
AbSciCon
2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:12,830 --> 00:00:09,250
[Applause]

3
00:00:16,129 --> 00:00:12,840
good afternoon everyone today I want to

4
00:00:20,350 --> 00:00:16,139
talk about truth statistically distinct

5
00:00:25,190 --> 00:00:20,360
patterns from two distinct this

6
00:00:30,409 --> 00:00:25,200
distinctly this statistical patterns

7
00:00:33,620 --> 00:00:30,419
based on two different properties one is

8
00:00:36,350 --> 00:00:33,630
based on the molecular structure which

9
00:00:42,010 --> 00:00:36,360
is captured by chirality and the other

10
00:00:46,250 --> 00:00:42,020
one is captured by hierarchical

11
00:00:49,220 --> 00:00:46,260
biochemical organizations and in the end

12
00:00:53,840 --> 00:00:49,230
of the talk I would like to discuss how

13
00:00:59,150 --> 00:00:53,850

these two patterns related to each other

14
00:01:04,179 --> 00:00:59,160
and give us how these laws of chemistry

15
00:01:08,410 --> 00:01:04,189
and principle of biology biology is

16
00:01:17,059 --> 00:01:08,420
related to each other so before and

17
00:01:21,109 --> 00:01:17,069
after de Luca the Luca appeared it the

18
00:01:23,410 --> 00:01:21,119
systems is dumped before the look up

19
00:01:26,419 --> 00:01:23,420
here the systems are more dominant

20
00:01:30,429 --> 00:01:26,429
dominated by laws of physics but after

21
00:01:33,679 --> 00:01:30,439
that it is usually considered more

22
00:01:37,489 --> 00:01:33,689
dominant either by were organized by

23
00:01:39,669 --> 00:01:37,499
principles of biology but yet we don't

24
00:01:47,419 --> 00:01:39,679
know what it is actually happened

25
00:01:49,609 --> 00:01:47,429
between these two process but we have

26
00:01:52,239 --> 00:01:49,619
some general even though we don't know

27
00:01:56,239 --> 00:01:52,249
the rigorous a theory between these two

28
00:01:58,639 --> 00:01:56,249
still we have some general

29
00:02:02,089 --> 00:01:58,649
really we have idea about the general

30
00:02:05,800 --> 00:02:02,099
relationships so usually the principle

31
00:02:09,230 --> 00:02:05,810
of biology is considered as constraint

32
00:02:12,130 --> 00:02:09,240
for the laws of a lot of chemistry and

33
00:02:16,070 --> 00:02:12,140
the laws of chemistry the chemicals P

34
00:02:18,460 --> 00:02:16,080
its governing the chemical space of the

35
00:02:22,810 --> 00:02:18,470
chemist chemical molecules and

36
00:02:27,780 --> 00:02:22,820
their collective complicated a

37
00:02:30,640 --> 00:02:27,790
collective a relationship emerged

38
00:02:37,270 --> 00:02:30,650

have some organization which follows

39
00:02:40,480 --> 00:02:37,280
principles of a biology and in our study

40
00:02:43,780 --> 00:02:40,490
indeed we are focused we are interested

41
00:02:46,930 --> 00:02:43,790
in the universal scaling behavior across

42
00:02:49,650 --> 00:02:46,940
different levels of biological system as

43
00:02:54,340 --> 00:02:49,660
constrained and the for emergence

44
00:02:59,220 --> 00:02:54,350
emergent property we are focused on the

45
00:03:02,700 --> 00:02:59,230
homo chirality and which is emerged from

46
00:03:06,480 --> 00:03:02,710
which we consider emerging property from

47
00:03:12,280 --> 00:03:06,490
complex collective interactions of

48
00:03:16,510 --> 00:03:12,290
chirality Molecular chirality so to do

49
00:03:19,440 --> 00:03:16,520
so we adopted network theory and and the

50
00:03:23,770 --> 00:03:19,450
biochemical networks which is

51
00:03:31,420 --> 00:03:23,780
independent of the very details of the

52
00:03:36,479 --> 00:03:31,430
systems and the components in a seminal

53
00:03:40,810 --> 00:03:36,489
paper written by young adults if they

54
00:03:45,060 --> 00:03:40,820
the attempt they studied biochemical

55
00:03:49,620 --> 00:03:45,070
networks by educating the enzymes and

56
