Delhi can which gives

1904

01:09:09,769 --> 01:09:07,380

Testament to the power of our

1905

01:09:11,749 --> 01:09:09,779

statistical methods and Hardware that we

1906

01:09:14,030 --> 01:09:11,759

have that far surpasses I think the

1907

01:09:15,289 --> 01:09:14,040

combined power and valuability of brains

1908

01:09:17,150 --> 01:09:15,299

which probably would not be able to

1909

01:09:18,289 --> 01:09:17,160

integrate so much information over such

1910

01:09:20,269 --> 01:09:18,299

a big distance

1911

01:09:22,729 --> 01:09:20,279

for us the world is learnable because

1912

01:09:25,309 --> 01:09:22,739

it's adjacent frames are correlated

1913

01:09:28,010 --> 01:09:25,319

basically information gets preserved in

1914

01:09:29,269 --> 01:09:28,020

the world so time and we only need to

1915

01:09:31,130 --> 01:09:29,279

learn the way in which the information

1916

01:09:33,349 --> 01:09:31,140

gets transmogorified

1917

01:09:34,910 --> 01:09:33,359

and these transformifications of

1918

01:09:37,010 --> 01:09:34,920

information means that we have a dynamic

1919

01:09:38,689 --> 01:09:37,020

World in which the static image is an

1920

01:09:40,849 --> 01:09:38,699

exception the identity function is a

1921

01:09:43,849 --> 01:09:40,859

special case of how the universe changes

1922

01:09:46,189 --> 01:09:43,859

and we mostly learn change we just got

1923

01:09:48,289 --> 01:09:46,199

visited by my cat and my cat has

1924

01:09:49,910 --> 01:09:48,299

difficulty to recognize static objects

1925

01:09:51,829 --> 01:09:49,920

compared to moving objects where it's

1926

01:09:54,229 --> 01:09:51,839

much much easier to see a moving ball

1927

01:09:55,850 --> 01:09:54,239

than a ball that is laying still yeah

1928

01:09:57,530 --> 01:09:55,860

and it's because it's much easier to

1929

01:10:00,290 --> 01:09:57,540

segment it out the environment when it

1930

01:10:01,910 --> 01:10:00,300

moves right so the task of learning on a

1931

01:10:03,890 --> 01:10:01,920

moving environmental Dynamic environment

1932

01:10:06,709 --> 01:10:03,900

is much easier because it imposes

1933

01:10:09,290 --> 01:10:06,719

constraints on the world and so how do

1934

01:10:11,570 --> 01:10:09,300

we represent a moving world compared to

1935

01:10:14,450 --> 01:10:11,580

a static well the semantics of features

1936

01:10:16,250 --> 01:10:14,460

changes and the uh an object is

1937

01:10:18,709 --> 01:10:16,260

basically composed of features that are

1938

01:10:21,169 --> 01:10:18,719

there can be objects themselves and the

1939

01:10:23,930 --> 01:10:21,179

scene is the decomposition of all the

1940

01:10:25,850 --> 01:10:23,940

features that we see into a complete set

1941

01:10:27,410 --> 01:10:25,860

of objects that explain the entirety of

1942

01:10:29,030 --> 01:10:27,420

the scene and the interaction between

1943

01:10:32,450 --> 01:10:29,040

them and causality is the interaction

1944

01:10:33,950 --> 01:10:32,460

between objects right and in a static

1945

01:10:35,510 --> 01:10:33,960

image these objects don't do anything

1946

01:10:37,130 --> 01:10:35,520

they don't interact with each other they

1947

01:10:38,870 --> 01:10:37,140

just stand in some kind of relationship

1948

01:10:40,610 --> 01:10:38,880

that you need to infer which is super

1949

01:10:43,729 --> 01:10:40,620

difficult because you only have this

1950

01:10:46,250 --> 01:10:43,739

static snapshot and so the features are

1951

01:10:48,890 --> 01:10:46,260

classifiers that tell you how to whether

1952

01:10:52,490 --> 01:10:48,900

a feature is a hand or a foot or a pen

1953

01:10:54,950 --> 01:10:52,500

or a Sun or a flashlight or whatever and

1954

01:10:56,209 --> 01:10:54,960

how they relate to the larger scene in

1955

01:10:57,590 --> 01:10:56,219

which again you have a static

1956

01:10:59,450 --> 01:10:57,600

relationship in which you need to

1957

01:11:01,490 --> 01:10:59,460

classify the objects based on the

1958

01:11:02,870 --> 01:11:01,500

features that contribute to them and you

1959

01:11:04,490 --> 01:11:02,880

need to find some kind of description

1960

01:11:05,930 --> 01:11:04,500

where you interpret the features which

1961

01:11:07,610 --> 01:11:05,940

are usually ambiguous and could be many

1962

01:11:09,350 --> 01:11:07,620

different things depending on the

1963

01:11:11,510 --> 01:11:09,360

context which you interpret them into

1964

01:11:14,450 --> 01:11:11,520

one optimal Global configuration right

1965

01:11:16,790 --> 01:11:14,460

but if scene is moving this changes a

1966

01:11:18,530 --> 01:11:16,800

little bit what happens now is that the

1967

01:11:20,689 --> 01:11:18,540

features become operators they're no

1968

01:11:22,669 --> 01:11:20,699

longer classifiers that tell you how

1969

01:11:24,050 --> 01:11:22,679

your internal State needs to change how

1970

01:11:25,669 --> 01:11:24,060

your world needs to change or your

1971

01:11:27,709 --> 01:11:25,679

simulation of the universe in your mind

1972

01:11:30,709 --> 01:11:27,719

needs to change to track the sensory

1973

01:11:33,350 --> 01:11:30,719

patterns right so a feature now is an

1974

01:11:36,110 --> 01:11:33,360

change operator a transformation

1975

01:11:38,270 --> 01:11:36,120

and uh the feature is in some sense a

1976

01:11:39,830 --> 01:11:38,280

controller that tells you how the bits

1977

01:11:42,649 --> 01:11:39,840

are moving and in your local model of

1978

01:11:44,930 --> 01:11:42,659

the universe and they are organized in a

1979

01:11:46,729 --> 01:11:44,940

hierarchy of controllers

1980

01:11:48,470 --> 01:11:46,739

and these controllers need to be turned

1981

01:11:50,030 --> 01:11:48,480

on and off at the level of the scene and

1982

01:11:51,590 --> 01:11:50,040

they have a lot of flexibility once you

1983

01:11:52,729 --> 01:11:51,600

have them they can move around in the

1984

01:11:54,590 --> 01:11:52,739

scene they're basically no

1985

01:11:57,050 --> 01:11:54,600

self-organizing self-stabilizing

1986

01:11:59,450 --> 01:11:57,060

entities in the same way as the mouse is

1987

01:12:01,310 --> 01:11:59,460

moving around in your organism a feature

1988

01:12:03,110 --> 01:12:01,320

can move around in the organism and

1989

01:12:05,450 --> 01:12:03,120

shift itself around to communicate with

1990

01:12:08,090 --> 01:12:05,460

other features until they negotiate a

1991

01:12:10,130 --> 01:12:08,100

valid interpretation of reality

1992

01:12:12,950 --> 01:12:10,140

that's that's incredibly interesting

1993

01:12:15,950 --> 01:12:12,960

because I you know as soon as you

1994

01:12:18,830 --> 01:12:15,960

started saying that uh I was starting to

1995

01:12:20,750 --> 01:12:18,840

think that the the virtualization that

1996

01:12:22,850 --> 01:12:20,760

enables right so the earlier part of

1997

01:12:24,250 --> 01:12:22,860

which we're saying the virtualization of

1998

01:12:27,410 --> 01:12:24,260

um

1999

01:12:28,370 --> 01:12:27,420

uh the the information that allows you

2000

01:12:30,229 --> 01:12:28,380

to

2001
01:12:33,410 --> 01:12:30,239
um deal with with unreliable hardware

2002
01:12:35,209 --> 01:12:33,420
and everything the the bioelectric uh

2003
01:12:36,770 --> 01:12:35,219
circuits that we deal with are a great

2004
01:12:39,229 --> 01:12:36,780
candidate for that because actually we

2005
01:12:41,209 --> 01:12:39,239
see exactly that we see a bioelectric

2006
01:12:43,310 --> 01:12:41,219
pattern that is very resistant to

2007
01:12:44,450 --> 01:12:43,320
changes in the details and make sure

2008
01:12:46,910 --> 01:12:44,460
that everybody does the right thing

2009
01:12:49,250 --> 01:12:46,920
under a wide range of you know different

2010
01:12:50,870 --> 01:12:49,260
defects and so on but but but even more

2011
01:12:52,729 --> 01:12:50,880
than that the other thing that what you

2012
01:12:54,410 --> 01:12:52,739
were just um emphasizing this the fact

2013
01:12:56,630 --> 01:12:54,420

that we learned the Delta right and that

2014

01:12:58,669 --> 01:12:56,640

and that we're looking for change very

2015

01:13:00,290 --> 01:12:58,679

interesting if you if you pivot the

2016

01:13:02,770 --> 01:13:00,300

whole thing from the temporal domain to

2017

01:13:05,930 --> 01:13:02,780

the spatial domain so so in development

2018

01:13:08,270 --> 01:13:05,940

what we we when we look at these

2019

01:13:10,070 --> 01:13:08,280

bioelectric patterns now now these

2020

01:13:11,870 --> 01:13:10,080

patterns are across space not across

2021

01:13:13,310 --> 01:13:11,880

time so so on like a neuroscience where

2022

01:13:15,410 --> 01:13:13,320

everything is kind of in the temporal

2023

01:13:17,870 --> 01:13:15,420

domain for neurons these things these

2024

01:13:19,490 --> 01:13:17,880

are voltage static voltage patterns

2025

01:13:22,729 --> 01:13:19,500

across tissue right across the whole

2026

01:13:24,709 --> 01:13:22,739

thing so for the longest time you know

2027

01:13:26,810 --> 01:13:24,719

we asked this question how are these

2028

01:13:28,790 --> 01:13:26,820

read out what how do cells actually read

2029

01:13:30,770 --> 01:13:28,800

these because because one possibility

2030

01:13:33,649 --> 01:13:30,780

early this was a very early hypothesis

2031

01:13:35,450 --> 01:13:33,659

you know 20 years ago was that maybe the

2032

01:13:37,189 --> 01:13:35,460

local voltage tells every cell what to

2033

01:13:39,490 --> 01:13:37,199

be so it's like a paint by numbers kind

2034

01:13:42,590 --> 01:13:39,500

of thing and every and and each voltage

2035

01:13:44,270 --> 01:13:42,600

you know each voltage value corresponds

2036

01:13:46,729 --> 01:13:44,280

to some kind of outcome that turned out

2037

01:13:48,530 --> 01:13:46,739

to be false what we did find is that

2038

01:13:51,050 --> 01:13:48,540

there and we have computational models

2039

01:13:54,410 --> 01:13:51,060

of how this works now

2040

01:13:56,570 --> 01:13:54,420

um what is read out is the Delta the

2041

01:13:58,010 --> 01:13:56,580

difference between regions it doesn't

2042

01:13:59,930 --> 01:13:58,020

care nobody cares about what the

2043

01:14:02,330 --> 01:13:59,940

absolute voltage is what what what is

2044

01:14:04,250 --> 01:14:02,340

read out in terms of outcomes for for

2045

01:14:06,290 --> 01:14:04,260

Downstream cell Behavior gene expression

2046

01:14:07,729 --> 01:14:06,300

all that what is actually right out is

2047

01:14:10,070 --> 01:14:07,739

the voltage difference between two

2048

01:14:11,689 --> 01:14:10,080

adjacent domains so that is exactly

2049

01:14:13,729 --> 01:14:11,699

actually what it's doing just in a

2050

01:14:16,970 --> 01:14:13,739

spatial domain it it only keys off of

2051
01:14:19,850 --> 01:14:16,980
the Delta and what is in what is learned

2052
01:14:21,709 --> 01:14:19,860
from that is um exactly just as as you

2053
01:14:23,810 --> 01:14:21,719
as you were saying it modifies uh the

2054
01:14:25,370 --> 01:14:23,820
controller for for what's Downstream of

2055
01:14:27,050 --> 01:14:25,380
that and there may be multiple ones that

2056
01:14:29,030 --> 01:14:27,060
are sort of moving around in Cohen

2057
01:14:30,169 --> 01:14:29,040
having I mean it's a very it's a very

2058
01:14:31,910 --> 01:14:30,179
compelling

2059
01:14:34,130 --> 01:14:31,920
um picture actually and way to look at

2060
01:14:36,410 --> 01:14:34,140
some of the some of the simulations that

2061
01:14:38,750 --> 01:14:36,420
that we've been doing about how the

2062
01:14:40,970 --> 01:14:38,760
bioelectric data are interpreted by the

2063
01:14:42,770 --> 01:14:40,980

rest of the cells you know it's very

2064

01:14:44,990 --> 01:14:42,780

interesting could we take a couple of

2065

01:14:46,790 --> 01:14:45,000

couple minute break yeah sure I'll get a

2066

01:14:48,890 --> 01:14:46,800

new coffee all right

2067

01:14:49,970 --> 01:14:48,900

speaking of coffee a brief note from our

2068

01:14:52,250 --> 01:14:49,980

sponsor

2069

