

1

00:00:00,158 --> 00:00:02,741  
(upbeat music)

2

00:00:08,900 --> 00:00:10,220  
- Hi, everyone, and thanks

3

00:00:10,220 --> 00:00:13,420  
for coming back to  
Conversations at the Perimeter.

4

00:00:13,420 --> 00:00:17,090  
Today, we're bringing you a  
conversation with Estelle Inack.

5

00:00:17,090 --> 00:00:19,870  
She's a research scientist  
here at Perimeter,

6

00:00:19,870 --> 00:00:23,350  
and she's also the Co-Founder  
and Chief Technology Officer

7

00:00:23,350 --> 00:00:25,340  
of the company yiyaniQ.

8

00:00:25,340 --> 00:00:27,810  
- I love this conversation with Estelle,

9

00:00:27,810 --> 00:00:30,240  
partly because I found  
it a little challenging,

10

00:00:30,240 --> 00:00:33,247  
the terminology like  
artificial intelligence

11

00:00:33,247 --> 00:00:35,890  
and machine learning and neural networks.

12

00:00:35,890 --> 00:00:39,180  
These are terms that I've come  
across before in our work,

13

00:00:39,180 --> 00:00:41,880  
but they get thrown around  
a lot in popular culture.

14

00:00:41,880 --> 00:00:44,420  
And it was great to hear  
from an expert who's working,

15

00:00:44,420 --> 00:00:45,480  
not just in these fields,

16

00:00:45,480 --> 00:00:49,070  
but really finding the  
intersections between these fields.

17

00:00:49,070 --> 00:00:51,690  
She was a very generous  
tour guide with us.

18

00:00:51,690 --> 00:00:53,670  
- I agree, and I really also loved hearing

19

00:00:53,670 --> 00:00:56,150  
about how her work is  
really at the intersection

20

00:00:56,150 --> 00:00:58,900  
of quantum science and  
artificial intelligence,

21

00:00:58,900 --> 00:01:01,890  
but also at the intersection  
of academic research

22

00:01:01,890 --> 00:01:03,630

and industry applications.

23

00:01:03,630 --> 00:01:06,240

- And her personal story  
is pretty amazing too.

24

00:01:06,240 --> 00:01:09,700

You know, she's a scientist  
who's now working in a startup.

25

00:01:09,700 --> 00:01:11,980

She's trying to learn the business world.

26

00:01:11,980 --> 00:01:14,990

Estelle just has a fascinating  
personal story as well.

27

00:01:14,990 --> 00:01:17,250

She's originally from Cameroon,

28

00:01:17,250 --> 00:01:19,920

and she originally wanted to do something

29

00:01:19,920 --> 00:01:21,440

completely different than physics.

30

00:01:21,440 --> 00:01:22,760

We won't give any spoilers,

31

00:01:22,760 --> 00:01:25,870

but her journey into physics  
was really fascinating,

32

00:01:25,870 --> 00:01:28,730

especially because she faced  
quite a lot of obstacles

33

00:01:28,730 --> 00:01:31,160

in her native Africa to

becoming a physicist.

34

00:01:31,160 --> 00:01:33,620  
And we learned that she's  
actually gone back to Africa

35

00:01:33,620 --> 00:01:37,000  
to try to help inspire other  
women scientists there.

36

00:01:37,000 --> 00:01:39,360  
- We're excited for you  
to hear the conversation.

37

00:01:39,360 --> 00:01:42,614  
Let's step inside the  
Perimeter with Estelle Inack.

38

00:01:42,614 --> 00:01:45,530  
(upbeat music)

39

00:01:45,530 --> 00:01:46,690  
Okay. Hi, Estelle.

40

00:01:46,690 --> 00:01:49,500  
Thanks so much for sitting  
down with us today.

41

00:01:49,500 --> 00:01:51,407  
- Thanks for the invitation.

42

00:01:51,407 --> 00:01:52,240  
- It's great to have you here.

43

00:01:52,240 --> 00:01:53,290  
- It's my pleasure.

44

00:01:53,290 --> 00:01:56,070  
- So you work in a really exciting field

45

00:01:56,070 --> 00:01:59,240  
that's also pretty new or  
at least rapidly growing,

46

00:01:59,240 --> 00:02:02,080  
that is often called quantum intelligence.

47

00:02:02,080 --> 00:02:03,400  
Can you tell us a little bit

48

00:02:03,400 --> 00:02:06,873  
about what draws you to this  
field and why it's so exciting?

49

00:02:08,180 --> 00:02:10,980  
- So it's basically a very fancy name

50

00:02:10,980 --> 00:02:13,190  
that means a lot of different things,

51

00:02:13,190 --> 00:02:16,370  
depending on how you take  
different combinations

52

00:02:16,370 --> 00:02:18,730  
of artificial intelligence  
and quantum computing.

53

00:02:18,730 --> 00:02:20,870  
So for example, for some people

54

00:02:20,870 --> 00:02:24,090  
it might mean using quantum computers

55

00:02:24,090 --> 00:02:26,873  
to perform artificial intelligence tasks,

56

00:02:26,873 --> 00:02:28,880  
in the field that they call  
quantum machine learning.

57  
00:02:28,880 --> 00:02:32,570  
For other people, it could  
mean using quantum computers

58  
00:02:32,570 --> 00:02:35,570  
with artificial intelligence  
for quantum control,

59  
00:02:35,570 --> 00:02:37,250  
for example, for quantum state preparation.

