



1
00:00:00,480 --> 00:00:09,270

[Music]

2
00:00:13,470 --> 00:00:11,699

I will start to talk with the fact that

3
00:00:16,140 --> 00:00:13,480

I do have some good news and some bad

4
00:00:17,640 --> 00:00:16,150

news and I will disappoint you later not

5
00:00:19,769 --> 00:00:17,650

at the beginning so for now we're gonna

6
00:00:21,060 --> 00:00:19,779

talk about fun stuff but at the same

7
00:00:23,970 --> 00:00:21,070

disappointment that I'm suffering as a

8
00:00:25,499 --> 00:00:23,980

result of this I guess research agenda

9
00:00:28,560 --> 00:00:25,509

you guys will get to share in a little

10
00:00:30,240 --> 00:00:28,570

bit so the good news evolution is

11
00:00:32,940 --> 00:00:30,250

intelligent and those of you that are

12
00:00:35,060 --> 00:00:32,950

familiar with self-organization have

13
00:00:36,810 --> 00:00:35,070

probably heard this statement before

14

00:00:38,880 --> 00:00:36,820

underneath that statement you see

15

00:00:40,560 --> 00:00:38,890

actually a painting of Alex gray who was

16

00:00:42,060 --> 00:00:40,570

actually trying to depict this in one

17

00:00:43,860 --> 00:00:42,070

way or another and those of you are

18

00:00:45,569 --> 00:00:43,870

familiar with his art know that he's

19

00:00:47,489 --> 00:00:45,579

really really trying to get at some of

20

00:00:50,009 --> 00:00:47,499

the more deeper aspects of what you and

21

00:00:51,479 --> 00:00:50,019

I are talking about today and so the

22

00:00:53,489 --> 00:00:51,489

statement that evolution is intelligent

23

00:00:55,049 --> 00:00:53,499

is you know you see that there's a

24

00:00:56,639 --> 00:00:55,059

little asterisk there because if I ask

25

00:00:58,079 --> 00:00:56,649

many of you here what constitutes

26

00:00:58,950 --> 00:00:58,089

intelligence you're gonna give me a

27

00:01:00,750 --> 00:00:58,960

different answer

28

00:01:03,180 --> 00:01:00,760

same for consciousness right which is

29

00:01:04,380 --> 00:01:03,190

why it's a really big really important

30

00:01:09,180 --> 00:01:04,390

to actually define a lot of these things

31

00:01:11,120 --> 00:01:09,190

at times now the motivation for this

32

00:01:13,859 --> 00:01:11,130

talk was actually coming from

33

00:01:15,840 --> 00:01:13,869

intelligent design slash creationist

34

00:01:17,730 --> 00:01:15,850

arguments for what exists today now I'm

35

00:01:20,340 --> 00:01:17,740

not a creationist Torrent or intelligent

36

00:01:23,249 --> 00:01:20,350

design person however I do share the

37

00:01:25,580 --> 00:01:23,259

opinion with them that the degree to

38

00:01:29,340 --> 00:01:25,590

which I guess nature

39

00:01:31,920 --> 00:01:29,350

biology physics etc is specialized for I

40

00:01:33,899 --> 00:01:31,930

guess succeeding on this planet seems to

41

00:01:37,440 --> 00:01:33,909

be rather interesting I mean we are very

42

00:01:39,690 --> 00:01:37,450

very effective creatures at you know at

43

00:01:42,060 --> 00:01:39,700

our metabolism is fairly efficient when

44

00:01:44,399 --> 00:01:42,070

you look at I guess at least plants the

45

00:01:45,929 --> 00:01:44,409

metabolism that goes on as a result of

46

00:01:47,580 --> 00:01:45,939

chlorophyll goes way beyond anything

47

00:01:50,429 --> 00:01:47,590

human beings have created so how did

48

00:01:52,289 --> 00:01:50,439

this happen right and the motivation for

49

00:01:54,660 --> 00:01:52,299

the intelligent design argument is the

50

00:01:56,249 --> 00:01:54,670

famous watchmaker argument that if you

51
00:01:58,620 --> 00:01:56,259
are walking around in in an empty field

52
00:02:00,959 --> 00:01:58,630
you kick something you pick it up it

53
00:02:02,700 --> 00:02:00,969
looks like a pocket watch well then you

54
00:02:04,349 --> 00:02:02,710
must automatically assume that it wasn't

55
00:02:06,179 --> 00:02:04,359
a natural product because it's complex

56
00:02:09,240 --> 00:02:06,189
and designed so there must be a designer

57
00:02:10,760 --> 00:02:09,250
this is a teleological argument for the

58
00:02:12,600 --> 00:02:10,770
existence of God one of the famous ones

59
00:02:15,480 --> 00:02:12,610
one of the famous ones has been

60
00:02:16,560 --> 00:02:15,490
completely blown to pieces because how

61
00:02:18,449 --> 00:02:16,570
do you actually define intelligence

62
00:02:20,070 --> 00:02:18,459
something that looks intelligent to us

63
00:02:22,080 --> 00:02:20,080

may not be intelligent to some other

64

00:02:22,950 --> 00:02:22,090

people right so if in fact you don't

65

00:02:24,330 --> 00:02:22,960

have

66

00:02:25,500 --> 00:02:24,340

definition of intelligence then you

67

00:02:27,870 --> 00:02:25,510

can't really say that there must have

68

00:02:30,030 --> 00:02:27,880

been a designer involved in the process

69

00:02:32,810 --> 00:02:30,040

and that I'm completely on board with

70

00:02:35,370 --> 00:02:32,820

that right however it does seem that

71

00:02:37,470 --> 00:02:35,380

things in the natural world are and

72

00:02:39,690 --> 00:02:37,480

candidly specified to take advantages of

73