01:14:54,169 --> 01:14:52,260

coffee helps me work it helps me fast

2070

01:14:56,270 --> 01:14:54,179

from carbs it's become one of the best

2071

01:14:57,649 --> 01:14:56,280

parts of my day consistently that's why

2072

01:14:59,750 --> 01:14:57,659

I'm delighted that we're collaborating

2073

01:15:01,910 --> 01:14:59,760

with Trade coffee they partner with top

2074

01:15:04,250 --> 01:15:01,920

independent Roasters to Freshly roast

2075

01:15:06,229 --> 01:15:04,260

and send the finest coffee in the

2076

01:15:08,330 --> 01:15:06,239

country directly to your home on your

2077

01:15:10,430 --> 01:15:08,340

preferred schedule this matters to me as

2078

01:15:12,649 --> 01:15:10,440

I work from home their team of experts

2079

01:15:15,229 --> 01:15:12,659

do all the work testing hundreds of

2080

01:15:18,590 --> 01:15:15,239

disparate coffees to land on a final

2081

01:15:20,930 --> 01:15:18,600

curated collection of 450 exceptional

2082

01:15:22,910 --> 01:15:20,940

coffees I chose these three and the team

2083

01:15:24,470 --> 01:15:22,920

at Trade coffee worked to create a

2084

01:15:26,510 --> 01:15:24,480

special lineup for theories of

2085

01:15:28,430 --> 01:15:26,520

everything for the tow audience based on

2086

01:15:30,350 --> 01:15:28,440

some questions they asked me such as how

2087

01:15:32,510 --> 01:15:30,360

much caffeine do I enjoy and what's the

2088

01:15:34,729 --> 01:15:32,520

bitterness ratio Etc you can get that

2089

01:15:36,770 --> 01:15:34,739

line up or if that's not let's say your

2090

01:15:39,169 --> 01:15:36,780

cup of coffee then you can take your own

2091

01:15:41,450 --> 01:15:39,179

quiz on their website to find a set that

2092

01:15:43,070 --> 01:15:41,460

matches your specific profile if you'd

2093

01:15:44,810 --> 01:15:43,080

like to support small businesses and

2094

01:15:47,390 --> 01:15:44,820

Brew the best cup of coffee you've ever

2095

01:15:49,550 --> 01:15:47,400

made at home then it's time to try Trade

2096

01:15:52,010 --> 01:15:49,560

coffee right now trade is offering our

2097

01:15:54,910 --> 01:15:52,020

listeners thirty dollars off your first

2098

01:15:58,450 --> 01:15:54,920

order plus free shipping at

2099

01:16:01,430 --> 01:15:58,460

drinktrade.com everything that's

2100

01:16:04,310 --> 01:16:01,440

drinktrade.com everything for thirty

2101
01:16:06,110 --> 01:16:04,320
dollars off so Professor Levin use the

2102
01:16:07,430 --> 01:16:06,120
word competence earlier and I'd like you

2103
01:16:08,510 --> 01:16:07,440
to Define that

2104
01:16:09,350 --> 01:16:08,520
yeah

2105
01:16:12,530 --> 01:16:09,360
um

2106
01:16:15,770 --> 01:16:12,540
I in order to Define it uh I I want to

2107
01:16:19,130 --> 01:16:15,780
put out two two concepts to this one one

2108
01:16:20,930 --> 01:16:19,140
idea is that to me and this goes back to

2109
01:16:24,649 --> 01:16:20,940
what we were talking about before is the

2110
01:16:28,610 --> 01:16:24,659
engineering stance on things I

2111
01:16:30,830 --> 01:16:28,620
think that useful cognitive claims such

2112
01:16:32,810 --> 01:16:30,840
as something you know when you say this

2113
01:16:34,790 --> 01:16:32,820

system has whatever or it can whatever

2114

01:16:36,709 --> 01:16:34,800

right as far as various types of

2115

01:16:38,870 --> 01:16:36,719

cognitive capacities I think those kind

2116

01:16:41,030 --> 01:16:38,880

of claims are really engineering uh

2117

01:16:43,189 --> 01:16:41,040

claims that is when you tell me that

2118

01:16:45,590 --> 01:16:43,199

something is competent at a particular

2119

01:16:47,450 --> 01:16:45,600

level maybe right so so you can think

2120

01:16:48,370 --> 01:16:47,460

about like like wiener and rosenberg's

2121

01:16:51,229 --> 01:16:48,380

scale of

2122

01:16:53,390 --> 01:16:51,239

cognition that goes from simple um you

2123

01:16:55,850 --> 01:16:53,400

know simple passive materials and then

2124

01:16:57,470 --> 01:16:55,860

reflexes and then all the way up to kind

2125

01:16:59,090 --> 01:16:57,480

of second order metacognition and all

2126
01:17:01,729 --> 01:16:59,100
that when you tell me that something is

2127
01:17:04,070 --> 01:17:01,739
on that ladder and where it is what

2128
01:17:06,709 --> 01:17:04,080
you're really telling me is if I want to

2129
01:17:08,689 --> 01:17:06,719
predict Its Behavior or I want to use it

2130
01:17:10,610 --> 01:17:08,699
in an engineering context or I want to

2131
01:17:13,070 --> 01:17:10,620
interact with it or relate to it in some

2132
01:17:14,390 --> 01:17:13,080
way this is what I can expect so right

2133
01:17:16,970 --> 01:17:14,400
so that's what you really telling me so

2134
01:17:19,010 --> 01:17:16,980
all of these terms what they really are

2135
01:17:22,430 --> 01:17:19,020
are engineering protocols so if you tell

2136
01:17:25,070 --> 01:17:22,440
me that something has the capacity to do

2137
01:17:26,750 --> 01:17:25,080
um a associate of learning or or

2138
01:17:28,550 --> 01:17:26,760

whatever what you're telling me is that

2139

01:17:30,229 --> 01:17:28,560

hey you can do something more with this

2140

01:17:33,350 --> 01:17:30,239

than you could with a mechanical clock

2141

01:17:35,209 --> 01:17:33,360

you can provide certain types of uh

2142

01:17:36,470 --> 01:17:35,219

stimuli or experiences and you can

2143

01:17:38,270 --> 01:17:36,480

expect that to do this or that

2144

01:17:40,970 --> 01:17:38,280

afterwards or if you tell me that

2145

01:17:43,370 --> 01:17:40,980

something is a um a homeous you know a

2146

01:17:46,010 --> 01:17:43,380

homeostat that means that hey I can

2147

01:17:47,990 --> 01:17:46,020

count on it to keep some variable in at

2148

01:17:50,209 --> 01:17:48,000

a particular range without having to be

2149

01:17:51,770 --> 01:17:50,219

there myself to control it all the way

2150

01:17:53,149 --> 01:17:51,780

it has a certain autonomy now how much

2151
01:17:55,550 --> 01:17:53,159
right and if you tell me that something

2152
01:17:57,530 --> 01:17:55,560
is really intelligent and it can do XYZ

2153
01:17:59,090 --> 01:17:57,540
then I know that okay you're telling me

2154
01:18:01,250 --> 01:17:59,100
that it has even more autonomous

2155
01:18:02,870 --> 01:18:01,260
behavior in certain contexts so so all

2156
01:18:04,850 --> 01:18:02,880
of these terms to me what they really

2157
01:18:06,350 --> 01:18:04,860
are they're not and that has an

2158
01:18:08,870 --> 01:18:06,360
important implication the implication is

2159
01:18:10,850 --> 01:18:08,880
that they're Observer dependent that

2160
01:18:13,370 --> 01:18:10,860
that that that you you've picked some

2161
01:18:15,290 --> 01:18:13,380
kind of problem space you've picked uh

2162
01:18:16,729 --> 01:18:15,300
some kind of perspective and from that

2163
01:18:18,590 --> 01:18:16,739

problem problem space in that

2164

01:18:21,229 --> 01:18:18,600

perspective you're telling me that with

2165

01:18:23,870 --> 01:18:21,239

with sort of given certain goal States

2166

01:18:25,610 --> 01:18:23,880

this system has that much competency to

2167

01:18:27,290 --> 01:18:25,620

pursue those gold States and different

2168

01:18:28,910 --> 01:18:27,300

observers can have different views on

2169

01:18:31,130 --> 01:18:28,920

this for any given system so for example

2170

01:18:33,229 --> 01:18:31,140

somebody might look at a brain like

2171

01:18:34,610 --> 01:18:33,239

let's say a human brain and say well I'm

2172

01:18:36,229 --> 01:18:34,620

pretty sure the only thing this is this

2173

01:18:38,090 --> 01:18:36,239

is a paperweight so it's really pretty

2174

01:18:39,890 --> 01:18:38,100

much just competent in going down

2175

01:18:41,570 --> 01:18:39,900

gravitational gradient so all I can do

2176

01:18:43,130 --> 01:18:41,580

is hold down paper that's it and

2177

01:18:44,270 --> 01:18:43,140

somebody else will look at and say ah

2178

01:18:45,110 --> 01:18:44,280

you missed the whole point you missed

2179

01:18:46,729 --> 01:18:45,120

the whole point this thing is

2180

01:18:49,550 --> 01:18:46,739

competencies in behavioral space and

2181

01:18:52,669 --> 01:18:49,560

linguistic space right so these are all

2182

01:18:54,350 --> 01:18:52,679

um empirically testable uh engineering

2183

01:18:56,390 --> 01:18:54,360

claims about what you can expect the

2184

01:18:59,810 --> 01:18:56,400

system to do so when I say competency

2185

01:19:01,430 --> 01:18:59,820

what I mean is we specify a space a

2186

01:19:02,450 --> 01:19:01,440

problem space and at the time when we

2187

01:19:05,090 --> 01:19:02,460

were talking about this the problem

2188

01:19:07,310 --> 01:19:05,100

space that I was talking about was the

2189

01:19:09,169 --> 01:19:07,320

the anatomical morphe space that was the

2190

01:19:10,610 --> 01:19:09,179

space we were talking about so so the

2191

01:19:12,590 --> 01:19:10,620

space of possible anatomical

2192

01:19:14,630 --> 01:19:12,600

configurations and specifically

2193

01:19:17,149 --> 01:19:14,640

navigating that morph of space so you

2194

01:19:19,790 --> 01:19:17,159

start off as an egg or you start off as

2195

01:19:22,070 --> 01:19:19,800

a damaged limb or whatever and you

2196

01:19:23,630 --> 01:19:22,080

navigate that morphe space into the

2197

01:19:25,790 --> 01:19:23,640

correct structure so so when I say

2198

01:19:28,850 --> 01:19:25,800

competency I mean you have the ability

2199

01:19:31,370 --> 01:19:28,860

to deploy certain kinds of tricks to

2200

01:19:34,910 --> 01:19:31,380

navigate that amorphous space with some

2201

01:19:36,530 --> 01:19:34,920

level of uh performance that I can count

2202

01:19:38,510 --> 01:19:36,540

on and so the competency might be really

2203

01:19:40,310 --> 01:19:38,520

low or it might be really high then I

2204

01:19:42,169 --> 01:19:40,320

would have to make specific claims about

2205

01:19:43,790 --> 01:19:42,179

what I mean here's an example of a

2206

01:19:44,930 --> 01:19:43,800

compound and there are many you know if

2207

01:19:46,729 --> 01:19:44,940

you just think about the Behavioral

2208

01:19:48,830 --> 01:19:46,739

Science of navigation there are many

2209

01:19:50,630 --> 01:19:48,840

competencies you can think about does it

2210

01:19:51,950 --> 01:19:50,640

you know does it does it know ahead of

2211

01:19:54,350 --> 01:19:51,960

time where it's going does it have a

2212

01:19:56,810 --> 01:19:54,360

memory of where it's been or is it a

2213

01:19:59,870 --> 01:19:56,820

very simple you know sort of reflex arc

2214

01:20:01,970 --> 01:19:59,880

is all it has or um here's one one

2215

01:20:04,070 --> 01:20:01,980

example of a pretty cool competency that

2216

01:20:04,729 --> 01:20:04,080

um that that a lot of biological systems

2217

01:20:08,570 --> 01:20:04,739

have

2218

01:20:11,050 --> 01:20:08,580

if we take some cells that are in the

2219

01:20:14,570 --> 01:20:11,060

tail of a tadpole and we

2220

01:20:16,910 --> 01:20:14,580

give them a particular we we modify

2221

01:20:19,550 --> 01:20:16,920

their ion channels uh with such that

2222

01:20:22,370 --> 01:20:19,560

they now acquire

2223

01:20:24,290 --> 01:20:22,380

um a a the goal of navigating to an eye

2224

01:20:25,490 --> 01:20:24,300

fate in more in in this morphe space

2225

01:20:27,590 --> 01:20:25,500

meaning that they're going to make an

2226

01:20:28,850 --> 01:20:27,600

eye these things in fact will create an

2227

01:20:30,950 --> 01:20:28,860

eye and they'll make an eye in the tail

2228

01:20:32,750 --> 01:20:30,960

on the gut wherever you want but one of

2229

01:20:34,729 --> 01:20:32,760

the cool and so that's already pretty

2230

01:20:38,630 --> 01:20:34,739

pretty cool but but one of the amazing

2231

01:20:40,550 --> 01:20:38,640

aspects is if I only modify a few cells

2232

01:20:42,290 --> 01:20:40,560

not enough to make an actual eye just

2233

01:20:43,970 --> 01:20:42,300

just a handful of cells and we've done

2234

01:20:46,850 --> 01:20:43,980