60  
00:02:37,250 --> 00:02:38,860  
For other people, it can mean

61  
00:02:38,860 --> 00:02:40,310  
using machine learning techniques

62  
00:02:40,310 --> 00:02:43,100  
that you borrow from AI research

63  
00:02:43,100 --> 00:02:46,560  
to basically probe the behavior  
of quantum many-body system.

64  
00:02:46,560 --> 00:02:49,910  
And this is more of the  
field where I am now,

65  
00:02:49,910 --> 00:02:51,670  
borrowing machine learning techniques

66  
00:02:51,670 --> 00:02:54,130  
to probe the behavior of  
quantum many-body systems.

67

00:02:54,130 --> 00:02:55,550  
- You mentioned a few terms there

68  
00:02:55,550 --> 00:02:57,460  
that I'm hoping you  
can elaborate on a bit.

69  
00:02:57,460 --> 00:02:59,900  
A lot of people have heard the  
term artificial intelligence.

70  
00:02:59,900 --> 00:03:01,390  
It's very much in the news.

71  
00:03:01,390 --> 00:03:02,223  
I think a lot of people

72  
00:03:02,223 --> 00:03:04,070  
have heard the term quantum computing,

73  
00:03:04,070 --> 00:03:07,050  
maybe a little bit less so  
in the public consciousness.

74  
00:03:07,050 --> 00:03:08,770  
Can you tell us what those are

75  
00:03:08,770 --> 00:03:12,050  
and how you're sort of  
bridging the two fields?

76  
00:03:12,050 --> 00:03:14,980  
- Yes, so there are so many  
different ways, as I mentioned,

77  
00:03:14,980 --> 00:03:16,990  
and different ways of  
bridging the two phase.

78

00:03:16,990 --> 00:03:18,960  
So quantum computers, for example,

79  
00:03:18,960 --> 00:03:22,750  
is just a different way of  
computing, a different paradigm.

80  
00:03:22,750 --> 00:03:26,880  
It's using some of the  
properties of quantum physics

81  
00:03:26,880 --> 00:03:29,150  
to hopefully speed up some calculations

82  
00:03:29,150 --> 00:03:31,374  
that are currently intractable

83  
00:03:31,374 --> 00:03:34,060  
on the current class of  
computers that we have.

84  
00:03:34,060 --> 00:03:36,010  
Some people used to call that

85  
00:03:36,010 --> 00:03:37,710  
like the second quantum wave revolution,

86  
00:03:37,710 --> 00:03:40,180  
because already with the  
current computers that we have,

87  
00:03:40,180 --> 00:03:42,900  
we already use quantum  
mechanics, transistors.

88  
00:03:42,900 --> 00:03:45,420  
But now we want to use, to leverage

89  
00:03:45,420 --> 00:03:47,700



other properties of quantum system,

90

00:03:47,700 --> 00:03:51,630

either entanglement,  
superposition, quantum tunneling,

91

00:03:51,630 --> 00:03:54,250

to yeah, have some speed  
up on some algorithm

92

00:03:54,250 --> 00:03:55,780

like Shor's algorithm, for example.

93

00:03:55,780 --> 00:03:58,290

So it's a totally  
different kind of paradigm.

94

00:03:58,290 --> 00:04:02,800

Now a artificial intelligence  
is in general, basically

95

00:04:02,800 --> 00:04:06,140

thinking about having an  
intelligence that is not human

96

00:04:06,140 --> 00:04:09,330

that is able to perform human-like tasks.

97

00:04:09,330 --> 00:04:12,566

Right, and under it, you can  
actually write some algorithms

98

00:04:12,566 --> 00:04:13,620

that we do that.

99

00:04:13,620 --> 00:04:15,010

You have machine learning

100

00:04:15,010 --> 00:04:17,300

and you can have neural networks,

101

00:04:17,300 --> 00:04:20,290

that kind of generally people think of it

102

00:04:20,290 --> 00:04:22,070

like representation of the brain,

103

00:04:22,070 --> 00:04:23,810

even though sometimes it's not like that.

104

00:04:23,810 --> 00:04:25,510

Even though it's remarkable to see

105

00:04:25,510 --> 00:04:28,030

that some of the intuition behind things

106

00:04:28,030 --> 00:04:29,797

like conversational knowledge works is

107

00:04:29,797 --> 00:04:33,670

basically how we see, to  
basically come with the design

108

00:04:33,670 --> 00:04:36,440

of that kind of deep  
neural networks, basically,

109

00:04:36,440 --> 00:04:39,850

to be able to do image  
recognition, for example.

110

00:04:39,850 --> 00:04:42,500

So that's basically two  
different communities

111

00:04:42,500 --> 00:04:45,780

and a lot of sub-fields  
within those communities.

112

00:04:45,780 --> 00:04:47,340  
And now within the sub-fields,

113

00:04:47,340 --> 00:04:50,210  
yeah, you can find some correlations.

114

00:04:50,210 --> 00:04:52,510  
I will tell you, for example,  
one of the correlation

115

00:04:52,510 --> 00:04:55,370  
that I'm mostly familiar  
with in simulating

116

00:04:55,370 --> 00:04:56,930  
quantum many-body systems

117

00:04:56,930 --> 00:05:00,200  
on what we call classical  
architectures like your laptop

118

00:05:00,200 --> 00:05:02,560  
or whatever cluster we are  
using here at Perimeter, right?