00:02:41,850 --> 00:02:39,700

all the different aspects of our energy

74

00:02:44,250 --> 00:02:41,860

arrays various other electromagnetic

75

00:02:46,350 --> 00:02:44,260

interactions for example like this

76
00:02:48,330 --> 00:02:46,360
sunflower when you look at the packing

77
00:02:50,730 --> 00:02:48,340
of sunflower seeds inside the sunflower

78
00:02:52,860 --> 00:02:50,740
it is the most energy-efficient packing

79
00:02:54,930 --> 00:02:52,870
for seeds right so how did that actually

80
00:02:56,610 --> 00:02:54,940
happen how did the sunflower figure out

81
00:02:58,980 --> 00:02:56,620
that I have to arrange my seeds in these

82
00:03:01,760 --> 00:02:58,990
particular fractal arrangements such

83
00:03:03,480 --> 00:03:01,770
that I get maximum Sun maximum future

84
00:03:05,520 --> 00:03:03,490
reproduction and more beautiful

85
00:03:08,310 --> 00:03:05,530
sunflowers for all for us all to look at

86
00:03:10,200 --> 00:03:08,320
and so the process which is involved in

87
00:03:12,000 --> 00:03:10,210
this particular arrangement

88
00:03:14,730 --> 00:03:12,010

it's called self-organization it is very

89

00:03:16,440 --> 00:03:14,740

present in in the physical world as well

90

00:03:18,320 --> 00:03:16,450

as the biological world so I'll just

91

00:03:20,130 --> 00:03:18,330

define it really briefly at first

92

00:03:21,960 --> 00:03:20,140

self-organization is the process where a

93

00:03:24,540 --> 00:03:21,970

structure or pattern appears in the

94

00:03:26,310 --> 00:03:24,550

system without a central authority or

95

00:03:27,930 --> 00:03:26,320

external element imposing it through a

96

00:03:29,730 --> 00:03:27,940

predetermined physical interaction or

97

00:03:31,470 --> 00:03:29,740

planning this is exactly what's

98

00:03:33,300 --> 00:03:31,480

happening with Larissa's neurons they

99

00:03:36,300 --> 00:03:33,310

were self-organizing there wasn't a

100

00:03:38,670 --> 00:03:36,310

brain imposing organization and in fact

101
00:03:40,470 --> 00:03:38,680
in the sunflower there isn't somebody

102
00:03:43,170 --> 00:03:40,480
saying arrange these seeds like this

103
00:03:45,420 --> 00:03:43,180
right and so the neat thing about these

104
00:03:47,490 --> 00:03:45,430
patterns that emerge is that the

105
00:03:49,290 --> 00:03:47,500
globally coherent pattern appears from

106
00:03:50,730 --> 00:03:49,300
the local interactions of the elements

107
00:03:52,860 --> 00:03:50,740
that make up the system so the

108
00:03:55,470 --> 00:03:52,870
organization is achieved both in

109
00:03:57,720 --> 00:03:55,480
parallel and distributed fashion so it's

110
00:03:59,930 --> 00:03:57,730
one of these interesting processes and

111
00:04:01,710 --> 00:03:59,940
the first person to really talk about

112
00:04:03,890 --> 00:04:01,720
self-organization was a Manuel Khan

113
00:04:06,060 --> 00:04:03,900

right and he actually defined a

114

00:04:08,520 --> 00:04:06,070

self-organizing system as a system that

115

00:04:09,960 --> 00:04:08,530

is at the same time the means and the

116

00:04:12,150 --> 00:04:09,970

ends to what's going on

117

00:04:13,620 --> 00:04:12,160

so that's sulphur self-organization you

118

00:04:14,880 --> 00:04:13,630

have a bunch of low level of interaction

119

00:04:17,280 --> 00:04:14,890

so I'll give you guys a number of

120

00:04:19,229 --> 00:04:17,290

examples that are producing phenomenon

121

00:04:21,450 --> 00:04:19,239

that are not previously predicted by

122

00:04:23,190 --> 00:04:21,460

these low level aspects of these systems

123

00:04:25,110 --> 00:04:23,200

so if you were to take the system

124

00:04:28,080 --> 00:04:25,120

brand-new you had never seen it add some

125

00:04:29,880 --> 00:04:28,090

energy to it once this system reaches

126

00:04:31,920 --> 00:04:29,890

the energy level which is just at the

127

00:04:34,110 --> 00:04:31,930

edge of chaos which is called pink noise

128

00:04:36,220 --> 00:04:34,120

now I'll get to that in a second itself

129

00:04:37,150 --> 00:04:36,230

organizes and produces B

130

00:04:39,130 --> 00:04:37,160

behavior that has not previously

131

00:04:40,630 --> 00:04:39,140

predicted if you have never observed it

132

00:04:42,340 --> 00:04:40,640

before so it's something that looks

133

00:04:44,890 --> 00:04:42,350

pretty amazing especially the first time

134

00:04:47,740 --> 00:04:44,900

you observe it now self-organization is

135

00:04:49,240 --> 00:04:47,750

evident in a lot of things but something

136

00:04:52,060 --> 00:04:49,250

that you may have had experience with

137

00:04:53,770 --> 00:04:52,070

our roll cells and so on the left hand

138

00:04:56,830 --> 00:04:53,780

side those are actually roll cells of a

139

00:04:58,480 --> 00:04:56,840

very very cool lithium which most of you

140

00:05:00,520 --> 00:04:58,490

have probably not seen but in the right

141

00:05:03,070 --> 00:05:00,530

hand side are roll cells of olive oil

142

00:05:04,780 --> 00:05:03,080

and so when you put a thin layer of

143

00:05:07,210 --> 00:05:04,790

olive oil in a pan and start heating it