this and you can see this work

2235

01:20:48,590 --> 01:20:46,860

one of the competencies they have is to

2236

01:20:51,229 --> 01:20:48,600

recruit local neighbors that were

2237

01:20:53,030 --> 01:20:51,239

themselves not in any way manipulated to

2238

01:20:54,410 --> 01:20:53,040

help them achieve that goal it's a

2239

01:20:55,790 --> 01:20:54,420

little bit like in an ant colony right

2240

01:20:57,290 --> 01:20:55,800

there's a there's this idea of

2241

01:20:58,490 --> 01:20:57,300

Recruitment and ants and termites is an

2242

01:21:00,530 --> 01:20:58,500

idea of recruitment where where

2243

01:21:01,610 --> 01:21:00,540

individuals can can recruit others and

2244

01:21:03,350 --> 01:21:01,620

you know talk about a flexible

2245

01:21:05,750 --> 01:21:03,360

collective intelligence this is it this

2246

01:21:08,090 --> 01:21:05,760

is they they you you've re-specified the

2247

01:21:09,649 --> 01:21:08,100

goal for that set of cells but one of

2248

01:21:11,930 --> 01:21:09,659

the things that they do without us

2249

01:21:13,910 --> 01:21:11,940

telling them how to do it or having to

2250

01:21:16,070 --> 01:21:13,920

micromanage it they already have the

2251
01:21:18,950 --> 01:21:16,080
competency to recruit as many cells as

2252
01:21:20,630 --> 01:21:18,960
they need to get the job done so that's

2253
01:21:22,490 --> 01:21:20,640
a very nice for an engineer that's a

2254
01:21:24,830 --> 01:21:22,500
very nice competency because it means

2255
01:21:26,750 --> 01:21:24,840
that I don't need to worry about taking

2256
01:21:29,270 --> 01:21:26,760
care of getting exactly the right number

2257
01:21:31,250 --> 01:21:29,280
of cells if I'm if I'm a little bit over

2258
01:21:33,110 --> 01:21:31,260
that's fine if I'm way under also fine

2259
01:21:35,510 --> 01:21:33,120
the system has that competency of

2260
01:21:37,189 --> 01:21:35,520
recruiting other cells to get the job

2261
01:21:39,410 --> 01:21:37,199
done so so that's what I so that's what

2262
01:21:40,970 --> 01:21:39,420
I meant so to me to make an um any kind

2263
01:21:43,610 --> 01:21:40,980

of a cognitive claim you have to specify

2264

01:21:45,350 --> 01:21:43,620

the problem space you have to specify

2265

01:21:47,330 --> 01:21:45,360

the goal goal towards which it's

2266

01:21:49,310 --> 01:21:47,340

expressing competencies and that may

2267

01:21:51,229 --> 01:21:49,320

right and and then and then you can make

2268

01:21:53,390 --> 01:21:51,239

a claim about well how competent is it

2269

01:21:54,709 --> 01:21:53,400

to get to that goal and somebody I wish

2270

01:21:56,510 --> 01:21:54,719

I could remember who it was but somebody

2271

01:21:58,250 --> 01:21:56,520

made this really nice analogy about kind

2272

01:22:00,950 --> 01:21:58,260

of the ends of that spectrum they said

2273

01:22:03,229 --> 01:22:00,960

two magnets try to get together and

2274

01:22:05,030 --> 01:22:03,239

Romeo and Juliet try to get together but

2275

01:22:06,410 --> 01:22:05,040

the degree of flexible problem solving

2276

01:22:09,229 --> 01:22:06,420

that you can expect out of those two

2277

01:22:11,090 --> 01:22:09,239

systems is incredibly different and

2278

01:22:12,950 --> 01:22:11,100

within that range there are all kinds of

2279

01:22:14,570 --> 01:22:12,960

in-between systems that may be better or

2280

01:22:16,430 --> 01:22:14,580

worse and may deploy different kinds of

2281

01:22:18,470 --> 01:22:16,440

strategies you know can they avoid local

2282

01:22:20,390 --> 01:22:18,480

Optima can they have a memory of the

2283

01:22:22,010 --> 01:22:20,400

where they've been can they look further

2284

01:22:23,570 --> 01:22:22,020

than their local environment a million

2285

01:22:25,130 --> 01:22:23,580

different things so that's that's what I

2286

01:22:28,189 --> 01:22:25,140

meant by competency it's it's it's it's

2287

01:22:30,950 --> 01:22:28,199

a claim about what and what an engineer

2288

01:22:32,689 --> 01:22:30,960

can expect the system to do given a

2289

01:22:34,850 --> 01:22:32,699

particular problem space in a particular

2290

01:22:35,930 --> 01:22:34,860

goal that you think it's uh trying to

2291

01:22:37,669 --> 01:22:35,940

reach

2292

01:22:42,050 --> 01:22:37,679

so the way in which you use the word

2293

01:22:43,790 --> 01:22:42,060

competency could be treated as the

2294

01:22:46,130 --> 01:22:43,800

capacity of a system for adaptive

2295

01:22:51,110 --> 01:22:48,070

yeah yeah yeah

2296

01:22:53,209 --> 01:22:51,120

one uh issue that I have with the notion

2297

01:22:55,610 --> 01:22:53,219

of goals and goal directedness is that

2298

01:22:58,250 --> 01:22:55,620

sometimes you only have a tendency in a

2299

01:23:00,830 --> 01:22:58,260

system to go in a certain direction and

2300

01:23:03,350 --> 01:23:00,840

so it's it's directed but the goal is

2301

01:23:05,030 --> 01:23:03,360

something that can be emergent sometimes

2302

01:23:06,470 --> 01:23:05,040

it's not sometimes there is an explicit

2303

01:23:08,270 --> 01:23:06,480

representation in the system of a

2304

01:23:10,310 --> 01:23:08,280

discrete event that is associated or a

2305

01:23:11,990 --> 01:23:10,320

class of events this fulfilling a

2306

01:23:13,430 --> 01:23:12,000

certain condition that the system has

2307

01:23:14,990 --> 01:23:13,440

committed itself to and if you don't

2308

01:23:17,390 --> 01:23:15,000

have that you don't have a proper goal

2309

01:23:20,630 --> 01:23:17,400

but in real systems it's difficult to

2310

01:23:22,910 --> 01:23:20,640

say I mean when do we pursue goals right

2311

01:23:24,830 --> 01:23:22,920

sometimes we just are vaguely hungry are

2312

01:23:26,270 --> 01:23:24,840

moving towards the kitchen because we

2313

01:23:28,550 --> 01:23:26,280

hope that something will

2314

01:23:31,370 --> 01:23:28,560

opportunistically emerge that will deal

2315

01:23:33,229 --> 01:23:31,380

with this vague tendency in our Behavior

2316

01:23:35,390 --> 01:23:33,239

we could also say we have the goal of

2317

01:23:37,490 --> 01:23:35,400

finding food but uh that is a

2318

01:23:40,729 --> 01:23:37,500

rationalization that is maybe stretching

2319

01:23:42,530 --> 01:23:40,739

sick sometimes yeah so uh sometimes a

2320

01:23:44,870 --> 01:23:42,540

better distinction for me is

2321

01:23:47,750 --> 01:23:44,880

going from a simple controller to an

2322

01:23:49,610 --> 01:23:47,760

agent and I try to because we are very

2323

01:23:51,050 --> 01:23:49,620

good at discovering agency in the world

2324

01:23:53,149 --> 01:23:51,060

what does it actually mean when we

2325

01:23:56,330 --> 01:23:53,159

discover agency and when we discover our

2326

01:23:56,930 --> 01:23:56,340

own agency and start to amplify it

2327

01:23:59,209 --> 01:23:56,940

um

2328

01:24:00,950 --> 01:23:59,219

by making models of who we are and how

2329

01:24:02,990 --> 01:24:00,960

we deal with the world and with others

2330

01:24:04,729 --> 01:24:03,000

and so on the minimal definition of

2331

01:24:06,290 --> 01:24:04,739

agent that I found it's a controller for

2332

01:24:08,630 --> 01:24:06,300

future States

2333

01:24:11,390 --> 01:24:08,640

the thermostat doesn't have a goal by

2334

01:24:14,149 --> 01:24:11,400

itself right it just has a Target value

2335

01:24:15,890 --> 01:24:14,159

and a sensor that tells the deviation

2336

01:24:18,169 --> 01:24:15,900

from the target value and when that

2337

01:24:21,530 --> 01:24:18,179

exceeds a certain threshold the heating

2338

01:24:22,850 --> 01:24:21,540

is turned on and if it goes below a

2339

01:24:24,950 --> 01:24:22,860

certain threshold the heating is turned

2340

01:24:26,510 --> 01:24:24,960

off again and this is it so the

2341

01:24:29,570 --> 01:24:26,520

thermostat is not an agent and it only

2342

01:24:30,830 --> 01:24:29,580

reacts to the present frame it's only a

2343

01:24:33,350 --> 01:24:30,840

reactive system

2344

01:24:36,169 --> 01:24:33,360

whereas an agent is proactive which

2345

01:24:38,930 --> 01:24:36,179

means that it's trying to um not just

2346

01:24:41,810 --> 01:24:38,940

minimize the current deviation from the

2347

01:24:43,370 --> 01:24:41,820

target value but the integral over at

2348

01:24:45,770 --> 01:24:43,380

the time span previously the future

2349

01:24:49,189 --> 01:24:45,780

deviation so it builds an expectation

2350

01:24:51,530 --> 01:24:49,199

about how uh an action is going to

2351

01:24:54,110 --> 01:24:51,540

change this trajectory of the universe

2352

01:24:57,110 --> 01:24:54,120

and over that trajectory it tries to

2353

01:24:59,750 --> 01:24:57,120

figure out some measure of how big the

2354

01:25:02,030 --> 01:24:59,760

compound Target deviation is going to be

2355

01:25:03,890 --> 01:25:02,040

and so as a result you get a branching

2356

01:25:05,390 --> 01:25:03,900

universe and the branches in this

2357

01:25:08,090 --> 01:25:05,400

universe some of these branches depend

2358

01:25:09,950 --> 01:25:08,100

on actions that are available to you and

2359

01:25:13,669 --> 01:25:09,960

that translate into decisions that you

2360

01:25:15,050 --> 01:25:13,679

can make that uh move you into more or

2361

01:25:16,729 --> 01:25:15,060

less preferable wealth States and

2362

01:25:19,610 --> 01:25:16,739

suddenly you have a system with emergent

2363

01:25:22,070 --> 01:25:19,620

beliefs desires and intentions but to

2364

01:25:25,010 --> 01:25:22,080

make that happen to move from a

2365

01:25:27,290 --> 01:25:25,020

controller to agency and agent has been

2366

01:25:30,470 --> 01:25:27,300

a controller with an integrated setpoint

2367

01:25:33,110 --> 01:25:30,480

generator and the ability to control

2368

01:25:36,590 --> 01:25:33,120

future states that requires that you can

2369

01:25:38,570 --> 01:25:36,600

make models that are counterfactual so

2370

01:25:41,030 --> 01:25:38,580

because the future universe doesn't

2371

01:25:43,130 --> 01:25:41,040

exist right now you need to create a

2372

01:25:45,350 --> 01:25:43,140

counterfactual universe The Future model

2373

01:25:46,910 --> 01:25:45,360

of the future Universe maybe even a

2374

01:25:48,350 --> 01:25:46,920

model of the past universe that allows

2375

01:25:50,750 --> 01:25:48,360

you to reason about possible for future

2376

01:25:53,030 --> 01:25:50,760

universes and so on and to make these

2377

01:25:54,890 --> 01:25:53,040

counterfactual causal models of the

2378

01:25:55,970 --> 01:25:54,900

universe you need to have a turing

2379

01:25:58,129 --> 01:25:55,980

machine

2380

01:26:00,890 --> 01:25:58,139

so without a computer without something

2381

01:26:02,810 --> 01:26:00,900

that is too incomplete that insulates

2382

01:26:05,270 --> 01:26:02,820

you from the causal structure of your

2383

01:26:07,250 --> 01:26:05,280

substrate that allows you to build

2384

01:26:09,590 --> 01:26:07,260

representations regardless of what the

2385

01:26:11,510 --> 01:26:09,600

universe says right now around you right

2386

01:26:14,510 --> 01:26:11,520

you need to have that machine and the

2387

01:26:17,149 --> 01:26:14,520

simplest uh system in nature that has

2388

01:26:19,669 --> 01:26:17,159

turing machine integrated is the cell

2389

01:26:22,490 --> 01:26:19,679

so uh it's very difficult to find a

2390

01:26:25,250 --> 01:26:22,500

system in nature that is an agent that

2391

01:26:27,229 --> 01:26:25,260

is not made from cells as a result

2392

01:26:29,510 --> 01:26:27,239

maybe there are systems in nature that

2393

01:26:32,990 --> 01:26:29,520

are able to uh compute things and make

2394

01:26:35,810 --> 01:26:33,000

models but uh I I'm not aware of any so

2395

01:26:37,810 --> 01:26:35,820

the simplest one that I know that can do

2396

01:26:41,750 --> 01:26:37,820

this reliably is the cells or

2397

01:26:44,390 --> 01:26:41,760

arrangement of sets and that can possess

2398

01:26:46,970 --> 01:26:44,400

agency which is interesting thing that