119

00:05:02,560 --> 00:05:05,560  
So for us to be able to simulate  
quantum many-body systems

120

00:05:05,560 --> 00:05:07,270  
are different methods.

121

00:05:07,270 --> 00:05:10,420  
One of the popular methods is  
a quantum Monte Carlo method

122

00:05:10,420 --> 00:05:12,570  
called variational Monte Carlo.

123

00:05:12,570 --> 00:05:15,550

To use that, you need to be able to have

124

00:05:15,550 --> 00:05:19,040

what is called an ansatz,  
which is just a good guess

125

00:05:19,040 --> 00:05:21,820

of what the ground state wave function

126

00:05:21,820 --> 00:05:24,480

of your quantum many-body system is.

127

00:05:24,480 --> 00:05:27,810

But to have this good guess,  
you need to understand

128

00:05:27,810 --> 00:05:30,980

the Hamiltonian or the physics  
of the problem at hand.

129

00:05:30,980 --> 00:05:32,060

Is it fermions?

130

00:05:32,060 --> 00:05:33,290

Is it bosons, right?

131

00:05:33,290 --> 00:05:35,600

What are the interaction strength?

132

00:05:35,600 --> 00:05:37,500

What is the Hilbert space?

133

00:05:37,500 --> 00:05:39,370

Is it a Fock space, right?

134

00:05:39,370 --> 00:05:42,240

And based on that, on the symmetries of the system,

135

00:05:42,240 --> 00:05:44,820  
you come up with a good ansatz.

136

00:05:44,820 --> 00:05:46,140  
Now, not everybody can do that, right?

137

00:05:46,140 --> 00:05:48,500  
We really need very specialized knowledge.

138

00:05:48,500 --> 00:05:50,403  
And the moment you perturb the Hamiltonian,

139

00:05:50,403 --> 00:05:52,380  
that you go to another Hamiltonian,

140

00:05:52,380 --> 00:05:53,960  
maybe it's totally out of your field.

141

00:05:53,960 --> 00:05:56,120  
If you leave fermions and go to bosons,

142

00:05:56,120 --> 00:05:58,060  
you don't get the intuition anymore.

143

00:05:58,060 --> 00:06:00,180  
So the idea of neural networks,

144

00:06:00,180 --> 00:06:02,570  
that is borrowing like some knowledge from neural networks.

145

00:06:02,570 --> 00:06:04,500  
Since there are universal approximators,

146

00:06:04,500 --> 00:06:07,300  
and hopefully they should  
be able to represent

147  
00:06:07,300 --> 00:06:08,510  
any kind of function,

148  
00:06:08,510 --> 00:06:10,590  
then why not representing then

149  
00:06:10,590 --> 00:06:13,220  
the ground state wave function  
of a many-body system.

150  
00:06:13,220 --> 00:06:15,640  
That was the original idea of borrowing

151  
00:06:15,640 --> 00:06:17,350  
this kind of neural network,

152  
00:06:17,350 --> 00:06:20,050  
basically perform quantum  
many-body simulations.

153  
00:06:20,050 --> 00:06:23,040  
And even though nowadays  
we see that we still need

154  
00:06:23,040 --> 00:06:27,770  
a little bit of quantum intuition  
to make it work perfectly,

155  
00:06:27,770 --> 00:06:30,680  
like you need knowledge of  
symmetries, for example,

156  
00:06:30,680 --> 00:06:32,370  
we encode it in a neural network

157

00:06:32,370 --> 00:06:35,970  
to make it represent your  
system in a much better way.

158  
00:06:35,970 --> 00:06:37,300  
But yeah, so the story is

159  
00:06:37,300 --> 00:06:40,670  
that, yeah, we saw how it  
was working amazingly well

160  
00:06:40,670 --> 00:06:41,780  
in machine learning.

161  
00:06:41,780 --> 00:06:44,700  
And it is also starting  
to work quite well.

162  
00:06:45,890 --> 00:06:47,530  
- You and I, Estelle, we actually work

163  
00:06:47,530 --> 00:06:49,120  
in similar research areas.

164  
00:06:49,120 --> 00:06:50,880  
You kind of said already, we're both part

165  
00:06:50,880 --> 00:06:53,590  
of this Perimeter Institute  
Quantum Intelligence Lab.

166  
00:06:53,590 --> 00:06:55,670  
We have our matching hoodies today.

167  
00:06:55,670 --> 00:06:57,460  
- Green hoodies.

168  
00:06:57,460 --> 00:07:00,107  
That's because the acronym

for that institute is

169

00:07:00,107 --> 00:07:01,430

- Is PIQuILs.

- PIQuILs.

170

00:07:01,430 --> 00:07:02,960

- They have to be, everything's green

171

00:07:02,960 --> 00:07:05,217

at the PIQuIL.

- PIQuIL.

172

00:07:05,217 --> 00:07:06,050

- Yes.

(all laughing)

173

00:07:06,050 --> 00:07:08,030

- And I think something

that's pretty unique

174

00:07:08,030 --> 00:07:09,850

about this group, at least compared

175

00:07:09,850 --> 00:07:11,950

to maybe other research

groups at Perimeter is

176

00:07:11,950 --> 00:07:14,640

that there tends to be

a lot of opportunities

177

00:07:14,640 --> 00:07:16,850

for collaborations with industry.