144

00:05:09,160 --> 00:05:07,220

up what actually happens is an image

145

00:05:11,200 --> 00:05:09,170

sort of like on the left hand side of

146

00:05:13,660 --> 00:05:11,210

the screen when enough energy is added

147

00:05:15,310 --> 00:05:13,670

there are these vertical roll cells that

148

00:05:16,900 --> 00:05:15,320

are created where the heat exchange

149

00:05:19,240 --> 00:05:16,910

between the bottom of the oil and the

150

00:05:22,540 --> 00:05:19,250

top of the oil is operating at a maximum

151
00:05:24,310 --> 00:05:22,550
most efficient process right so at some

152
00:05:25,840 --> 00:05:24,320
point this system self-organized into

153
00:05:27,190 --> 00:05:25,850
something that's very very pretty and

154
00:05:29,560 --> 00:05:27,200
that is actually exchanging heat

155
00:05:32,200 --> 00:05:29,570
optimally and so this was not predicted

156
00:05:33,910 --> 00:05:32,210
by any properties of oil any properties

157
00:05:36,220 --> 00:05:33,920
of the pan that it was on it was only

158
00:05:39,040 --> 00:05:36,230
observed once you added this critical

159
00:05:41,440 --> 00:05:39,050
amount of energy and so in fact besides

160
00:05:43,630 --> 00:05:41,450
the the roll cells that you see commonly

161
00:05:45,970 --> 00:05:43,640
when you're cooking at various different

162
00:05:48,280 --> 00:05:45,980
I guess symmetry breaking scenarios or

163
00:05:50,860 --> 00:05:48,290

specific points of energy addition to

164

00:05:52,660 --> 00:05:50,870

the system they create new interesting

165

00:05:54,580 --> 00:05:52,670

heat exchange patterns so it's not just

166

00:05:58,540 --> 00:05:54,590

these little cells it's affect many many

167

00:06:01,300 --> 00:05:58,550

different ones and so in the inanimate

168

00:06:04,330 --> 00:06:01,310

world there are literally hundreds of

169

00:06:06,160 --> 00:06:04,340

examples of physics of self-organization

170

00:06:08,520 --> 00:06:06,170

happening in physics and in fact if you

171

00:06:10,090 --> 00:06:08,530

check out these scholarpedia entry and

172

00:06:11,980 --> 00:06:10,100

self-organization you will see that I

173

00:06:14,620 --> 00:06:11,990

mostly pulled most of these from there

174

00:06:17,410 --> 00:06:14,630

so things like the formation of spacial

175

00:06:19,300 --> 00:06:17,420

temporal patterns most of you have seen

176

00:06:21,940 --> 00:06:19,310

a laser in fact we're using one right

177

00:06:24,130 --> 00:06:21,950

now right so a laser pointer one thing

178

00:06:25,450 --> 00:06:24,140

the laser does is that enslaves the

179

00:06:27,280 --> 00:06:25,460

light particles that are around it it

180

00:06:29,200 --> 00:06:27,290

focuses them into a beam that is a

181

00:06:31,690 --> 00:06:29,210

self-organizing phenomenon actually and

182

00:06:33,490 --> 00:06:31,700

so that process is the result of these

183

00:06:35,560 --> 00:06:33,500

higher-order correlations happening

184

00:06:39,460 --> 00:06:35,570

within the beam and so some other

185

00:06:42,220 --> 00:06:39,470

examples include fluid dynamics gas gas

186

00:06:46,150 --> 00:06:42,230

discharge patterns things in plasma

187

00:06:48,210 --> 00:06:46,160

physics semiconductors formation of

188

00:06:50,189 --> 00:06:48,220

galaxies in terms of astrophysics

189

00:06:53,530 --> 00:06:50,199

climatology cloud formation

190

00:06:56,189 --> 00:06:53,540

meteorology coastal formation geophysics

191

00:06:58,030 --> 00:06:56,199

I I guess a number of things

192

00:07:01,060 --> 00:06:58,040

self-sustaining oscillators which I

193

00:07:02,530 --> 00:07:01,070

actually am very very interested in in

194

00:07:04,900 --> 00:07:02,540

chemistry those are you that are FEM

195

00:07:07,180 --> 00:07:04,910

chemists the Briggs rauscher reaction

196

00:07:09,330 --> 00:07:07,190

chemical reactions leading dissipative

197

00:07:12,580 --> 00:07:09,340

structures all those things show

198

00:07:15,129 --> 00:07:12,590

self-organizing properties and so in the

199

00:07:17,020 --> 00:07:15,139

in the I guess adamant world we also

200

00:07:18,730 --> 00:07:17,030

have a number of examples of this too

201
00:07:20,950 --> 00:07:18,740
and so this is really the part that

202
00:07:23,170 --> 00:07:20,960
interests me because on a physical scale

203
00:07:25,990 --> 00:07:23,180
I you know it's self-organization very

204
00:07:27,969 --> 00:07:26,000
much makes sense as a sort of phenomenon

205
00:07:30,100 --> 00:07:27,979
happens as a result of physical

206
00:07:32,710 --> 00:07:30,110
interactions between molecules in the

207
00:07:34,690 --> 00:07:32,720
animal world its start to become more

208
00:07:36,670 --> 00:07:34,700
interesting because it implies a few

209
00:07:39,460 --> 00:07:36,680
things about what's going on

210
00:07:41,680 --> 00:07:39,470
so since self-organizing systems are

211
00:07:46,210 --> 00:07:41,690
operating it's sort of an optimal

212
00:07:47,920 --> 00:07:46,220
capacity it very much suggests the sort

213
00:07:49,300 --> 00:07:47,930

of the intelligence of these processes

214

00:07:51,909 --> 00:07:49,310