2399

01:26:49,669 --> 01:26:46,980

explains this coincidence that living

2400

01:26:51,470 --> 01:26:49,679

things are agents and vice versa that

2401
01:26:53,750 --> 01:26:51,480
the agent that we discover are mostly

2402
01:26:56,570 --> 01:26:53,760
living things or there are robots that

2403
01:26:59,689 --> 01:26:56,580
have computers built into them or uh

2404
01:27:01,910 --> 01:26:59,699
virtual robots that have that rely on

2405
01:27:04,070 --> 01:27:01,920
computation so the ability to make

2406
01:27:06,770 --> 01:27:04,080
models of the future is the prerequisite

2407
01:27:09,770 --> 01:27:06,780
for agency and to make arbitrary models

2408
01:27:13,970 --> 01:27:09,780
which means structures that embody uh

2409
01:27:16,550 --> 01:27:13,980
causal uh simulations of some sort that

2410
01:27:19,610 --> 01:27:16,560
requires computation

2411
01:27:21,470 --> 01:27:19,620
yeah yeah um you know I'm on board with

2412
01:27:24,530 --> 01:27:21,480
that with that ladder of that that

2413
01:27:26,629 --> 01:27:24,540

taxonomy uh of of uh

2414

01:27:28,669 --> 01:27:26,639

of of goals and so on one one

2415

01:27:30,530 --> 01:27:28,679

interesting thing about uh about goals

2416

01:27:32,209 --> 01:27:30,540

and as you say some are emergent and and

2417

01:27:34,010 --> 01:27:32,219

some are not there's a there's an

2418

01:27:36,709 --> 01:27:34,020

interesting uh planarian

2419

01:27:37,850 --> 01:27:36,719

um uh version of this which is which is

2420

01:27:41,149 --> 01:27:37,860

this we

2421

01:27:42,770 --> 01:27:41,159

we made this hypothesis about so so with

2422

01:27:44,810 --> 01:27:42,780

implant area you chop it up into pieces

2423

01:27:46,610 --> 01:27:44,820

and every piece regenerates exactly the

2424

01:27:48,950 --> 01:27:46,620

right rest of the work right so if it's

2425

01:27:51,950 --> 01:27:48,960

if if you chop it into pieces each piece

2426
01:27:53,570 --> 01:27:51,960
will have one head one tail so and then

2427
01:27:55,310 --> 01:27:53,580
and then of course what happens is it

2428
01:27:57,649 --> 01:27:55,320
stops when it when it may when it

2429
01:28:00,830 --> 01:27:57,659
reaches a correct planarian then then it

2430
01:28:01,970 --> 01:28:00,840
stops and so so we started to think that

2431
01:28:03,709 --> 01:28:01,980
there are two there are a couple of

2432
01:28:06,110 --> 01:28:03,719
possibilities one possibility is that

2433
01:28:08,030 --> 01:28:06,120
this is a purely emergent process and

2434
01:28:10,189 --> 01:28:08,040
that the goal of rebuilding ahead is is

2435
01:28:12,410 --> 01:28:10,199
an emergent thing that comes about as a

2436
01:28:14,870 --> 01:28:12,420
consequence of other things or could

2437
01:28:16,550 --> 01:28:14,880
there be a an actual explicit

2438
01:28:18,709 --> 01:28:16,560

representation of what a correct

2439

01:28:20,810 --> 01:28:18,719

planarian is that serves as a set point

2440

01:28:22,850 --> 01:28:20,820

as an encoded as an explicitly encoded

2441

01:28:24,970 --> 01:28:22,860

set point for these cells to follow and

2442

01:28:27,169 --> 01:28:24,980

and because it's a cellular a collective

2443

01:28:29,330 --> 01:28:27,179

we're communicating electrically we

2444

01:28:32,149 --> 01:28:29,340

thought well maybe maybe what it's doing

2445

01:28:34,790 --> 01:28:32,159

is basically storing a memory of what

2446

01:28:36,709 --> 01:28:34,800

did you like you would in in a neural

2447

01:28:38,390 --> 01:28:36,719

circuit you're storing a memory of what

2448

01:28:39,770 --> 01:28:38,400

it should be so we started looking for

2449

01:28:42,470 --> 01:28:39,780

this and this is what we found and this

2450

01:28:45,290 --> 01:28:42,480

is this is kind of I think one type of

2451
01:28:48,229 --> 01:28:45,300
one one important type of goal in a in a

2452
01:28:50,990 --> 01:28:48,239
goal seeking system is is a is a goal

2453
01:28:52,490 --> 01:28:51,000
that you can rewrite without changing

2454
01:28:54,110 --> 01:28:52,500
the hardware and the system will now

2455
01:28:56,330 --> 01:28:54,120
pursue that goal instead of something

2456
01:28:57,649 --> 01:28:56,340
else in a purely emergent system that

2457
01:28:59,750 --> 01:28:57,659
doesn't work right if you have a

2458
01:29:01,010 --> 01:28:59,760
cellular automaton or a fractal or

2459
01:29:02,810 --> 01:29:01,020
something that that does some kind of

2460
01:29:04,129 --> 01:29:02,820
complex thing if you want to change what

2461
01:29:05,689 --> 01:29:04,139
that complex thing is you have to figure

2462
01:29:07,550 --> 01:29:05,699
out what the local rule how to change

2463
01:29:09,770 --> 01:29:07,560

the local rules that's very hard in most

2464

01:29:12,350 --> 01:29:09,780

cases but what we found in planaria is

2465

01:29:15,290 --> 01:29:12,360

that we can literally using a voltage

2466

01:29:18,530 --> 01:29:15,300

reporter die we can look at the worm and

2467

01:29:19,970 --> 01:29:18,540

we can see now the pattern the the and

2468

01:29:21,590 --> 01:29:19,980

it's a distributed pattern but we can

2469

01:29:23,689 --> 01:29:21,600

see the pattern that tells this animal

2470

01:29:25,850 --> 01:29:23,699

how many heads it's supposed to have and

2471

01:29:29,810 --> 01:29:25,860

what you can do is you can go in and

2472

01:29:31,550 --> 01:29:29,820

using a a brief transient uh

2473

01:29:33,950 --> 01:29:31,560

manipulation of the ion Channels with

2474

01:29:35,450 --> 01:29:33,960

drugs with ION channel drugs that and we

2475

01:29:37,189 --> 01:29:35,460

have a computational model that tells

2476
01:29:39,770 --> 01:29:37,199
you what those drugs should be that

2477
01:29:41,629 --> 01:29:39,780
bring briefly changes the electrical

2478
01:29:43,550 --> 01:29:41,639
state of the circuit but the circuit is

2479
01:29:46,430 --> 01:29:43,560
amazing it's it it once you've changed

2480
01:29:48,169 --> 01:29:46,440
that state it holds so so by default it

2481
01:29:50,090 --> 01:29:48,179
in a standard planarian it always says

2482
01:29:51,410 --> 01:29:50,100
one head but but it's kind of like a

2483
01:29:53,629 --> 01:29:51,420
flip-flop in that when you you

2484
01:29:55,430 --> 01:29:53,639
temporarily shift it it holds and you

2485
01:29:57,050 --> 01:29:55,440
can push it to a to a state that says

2486
01:29:58,729 --> 01:29:57,060
two heads so now something very

2487
01:30:00,590 --> 01:29:58,739
interesting happens

2488
01:30:02,270 --> 01:30:00,600

um two interesting things one is that if

2489

01:30:04,669 --> 01:30:02,280

you if you take those worms and you cut

2490

01:30:06,290 --> 01:30:04,679

those into pieces you get two-headed

2491

01:30:07,850 --> 01:30:06,300

worms even though the genetics are the

2492

01:30:09,229 --> 01:30:07,860

hardware is all wild type there's

2493

01:30:10,669 --> 01:30:09,239

nothing wrong with Hardware all the

2494

01:30:12,649 --> 01:30:10,679

proteins are the same all the genetics

2495

01:30:14,750 --> 01:30:12,659

is the same but the electric circuit now

2496

01:30:17,570 --> 01:30:14,760

says make two heads instead of one and

2497

01:30:19,669 --> 01:30:17,580

so this is in in an interesting way it

2498

01:30:21,169 --> 01:30:19,679

is an explicit goal because you can

2499

01:30:22,610 --> 01:30:21,179

rewrite it because much like with your

2500

01:30:24,350 --> 01:30:22,620

thermostat there's an interface for

2501
01:30:25,550 --> 01:30:24,360
changing what the goal state is and then

2502
01:30:26,870 --> 01:30:25,560
you don't even need to know how the rest

2503
01:30:28,729 --> 01:30:26,880
of the thermostat works as long as you

2504
01:30:30,530 --> 01:30:28,739
know how to use your how to modify that

2505
01:30:32,750 --> 01:30:30,540
interface the system takes care of the

2506
01:30:34,070 --> 01:30:32,760
rest the other interesting thing is and

2507
01:30:37,250 --> 01:30:34,080
and I love what you said about the

2508
01:30:39,770 --> 01:30:37,260
counter factuals what you can do is you

2509
01:30:41,330 --> 01:30:39,780
can change that electrical pattern in an

2510
01:30:44,209 --> 01:30:41,340
intact worm

2511
01:30:45,410 --> 01:30:44,219
and not cut it for a long time and if

2512
01:30:47,030 --> 01:30:45,420
you do that when you look at that

2513
01:30:49,669 --> 01:30:47,040

pattern that is a counterfactual

2514

01:30:52,610 --> 01:30:49,679

pattern because that two-headed pattern

2515

01:30:54,050 --> 01:30:52,620

is not a readout of the current state it

2516

01:30:56,510 --> 01:30:54,060

says two heads but the animal only has

2517

01:30:59,030 --> 01:30:56,520

one head it's a normal planarian so the

2518

01:31:01,430 --> 01:30:59,040

that pattern memory is not a readout of

2519

01:31:03,590 --> 01:31:01,440

what the animal is doing right now it is

2520

01:31:05,750 --> 01:31:03,600

a representation of what the animal will

2521

01:31:07,669 --> 01:31:05,760

do in the future if it happens to get

2522

01:31:09,530 --> 01:31:07,679

injured and you may never cut it or you

2523

01:31:11,570 --> 01:31:09,540

may cut it but if you do then the

2524

01:31:13,550 --> 01:31:11,580

pattern becomes uh then the cells

2525

01:31:15,229 --> 01:31:13,560

consult a pattern and build a two-headed

2526

01:31:17,390 --> 01:31:15,239

worm and then it becomes a you know the

2527

01:31:19,250 --> 01:31:17,400

current state but until then it's this

2528

01:31:21,229 --> 01:31:19,260

weird like primitive

2529

01:31:23,629 --> 01:31:21,239

um uh it's a primitive counterfactual

2530

01:31:26,930 --> 01:31:23,639

system because it's able to a body of a

2531

01:31:27,830 --> 01:31:26,940

planarian is able to store at least two

2532

01:31:30,169 --> 01:31:27,840

different

2533

01:31:32,330 --> 01:31:30,179

representations of what probably many

2534

01:31:33,770 --> 01:31:32,340

more but we found two so far what a

2535

01:31:35,330 --> 01:31:33,780

correct planarian should look like it

2536

01:31:36,890 --> 01:31:35,340

can have a memory of a one-headed

2537

01:31:39,770 --> 01:31:36,900

planarian or a memory of a two-headed

2538

01:31:41,750 --> 01:31:39,780

planarian and and and both of those can

2539

01:31:43,970 --> 01:31:41,760

live in exactly the same Hardware in

2540

01:31:46,250 --> 01:31:43,980

exactly the same the same body the other

2541

01:31:48,050 --> 01:31:46,260

kind of cool thing about this and um

2542

01:31:50,450 --> 01:31:48,060

I'll just mention this even though this

2543

01:31:52,669 --> 01:31:50,460

is this is you know disclaimer this is

2544

01:31:54,169 --> 01:31:52,679

not published yet so this is uh you know

2545

01:31:56,629 --> 01:31:54,179

take all this with a grain of salt the

2546

01:31:58,910 --> 01:31:56,639

the but but the the latest thing you can

2547

01:32:00,770 --> 01:31:58,920

do is you can actually treat it with

2548

01:32:03,350 --> 01:32:00,780

some of the same compounds that are used

2549

01:32:06,169 --> 01:32:03,360

in uh Neuroscience in in humans and in

2550

01:32:08,149 --> 01:32:06,179

rats as memory blockers so so things

2551

01:32:10,430 --> 01:32:08,159

that block recall or or memory

2552

01:32:11,990 --> 01:32:10,440

consolidation and when you do that you

2553

01:32:13,430 --> 01:32:12,000

can make the animal forget how many

2554

01:32:14,930 --> 01:32:13,440

heads it's supposed to have and then

2555

01:32:17,090 --> 01:32:14,940

they basically turn into a featureless

2556

01:32:18,709 --> 01:32:17,100

circle when when you can just wipe you

2557

01:32:20,270 --> 01:32:18,719

can just wipe the the pattern memory

2558

01:32:22,370 --> 01:32:20,280

completely with it using exactly the

2559

01:32:24,709 --> 01:32:22,380

same techniques you would use in a in a

2560

01:32:26,209 --> 01:32:24,719

rat or a human they just forget what to

2561

01:32:27,770 --> 01:32:26,219

do when they turn into they fail to

2562

01:32:31,550 --> 01:32:27,780

break Symmetry and they just become a

2563

01:32:33,470 --> 01:32:31,560

Circle so yeah I I think I think what

2564

01:32:35,870 --> 01:32:33,480