178

00:07:16,850 --> 00:07:18,450

So can you talk a little bit about that?

179

00:07:18,450 --> 00:07:21,030



And what maybe could be unique

180

00:07:21,030 --> 00:07:23,190  
or what's important about these academic

181

00:07:23,190 --> 00:07:25,650  
and industry collaboration?

182

00:07:25,650 --> 00:07:28,740  
- Definitely. What is unique  
first of all is the field.

183

00:07:28,740 --> 00:07:30,150  
The field, as I mentioned,

184

00:07:30,150 --> 00:07:33,600  
we are using a lot of state of  
machine learning techniques,

185

00:07:33,600 --> 00:07:36,560  
which we know industry use a lot.

186

00:07:36,560 --> 00:07:39,210  
Facebook, Google, they  
have huge research groups

187

00:07:39,210 --> 00:07:40,750  
that publish a lot of papers.

188

00:07:40,750 --> 00:07:45,360  
So already in that sense, we,  
just by using those tools,

189

00:07:45,360 --> 00:07:49,750  
we are already somehow in  
between industry research

190

00:07:49,750 --> 00:07:51,810  
and academia research.

191

00:07:51,810 --> 00:07:54,150

- Are those classical  
machine learning techniques?

192

00:07:54,150 --> 00:07:56,390

- Those are classical machine learnings.

193

00:07:56,390 --> 00:08:00,280

Even though now a lot  
of those big companies

194

00:08:00,280 --> 00:08:02,370

are having quantum groups as well,

195

00:08:02,370 --> 00:08:03,830

and they are developing

196

00:08:03,830 --> 00:08:05,790

quantum machine learning  
techniques as well,

197

00:08:05,790 --> 00:08:07,470

and a lot of startups as well.

198

00:08:07,470 --> 00:08:11,590

So the field of quantum computing  
is being pushed forward,

199

00:08:11,590 --> 00:08:15,240

both by academia and industry.

200

00:08:15,240 --> 00:08:20,030

And the PIQuIL is trying to  
bridge, I mean, those two worlds

201

00:08:20,030 --> 00:08:21,620

and to provide a platform

202

00:08:21,620 --> 00:08:25,660

where academia can talk to  
industry and vice versa,

203

00:08:25,660 --> 00:08:27,500

and together working on the projects

204

00:08:27,500 --> 00:08:30,593

we can speed with which we advance things.

205

00:08:31,570 --> 00:08:34,250

- I often think of it like an  
area with many bridges, right?

206

00:08:34,250 --> 00:08:36,730

Because you're trying to  
bridge academia and industry,

207

00:08:36,730 --> 00:08:39,810

but also quantum with machine learning.

208

00:08:39,810 --> 00:08:40,643

- Exactly.

209

00:08:40,643 --> 00:08:42,570

- Lots of different bridges  
you have to go over.

210

00:08:42,570 --> 00:08:44,460

- Exactly, exactly. And  
one interesting thing

211

00:08:44,460 --> 00:08:48,340

that has come up in the last few years

212

00:08:48,340 --> 00:08:50,550

is physicists are thinking

213

00:08:50,550 --> 00:08:54,500  
of actually importing some of the methods

214  
00:08:55,360 --> 00:08:57,560  
that we have been using to quantum matter

215  
00:08:57,560 --> 00:08:58,800  
to the machine learning community.

216  
00:08:58,800 --> 00:09:00,253  
I think of tensor networkss, for example.

217  
00:09:00,253 --> 00:09:02,730  
They're like, oh, we have  
a very good understanding

218  
00:09:02,730 --> 00:09:03,986  
on these tensor networks.

219  
00:09:03,986 --> 00:09:06,260  
We can interpret them

220  
00:09:06,260 --> 00:09:07,790  
instead of using your black boxes.

221  
00:09:07,790 --> 00:09:09,910  
So maybe you could use that

222  
00:09:09,910 --> 00:09:11,900  
for, I don't know, image recognition.

223  
00:09:11,900 --> 00:09:15,160  
And people have been doing  
that and it's working.

224  
00:09:15,160 --> 00:09:17,910  
So it is also a way for  
the physics community

225  
00:09:17,910 --> 00:09:21,317  
to somehow give back to the AI community.

226  
00:09:22,190 --> 00:09:24,650  
- You mentioned that what  
brought you to Perimeter

227  
00:09:24,650 --> 00:09:27,453  
in the first place was  
looking at Roger Melko's work.

228  
00:09:27,453 --> 00:09:29,710  
And now Roger is, he's the head of PIQuIL,

229  
00:09:29,710 --> 00:09:32,090  
the quantum intelligence lab.

230  
00:09:32,090 --> 00:09:35,540  
Can you just give us a sense  
of what it's like at PIQuIL?

231  
00:09:35,540 --> 00:09:38,569  
What is a day like at the PIQuIL?

232  
00:09:38,569 --> 00:09:40,170  
What are the sort of  
questions and problems

233  
00:09:40,170 --> 00:09:41,620  
that are being tackled there?

234  
00:09:42,570 --> 00:09:45,870  
- PIQuIL is really like a  
startup like kind of environment.

235  
00:09:45,870 --> 00:09:48,233  
Even though there's  
industry and academia there,

236

00:09:48,233 --> 00:09:51,360  
there's a lot of free discussions.

237

00:09:51,360 --> 00:09:52,580  
We have journal clubs.