now I'm not saying that someone

215

00:07:53,560 --> 00:07:51,919

somewhere created these things but if

216

00:07:55,210 --> 00:07:53,570

you were to create a biological system

217

00:07:56,830 --> 00:07:55,220

like our cell and you wanted to make it

218

00:07:59,920 --> 00:07:56,840

Optum optimally efficient in producing

219

00:08:03,279 --> 00:07:59,930

various chemicals from from its I guess

220

00:08:04,450 --> 00:08:03,289

from from its internal organelles then

221

00:08:07,150 --> 00:08:04,460

you would create something that looks

222

00:08:09,129 --> 00:08:07,160

very much like our cell what a lot of

223

00:08:10,870 --> 00:08:09,139

people don't talk about is that when you

224

00:08:12,580 --> 00:08:10,880

inherit your DNA from your parents

225

00:08:14,560 --> 00:08:12,590

you're not just inheriting DNA you're

226

00:08:17,440 --> 00:08:14,570

inheriting the entire cell in the entire

227

00:08:19,930 --> 00:08:17,450

cells mechanisms and so that's not in

228

00:08:22,270 --> 00:08:19,940

the DNA in fact right so they're they're

229

00:08:24,580 --> 00:08:22,280

the DNA itself is in fact the software

230

00:08:26,730 --> 00:08:24,590

that runs the hardware which is the cell

231

00:08:29,200 --> 00:08:26,740

and South's the cell itself is

232

00:08:32,170 --> 00:08:29,210

completely self organized it actually

233

00:08:34,510 --> 00:08:32,180

keeps critical critical amounts of

234

00:08:36,670 --> 00:08:34,520

various chemicals within its walls or I

235

00:08:38,199 --> 00:08:36,680

guess inside the cell walls and when he

236

00:08:39,610 --> 00:08:38,209

needs to produce those chemicals all it

237

00:08:41,860 --> 00:08:39,620

needs to do is Purdy produce little

238

00:08:43,870 --> 00:08:41,870

seeds most of you have experienced rain

239

00:08:45,430 --> 00:08:43,880

right so some of us that live in New

240

00:08:50,680 --> 00:08:45,440

Mexico desert haven't seen it for about

241

00:08:52,930 --> 00:08:50,690

120 days but but the way rain forms

242

00:08:54,760 --> 00:08:52,940

actually in rain clouds is that rain

243

00:08:56,230 --> 00:08:54,770

clouds are supersaturated right so when

244

00:08:57,490 --> 00:08:56,240

you when you wonder you know they're

245

00:08:59,650 --> 00:08:57,500

floating around they're super super

246

00:09:01,480 --> 00:08:59,660

saturated with water what makes the rain

247

00:09:03,220 --> 00:09:01,490

actually go there's a one raindrop is

248

00:09:03,910 --> 00:09:03,230

the - is it sort of a cascade that

249

00:09:06,069 --> 00:09:03,920

happens

250

00:09:07,660 --> 00:09:06,079

in reality rain clouds are fractal and

251
00:09:09,340 --> 00:09:07,670
so when we when we get to fractals all

252
00:09:11,199 --> 00:09:09,350
you need is a couple of seeds and that

253
00:09:13,299 --> 00:09:11,209
self-organizing process just turns the

254
00:09:15,099 --> 00:09:13,309
entire thing on and it's raining so

255
00:09:16,210 --> 00:09:15,109
that's that's again a physical example

256
00:09:18,069 --> 00:09:16,220
so in the animal world we have

257
00:09:20,379 --> 00:09:18,079
morphogenesis growth of plants and

258
00:09:22,509 --> 00:09:20,389
animals particularly trees it's very

259
00:09:24,429 --> 00:09:22,519
evident that they're self-organized cell

260
00:09:26,169 --> 00:09:24,439
operation growth of brains and in fact

261
00:09:27,489 --> 00:09:26,179
when you look at the self-organization

262
00:09:29,289 --> 00:09:27,499
of neural structure it's one of the best

263
00:09:32,280 --> 00:09:29,299

evidences in the in the biological world

264

00:09:34,269 --> 00:09:32,290

it's especially relevant to humans

265

00:09:37,109 --> 00:09:34,279

population dynamics growth and

266

00:09:38,949 --> 00:09:37,119

competition and extinction and in the

267

00:09:40,900 --> 00:09:38,959

epidemiology you see it in the spread of

268

00:09:43,059 --> 00:09:40,910

diseases in ecology you see it in a

269

00:09:46,329 --> 00:09:43,069

survival and existence of serious niches

270

00:09:48,359 --> 00:09:46,339

and ecosystems and the I guess part that

271

00:09:51,009 --> 00:09:48,369

interests me the most is the

272

00:09:52,590 --> 00:09:51,019

self-organization President evolution so

273

00:09:55,479 --> 00:09:52,600

when you look at mutation selection

274

00:09:57,429 --> 00:09:55,489

particularly prebiotic evolution you can

275

00:09:59,409 --> 00:09:57,439

see self-organization happening when you

276

00:10:01,449 --> 00:09:59,419

actually look at the I guess the eigen

277

00:10:03,519 --> 00:10:01,459

schuster hyper cycle which created the

278

00:10:06,239 --> 00:10:03,529

first amino acids that became ourselves

279

00:10:11,009 --> 00:10:06,249

etc etc that process is the result of

280

00:10:12,999 --> 00:10:11,019

self-organization of molecules and so if

281

00:10:14,919 --> 00:10:13,009

self-organization is in fact a mechanism

282

00:10:17,169 --> 00:10:14,929

of evolution it would imply that if

283

00:10:19,659 --> 00:10:17,179

evolution is somehow working in a semi

284

00:10:21,309 --> 00:10:19,669