you were saying is is right on with with

2565

01:32:37,729 --> 01:32:35,880

this this ability to uh store

2566

01:32:39,890 --> 01:32:37,739

counterfactual states that are not true

2567

01:32:41,750 --> 01:32:39,900

now but may represent

2568

01:32:44,090 --> 01:32:41,760

aspects of the of the future I think

2569

01:32:46,510 --> 01:32:44,100

that's that's a very important capacity

2570

01:32:49,430 --> 01:32:46,520

another important notion is a constraint

2571

01:32:52,070 --> 01:32:49,440

uh constraint satisfaction a constraint

2572

01:32:54,110 --> 01:32:52,080

is a rule that tells you uh whether two

2573

01:32:55,490 --> 01:32:54,120

things are compatible or not and the

2574

01:32:57,410 --> 01:32:55,500

constraint is satisfied if they're

2575

01:32:59,030 --> 01:32:57,420

compatible so you basically have a

2576

01:33:01,330 --> 01:32:59,040

number of conditions that you establish

2577

01:33:04,310 --> 01:33:01,340

by measuring that somehow for instance

2578

01:33:07,250 --> 01:33:04,320

uh whether you have a head or multiple

2579

01:33:09,169 --> 01:33:07,260

heads and you try to find a solution

2580

01:33:11,390 --> 01:33:09,179

where you can end up with exactly one

2581

01:33:13,970 --> 01:33:11,400

head and if you end up with exactly one

2582

01:33:15,530 --> 01:33:13,980

head based on the starting State then

2583

01:33:18,770 --> 01:33:15,540

you have managed to find a way to

2584

01:33:21,530 --> 01:33:18,780

satisfy your constraints and so in a

2585

01:33:24,890 --> 01:33:21,540

sense uh what you call a competency is

2586

01:33:27,709 --> 01:33:24,900

the ability of a system to take a region

2587

01:33:30,290 --> 01:33:27,719

of this of states of the space of the

2588

01:33:32,090 --> 01:33:30,300

universe some basically some local

2589

01:33:36,470 --> 01:33:32,100

region of possible state that the Euros

2590

01:33:39,410 --> 01:33:36,480

can be in and move that region to a

2591

01:33:40,669 --> 01:33:39,420

smaller region that is acceptable so the

2592

01:33:42,110 --> 01:33:40,679

basically there is a region on the

2593

01:33:43,070 --> 01:33:42,120

universe State space where you have only

2594

01:33:44,689 --> 01:33:43,080

one head

2595

01:33:46,189 --> 01:33:44,699

and there's a larger region where you

2596

01:33:48,530 --> 01:33:46,199

don't have any head at all but the

2597

01:33:50,930 --> 01:33:48,540

starting state of your organism and then

2598

01:33:52,910 --> 01:33:50,940

you try to get from A to B so you get

2599

01:33:55,010 --> 01:33:52,920

from this larger region to the one in

2600

01:33:56,390 --> 01:33:55,020

which you want to be of course if you

2601
01:33:58,610 --> 01:33:56,400
have one head you want to stay in the

2602
01:34:00,709 --> 01:33:58,620
region in which you have one head which

2603
01:34:02,750 --> 01:34:00,719
of course is usually much easier but the

2604
01:34:06,290 --> 01:34:02,760
ability basically to condense the space

2605
01:34:09,290 --> 01:34:06,300
to get to Bridge Over many regions into

2606
01:34:11,090 --> 01:34:09,300
the target region is what comes down to

2607
01:34:13,490 --> 01:34:11,100
this this is what this competency is the

2608
01:34:15,470 --> 01:34:13,500
system basically has an emergent wanting

2609
01:34:17,330 --> 01:34:15,480
to go in this region and it's trying to

2610
01:34:19,310 --> 01:34:17,340
move there and so there are constraints

2611
01:34:21,530 --> 01:34:19,320
on the level of the substrate

2612
01:34:23,330 --> 01:34:21,540
uh that are battling with the functional

2613
01:34:25,430 --> 01:34:23,340

constraints that the organism wants to

2614

01:34:28,189 --> 01:34:25,440

realize to fulfill its function and

2615

01:34:29,510 --> 01:34:28,199

sometimes uh you cannot satisfy this and

2616

01:34:30,830 --> 01:34:29,520

you end up with two heads because you

2617

01:34:33,890 --> 01:34:30,840

don't know which one you'll get rid of

2618

01:34:37,010 --> 01:34:33,900

or how to digest one of the heads and so

2619

01:34:40,310 --> 01:34:37,020

on and you end up with some Siamese twin

2620

01:34:42,169 --> 01:34:40,320

and uh so this this is an interesting

2621

01:34:44,629 --> 01:34:42,179

constraint that you have to solve for

2622

01:34:46,430 --> 01:34:44,639

when you are dealing with reality and

2623

01:34:49,550 --> 01:34:46,440

how you battle with the substrate until

2624

01:34:50,950 --> 01:34:49,560

you get to the functional solution that

2625

01:34:53,510 --> 01:34:50,960

you evolve for

2626

01:34:56,570 --> 01:34:53,520

yeah it's that's that's interesting I

2627

01:35:00,229 --> 01:34:56,580

mean we we've also found that there are

2628

01:35:02,390 --> 01:35:00,239

so so we look at exactly this uh the the

2629

01:35:03,830 --> 01:35:02,400

navigation this kind of navigation and

2630

01:35:05,629 --> 01:35:03,840

Morpher space how you get from here to

2631

01:35:07,790 --> 01:35:05,639

there and what paths are possible to get

2632

01:35:10,129 --> 01:35:07,800

from here to there and so on one of the

2633

01:35:12,350 --> 01:35:10,139

things that we found is that there are

2634

01:35:15,709 --> 01:35:12,360

regions of that space that belong to

2635

01:35:17,990 --> 01:35:15,719

other species and you can you can push a

2636

01:35:20,750 --> 01:35:18,000

a planarian with a standard wild type

2637

01:35:22,070 --> 01:35:20,760

genome into the goal state of a

2638

01:35:23,810 --> 01:35:22,080

completely different species so we can

2639

01:35:25,310 --> 01:35:23,820

get them to grow ahead so there's a

2640

01:35:27,050 --> 01:35:25,320

species that normally has a triangular

2641

01:35:28,970 --> 01:35:27,060

head you can make it grow a round head

2642

01:35:32,030 --> 01:35:28,980

like a like an like a different species

2643

01:35:35,450 --> 01:35:32,040

or or a flathead or whatever uh you can

2644

01:35:37,189 --> 01:35:35,460

so those are about 100 100 to 150

2645

01:35:40,250 --> 01:35:37,199

million years of evolutionary distance

2646

01:35:43,550 --> 01:35:40,260

and you can do it you know within within

2647

01:35:45,110 --> 01:35:43,560

a few days just by um by by perturbing

2648

01:35:47,689 --> 01:35:45,120

that electrical circuit so that it lands

2649

01:35:50,330 --> 01:35:47,699

in the wrong space and then outside of

2650

01:35:52,250 --> 01:35:50,340

that there are regions that don't belong

2651

01:35:54,169 --> 01:35:52,260

to planaria at all so planaria are

2652

01:35:56,270 --> 01:35:54,179

normally nice and flat we can make we've

2653

01:35:58,010 --> 01:35:56,280

made planarians that are they look like

2654

01:35:59,450 --> 01:35:58,020

a they are cylinder like like a ski cap

2655

01:36:02,090 --> 01:35:59,460

you know they become like a like a like

2656

01:36:04,070 --> 01:36:02,100

a hemisphere or really weird ones that

2657

01:36:05,510 --> 01:36:04,080

are spiky they're they're like a ball

2658

01:36:07,970 --> 01:36:05,520

with spikes on it they're all kinds of

2659

01:36:11,090 --> 01:36:07,980

other uh regions in that space that you

2660

01:36:13,189 --> 01:36:11,100

can that you can push them to uh and so

2661

01:36:15,229 --> 01:36:13,199

those are new those are not species that

2662

01:36:17,330 --> 01:36:15,239

they diverge from those are no one's

2663

01:36:18,649 --> 01:36:17,340

ever said to my knowledge that's yes

2664

01:36:19,910 --> 01:36:18,659

there's no such there are no such

2665

01:36:21,350 --> 01:36:19,920

species

2666

01:36:22,729 --> 01:36:21,360

um it's easier to you know and we've

2667

01:36:25,550 --> 01:36:22,739

done this in frog too you can you can

2668

01:36:27,410 --> 01:36:25,560

push tadpoles to make it to look like

2669

01:36:29,270 --> 01:36:27,420

those of other species

2670

01:36:30,709 --> 01:36:29,280

um or you can make you know I mean

2671

01:36:32,930 --> 01:36:30,719

that's a whole interesting thing for

2672

01:36:34,669 --> 01:36:32,940

evolution anyway right what one species

2673

01:36:36,770 --> 01:36:34,679

birth defect is a pretty is a perfectly

2674

01:36:39,169 --> 01:36:36,780

reasonable different species so we can

2675

01:36:42,590 --> 01:36:39,179

make we can make tadpoles with a rounded

2676

01:36:44,030 --> 01:36:42,600

tail which for a xenopus tadpole is a

2677

01:36:46,729 --> 01:36:44,040

terrible Tale But for zebrafish that's

2678

01:36:49,310 --> 01:36:46,739

exactly the right tale so you can sort

2679

01:36:51,610 --> 01:36:49,320

of Imagine imagine right Evolution uh

2680

01:36:53,629 --> 01:36:51,620

manipulating the different information

2681

01:36:55,010 --> 01:36:53,639

processing whether whether by the

2682

01:36:57,410 --> 01:36:55,020

bioelectrical circuits or other other

2683

01:37:00,229 --> 01:36:57,420

Machinery uh that help the system

2684

01:37:01,810 --> 01:37:00,239

explore that morphe space and you know

2685

01:37:05,870 --> 01:37:01,820

start to

2686

01:37:07,550 --> 01:37:05,880

from from whatever the you know that

2687

01:37:09,709 --> 01:37:07,560

speciation is moving away from your

2688

01:37:12,350 --> 01:37:09,719

standard attractor that you usually land

2689

01:37:15,410 --> 01:37:12,360

on how does this relate to intelligence

2690

01:37:17,390 --> 01:37:15,420

well intelligence is the ability to make

2691

01:37:19,129 --> 01:37:17,400

models and and usually in the service of

2692

01:37:22,310 --> 01:37:19,139

control at least that's the way I would

2693

01:37:24,350 --> 01:37:22,320

uh explain intelligence

2694

01:37:26,270 --> 01:37:24,360

there are other definitions but it's the

2695

01:37:27,350 --> 01:37:26,280

simplest one that I found it also

2696

01:37:29,209 --> 01:37:27,360

accounts for the fact that many

2697

01:37:31,550 --> 01:37:29,219

intelligent people are not very good at

2698

01:37:33,290 --> 01:37:31,560

getting things done uh that's it's

2699

01:37:36,110 --> 01:37:33,300

basically an intelligence and goal

2700

01:37:38,510 --> 01:37:36,120

rationality are support orthogonal

2701

01:37:41,750 --> 01:37:38,520

and excessive intelligence is often a

2702

01:37:44,090 --> 01:37:41,760

prosthesis for bad regulation have you

2703

01:37:47,270 --> 01:37:44,100

read the intelligence trap

2704

01:37:49,550 --> 01:37:47,280

no okay the author makes a similar case

2705

01:37:51,290 --> 01:37:49,560

and he's coming on shortly essentially

2706

01:37:53,209 --> 01:37:51,300

saying that there are certain traps that

2707

01:37:55,610 --> 01:37:53,219

people with high IQs have that are not

2708

01:37:58,070 --> 01:37:55,620

beneficial for them as biological beings

2709

01:37:59,810 --> 01:37:58,080

they're mainly cognitive biases so for

2710

01:38:01,729 --> 01:37:59,820

instance it's extremely interesting so

2711

01:38:03,530 --> 01:38:01,739

let's just give one of the biases to say

2712

01:38:05,450 --> 01:38:03,540

you're either liberal biased or you're

2713

01:38:07,250 --> 01:38:05,460

conservative biased and then you were to

2714

01:38:08,990 --> 01:38:07,260

give a test where there's some data that

2715

01:38:10,970 --> 01:38:09,000

says that on the surface it shows that

2716

01:38:13,790 --> 01:38:10,980

the data shows that gun control prevents

2717

01:38:15,649 --> 01:38:13,800

gun violence well the Liberals are more

2718

01:38:17,629 --> 01:38:15,659

likely to say yes this data does show

2719

01:38:19,070 --> 01:38:17,639

that but if you're conservative you're

2720

01:38:20,870 --> 01:38:19,080

more likely to find oh actually the

2721

01:38:23,870 --> 01:38:20,880

subtleties in the data show that gun

2722

01:38:25,129 --> 01:38:23,880

control increases gun violence and then

2723

01:38:26,510 --> 01:38:25,139

they thought okay well let's just switch

2724

01:38:28,370 --> 01:38:26,520

this to make it such that The

2725

01:38:31,010 --> 01:38:28,380

Superficial data suggests that gun

2726

01:38:32,390 --> 01:38:31,020

control increases violence you need to

2727

01:38:33,890 --> 01:38:32,400

look at the data carefully to show that