238

00:09:52,580 --> 00:09:54,170  
It was virtual during COVID.

239

00:09:54,170 --> 00:09:56,490  
Now we are starting to come back person.

240

00:09:56,490 --> 00:10:00,210  
A lot of discussions about  
Slack, "Oh, this is a new paper.

241

00:10:00,210 --> 00:10:01,577  
What do you think of?

242

00:10:01,577 --> 00:10:03,450  
Oh, I have a problem in my research.

243

00:10:03,450 --> 00:10:05,230  
Do you have a solution for  
that" and things like that.

244

00:10:05,230 --> 00:10:06,833  
So really a lot of interaction.

245

00:10:07,940 --> 00:10:10,030  
- And so you first came here to Perimeter

246

00:10:10,030 --> 00:10:12,560  
maybe to pursue more the  
academic side of things,

247

00:10:12,560 --> 00:10:13,970  
but as time has gone on,

248

00:10:13,970 --> 00:10:16,370

you've become more and more  
involved with industry.

249

00:10:16,370 --> 00:10:18,740

And now you're actually the Co-Founder

250

00:10:18,740 --> 00:10:20,650

and the Chief Technology Officer

251

00:10:20,650 --> 00:10:23,520

of a company called yiyaniQ.

252

00:10:23,520 --> 00:10:25,840

Can you tell us a little  
bit about your company

253

00:10:25,840 --> 00:10:28,040

and what it's trying to do?

254

00:10:28,040 --> 00:10:32,020

- Definitely, maybe I will take  
a step back by a little bit.

255

00:10:32,020 --> 00:10:34,330

I was doing my PhD and then  
I was doing my post doc.

256

00:10:34,330 --> 00:10:37,560

So I was mostly focused on academic work.

257

00:10:37,560 --> 00:10:39,760

But even though I was focused on that,

258

00:10:39,760 --> 00:10:44,110

my specialty is developing  
algorithms to solve optimization

259

00:10:44,110 --> 00:10:47,280  
beside probing the behavior  
of quantum many-body system,

260

00:10:47,280 --> 00:10:50,720  
but optimization points that  
are like real-world problems.

261

00:10:50,720 --> 00:10:53,040  
But typically the way we solve it is okay.

262

00:10:53,040 --> 00:10:55,983  
Like physicists, we like to  
have like a very easy model

263

00:10:55,983 --> 00:10:58,130  
that we can benchmark  
and things like that.

264

00:10:58,130 --> 00:10:59,440  
That is not really reality.

265

00:10:59,440 --> 00:11:02,610  
It is not gonna affect  
the life of somebody.

266

00:11:02,610 --> 00:11:06,504  
And so I always had behind my  
mind, in the back of my mind

267

00:11:06,504 --> 00:11:10,940  
that these algorithms, we  
could actually try to use them

268

00:11:10,940 --> 00:11:13,180  
to solve real-world  
problems, not just write it

269

00:11:13,180 --> 00:11:15,270



at the end of the  
conclusions of our papers.

270

00:11:15,270 --> 00:11:17,940

And, oh, you can use it  
to solve a real-world.

271

00:11:17,940 --> 00:11:19,810

So I had that in back of my mind.

272

00:11:19,810 --> 00:11:23,370

And yeah, so last, I  
think one year and a half,

273

00:11:23,370 --> 00:11:28,090

we had these very nice results  
of an algorithm we designed.

274

00:11:28,090 --> 00:11:31,610

And we decided to basically  
file a patent away.

275

00:11:31,610 --> 00:11:34,140

And that was the moment I was like, okay,

276

00:11:34,140 --> 00:11:35,810

now we need to try to commercialize it

277

00:11:35,810 --> 00:11:39,080

and see whether we can  
have real-world impact.

278

00:11:39,080 --> 00:11:41,040

And we created yiyaniQ.

279

00:11:41,040 --> 00:11:44,520

So the company right now  
is focusing on designing

280

00:11:44,520 --> 00:11:46,860  
what we call quantum intelligent algorithm

281  
00:11:46,860 --> 00:11:49,190  
to basically speed up derivative pricing,

282  
00:11:49,190 --> 00:11:53,330  
which is a specific problem  
in quantitative finance,

283  
00:11:53,330 --> 00:11:55,480  
in the sales side of financial market.

284  
00:11:55,480 --> 00:11:57,270  
In the beginning, I  
was very much confused.

285  
00:11:57,270 --> 00:12:00,160  
I had a hammer, I didn't  
know where I'd find the nail.

286  
00:12:00,160 --> 00:12:04,170  
So there are so many different  
optimization point out there.

287  
00:12:04,170 --> 00:12:05,750  
Some are very interesting.

288  
00:12:05,750 --> 00:12:06,840  
Some are very challenging.

289  
00:12:06,840 --> 00:12:08,080  
Others are boring.

290  
00:12:08,080 --> 00:12:11,180  
I really needed to find one  
that was challenging enough,

291  
00:12:11,180 --> 00:12:13,770

but I found that very fast  
that, yeah, you need somebody

292

00:12:13,770 --> 00:12:16,600  
who has expertise to  
be able to design that.

293

00:12:16,600 --> 00:12:19,360  
And I met him in an incubator

294

00:12:19,360 --> 00:12:22,443  
called Creative Disruption  
Lab, Behnam Javanparast.