optimal or near optimal level and and

285

00:10:23,470 --> 00:10:21,319

I'm just gonna call that intelligent for

286

00:10:25,659 --> 00:10:23,480

now now I'm not the first person at all

287

00:10:27,039 --> 00:10:25,669

to say this right the first person who

288

00:10:29,799 --> 00:10:27,049

really stayed out loud and say it proud

289

00:10:31,840 --> 00:10:29,809

was I was Kathlyn in 1993 who wrote a

290

00:10:33,639 --> 00:10:31,850

great book called the origin of order

291

00:10:36,249 --> 00:10:33,649

self-organization and selection and

292

00:10:37,449 --> 00:10:36,259

evolution he identified

293

00:10:39,579 --> 00:10:37,459

self-organization as a prominent

294

00:10:41,919 --> 00:10:39,589

evolutionary mechanism it actually gives

295

00:10:44,949 --> 00:10:41,929

you hundreds of great examples of where

296

00:10:46,389 --> 00:10:44,959

this where this applies however the

297

00:10:49,569 --> 00:10:46,399

average evolutionary scientists they

298

00:10:51,519 --> 00:10:49,579

have averaged you know genetic genetic

299

00:10:53,889 --> 00:10:51,529

person that studies the transmission of

300

00:10:55,840 --> 00:10:53,899

genes populations etc etc generally

301

00:10:58,359 --> 00:10:55,850

ignores molecular biology and

302

00:11:00,279 --> 00:10:58,369

particularly self-organization so even

303

00:11:01,989 --> 00:11:00,289

though you know Kaufmann made a big deal

304

00:11:03,909 --> 00:11:01,999

about in 1993 and several other

305

00:11:05,710 --> 00:11:03,919

biologists and geneticists have come out

306

00:11:08,739 --> 00:11:05,720

in support of self-organization as a

307

00:11:11,949 --> 00:11:08,749

main driving process in evolution it's

308

00:11:13,449 --> 00:11:11,959

generally being ignored now there's a

309

00:11:15,909 --> 00:11:13,459

recent paper that came out by Johnson

310

00:11:17,740 --> 00:11:15,919

and lamb where they really looked at the

311

00:11:21,550 --> 00:11:17,750

interaction between self-organization

312

00:11:23,670 --> 00:11:21,560

and and natural selection as and and I

313

00:11:25,960 --> 00:11:23,680

think they have it right in many ways

314

00:11:28,150 --> 00:11:25,970

they state that self-organization

315

00:11:29,980 --> 00:11:28,160

constrains the possible solutions that

316

00:11:31,929 --> 00:11:29,990

biology can come up with so in fact if

317

00:11:34,269 --> 00:11:31,939

we're if we're if if we're designed to

318

00:11:36,129 --> 00:11:34,279

be sort of semi optimal organisms then

319

00:11:37,720 --> 00:11:36,139

clearly natural selection is involved in

320

00:11:38,920 --> 00:11:37,730

in survival of the fittest right and I

321

00:11:40,809 --> 00:11:38,930

tell my intro psych students the

322

00:11:45,610 --> 00:11:40,819

survival of the most successfully horny

323

00:11:47,730 --> 00:11:45,620

actually and so realistically natural

324

00:11:49,389 --> 00:11:47,740

selection is very much in play but

325

00:11:51,610 --> 00:11:49,399

self-organization constrains the

326

00:11:55,689 --> 00:11:51,620

possible solutions that are available

327

00:11:57,519 --> 00:11:55,699

for for it I guess for this for the

328

00:11:59,410 --> 00:11:57,529

various possible ice I guess organelles

329

00:12:02,350 --> 00:11:59,420

organs and other things that are true to

330

00:12:04,030 --> 00:12:02,360

biological creatures so my goal is to

331

00:12:05,559 --> 00:12:04,040

really show the rest of the genetic

332

00:12:08,139 --> 00:12:05,569

scientists who are ignoring this stuff

333

00:12:10,059 --> 00:12:08,149

that there is really a fingerprint of

334

00:12:12,309 --> 00:12:10,069

self-organization even at the level of

335

00:12:14,710 --> 00:12:12,319

natural selection so when we look at

336

00:12:17,829 --> 00:12:14,720

when we look at fingerprints I guess the

337

00:12:19,030 --> 00:12:17,839

the fingerprint form in this particular

338

00:12:20,920 --> 00:12:19,040

instance would be the occurrence of

339

00:12:23,499 --> 00:12:20,930
mutations the assumption is that

340

00:12:25,090 --> 00:12:23,509
mutations are in fact random but if

341

00:12:26,170 --> 00:12:25,100
those mutations are not random but

342

00:12:28,240 --> 00:12:26,180
structured then the occurrence of

343

00:12:30,670 --> 00:12:28,250
mutations are self organized so I

344

00:12:33,100 --> 00:12:30,680
structured in a particular way and so I

345

00:12:34,749 --> 00:12:33,110
will explain what kind of structure it

346

00:12:36,129 --> 00:12:34,759
needs now most of you probably familiar

347

00:12:37,720 --> 00:12:36,139
with the term white noise it's the

348

00:12:39,610 --> 00:12:37,730
statisfy here on the radio when you're

349

00:12:41,980 --> 00:12:39,620
not tuned to anything or on television

350

00:12:43,809 --> 00:12:41,990
if it's not too into a station there are

351

00:12:46,660 --> 00:12:43,819

different colors of noise as it turns

352

00:12:49,540 --> 00:12:46,670

out and those colors define statistical

353

00:12:51,970 --> 00:12:49,550

aspects of that noise and so pink noise

354

00:12:54,850 --> 00:12:51,980