2728

01:38:35,209 --> 01:38:33,900

it actually prevents violence well the

2729

01:38:37,149 --> 01:38:35,219

conservatives in that case would be more

2730

01:38:39,590 --> 01:38:37,159

quickly to say oh look the gun control

2731

01:38:41,810 --> 01:38:39,600

increases violence and the Liberals

2732

01:38:43,010 --> 01:38:41,820

would find the the loophole well that's

2733

01:38:45,229 --> 01:38:43,020

one of the reasons why I don't mind

2734

01:38:47,629 --> 01:38:45,239

interviewing people who are biased

2735

01:38:49,970 --> 01:38:47,639

because to me they're more able to find

2736

01:38:52,970 --> 01:38:49,980

a justification for something that that

2737

01:38:55,010 --> 01:38:52,980

may be true but I or and others are so

2738

01:38:56,750 --> 01:38:55,020

well we all have our own biases we're so

2739

01:38:59,209 --> 01:38:56,760

inclined in some other direction that we

2740

01:39:00,350 --> 01:38:59,219

just we're blind to it but anyway the

2741

01:39:02,270 --> 01:39:00,360

point is to affirm what you're saying

2742

01:39:04,370 --> 01:39:02,280

yosha okay so I know Michael has a hard

2743

01:39:07,310 --> 01:39:04,380

cut off at 2PM so I want to ask the

2744

01:39:09,530 --> 01:39:07,320

question for AGI that is artificial

2745

01:39:11,810 --> 01:39:09,540

general intelligence it seems as though

2746

01:39:14,689 --> 01:39:11,820

we're far away or that our current

2747

01:39:16,669 --> 01:39:14,699

methods of machine learning and what we

2748

01:39:18,530 --> 01:39:16,679

learn in Neuroscience or or what we

2749

01:39:20,209 --> 01:39:18,540

learn in computer science is something

2750

01:39:22,129 --> 01:39:20,219

that we're missing some paradigm shift

2751

01:39:23,390 --> 01:39:22,139

or we're missing some new techniques is

2752

01:39:25,189 --> 01:39:23,400

there something from Michael's work

2753

01:39:26,750 --> 01:39:25,199

Yoshi I'm asking you this and then

2754

01:39:28,189 --> 01:39:26,760

Michael please respond is there

2755

01:39:30,169 --> 01:39:28,199

something from Michael's work that you

2756

01:39:33,709 --> 01:39:30,179

think can be applied to the development

2757

01:39:35,450 --> 01:39:33,719

of AGI if such a creature mind can exist

2758

01:39:37,070 --> 01:39:35,460

because there are some arguments against

2759

01:39:38,990 --> 01:39:37,080

it so first of all I don't know how far

2760

01:39:40,490 --> 01:39:39,000

we are for the HEI it could be that the

2761

01:39:41,750 --> 01:39:40,500

existing private names are sufficient to

2762

01:39:43,850 --> 01:39:41,760

brute force it

2763

01:39:45,470 --> 01:39:43,860

but we don't know that yet right so

2764

01:39:48,050 --> 01:39:45,480

we're going to find out in the next few

2765

01:39:49,550 --> 01:39:48,060

months uh but it could also be that we

2766

01:39:51,830 --> 01:39:49,560

need to rewrite the stack to build

2767

01:39:53,390 --> 01:39:51,840

systems that work in real time that are

2768

01:39:56,090 --> 01:39:53,400

entangled with the environment that can

2769

01:39:58,370 --> 01:39:56,100

build uh shared representations with the

2770

01:40:00,770 --> 01:39:58,380

environment and uh that we need to

2771

01:40:02,450 --> 01:40:00,780

rewrite the stack and there are actually

2772

01:40:04,490 --> 01:40:02,460

a number of questions that I'd like to

2773

01:40:07,610 --> 01:40:04,500

ask Michael

2774

01:40:09,709 --> 01:40:07,620

um what uh I noticed that Michael is

2775

01:40:11,750 --> 01:40:09,719

wisely reluctant to use certain words

2776

01:40:13,010 --> 01:40:11,760

like Consciousness a lot and it's

2777

01:40:14,750 --> 01:40:13,020

because a lot of people are very

2778

01:40:16,189 --> 01:40:14,760

opinionated about what these concepts

2779

01:40:18,470 --> 01:40:16,199

mean and you first have to deal with

2780

01:40:20,090 --> 01:40:18,480

these opinions before you come down to

2781

01:40:21,830 --> 01:40:20,100

saying oh here I have the following

2782

01:40:24,169 --> 01:40:21,840

proposal for implementing reflexive

2783

01:40:27,590 --> 01:40:24,179

attention as a tool to form coherence

2784

01:40:29,330 --> 01:40:27,600

and a representation and this leads to

2785

01:40:30,470 --> 01:40:29,340

the same phenomena as what you call

2786

01:40:33,290 --> 01:40:30,480

consciousness

2787

01:40:34,790 --> 01:40:33,300

right so uh that is is a detailed

2788

01:40:36,470 --> 01:40:34,800

discussion maybe you don't want to have

2789

01:40:37,970 --> 01:40:36,480

that discussion in every Foreman rather

2790

01:40:40,490 --> 01:40:37,980

than uh that and then having this

2791

01:40:42,470 --> 01:40:40,500

discussion you may be looking at uh how

2792

01:40:44,810 --> 01:40:42,480

to create coherence using a reflexive

2793

01:40:47,330 --> 01:40:44,820

attention process that makes a real-time

2794

01:40:48,890 --> 01:40:47,340

model of what it's attending to and the

2795

01:40:51,530 --> 01:40:48,900

fact that it's attending to it so it

2796

01:40:54,830 --> 01:40:51,540

remains coherent but for itself so this

2797

01:40:56,810 --> 01:40:54,840

is a concrete thing but uh I wonder how

2798

01:40:58,490 --> 01:40:56,820

to implement this in a self-organized

2799

01:41:00,950 --> 01:40:58,500

fashion if the substrate that you have

2800

01:41:04,250 --> 01:41:00,960

are individual agents and there is a

2801
01:41:07,430 --> 01:41:04,260
similarity here between societies and

2802
01:41:09,970 --> 01:41:07,440
brains and social networks

2803
01:41:12,229 --> 01:41:09,980
that is uh if you have

2804
01:41:13,370 --> 01:41:12,239
self-interested agents in a way that try

2805
01:41:15,290 --> 01:41:13,380
to survive

2806
01:41:17,330 --> 01:41:15,300
and that get their rewards from other

2807
01:41:19,189 --> 01:41:17,340
agents that are similar to them

2808
01:41:22,189 --> 01:41:19,199
structurally

2809
01:41:23,870 --> 01:41:22,199
and and they have the capacity to learn

2810
01:41:27,649 --> 01:41:23,880
to some degree

2811
01:41:30,229 --> 01:41:27,659
and that capacity is sufficient so they

2812
01:41:34,430 --> 01:41:30,239
can in the aggregate learn arbitrary

2813
01:41:37,129 --> 01:41:34,440

programs arbitrary computable functions

2814

01:41:38,930 --> 01:41:37,139

and it's efficient enough so they can

2815

01:41:42,770 --> 01:41:38,940

Converge on the functions that they need

2816

01:41:44,149 --> 01:41:42,780

to to as a group reap rewards that apply

2817

01:41:46,189 --> 01:41:44,159

to the whole group because they have a

2818

01:41:47,750 --> 01:41:46,199

shared Destiny like the poor little

2819

01:41:49,250 --> 01:41:47,760

cells that are locked in the same skull

2820

01:41:52,430 --> 01:41:49,260

and they are all going to die together

2821

01:41:54,169 --> 01:41:52,440

if they up so they have to get

2822

01:41:56,570 --> 01:41:54,179

along they have to form an organization

2823

01:41:58,790 --> 01:41:56,580

that is Distributing rewards among each

2824

01:42:01,729 --> 01:41:58,800

other and this gives us a search space

2825

01:42:04,250 --> 01:42:01,739

for possible systems that can exist and

2826

01:42:08,209 --> 01:42:04,260

the search space is mostly given I think

2827

01:42:09,830 --> 01:42:08,219

by the minimal agent that is able to

2828

01:42:11,090 --> 01:42:09,840

learn how to distribute rewards

2829

01:42:13,609 --> 01:42:11,100

efficiently

2830

01:42:15,649 --> 01:42:13,619

while doing something useful using these

2831

01:42:17,689 --> 01:42:15,659

rewards to change how you do something

2832

01:42:20,209 --> 01:42:17,699

useful so you have an emerging form of

2833

01:42:22,129 --> 01:42:20,219

governance in these systems there's not

2834

01:42:24,050 --> 01:42:22,139

some centralized control that is imposed

2835

01:42:25,550 --> 01:42:24,060

on the system from the outside as an

2836

01:42:28,310 --> 01:42:25,560

existing machine learning approaches and

2837

01:42:30,649 --> 01:42:28,320

AI approaches but this is this only is

2838

01:42:32,750 --> 01:42:30,659

an emergent pattern in the interactions

2839

01:42:35,270 --> 01:42:32,760

between the individual small units small

2840

01:42:37,070 --> 01:42:35,280

reinforcement learning agents and this

2841

01:42:39,169 --> 01:42:37,080

control architecture leads to

2842

01:42:41,030 --> 01:42:39,179

hierarchical government it's not fully

2843

01:42:42,770 --> 01:42:41,040

decentralized in any way there are

2844

01:42:44,390 --> 01:42:42,780

centralized structures that distribute

2845

01:42:46,729 --> 01:42:44,400

rewards for instance via the

2846

01:42:48,649 --> 01:42:46,739

dopaminergic system and very centralized

2847

01:42:50,629 --> 01:42:48,659

top-down Manner and that's because every

2848

01:42:52,490 --> 01:42:50,639

regulation has an optimal layer where it

2849

01:42:54,649 --> 01:42:52,500

needs to take place some stuff needs to

2850

01:42:56,450 --> 01:42:54,659

be decided very high up some stuff needs

2851
01:42:58,430 --> 01:42:56,460
to be optimally regulated very low down

2852
01:43:00,410 --> 01:42:58,440
depending on the incentives game

2853
01:43:02,750 --> 01:43:00,420
theoretically a government is an agent

2854
01:43:06,229 --> 01:43:02,760
that imposes an offset on your payoff

2855
01:43:08,270 --> 01:43:06,239
metrics to make your Nash equilibrium

2856
01:43:10,189 --> 01:43:08,280
compatible with the globally best

2857
01:43:12,530 --> 01:43:10,199
outcome

2858
01:43:14,330 --> 01:43:12,540
right so to do this you need to have

2859
01:43:16,070 --> 01:43:14,340
agents that are sensitive to rewards

2860
01:43:18,950 --> 01:43:16,080
it's super interesting to think about

2861
01:43:20,870 --> 01:43:18,960
these reward infrastructures Elon Musk

2862
01:43:22,790 --> 01:43:20,880
has bought Twitter I think because he

2863
01:43:24,830 --> 01:43:22,800

has realized that Twitter is the network

2864

01:43:27,229 --> 01:43:24,840

of among all the social networks that is

2865

01:43:29,270 --> 01:43:27,239

closest to a global brain

2866

01:43:30,649 --> 01:43:29,280

it's totally mind-blowing to realize

2867

01:43:33,169 --> 01:43:30,659

that he basically trades a bunch of

2868

01:43:36,290 --> 01:43:33,179

frothy stock for the opportunity to

2869

01:43:38,270 --> 01:43:36,300

become Pope pope of a religion that has

2870

01:43:40,010 --> 01:43:38,280

more active participants than

2871

01:43:42,290 --> 01:43:40,020

Catholicism even right daily

2872

01:43:44,270 --> 01:43:42,300

practitioning people who enter this

2873

01:43:45,709 --> 01:43:44,280

church and think together and it's a

2874

01:43:46,970 --> 01:43:45,719

thing that is completely incoherent at

2875

01:43:49,129 --> 01:43:46,980

this point almost and completely

2876

01:43:50,450 --> 01:43:49,139

incorrect the bubbles of sentience but

2877

01:43:52,010 --> 01:43:50,460

for the most part this thing is just

2878

01:43:54,229 --> 01:43:52,020

screeching at itself

2879

01:43:56,149 --> 01:43:54,239

and now the SD question can we fix the

2880

01:43:57,410 --> 01:43:56,159

incentives of Twitter to turn it into a

2881

01:44:01,910 --> 01:43:57,420

global brain

2882

01:44:03,770 --> 01:44:01,920

believes that this is the case and

2883

01:44:05,510 --> 01:44:03,780

that's the experiment that he is trying

2884

01:44:07,250 --> 01:44:05,520

to do which makes me super excited right

2885

01:44:09,530 --> 01:44:07,260

this might fail is a very big chance

2886

01:44:11,330 --> 01:44:09,540

that it fails but there is also the

2887

01:44:13,189 --> 01:44:11,340

chance that we get the global brain that

2888

01:44:15,830 --> 01:44:13,199

we get emerging collective intelligence

2889

01:44:17,209 --> 01:44:15,840

it is working in real time using the

2890

01:44:19,970 --> 01:44:17,219

internet in a way that didn't exist

2891

01:44:22,250 --> 01:44:19,980

before so super fascinating thing that

2892

01:44:24,109 --> 01:44:22,260

might happen here and it's fascinating

2893

01:44:26,870 --> 01:44:24,119

that very few people are seeing this

2894

01:44:29,270 --> 01:44:26,880