295

00:12:23,288 --> 00:12:25,570  
And he has a PhD in theoretical physics,

296

00:12:25,570 --> 00:12:26,470  
in condensed matter as well.

297

00:12:26,470 --> 00:12:27,930  
So we could talk to each other,

298

00:12:27,930 --> 00:12:30,540  
but he also worked in a bank  
for more than seven years.

299

00:12:30,540 --> 00:12:32,920  
So it was quite very easy for us

300

00:12:32,920 --> 00:12:36,093  
to kind bring our  
perspectives to found yiyaniQ.

301

00:12:37,874 --> 00:12:39,110  
- I'm hoping you can tell us a bit more

302

00:12:39,110 --> 00:12:41,430  
about optimization problems generally.

303

00:12:41,430 --> 00:12:43,700

Could you tell what the term means

304

00:12:43,700 --> 00:12:46,753

and how you apply your techniques to it?

305

00:12:47,820 --> 00:12:49,800

- Usually for us physicists,

306

00:12:49,800 --> 00:12:54,270

it is useful for us to

kind of map a problem

307

00:12:54,270 --> 00:12:58,600

into a configuration

that we understand best.

308

00:12:58,600 --> 00:13:01,290

And one sweet thing is that we can view

309

00:13:01,290 --> 00:13:04,580

optimization problems as a search problem

310

00:13:04,580 --> 00:13:06,730

in a very complex landscape,

311

00:13:06,730 --> 00:13:07,897

where in an optimization problem,

312

00:13:07,897 --> 00:13:11,700

typically you have a function

you want to minimize.

313

00:13:11,700 --> 00:13:13,990

Everybody more or less

understands functions,

314

00:13:13,990 --> 00:13:15,130  
but for a physicist,

315  
00:13:15,130 --> 00:13:18,310  
I can see that function as an Hamiltonian.

316  
00:13:18,310 --> 00:13:20,497  
Directly when you tell me  
Hamiltonian, I was like, yay.

317  
00:13:20,497 --> 00:13:23,023  
I have a lot of tools in my toolbox

318  
00:13:23,023 --> 00:13:24,736  
to be able to deal with that.

319  
00:13:24,736 --> 00:13:28,290  
And I can view the  
Hamiltonian as a landscape.

320  
00:13:28,290 --> 00:13:31,280  
You could imagine, for  
example, in the Himalayas,

321  
00:13:31,280 --> 00:13:33,140  
you have a lot of hills and valleys,

322  
00:13:33,140 --> 00:13:35,420  
can be kind of very crazy landscape.

323  
00:13:35,420 --> 00:13:38,800  
And solving the optimization problem means

324  
00:13:38,800 --> 00:13:40,410  
from a physics standpoint is

325  
00:13:40,410 --> 00:13:43,320  
finding the ground  
state of the Hamiltonian

326  
00:13:43,320 --> 00:13:46,090  
that represents that optimization problem.

327  
00:13:46,090 --> 00:13:47,950  
But from a graphical point of view,

328  
00:13:47,950 --> 00:13:52,820  
it means finding the deepest  
valley in that mountain.

329  
00:13:52,820 --> 00:13:54,520  
And for you to find the deepest valley,

330  
00:13:54,520 --> 00:13:56,980  
you need to search, go up and down.

331  
00:13:56,980 --> 00:13:58,910  
And depending on how you search,

332  
00:13:58,910 --> 00:14:01,890  
you can be more efficient  
in finding the landscape.

333  
00:14:01,890 --> 00:14:05,240  
But if your landscape, for  
example, has a lot of valleys,

334  
00:14:05,240 --> 00:14:07,169  
a lot of saddle points,

335  
00:14:07,169 --> 00:14:10,110  
it has tall hills, right,

336  
00:14:10,110 --> 00:14:13,160  
and maybe very wide hills,

337  
00:14:13,160 --> 00:14:14,720

it might be difficult for you

338

00:14:14,720 --> 00:14:17,460  
to be able to find the deepest valleys.

339

00:14:17,460 --> 00:14:18,830  
This is hardest search problem

340

00:14:18,830 --> 00:14:21,930  
where solving on optimization  
problem would be seen.

341

00:14:21,930 --> 00:14:24,610  
- Would it be similar  
to if you wanted to find

342

00:14:24,610 --> 00:14:27,150  
the deepest valley in the Himalayas,

343

00:14:27,150 --> 00:14:29,360  
you could walk up and  
down all of these things,

344

00:14:29,360 --> 00:14:31,480  
but optimization is a way,

345

00:14:31,480 --> 00:14:34,780  
is an attempt to not put in  
that sort of brute force work,

346

00:14:34,780 --> 00:14:38,170  
but find the simplest route to the answer.

347

00:14:38,170 --> 00:14:40,570  
- Exactly, it's finding the  
simplest route to the answer,

348

00:14:40,570 --> 00:14:44,360  
which definitely what you just

described going up and down

349

00:14:44,360 --> 00:14:46,070  
could be mimicked with algorithms.

350

00:14:46,070 --> 00:14:47,970  
And it has been mimicked with algorithm.

351

00:14:47,970 --> 00:14:51,090  
The most notable one  
is simulated annealing,

352

00:14:51,090 --> 00:14:54,320  
where going up and down is  
having some thermal energy

353

00:14:54,320 --> 00:14:56,520  
to basically overcome barrier

354

00:14:56,520 --> 00:15:00,270  
till hopefully, basically  
you find the deepest minimum.