00:03:53,670 --> 00:03:49,630
used check database and they build the

57
00:03:57,670 --> 00:03:53,680
metabolic Network and that these

58
00:04:03,100 --> 00:03:57,680
networks even can be further abstracted

59
00:04:06,910 --> 00:04:03,110
to connections between the chemical and

60
00:04:08,610 --> 00:04:06,920
biochemical compounds and that they are

61
00:04:11,140 --> 00:04:08,620
connected to each other when they

62
00:04:14,710 --> 00:04:11,150
participated in same biochemical

63
00:04:18,550 --> 00:04:14,720

reactions and the watch on at all found

64
00:04:20,920 --> 00:04:18,560
is that if the connect the connectivity

65
00:04:23,730 --> 00:04:20,930
patterns follows power logically

66
00:04:29,749 --> 00:04:23,740
distribution can be returned by this

67
00:04:33,389 --> 00:04:29,759
formula and then this power exponent is

68
00:04:38,609 --> 00:04:33,399
parla exponent lies between certain

69
00:04:40,889 --> 00:04:38,619
range range for biological systems so

70
00:04:44,609 --> 00:04:40,899
many people were asking if this says

71
00:04:47,369 --> 00:04:44,619
characteristics of a biology the answer

72
00:04:50,639 --> 00:04:47,379
this unfortunately the answer is no

73
00:04:54,389 --> 00:04:50,649
first of all there are lots of social

74
00:04:57,059 --> 00:04:54,399
networks or technology networks which

75
00:05:01,469 --> 00:04:57,069
shows the same property and they and

76
00:05:05,999 --> 00:05:01,479
secondly they used only 46 biochemical

77
00:05:09,599 --> 00:05:06,009
networks which is too small to decide to

78
00:05:12,179 --> 00:05:09,609
extract any general principles and then

79
00:05:15,379 --> 00:05:12,189
they only focused on the individual

80
00:05:19,879 --> 00:05:15,389
organism a level of biochemical networks

81
00:05:24,169 --> 00:05:19,889
and as you know the biochemical own

82
00:05:28,619 --> 00:05:24,179
living process is really difficult

83
00:05:32,789 --> 00:05:28,629
divided or isolated and these days

84
00:05:37,429 --> 00:05:32,799
people are more interested in finding

85
00:05:42,600 --> 00:05:37,439
the orbit understanding planetary scale

86
00:05:46,979 --> 00:05:42,610
organization of life so this is network

87
00:05:49,019 --> 00:05:46,989
visualization these nodes are chemical

88
00:05:50,659 --> 00:05:49,029

compounds and they are connected to each

89
00:05:56,909 --> 00:05:50,669
other when they share the biochemical

90
00:05:59,879 --> 00:05:56,919
reactions and these sides of nose it

91
00:06:01,799 --> 00:05:59,889
indicates the number of a connection and

92
00:06:07,999 --> 00:06:01,809
number of reactions they are participate

93
00:06:12,179 --> 00:06:08,009
and this consists of over 8,000

94
00:06:16,189 --> 00:06:12,189
biochemical reactions and 9,000

95
00:06:23,969 --> 00:06:16,199
biochemical reactions and over 7,000

96
00:06:27,079 --> 00:06:23,979
biochemical compounds and so we consider

97
00:06:30,449 --> 00:06:27,089
the three different levels of

98
00:06:35,009 --> 00:06:30,459
organizations first individual organism

99
00:06:39,809 --> 00:06:35,019
a level and then ecosystem and then the

100
00:06:42,270 --> 00:06:39,819
whole biosphere and these are embedded a

101
00:06:46,590 --> 00:06:42,280
hierarchical structure as you can see

102
00:06:50,520 --> 00:06:46,600
and using the CAG data and the jgi

103
00:06:54,090 --> 00:06:50,530
Patrick database we generated three

104
00:06:58,379 --> 00:06:54,100
different levels of biochemical networks

105
00:07:01,950 --> 00:06:58,389
for individual we had over three twenty

106
00:07:05,010 --> 00:07:01,960
twenty thousand two genomes and then of

107
00:07:08,340 --> 00:07:05,020
to generate the ecosystem network we

108
00:07:12,870 --> 00:07:08,350
utilized us over six thousand the

109
00:07:18,780 --> 00:07:12,880
marinum data and as a prop as a proxy of

110