that Elon Musk is crazy enough to to

2895

01:44:31,430 --> 01:44:29,280

spend 44 billion dollars on that

2896

01:44:32,629 --> 01:44:31,440

experiment just because he can and has

2897

01:44:34,550 --> 01:44:32,639

nothing else to do with things it's

2898

01:44:36,470 --> 01:44:34,560

meaningful to do it more meaningful than

2899

01:44:41,090 --> 01:44:36,480

having so much money in the bank right

2900

01:44:43,129 --> 01:44:41,100

so this makes me interested in this test

2901
01:44:44,870 --> 01:44:43,139
bed for rewards and this is something

2902
01:44:46,729 --> 01:44:44,880
that translates into the way in which

2903
01:44:48,530 --> 01:44:46,739
society is organized because social

2904
01:44:50,390 --> 01:44:48,540
media is not different from society not

2905
01:44:52,310 --> 01:44:50,400
separate from it problem of governing

2906
01:44:54,649 --> 01:44:52,320
social media is exactly the same thing

2907
01:44:56,330 --> 01:44:54,659
as governing a society you need a right

2908
01:44:58,129 --> 01:44:56,340
form of government you need a legal

2909
01:44:59,990 --> 01:44:58,139
system ultimately you need

2910
01:45:01,669 --> 01:45:00,000
representation and all these issues

2911
01:45:04,850 --> 01:45:01,679
right it's not just the moderation team

2912
01:45:06,109 --> 01:45:04,860
and the same thing is also true for the

2913
01:45:09,050 --> 01:45:06,119

brain what is the government of the

2914

01:45:11,090 --> 01:45:09,060

brain that emerges in what Gary Edelman

2915

01:45:13,550 --> 01:45:11,100

calls neural Darwinism among different

2916

01:45:15,410 --> 01:45:13,560

forms of organization in the mind until

2917

01:45:17,209 --> 01:45:15,420

you have a model of a self-organizing

2918

01:45:19,310 --> 01:45:17,219

agent that discovers that what it's

2919

01:45:20,870 --> 01:45:19,320

Computing is driving the behavior of an

2920

01:45:22,970 --> 01:45:20,880

agent in the real world and discovers a

2921

01:45:24,950 --> 01:45:22,980

first person perspective and so on how

2922

01:45:26,870 --> 01:45:24,960

does that work how can we get a system

2923

01:45:29,570 --> 01:45:26,880

that is looking for the right incentive

2924

01:45:32,930 --> 01:45:29,580

architecture and that is basically the

2925

01:45:35,330 --> 01:45:32,940

main topic where I I think that where

2926

01:45:37,189 --> 01:45:35,340

Michael's research is pointing from from

2927

01:45:40,550 --> 01:45:37,199

my perspective that is super interesting

2928

01:45:42,890 --> 01:45:40,560

we have this overlap between the looking

2929

01:45:47,570 --> 01:45:42,900

at cells and looking at the world and of

2930

01:45:51,350 --> 01:45:47,580

humans and animals and stuff in general

2931

01:45:54,169 --> 01:45:51,360

yeah yeah so super interesting um we so

2932

01:45:57,229 --> 01:45:54,179

so Chris fields and I are are working on

2933

01:45:59,350 --> 01:45:57,239

a model of of on a framework to

2934

01:46:01,370 --> 01:45:59,360

understand the the

2935

01:46:03,350 --> 01:46:01,380

where where

2936

01:46:05,689 --> 01:46:03,360

um Collective agents first come from

2937

01:46:08,450 --> 01:46:05,699

right oh well how Auto police is how do

2938

01:46:11,390 --> 01:46:08,460

they organize themselves and we've we've

2939

01:46:13,790 --> 01:46:11,400

we've we've got a model already about

2940

01:46:15,770 --> 01:46:13,800

this idea of of rewards and sells

2941

01:46:17,390 --> 01:46:15,780

rewarding other cells with with

2942

01:46:19,669 --> 01:46:17,400

neurotransmitters and things like this

2943

01:46:21,530 --> 01:46:19,679

to keep copies of themselves nearby

2944

01:46:23,750 --> 01:46:21,540

because they're the most predictable so

2945

01:46:25,250 --> 01:46:23,760

so this idea of reducing surprise well

2946

01:46:27,290 --> 01:46:25,260

what's the least surprising thing it's a

2947

01:46:29,030 --> 01:46:27,300

copy of yourself and so you can sort of

2948

01:46:31,669 --> 01:46:29,040

this with Chris calls it the Imperial

2949

01:46:34,370 --> 01:46:31,679

model of multicellularity but one thing

2950

01:46:37,729 --> 01:46:34,380

to really think about here is Imagine an

2951

01:46:39,290 --> 01:46:37,739

embryo this is a um an amniote embryo

2952

01:46:40,790 --> 01:46:39,300

let's say a human or or a bird or

2953

01:46:43,850 --> 01:46:40,800

something like that and what you have

2954

01:46:46,669 --> 01:46:43,860

there is you have a flat disk of fifty

2955

01:46:48,470 --> 01:46:46,679

to ten thousand fifty thousand cells and

2956

01:46:50,510 --> 01:46:48,480

when people look at it you say what is

2957

01:46:52,910 --> 01:46:50,520

that they say it's an embryo one one

2958

01:46:54,950 --> 01:46:52,920

embryo well the reason it's one embryo

2959

01:46:56,990 --> 01:46:54,960

is that under normal conditions what's

2960

01:47:00,649 --> 01:46:57,000

going to happen is that in this in this

2961

01:47:02,149 --> 01:47:00,659

disc one cell is symmetry breaking one

2962

01:47:03,830 --> 01:47:02,159

cell is going to decide that it's the

2963

01:47:05,750 --> 01:47:03,840

organizer it's going to do local

2964

01:47:07,070 --> 01:47:05,760

activation long range inhibition it's

2965

01:47:09,169 --> 01:47:07,080

going to tell all the other cells you're

2966

01:47:11,470 --> 01:47:09,179

not the organizer I'm the organizer and

2967

01:47:15,530 --> 01:47:11,480

as a result you get one special point

2968

01:47:17,930 --> 01:47:15,540

that uh begins uh the a process that's

2969

01:47:19,430 --> 01:47:17,940

going to walk through this amorphous

2970

01:47:21,109 --> 01:47:19,440

space and create a particular

2971

01:47:22,490 --> 01:47:21,119

large-scale structure with two eyes and

2972

01:47:25,129 --> 01:47:22,500

four legs and whatever else it's going

2973

01:47:27,590 --> 01:47:25,139

to have but here's the interesting thing

2974

01:47:29,870 --> 01:47:27,600

those cells that's not really one embryo

2975

01:47:32,030 --> 01:47:29,880

that's that's um a weird kind of

2976

01:47:34,070 --> 01:47:32,040

Freudian ocean of potentiality what I

2977

01:47:35,390 --> 01:47:34,080

mean by that is if you take and I did

2978

01:47:37,609 --> 01:47:35,400

this as a grad student you can take a

2979

01:47:39,530 --> 01:47:37,619

needle and you can put a little scratch

2980

01:47:41,629 --> 01:47:39,540

through that blastoderm put a little

2981

01:47:43,609 --> 01:47:41,639

scratch through it what will happen is

2982

01:47:45,410 --> 01:47:43,619

the cells on either side of that scratch

2983

01:47:47,390 --> 01:47:45,420

don't feel each other they don't hear

2984

01:47:49,250 --> 01:47:47,400

each other's signals so that symmetry

2985

01:47:51,770 --> 01:47:49,260

breaking process will happen twice once

2986

01:47:53,270 --> 01:47:51,780

on each end and then when it heals

2987

01:47:55,669 --> 01:47:53,280

together what you end up with is two

2988

01:47:57,830 --> 01:47:55,679

conjoined twins because because each

2989

01:48:00,050 --> 01:47:57,840

side organized an embryo and now you've

2990

01:48:03,169 --> 01:48:00,060

got two conjoined twins now many

2991

01:48:06,050 --> 01:48:03,179

interesting things happen there uh one

2992

01:48:08,510 --> 01:48:06,060

is that every cell is some other cells

2993

01:48:11,030 --> 01:48:08,520

in external environment so in order to

2994

01:48:13,729 --> 01:48:11,040

make an embryo you have to self-organize

2995

01:48:15,709 --> 01:48:13,739

A system that puts an arbitrary boundary

2996

01:48:17,270 --> 01:48:15,719

between itself and the outside world you

2997

01:48:19,310 --> 01:48:17,280

have to decide where do I end and the

2998

01:48:22,430 --> 01:48:19,320

world begins and it's not given to you

2999

01:48:24,050 --> 01:48:22,440

uh you know somehow um from outside for

3000

01:48:25,609 --> 01:48:24,060

a biological system every biological

3001

01:48:27,830 --> 01:48:25,619

system has to figure this out for itself

3002

01:48:29,149 --> 01:48:27,840

unlike modern robotics or whatever where

3003

01:48:30,470 --> 01:48:29,159

it's very clear here's where you are

3004

01:48:32,149 --> 01:48:30,480

here's where the world is these are your

3005

01:48:34,010 --> 01:48:32,159

reflectors these are your sensors here's

3006

01:48:35,270 --> 01:48:34,020

the boundary of the outside world living

3007

01:48:36,770 --> 01:48:35,280

things don't have any of that they have

3008

01:48:39,950 --> 01:48:36,780

to figure out all of this out from

3009

01:48:41,510 --> 01:48:39,960

scratch the benefit to being able to

3010

01:48:43,370 --> 01:48:41,520

figure it out from scratch having to

3011

01:48:46,010 --> 01:48:43,380

figure out from scratch is that you are

3012

01:48:47,570 --> 01:48:46,020

then compatible with all kinds of weird

3013

01:48:49,370 --> 01:48:47,580

initial conditions for example if I

3014

01:48:50,990 --> 01:48:49,380

separate you in half you can make two

3015

01:48:52,729 --> 01:48:51,000

you can make twins you don't you don't

3016

01:48:54,050 --> 01:48:52,739

have a failure you know a total failure

3017

01:48:55,609 --> 01:48:54,060

because now you have half the number of

3018

01:48:58,910 --> 01:48:55,619

cells you can make twins you can make

3019

01:49:00,590 --> 01:48:58,920

triplets but probably you know many more

3020

01:49:02,390 --> 01:49:00,600

than that so if you ask the question you

3021

01:49:04,850 --> 01:49:02,400

look at that um blasted room and you ask

3022

01:49:06,410 --> 01:49:04,860

how many individuals are there you

3023

01:49:07,790 --> 01:49:06,420

actually don't know it could be zero it

3024

01:49:10,910 --> 01:49:07,800

could be one it could be some small

3025

01:49:13,609 --> 01:49:10,920

number of individuals that process of

3026

01:49:15,530 --> 01:49:13,619

Auto releases has to happen and and and

3027

01:49:17,570 --> 01:49:15,540

here all the here are a number of things

3028

01:49:20,270 --> 01:49:17,580

that that are uniquely biological that

3029

01:49:22,669 --> 01:49:20,280

that I think relate to the kind of

3030

01:49:25,970 --> 01:49:22,679

flexibility plasticity uh that you need

3031

01:49:27,169 --> 01:49:25,980

for for for AGI in whatever space it

3032

01:49:30,109 --> 01:49:27,179

doesn't have to be the same space that

3033

01:49:32,149 --> 01:49:30,119

we work in but your your boundaries are

3034

01:49:33,530 --> 01:49:32,159

not set for you by an outside Creator

3035

01:49:34,850 --> 01:49:33,540

you have to figure out where your

3036

01:49:37,310 --> 01:49:34,860

boundaries are where is the outside

3037

01:49:39,229 --> 01:49:37,320

world so you make hypotheses about where

3038

01:49:41,030 --> 01:49:39,239

you end and where the world begins you

3039

01:49:42,890 --> 01:49:41,040

don't actually know what your structure

3040

01:49:44,629 --> 01:49:42,900

is kind of like Bond guards robots from

3041

01:49:45,950 --> 01:49:44,639

2006 where they didn't know their

3042

01:49:47,689 --> 01:49:45,960

structure and they had to make

3043

01:49:49,189 --> 01:49:47,699

hypotheses about well do I have wheels

3044

01:49:52,850 --> 01:49:49,199

do I have legs what do I have and then

3045

01:49:55,129 --> 01:49:52,860

make a model based on basically babbling

3046

01:49:56,750 --> 01:49:55,139

right like the way that babies babble so

3047

01:49:58,729 --> 01:49:56,760

so you have to figure out you have to

3048

01:50:00,169 --> 01:49:58,739

make a model of of where the boundary is

3049

01:50:02,629 --> 01:50:00,179

you have to make a model of what your

3050

01:50:04,850 --> 01:50:02,639

structure is you are energy limited

3051

01:50:06,890 --> 01:50:04,860

which most the most Ai and Robotics

3052

01:50:09,649 --> 01:50:06,900

nowadays are not when your energy and

3053

01:50:11,629 --> 01:50:09,659

time limited it means that you cannot

3054

01:50:13,430 --> 01:50:11,639

pay attention to everything you are

3055

01:50:14,930 --> 01:50:13,440

forced to coarse grain in some way and

3056

01:50:16,790 --> 01:50:14,940