355

00:15:00,270 --> 00:15:02,250  
But imagine that you're going  
up and down with your car.

356

00:15:02,250 --> 00:15:04,470  
Some moment, I mean, fuel is gone.

357

00:15:04,470 --> 00:15:05,610  
What do you do?

358

00:15:05,610 --> 00:15:06,760  
So in the simulation is

359

00:15:06,760 --> 00:15:08,840  
when you are ramping down the temperature,



360

00:15:08,840 --> 00:15:11,550  
and then yeah, there's  
no temperature, no fuel,

361

00:15:11,550 --> 00:15:13,620  
which means no fuel, no kinetic energy.

362

00:15:13,620 --> 00:15:16,200  
And then you get stuck in  
a local minimum, right?

363

00:15:16,200 --> 00:15:18,660  
But you could think of  
a different paradigm

364

00:15:18,660 --> 00:15:21,670  
which people have thought  
of using quantum computers

365

00:15:21,670 --> 00:15:24,470  
or using one property of quantum system

366

00:15:24,470 --> 00:15:26,490  
that is called quantum tunneling. Right?

367

00:15:26,490 --> 00:15:29,200  
Then instead of going  
up and down the valley,

368

00:15:29,200 --> 00:15:31,800  
you basically tunnel through the hills

369

00:15:31,800 --> 00:15:33,910  
in the search of the deepest minimum.

370

00:15:33,910 --> 00:15:36,330  
And then that hopefully  
will be a faster way

371  
00:15:36,330 --> 00:15:38,250  
for you to find the deepest minimum.

372  
00:15:38,250 --> 00:15:41,280  
This is not a crazy intuition,  
because when you think

373  
00:15:41,280 --> 00:15:44,140  
about the way we build tunnels nowadays,

374  
00:15:44,140 --> 00:15:46,790  
if you're like a building  
company and they say, okay,

375  
00:15:46,790 --> 00:15:49,040  
you need to build like either rail tracks

376  
00:15:49,040 --> 00:15:51,810  
or you need to build a  
road through the mountain,

377  
00:15:51,810 --> 00:15:55,200  
if you see that the mountain  
is for example, very tall,

378  
00:15:55,200 --> 00:15:58,350  
but then the width is not that long,

379  
00:15:58,350 --> 00:16:00,663  
you're not gonna build these  
tracks on top of the mountain.

380  
00:16:00,663 --> 00:16:01,850  
That doesn't make sense.

381  
00:16:01,850 --> 00:16:04,230  
You build a tunnel, quantum tunneling.

382

00:16:04,230 --> 00:16:06,820  
So that's kind of the idea.

383  
00:16:06,820 --> 00:16:08,990  
But at the same time, if your mountain,

384  
00:16:08,990 --> 00:16:10,850  
the height is not that high

385  
00:16:10,850 --> 00:16:14,200  
but it has a very like long width,

386  
00:16:14,200 --> 00:16:15,510  
doesn't make sense to build a tunnel.

387  
00:16:15,510 --> 00:16:16,343  
You just go over it.

388  
00:16:16,343 --> 00:16:18,800  
So classically it's better.

389  
00:16:18,800 --> 00:16:21,389  
So that's the reason why most of the time,

390  
00:16:21,389 --> 00:16:24,020  
people do not care  
whether quantum tunneling

391  
00:16:24,020 --> 00:16:26,430  
or quantum annealing or  
classical learning is better.

392  
00:16:26,430 --> 00:16:30,360  
It totally depends on the  
shape of the landscape,

393  
00:16:30,360 --> 00:16:32,320  
and the shape of the landscape depends

394

00:16:32,320 --> 00:16:34,120  
on the hardness of the problem.

395

00:16:34,120 --> 00:16:36,720  
- You told us that your company, yiyaniQ,

396

00:16:36,720 --> 00:16:39,406  
its main focus is using these techniques

397

00:16:39,406 --> 00:16:42,070  
on the problem of pricing derivatives.

398

00:16:42,070 --> 00:16:44,500  
And that's a financial markets term

399

00:16:44,500 --> 00:16:45,540  
that I barely understand.

400

00:16:45,540 --> 00:16:47,810  
I believe derivatives are contracts

401

00:16:47,810 --> 00:16:49,580  
between financial institutions

402

00:16:49,580 --> 00:16:52,010  
that are based on assets  
within these contracts.

403

00:16:52,010 --> 00:16:53,240  
That's about all I know,

404

00:16:53,240 --> 00:16:54,893  
but it's a difficult problem.

405

00:16:55,810 --> 00:16:58,070  
Pricing derivatives, I know,  
is a very difficult thing.

406

00:16:58,070 --> 00:17:00,440

I'm hoping you can tell  
us why it's difficult,

407

00:17:00,440 --> 00:17:02,020

how it's currently done

408

00:17:02,020 --> 00:17:05,320

and how you hope to do it  
better and more efficiently.

409

00:17:05,320 --> 00:17:07,040

- Yeah, that's a very, very good question.

410

00:17:07,040 --> 00:17:09,440

Indeed, like we are  
focusing on what is called

411

00:17:09,440 --> 00:17:10,850

over-the-counter derivatives

412

00:17:10,850 --> 00:17:14,870

that are mainly traded by very  
big financial institutions.