00:07:22,500 --> 00:07:18,790
a biosphere we utilized or the whole the

111
00:07:29,700 --> 00:07:22,510
every cattle I had every reactions in

112
00:07:34,580 --> 00:07:29,710
the cake data and the first result we

113
00:07:37,770 --> 00:07:34,590

found is that we consider we measured

114
00:07:41,030 --> 00:07:37,780
well established two networks network

115
00:07:44,310 --> 00:07:41,040
measures for individual networks and

116
00:07:47,909 --> 00:07:44,320
sixth out over sixty thousand ecosystem

117
00:07:51,300 --> 00:07:47,919
networks and we found that there are

118
00:07:54,740 --> 00:07:51,310
these two paths scaling roll scaling

119
00:07:57,180 --> 00:07:54,750
happens follows same functional forms

120
00:08:02,210 --> 00:07:57,190
even though they are positively

121
00:08:06,690 --> 00:08:02,220
different but there are qualitative

122
00:08:10,640 --> 00:08:06,700
organizing principles exhibit from both

123
00:08:15,029 --> 00:08:10,650
levels of our organizations and then we

124
00:08:20,480 --> 00:08:15,039
checked if this is if we tested if this

125
00:08:24,029 --> 00:08:20,490
is a result of a random chemistry or

126
00:08:27,750 --> 00:08:24,039
it's a related from it is originated

127
00:08:33,990 --> 00:08:27,760
from biological biological organization

128
00:08:37,110 --> 00:08:34,000
principle so to do so we generated 5,000

129
00:08:40,649 --> 00:08:37,120
random reaction Network these are the

130
00:08:44,870 --> 00:08:40,659
reaction itself is from CagA data but

131
00:08:47,400 --> 00:08:44,880
the combinations are random is like

132
00:08:51,620 --> 00:08:47,410
those combinations are randomly

133
00:08:53,579 --> 00:08:51,630
connected and that you can see that the

134
00:08:56,769 --> 00:08:53,589
these

135
00:09:02,139 --> 00:08:56,779
random reaction networks doesn't share

136
00:09:06,009 --> 00:09:02,149
the same form of scaling laws and then

137
00:09:08,680 --> 00:09:06,019
we could see that these biological

138
00:09:11,769 --> 00:09:08,690

biochemical networks these are scaling

139
00:09:17,920 --> 00:09:11,779
this is that this statistically distinct

140
00:09:20,019 --> 00:09:17,930
patterns actually explains you it's from

141
00:09:25,750 --> 00:09:20,029
it's always negative from biological

142
00:09:30,639 --> 00:09:25,760
organization organization principles so

143
00:09:33,579 --> 00:09:30,649
next our folk the our next focus was

144
00:09:35,860 --> 00:09:33,589
about the chiral nature of these

145
00:09:40,030 --> 00:09:35,870
biochemical networks we use it the same

146
00:09:45,250 --> 00:09:40,040
system and you in a different levels of

147
00:09:50,380 --> 00:09:45,260
organization and hierarchy is can be

148
00:09:54,009 --> 00:09:50,390
simply defined by the object whose

149
00:09:58,840 --> 00:09:54,019
mirror image cannot be imposed exactly

150
00:10:03,340 --> 00:09:58,850
and historically it was the study was

151
00:10:07,840 --> 00:10:03,350
focused on macromolecules like a DNA RNA

152
00:10:10,660 --> 00:10:07,850
or proteins however since we are

153
00:10:15,880 --> 00:10:10,670
considered we consider the function of

154
00:10:18,699 --> 00:10:15,890
life as emergent phenomena we were

155
00:10:20,769 --> 00:10:18,709
considering homo chirality we were

156
00:10:24,040 --> 00:10:20,779
thinking chirality from colonic P is

157
00:10:26,680 --> 00:10:24,050
also probably emergent property from

158
00:10:30,310 --> 00:10:26,690
messy chemical systems to test this

159
00:10:33,780 --> 00:10:30,320
hypothesis we annotated the whole

160
00:10:39,389 --> 00:10:33,790
biochemical networks with the

161
00:10:42,759 --> 00:10:39,399
biochemical molecules of the whole bio

162
00:10:46,050 --> 00:10:42,769
biosphere as chiral molecules or a

163
00:10:51,519 --> 00:10:46,060

chiral molecules here the blue color

164
00:10:56,579 --> 00:10:51,529