lose a lot of information and compress

3057

01:50:19,129 --> 01:50:16,800

it down so you have to you have to

3058

01:50:20,810 --> 01:50:19,139

choose a lens a coarse graining lens on

3059

01:50:22,550 --> 01:50:20,820

the world and figure out how you're

3060

01:50:25,550 --> 01:50:22,560

going to represent things

3061

01:50:27,470 --> 01:50:25,560

um uh and and all of this has to and and

3062

01:50:29,470 --> 01:50:27,480

there are many more things that we could

3063

01:50:31,970 --> 01:50:29,480

talk about but all of these things are

3064

01:50:33,890 --> 01:50:31,980

self-constructions from the from the

3065

01:50:35,870 --> 01:50:33,900

very beginning and and then and then you

3066

01:50:37,970 --> 01:50:35,880

have to you have to uh you start to act

3067

01:50:40,010 --> 01:50:37,980

in various in various spaces which again

3068

01:50:41,450 --> 01:50:40,020

are not predefined for you you have to

3069

01:50:43,250 --> 01:50:41,460

solve problems that are metabolic

3070

01:50:45,410 --> 01:50:43,260

physiological anatomical maybe

3071

01:50:48,290 --> 01:50:45,420

behavioral if you have muscles

3072

01:50:50,090 --> 01:50:48,300

um but but nobody's telling nobody's

3073

01:50:51,830 --> 01:50:50,100

defining the space for you

3074

01:50:53,330 --> 01:50:51,840

um for example if you're a bacterium a

3075

01:50:54,830 --> 01:50:53,340

Chris field zupo points this out if

3076
01:50:57,649 --> 01:50:54,840
you're a bacterium and you're in some

3077
01:50:59,510 --> 01:50:57,659
sort of chemical gradient you want to

3078
01:51:01,070 --> 01:50:59,520
increase the amount of sugar in your

3079
01:51:02,750 --> 01:51:01,080
environment you could act in

3080
01:51:05,390 --> 01:51:02,760
three-dimensional Space by physically

3081
01:51:07,189 --> 01:51:05,400
swimming up the gradient or you can act

3082
01:51:08,629 --> 01:51:07,199
in transcriptional Space by turning on

3083
01:51:10,609 --> 01:51:08,639
other genes that are better at

3084
01:51:12,050 --> 01:51:10,619
converting whatever sugar happens to be

3085
01:51:13,850 --> 01:51:12,060
around and that solves your your

3086
01:51:16,010 --> 01:51:13,860
metabolic problem instead of right so

3087
01:51:18,350 --> 01:51:16,020
you have these hybrid problem spaces so

3088
01:51:20,330 --> 01:51:18,360

all of this I think what what

3089

01:51:21,709 --> 01:51:20,340

contributes in a strong sense to all the

3090

01:51:23,930 --> 01:51:21,719

things that that we were just talking

3091

01:51:25,970 --> 01:51:23,940

about is the fact that everything is in

3092

01:51:27,590 --> 01:51:25,980

in biology is self-constructed from the

3093

01:51:28,729 --> 01:51:27,600

beginning you can't rely on you don't

3094

01:51:30,590 --> 01:51:28,739

know ahead of time when you're a new

3095

01:51:32,930 --> 01:51:30,600

creature Born Into the world and we have

3096

01:51:34,189 --> 01:51:32,940

many I have many examples of of this

3097

01:51:35,689 --> 01:51:34,199

kind of stuff you don't know how many

3098

01:51:38,149 --> 01:51:35,699

cells you have how big your cells are

3099

01:51:39,890 --> 01:51:38,159

you can't count on any of the priors so

3100

01:51:42,830 --> 01:51:39,900

you have this like weird thing that

3101
01:51:45,109 --> 01:51:42,840
Evolution makes these these machines

3102
01:51:46,669 --> 01:51:45,119
that don't take the past history too

3103
01:51:49,070 --> 01:51:46,679
seriously it doesn't over train on them

3104
01:51:50,930 --> 01:51:49,080
it makes problem-solving machines that

3105
01:51:53,209 --> 01:51:50,940
use whatever Hardware you have this is

3106
01:51:55,250 --> 01:51:53,219
why we can make weird chimeras and and

3107
01:51:57,770 --> 01:51:55,260
and cyborgs and and you can mix things

3108
01:52:00,830 --> 01:51:57,780
and mix and match the biology in every

3109
01:52:03,050 --> 01:52:00,840
in every way with other living things or

3110
01:52:04,729 --> 01:52:03,060
with with non-living things because all

3111
01:52:06,350 --> 01:52:04,739
of this is interoperable because it does

3112
01:52:08,270 --> 01:52:06,360
not make assumptions about what you have

3113
01:52:10,010 --> 01:52:08,280

to have it tries to solve whatever

3114

01:52:13,070 --> 01:52:10,020

problem it's given it plays the hands

3115

01:52:16,070 --> 01:52:13,080

that it's dealt and um that that that

3116

01:52:19,010 --> 01:52:16,080

results in uh that assumption that you

3117

01:52:20,570 --> 01:52:19,020

cannot uh you cannot trust what you come

3118

01:52:22,970 --> 01:52:20,580

into the world with you cannot assume

3119

01:52:24,770 --> 01:52:22,980

that the hardware is what it is it gives

3120

01:52:27,050 --> 01:52:24,780

rise to a lot of that intelligence I

3121

01:52:28,729 --> 01:52:27,060

think and a lot of that plasticity so if

3122

01:52:31,669 --> 01:52:28,739

you translate this into necessary

3123

01:52:34,490 --> 01:52:31,679

insufficient conditions what seems to be

3124

01:52:37,970 --> 01:52:34,500

necessary for the emergence of general

3125

01:52:41,870 --> 01:52:37,980

intelligence in bunch of cells or units

3126
01:52:44,030 --> 01:52:41,880
is that basically each of them is a

3127
01:52:46,790 --> 01:52:44,040
small agent which means it's able to

3128
01:52:49,310 --> 01:52:46,800
behave with an expectation of minimizing

3129
01:52:50,510 --> 01:52:49,320
future Target value deviations so it

3130
01:52:52,430 --> 01:52:50,520
learns that the configurations

3131
01:52:55,550 --> 01:52:52,440
environment that signal anticipated

3132
01:52:57,229 --> 01:52:55,560
reward next thing these units need to be

3133
01:52:58,910 --> 01:52:57,239
not just agents that need to be

3134
01:53:01,189 --> 01:52:58,920
connected to each other

3135
01:53:03,229 --> 01:53:01,199
and they need to get their Rewards or

3136
01:53:04,729 --> 01:53:03,239
proxy rewards something that allows them

3137
01:53:06,830 --> 01:53:04,739
to anticipate whether the organism is

3138
01:53:09,830 --> 01:53:06,840

going to feed them in the future from

3139

01:53:12,229 --> 01:53:09,840

other units that also adaptive

3140

01:53:14,149 --> 01:53:12,239

so you need multiple message types and

3141

01:53:17,750 --> 01:53:14,159

the ability to recognize and send them

3142

01:53:21,169 --> 01:53:19,430

uh what else do you need you need enough

3143

01:53:23,810 --> 01:53:21,179

of them of course

3144

01:53:25,490 --> 01:53:23,820

what what's not clear to me is how

3145

01:53:27,350 --> 01:53:25,500

deterministic do the units need to be

3146

01:53:29,030 --> 01:53:27,360

how much memory do they need to be or

3147

01:53:31,149 --> 01:53:29,040

which way how much State can they store

3148

01:53:33,410 --> 01:53:31,159

how much uh

3149

01:53:35,629 --> 01:53:33,420

how deep in time does the indeed

3150

01:53:37,609 --> 01:53:35,639

recollection need to go and how much

3151
01:53:40,070 --> 01:53:37,619
forward in time do they need to be able

3152
01:53:43,609 --> 01:53:40,080
to form expectations so basically how

3153
01:53:45,169 --> 01:53:43,619
large is this activation front that they

3154
01:53:47,450 --> 01:53:45,179
can or this or the shape of the

3155
01:53:49,609 --> 01:53:47,460
distribution that they can learn

3156
01:53:50,810 --> 01:53:49,619
and have to learn to make this whole

3157
01:53:53,450 --> 01:53:50,820
thing happen

3158
01:53:56,330 --> 01:53:53,460
and so basically the conditions that are

3159
01:53:58,129 --> 01:53:56,340
necessary are relatively simple

3160
01:54:00,229 --> 01:53:58,139
if you just wait for long enough and get

3161
01:54:02,810 --> 01:54:00,239
a search assistance to percolate I

3162
01:54:05,510 --> 01:54:02,820
imagine that the compound agency will at

3163
01:54:07,609 --> 01:54:05,520

some level emerge on the system just in

3164

01:54:09,950 --> 01:54:07,619

the competition of

3165

01:54:11,930 --> 01:54:09,960

um possibilities in the same way as

3166

01:54:13,250 --> 01:54:11,940

emerging agency has emerged on Twitter

3167

01:54:15,590 --> 01:54:13,260

in a way with

3168

01:54:17,990 --> 01:54:15,600

um devoke religion in a way that people

3169

01:54:20,090 --> 01:54:18,000

who are starting to shift around their

3170

01:54:22,250 --> 01:54:20,100

behavior to maximize likes and retweets

3171

01:54:24,770 --> 01:54:22,260

and there was no external reward that

3172

01:54:26,810 --> 01:54:24,780

was given on Twitter so as a result a

3173

01:54:28,669 --> 01:54:26,820

local structure emerged a local agency

3174

01:54:31,370 --> 01:54:28,679

that was Shifting the rewards by itself

3175

01:54:33,350 --> 01:54:31,380

an emerging causal structure that was in

3176

01:54:35,950 --> 01:54:33,360

some sense in Dawn what causation

3177

01:54:39,250 --> 01:54:35,960

going to organize groups of people into

3178

01:54:41,570 --> 01:54:39,260

a behavioral things it's really

3179

01:54:44,270 --> 01:54:41,580

interesting to look at better as

3180

01:54:46,729 --> 01:54:44,280

something like a mind at some level

3181

01:54:47,870 --> 01:54:46,739

right it's working slower but it would

3182

01:54:50,030 --> 01:54:47,880

probably be possible to make a

3183

01:54:51,890 --> 01:54:50,040

simulation of these Dynamics in a more

3184

01:54:53,750 --> 01:54:51,900

abstract way and to use this for

3185

01:54:56,450 --> 01:54:53,760

arbitrary problem solving

3186

01:54:58,609 --> 01:54:56,460

and so what would an experiment look

3187

01:55:00,530 --> 01:54:58,619

like in which we start with these

3188

01:55:02,990 --> 01:55:00,540

necessary conditions and narrow down the

3189

01:55:06,050 --> 01:55:03,000

sufficient conditions yeah

3190

01:55:07,669 --> 01:55:06,060

yeah yeah very very right on and that's

3191

01:55:09,950 --> 01:55:07,679

I mean yeah we're doing some of that

3192

01:55:11,990 --> 01:55:09,960

stuff uh some of that kind of modeling I

3193

01:55:14,090 --> 01:55:12,000

apologize I've got a I've got a um I've

3194

01:55:15,830 --> 01:55:14,100

gotta run here thank you both for coming

3195

01:55:16,970 --> 01:55:15,840

out for this I appreciate it thank you

3196

01:55:18,709 --> 01:55:16,980

so much and thank you for bringing us

3197

01:55:20,030 --> 01:55:18,719

together so a great great conversation I

3198

01:55:22,070 --> 01:55:20,040

really enjoyed it so yeah thank you

3199

01:55:24,470 --> 01:55:22,080

anyways I've enjoyed it very much thank

3200

01:55:26,810 --> 01:55:24,480

you thank you thank you so much thanks

3201

01:55:28,490 --> 01:55:26,820

Russia the podcast is now concluded

3202

01:55:30,050 --> 01:55:28,500

thank you for watching if you haven't

3203

01:55:31,790 --> 01:55:30,060

subscribed or clicked on that like

3204

01:55:35,030 --> 01:55:31,800

button now would be a great time to do

3205

01:55:36,890 --> 01:55:35,040

so as each subscribe and like helps

3206

01:55:39,229 --> 01:55:36,900

YouTube push this content to more people

3207

01:55:41,450 --> 01:55:39,239

also I recently found out that external

3208

01:55:43,550 --> 01:55:41,460

links count plenty toward the algorithm

3209

01:55:45,770 --> 01:55:43,560

which means that when you share on

3210

01:55:47,930 --> 01:55:45,780

Twitter on Facebook on Reddit

3211

01:55:49,729 --> 01:55:47,940

Etc it shows YouTube that people are

3212

01:55:51,830 --> 01:55:49,739

talking about this outside of YouTube

3213

01:55:53,689 --> 01:55:51,840

which in turn greatly AIDS the

3214

01:55:55,310 --> 01:55:53,699

Distribution on YouTube as well if you'd

3215

01:55:57,609 --> 01:55:55,320

like to support more conversations like

3216

01:55:59,689 --> 01:55:57,619

this then do consider visiting

3217

01:56:01,970 --> 01:55:59,699

theoriesofeverything.org again it's

3218

01:56:04,430 --> 01:56:01,980

support from the sponsors and you that

3219

01:56:06,109 --> 01:56:04,440

allow me to work on top full time you

3220

01:56:08,149 --> 01:56:06,119

get early access to ad-free audio

3221

01:56:10,250 --> 01:56:08,159

episodes there as well every dollar

3222

01:56:12,290 --> 01:56:10,260

helps far more than you may think either