is a fingerprint of self-organization so

355

00:12:56,530 --> 00:12:54,860

if we see the presence of noise that's

356

00:12:59,499 --> 00:12:56,540

structured in a pink matter and has a

357

00:13:01,119 --> 00:12:59,509

fractal dimension of 1 to 1 and 1/2 then

358

00:13:03,160 --> 00:13:01,129

in fact you can say that a biological

359

00:13:05,619 --> 00:13:03,170

system is in fact self organized this is

360

00:13:07,629 --> 00:13:05,629

very evident in heart rates actually so

361

00:13:09,129 --> 00:13:07,639

for all of using all of you in the

362

00:13:11,410 --> 00:13:09,139

audience who have a healthy heart as it

363

00:13:14,530 --> 00:13:11,420

turns out your heart is not very very

364

00:13:16,689 --> 00:13:14,540

steady it has a specific fluctuation

365

00:13:17,889 --> 00:13:16,699

which is in pink noise region it

366

00:13:19,420 --> 00:13:17,899

actually has a fractal dimension of

367

00:13:21,429 --> 00:13:19,430

nearly 1 so it's almost a perfect

368

00:13:25,540 --> 00:13:21,439

example of pink noise on a biological

369

00:13:26,439 --> 00:13:25,550

system now self similarity is something

370

00:13:28,179 --> 00:13:26,449

that you're all familiar with but

371

00:13:28,929 --> 00:13:28,189

probably just in the context of the

372

00:13:30,920 --> 00:13:28,939

Mandelbrot set

373

00:13:34,850 --> 00:13:30,930

exist

374

00:13:36,860 --> 00:13:34,860

larger level the same thing is true for

375

00:13:39,050 --> 00:13:36,870

pink noise it's the exact same concept

376

00:13:40,310 --> 00:13:39,060

so what's going on in this signal and

377

00:13:41,990 --> 00:13:40,320

this is let's say signal of the

378

00:13:43,970 --> 00:13:42,000

occurrence of mutations in our context

379

00:13:45,620 --> 00:13:43,980

is that smaller parts of the signal as

380

00:13:47,120 --> 00:13:45,630

you keep cutting it down look like the

381

00:13:49,100 --> 00:13:47,130

larger parts now they're not exact

382

00:13:50,449 --> 00:13:49,110

copies like Anna Mandelbrot but if you

383

00:13:51,710 --> 00:13:50,459

were to do a statistical analysis you

384

00:13:54,440 --> 00:13:51,720

would see that distributions are pretty

385

00:13:56,210 --> 00:13:54,450

much the same so when you actually look

386

00:13:57,920 --> 00:13:56,220

at noise you can you can calculate a

387

00:13:59,030 --> 00:13:57,930

spectral slope slope and fractal

388

00:14:01,220 --> 00:13:59,040

dimension which are basically

389

00:14:03,530 --> 00:14:01,230

interrelated by a mask of mathematical

390

00:14:05,210 --> 00:14:03,540

formula here's the different ranges of

391

00:14:07,280 --> 00:14:05,220

noises that exist so white noise is what

392

00:14:09,740 --> 00:14:07,290

we're all familiar with pink noise is

393

00:14:10,970 --> 00:14:09,750

the area that is involved in

394

00:14:12,920 --> 00:14:10,980

self-organization that we're most

395

00:14:14,540 --> 00:14:12,930

interested in these are Brownian motion

396

00:14:15,590 --> 00:14:14,550

noise a different kind of randomness and

397

00:14:17,090 --> 00:14:15,600

this is blue noise which is

398

00:14:19,250 --> 00:14:17,100

anti-correlated noise that means

399

00:14:22,639 --> 00:14:19,260

negative observations follow positive

400

00:14:24,019 --> 00:14:22,649

observations and so when we actually

401
00:14:25,519 --> 00:14:24,029
measure the fractal dimension of

402
00:14:28,100 --> 00:14:25,529
something we can do that to a signal

403
00:14:30,170 --> 00:14:28,110
signal of mutations particularly and so

404
00:14:31,430 --> 00:14:30,180
the analogy is when you're measuring a

405
00:14:34,820 --> 00:14:31,440
coastline you can do it with a ruler

406
00:14:36,829 --> 00:14:34,830
that's 50 meters or say 100 meters you

407
00:14:38,570 --> 00:14:36,839
get different answers that's exactly

408
00:14:41,060 --> 00:14:38,580
what we do when we actually are looking

409
00:14:42,410 --> 00:14:41,070
at the faculty mention of a signal so we

410
00:14:43,850 --> 00:14:42,420
actually just look at the signal and

411
00:14:45,710 --> 00:14:43,860
bend it up in different dimensions and

412
00:14:47,090 --> 00:14:45,720
then look at the standard deviations if

413
00:14:48,890 --> 00:14:47,100

those standard deviations are not all

414

00:14:50,570 --> 00:14:48,900

related it's white noise it's random if

415

00:14:52,010 --> 00:14:50,580

those standard deviations have a pattern

416

00:14:54,500 --> 00:14:52,020

if certain groups grouped together make

417

00:14:57,470 --> 00:14:54,510

differences that are relevant then in

418

00:14:59,600 --> 00:14:57,480

fact then the noise is pink so my

419

00:15:01,340 --> 00:14:59,610

proposed experiment here is to just to

420

00:15:04,460 --> 00:15:01,350

do a dispersion analysis a fractal

421

00:15:06,980 --> 00:15:04,470

dimension computation on the variable of

422

00:15:08,870 --> 00:15:06,990

mutation so if in fact the the you know

423

00:15:11,540 --> 00:15:08,880

captivity mutations are not random if

424

00:15:12,949 --> 00:15:11,550

they're pink then then evolution and

425

00:15:15,199 --> 00:15:12,959