indicates chiral molecules and the

165
00:11:00,850 --> 00:10:56,589
pinkness indicate a chiral molecules and

166
00:11:03,639 --> 00:11:00,860
you can see that actually these are not

167
00:11:05,920 --> 00:11:03,649
really you cannot really separate here

168
00:11:06,400 --> 00:11:05,930
the two groups and there are very

169
00:11:11,920 --> 00:11:06,410
comforting

170
00:11:17,019 --> 00:11:11,930
gated relationships between them and we

171
00:11:20,710 --> 00:11:17,029
I tested the scaling patterns for for

172
00:11:23,170 --> 00:11:20,720
characterizing these Kairo nature of

173
00:11:31,540 --> 00:11:23,180
biochemical networks at different level

174
00:11:33,970 --> 00:11:31,550
so these these as you can see that the

175
00:11:37,360 --> 00:11:33,980
ecosystem and the bacteria Eukarya

176
00:11:39,730 --> 00:11:37,370
archaea which represented a decently

177
00:11:43,980 --> 00:11:39,740
group represent the individual organism

178
00:11:47,350 --> 00:11:43,990
level biochemical networks and these are

179
00:11:49,749 --> 00:11:47,360
decreasing as the total number of

180
00:11:56,550 --> 00:11:49,759
compounds in the system increases and

181
00:12:00,009 --> 00:11:56,560
this is a biosphere and on country

182
00:12:02,949 --> 00:12:00,019
contradicting those patterns if we look

183
00:12:05,980 --> 00:12:02,959
at the random networks the chiral

184
00:12:10,119 --> 00:12:05,990
compound the percentage is really

185
00:12:13,949 --> 00:12:10,129
independent of the sides of networks so

186
00:12:17,309 --> 00:12:13,959
we can see that there is distinct

187
00:12:20,350 --> 00:12:17,319
distinct status group at urns which can

188
00:12:23,470 --> 00:12:20,360

differentiate the biochemical networks

189
00:12:29,350 --> 00:12:23,480
from random networks in terms of

190
00:12:32,530 --> 00:12:29,360
molecular chirality we so since this

191
00:12:36,100 --> 00:12:32,540
distinct pattern is observed we were

192
00:12:40,269 --> 00:12:36,110
interested in how we can explain in

193
00:12:44,079 --> 00:12:40,279
terms of evolution of biochemical

194
00:12:50,549 --> 00:12:44,089
networks so we use the network expansion

195
00:12:54,249 --> 00:12:50,559
ibrehem which has which started with

196
00:12:58,240 --> 00:12:54,259
random a certain set of seed compounds

197
00:13:02,079 --> 00:12:58,250
and when this is dissatisfied and this

198
00:13:05,259 --> 00:13:02,089
can't activate some biochemical

199
00:13:09,309 --> 00:13:05,269
reactions and then we include those

200
00:13:12,129 --> 00:13:09,319
reactions and their products and we

201
00:13:16,090 --> 00:13:12,139
repeat this process at the time step

202
00:13:26,000 --> 00:13:20,950
we use the UG so as you can see that

203
00:13:29,240 --> 00:13:26,010
this time evolution pattern really

204
00:13:33,440 --> 00:13:29,250
dependent really dependent on two

205
00:13:36,829 --> 00:13:33,450
factors one is the selection of exceed

206
00:13:41,329 --> 00:13:36,839
compounds the other one is the structure

207
00:13:43,610 --> 00:13:41,339
of the background the network since we

208
00:13:46,370 --> 00:13:43,620
have a week for the background network

209
00:13:50,300 --> 00:13:46,380
we adopted the whole channel network and

210
00:13:54,950 --> 00:13:50,310
then for the first step who we used we

211
00:13:59,300 --> 00:13:54,960
selected six acre of prime module seed

212
00:14:02,530 --> 00:13:59,310
compounds and this and this is the

213
00:14:06,820 --> 00:14:02,540

result the y and the x axis indicates

214
00:14:11,690 --> 00:14:06,830
timesteps y axis indicates the number of

215
00:14:15,230 --> 00:14:11,700
nodes usually added to the expansion and

216
00:14:18,470 --> 00:14:15,240
you can see that in the beginning and so

217
00:14:20,720 --> 00:14:18,480
I yellow in the case though the old

218
00:14:25,040 --> 00:14:20,730
compound number of all new compounds and

219
00:14:28,010 --> 00:14:25,050
the blue in the case the number of new

220
00:14:30,560 --> 00:14:28,020
chiral compounds and how data expanded

221
00:14:36,410 --> 00:14:30,570
network as you can see that in the

222
00:14:39,530 --> 00:14:36,420
beginning the number of new current

223
00:14:42,740 --> 00:14:39,540
component really grows slowly and it is

224
00:14:46,280 --> 00:14:42,750
more more dominated by a chiral

225
00:14:49,750 --> 00:14:46,290
compounds but then there is some peak

226
00:14:58,820 --> 00:14:49,760
after a few pick correct compounds

227
00:15:01,550 --> 00:14:58,830
really almost twice through three times

228
00:15:07,340 --> 00:15:01,560
more than a chiral compounds because

229
00:15:10,130 --> 00:15:07,350
these two this gap is equivalent to two

230
00:15:14,660 --> 00:15:10,140
number of a chiral compounds and then

231
00:15:18,110 --> 00:15:14,670
later when the all the new there are no

232
00:15:21,680 --> 00:15:18,120
more new compounds entered and explain

233
00:15:25,220 --> 00:15:21,690
to the network it's more like with the

234
00:15:26,050 --> 00:15:25,230
network all includes just chiral

235
00:15:29,380 --> 00:15:26,060
molecules

236
00:15:33,940 --> 00:15:29,390
so this is on the first step but it

237
00:15:39,000 --> 00:15:33,950
gives some idea it gives a solid idea

238
00:15:44,230 --> 00:15:39,010

about how the a chiral pre-primary

239
00:15:49,480 --> 00:15:44,240
precursor might utilize the dis web of

240
00:15:52,990 --> 00:15:49,490
biochemical reactions to to have a

241
00:16:01,830 --> 00:15:53,000
certain to have a de structure like the

242
00:16:04,750 --> 00:16:01,840
modern biology and then there are a few

243
00:16:10,890 --> 00:16:04,760
statistical results that we found based

244
00:16:14,050 --> 00:16:10,900
on the chiral chirality and this is a

245
00:16:16,960 --> 00:16:14,060
conversion rate between chiral and a

246
00:16:17,650 --> 00:16:16,970
chiral compounds through biochemical

247
00:16:21,130 --> 00:16:17,660
reactions

248
00:16:23,380 --> 00:16:21,140
so the y-axis shows the chiral compounds

249
00:16:25,990 --> 00:16:23,390
rate percentage in reactants

250
00:16:28,810 --> 00:16:26,000
input of the biochemical reaction a

251
00:16:32,850 --> 00:16:28,820
biochemical reaction and x-axis

252
00:16:35,770 --> 00:16:32,860
indicates chiral compounds in a products

253
00:16:41,380 --> 00:16:35,780
company products biochemical compounds

254
00:16:47,350 --> 00:16:41,390
and as you can see that three points has

255
00:16:51,070 --> 00:16:47,360
most frequently appeared and in this

256
00:16:56,110 --> 00:16:51,080
diagonal but also there are some high

257
00:16:58,780 --> 00:16:56,120
frequently appeared cells here so here

258
00:17:03,329 --> 00:16:58,790
you can see that when even though

259
00:17:08,050 --> 00:17:03,339
reactants are 100% chiral they are

260
00:17:11,069 --> 00:17:08,060
converted to some a chiral molecules

261
00:17:14,550 --> 00:17:11,079
through biochemical reactions also do

262
00:17:18,309 --> 00:17:14,560
this shows the relationship amongst

263
00:17:22,630 --> 00:17:18,319

biochem number of chiral centers and the

264
00:17:25,780 --> 00:17:22,640
molecular weight it is usually expected

265
00:17:28,120 --> 00:17:25,790
that these will be just two Renea

266
00:17:29,980 --> 00:17:28,130
relationship but it is really

267
00:17:32,110 --> 00:17:29,990
relationship but you can see that there

268
00:17:35,380 --> 00:17:32,120
are two distinct group that follows

269
00:17:39,100 --> 00:17:35,390
different increasing rates and these are

270
00:17:44,769 --> 00:17:39,110
the same relationships but in a

271
00:17:48,530 --> 00:17:44,779
different domains of life so conclusion

272
00:17:51,730 --> 00:17:48,540
and acknowledgement thank you