mutations are self-organizing are

426
00:15:16,640 --> 00:15:15,209
structured the problem is and here's the

427
00:15:19,819 --> 00:15:16,650
bad news and I'm disappointing you like

428
00:15:21,170 --> 00:15:19,829
one minute over my talk is that not a

429
00:15:23,030 --> 00:15:21,180
single geneticist out there that I've

430
00:15:25,280 --> 00:15:23,040
contacted wants to do this research the

431
00:15:26,930 --> 00:15:25,290
reason being is that it's really really

432
00:15:28,699 --> 00:15:26,940
expensive in order to actually do this

433
00:15:31,220 --> 00:15:28,709
research you need to keep track of the

434
00:15:33,740 --> 00:15:31,230
genotypes of successive mutations now

435
00:15:35,510 --> 00:15:33,750
you could do this with with viruses and

436
00:15:36,889 --> 00:15:35,520
bacteria on a small scale but you can't

437
00:15:38,210 --> 00:15:36,899
do it every single time most people to

438
00:15:41,360 --> 00:15:38,220

do genetic research you're keeping track

439

00:15:44,240 --> 00:15:41,370

of phenotypes not genotypes so in fact

440

00:15:45,110 --> 00:15:44,250

we have two rapid and we do have rapid

441

00:15:46,730 --> 00:15:45,120

DNA fingerprint

442

00:15:48,680 --> 00:15:46,740

techniques but they are extremely

443

00:15:51,680 --> 00:15:48,690

expensive so until it gets fairly

444

00:15:52,970 --> 00:15:51,690

inexpensive I'm sort of stuck and I'm

445

00:15:54,470 --> 00:15:52,980

just stuck talking to people like you

446

00:15:57,110 --> 00:15:54,480

which is kind of great if there any

447

00:15:58,400 --> 00:15:57,120

geneticist in the audience please please

448

00:16:00,170 --> 00:15:58,410

come talk to me to see if we can get

449

00:16:02,780 --> 00:16:00,180

this done so hopefully this is a

450

00:16:05,060 --> 00:16:02,790

temporary problem and sort of the real

451

00:16:06,650 --> 00:16:05,070

the real impetus is is to try to show

452

00:16:08,720 --> 00:16:06,660

that evolution is not it's just like

453

00:16:10,040 --> 00:16:08,730

sort of plan blind process that's sort

454

00:16:12,140 --> 00:16:10,050

of running into walls as it's going

455

00:16:14,990 --> 00:16:12,150

along what's going on is that evolution

456

00:16:17,150 --> 00:16:15,000

is designing creatures deciding that's a

457

00:16:18,500 --> 00:16:17,160

bad bad way to say producing creatures

458

00:16:21,050 --> 00:16:18,510

there are many ways optimally designed

459

00:16:24,050 --> 00:16:21,060

for survival on this planet at least in

460

00:16:25,640 --> 00:16:24,060

the local timeframe so in summary

461

00:16:27,560 --> 00:16:25,650

self-organization natural selection are

462

00:16:28,579 --> 00:16:27,570

both key processes and evolution and

463

00:16:30,880 --> 00:16:28,589

although there's ample evidence that

464

00:16:33,440 --> 00:16:30,890

self-organization is being ignored by

465

00:16:34,370 --> 00:16:33,450

evolutionary scientists so hopefully we

466

00:16:36,140 --> 00:16:34,380

can find a fingerprint of

467

00:16:37,550 --> 00:16:36,150

self-organization by employing

468

00:16:39,620 --> 00:16:37,560

dispersion analysis for regular

469

00:16:41,329 --> 00:16:39,630

mutations and this would this should

470

00:16:45,980 --> 00:16:41,339

actually prove the point

471

00:16:54,620 --> 00:16:45,990

finally all right thank you very much we

472

00:16:56,960 --> 00:16:54,630

have time for a couple questions you

473

00:16:57,980 --> 00:16:56,970

know if you don't know that computer is

474

00:17:01,699 --> 00:16:57,990

full of programs

475

00:17:06,020 --> 00:17:01,709

it could seem to be very self organized

476

00:17:09,199 --> 00:17:06,030

or in theory so how do you know that

477

00:17:11,960 --> 00:17:09,209

there are no programs recorded somewhere

478

00:17:15,079 --> 00:17:11,970

in more subtle world which programs

479

00:17:17,000 --> 00:17:15,089

these creatures for evolution right so

480

00:17:18,650 --> 00:17:17,010

that would be the sort of the modernized

481

00:17:20,360 --> 00:17:18,660

version of intelligent design that

482

00:17:21,860 --> 00:17:20,370

somewhere out there there's a Platonic

483

00:17:24,949 --> 00:17:21,870

ideal for these creatures and we're

484

00:17:26,059 --> 00:17:24,959

realizing them every so often I'm just

485

00:17:28,460 --> 00:17:26,069

gonna go to the simplest explanation

486

00:17:29,810 --> 00:17:28,470

right and use Occam's razor that you

487

00:17:31,730 --> 00:17:29,820

know I'm not gonna make believe that

488

00:17:33,310 --> 00:17:31,740

some programs exist somewhere but I do

489

00:17:35,000 --> 00:17:33,320

see evidence of self-organization

490

00:17:38,450 --> 00:17:35,010

everywhere and pretty much every aspect

491

00:17:41,570 --> 00:17:38,460

of life so in theory to me

492

00:17:43,040 --> 00:17:41,580

self-organization is just as basic as as

493

00:17:44,419 --> 00:17:43,050

gravity right although gravity is not

494

00:17:47,780 --> 00:17:44,429

well understood throw our gravity for a

495

00:17:49,460 --> 00:17:47,790

second electromagnetism right and so

496

00:17:51,410 --> 00:17:49,470

it's one of these natural processes of

497

00:17:53,300 --> 00:17:51,420

work of organization in the physical

498

00:17:54,620 --> 00:17:53,310

world that I think programs don't need

499

00:17:57,290 --> 00:17:54,630

to exist for which is why it's such a

500

00:17:58,320 --> 00:17:57,300

basic driving force in biology if we can

501
00:18:00,360 --> 00:17:58,330
create optimal

502
00:18:02,519 --> 00:18:00,370
all mechanisms like you know converting

503
00:18:04,710 --> 00:18:02,529
sunlight into energy using chlorophyll

504
00:18:06,779 --> 00:18:04,720
that you know work on a quantum level as

505
00:18:08,370 --> 00:18:06,789
far as we can tell then then biology

506
00:18:09,810 --> 00:18:08,380
will select those solutions from the

507
00:18:12,330 --> 00:18:09,820
ones that are less efficient and less

508
00:18:15,840 --> 00:18:12,340
less I guess our prominent for the

509
00:18:17,120 --> 00:18:15,850
animals that are getting them yes I

510
00:18:19,919 --> 00:18:17,130
wanted to know when you say

511
00:18:22,230 --> 00:18:19,929
self-organization so let's say there is

512
00:18:23,269 --> 00:18:22,240
one organism here that self-organizing

513
00:18:25,740 --> 00:18:23,279

and another one here that's

514

00:18:28,860 --> 00:18:25,750

self-organizing then if you take it to a

515

00:18:31,470 --> 00:18:28,870

next level by the same token are those

516

00:18:33,180 --> 00:18:31,480

two together also self-organizing so

517

00:18:36,360 --> 00:18:33,190

that eventually the whole universe is

518

00:18:39,120 --> 00:18:36,370

self-organizing and the claim is that

519

00:18:40,710 --> 00:18:39,130

all galaxies and flocks of birds and and

520

00:18:42,450 --> 00:18:40,720

our in fact self-organizing when you

521

00:18:45,180 --> 00:18:42,460

look at the average termite mound it is

522

00:18:46,919 --> 00:18:45,190

perfectly created to disperse energy to

523

00:18:48,779 --> 00:18:46,929

receive sunlight and disperse sunlight

524

00:18:50,430 --> 00:18:48,789

what it's necessary to happen now all

525

00:18:52,440 --> 00:18:50,440

those creatures are by themselves self

526

00:18:54,120 --> 00:18:52,450

organized in their cells in their brains

527

00:18:56,190 --> 00:18:54,130

and then that produces just the levels

528

00:18:57,690 --> 00:18:56,200

of self-organization so far as we can

529

00:18:59,850 --> 00:18:57,700

tell galaxy formation is this

530

00:19:01,470 --> 00:18:59,860

self-organizing process so the universe

531

00:19:03,419 --> 00:19:01,480

is probably self organized right okay so

532

00:19:05,610 --> 00:19:03,429

simplistically when we can say that

533

00:19:07,889 --> 00:19:05,620

there's self-organization at the micro

534

00:19:11,129 --> 00:19:07,899

level and then at the complete universal

535

00:19:13,440 --> 00:19:11,139

macro level so although they may not be

536

00:19:17,460 --> 00:19:13,450

a god who designed it the whole universe

537

00:19:19,019 --> 00:19:17,470

is self coordinated itself into a usable

538

00:19:23,779 --> 00:19:19,029

practical right and that's where

539

00:19:31,769 --> 00:19:27,360

do you mean by self-organization that

540

00:19:34,440 --> 00:19:31,779

there is predetermination no of emergent

541

00:19:36,330 --> 00:19:34,450

properties no it's exactly that there is

542

00:19:38,879 --> 00:19:36,340

no predetermination of emergent

543

00:19:40,560 --> 00:19:38,889

properties there's long-range

544

00:19:41,879 --> 00:19:40,570

correlations within the signal such that

545

00:19:43,289 --> 00:19:41,889

small parts of the signal look like

546

00:19:46,490 --> 00:19:43,299

larger parts of the signal but it's

547

00:19:49,139 --> 00:19:46,500

definitely not predetermined the

548

00:19:51,960 --> 00:19:49,149

previous speakers stole my thunder I was

549

00:19:53,789 --> 00:19:51,970

going to ask the idea of emergent

550

00:19:56,310 --> 00:19:53,799

properties it's made its way into the

551

00:19:58,889 --> 00:19:56,320

conventional science for the last 10 15

552

00:20:01,460 --> 00:19:58,899

years very strong I was wondering how

553

00:20:03,899 --> 00:20:01,470

you would compare your take on

554

00:20:05,879 --> 00:20:03,909

self-organizing to two emergent property

555

00:20:07,560 --> 00:20:05,889

I believe the average personal studies

556

00:20:10,139 --> 00:20:07,570

self-organization and dynamic systems

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00:20:11,820 --> 00:20:10,149

would claim that the order that is seen

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00:20:13,110 --> 00:20:11,830

as a result of self-organization is

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00:20:15,570 --> 00:20:13,120

in fact an emergent property that's

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00:20:16,529 --> 00:20:15,580

exactly what it is yeah okay well thank

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00:20:17,950 --> 00:20:16,539

you for one more time

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00:20:19,440 --> 00:20:17,960

great thank you very much