413

00:17:14,870 --> 00:17:19,660

And some of them, they're  
called like structured products,

414

00:17:19,660 --> 00:17:23,030

they are quite complicated to price.

415

00:17:23,030 --> 00:17:25,040

So the way it's currently being done

416

00:17:25,040 --> 00:17:28,170

is using Markov chain Monte Carlo.

417

00:17:28,170 --> 00:17:30,850  
And for you to be able to price them,

418  
00:17:30,850 --> 00:17:33,520  
you need to come up with a large number

419  
00:17:33,520 --> 00:17:36,060  
of possible financial scenarios

420  
00:17:36,060 --> 00:17:38,420  
that obeys the law of large numbers.

421  
00:17:38,420 --> 00:17:42,420  
So the variance of your  
estimator, of your price,

422  
00:17:42,420 --> 00:17:44,680  
goes down with one over the square root

423  
00:17:44,680 --> 00:17:47,180  
of the number of scenarios  
that you can generate.

424  
00:17:47,180 --> 00:17:50,890  
So basically you need to  
generate a lot of scenarios

425  
00:17:50,890 --> 00:17:53,180  
to come up with an accuracy

426  
00:17:53,180 --> 00:17:55,570  
that satisfies a trader, for example.

427  
00:17:55,570 --> 00:17:56,530  
That takes a lot of time.

428  
00:17:56,530 --> 00:17:59,820  
So we talked to some  
traders working at banks.

429

00:17:59,820 --> 00:18:01,190

They told us that some of the books

430

00:18:01,190 --> 00:18:05,660

that have a lot of underlying  
products in one contract

431

00:18:05,660 --> 00:18:09,220

can take from 60 to 90  
minutes time to price,

432

00:18:09,220 --> 00:18:11,450

and they need to price it a lot of times

433

00:18:11,450 --> 00:18:13,700

during the day, every day.

434

00:18:13,700 --> 00:18:17,500

So not only it takes a lot  
of time, since they have,

435

00:18:17,500 --> 00:18:20,240

like they cannot go beyond  
a certain amount of time,

436

00:18:20,240 --> 00:18:23,580

which means they cannot price  
a certain number of scenarios,

437

00:18:23,580 --> 00:18:26,050

they have to reduce the  
number of scenarios of price.

438

00:18:26,050 --> 00:18:29,180

It means they cannot have  
the margin that they expect.

439

00:18:29,180 --> 00:18:30,013

So they told us that sometimes

440

00:18:30,013 --> 00:18:33,890  
they could be mishedge of \$10 million.

441

00:18:33,890 --> 00:18:35,202  
That's the error bar

442

00:18:35,202 --> 00:18:36,842  
of price.  
- \$10 million error bar.

443

00:18:36,842 --> 00:18:37,675  
- Exactly.

444

00:18:37,675 --> 00:18:39,354  
- I wish I had that error bar.

445

00:18:39,354 --> 00:18:40,760  
- That's very huge.  
- Well, it depends

446

00:18:40,760 --> 00:18:41,956  
which direction it's in.

447

00:18:41,956 --> 00:18:42,987  
(all laughing)

448

00:18:42,987 --> 00:18:44,070  
- That's very huge.

449

00:18:44,070 --> 00:18:48,310  
So idea is basically because  
we know there are some methods

450

00:18:48,310 --> 00:18:52,400  
that are more efficient than  
Markov chain Monte Carlo,



451

00:18:52,400 --> 00:18:55,380  
be able to price it faster

452

00:18:55,380 --> 00:18:57,300  
and also more accurate.

453

00:18:57,300 --> 00:19:00,950  
This is what we are hoping to achieve.

454

00:19:00,950 --> 00:19:05,190  
So typically you want to  
find the deepest valley,

455

00:19:05,190 --> 00:19:06,340  
but sometimes it's very hard.

456

00:19:06,340 --> 00:19:08,160  
So if you want, you find a valley

457

00:19:08,160 --> 00:19:10,650  
that is not so far from the  
deepest valley, you're fine.

458

00:19:10,650 --> 00:19:13,220  
That's like they call it  
near optimal solutions.

459

00:19:13,220 --> 00:19:14,790  
That would be fine as well.

460

00:19:14,790 --> 00:19:16,670  
Say for example, you're solving

461

00:19:16,670 --> 00:19:19,770  
the traveling salesman  
premise, as you mentioned,

462

00:19:19,770 --> 00:19:22,470

if you don't find optimal path, okay,

463

00:19:22,470 --> 00:19:23,960  
the salesman will not be angry

464

00:19:23,960 --> 00:19:25,530  
if you find a near optimal path.

465

00:19:25,530 --> 00:19:27,741  
That saves him time and money.

466

00:19:27,741 --> 00:19:29,098  
- Right.  
- Right?

467

00:19:29,098 --> 00:19:30,151  
- He probably won't know

468

00:19:30,151 --> 00:19:31,870  
that it's not the actual optimal path.

469

00:19:31,870 --> 00:19:32,920  
- (laughs) He probably won't know.

470

00:19:32,920 --> 00:19:34,470  
- Yeah, that problem essentially is

471

00:19:34,470 --> 00:19:36,270  
how does a traveling salesperson

472

00:19:36,270 --> 00:19:37,950  
hit a certain number of cities

473

00:19:37,950 --> 00:19:40,130  
in the most efficient way possible.

474

00:19:40,130 --> 00:19:43,500  
And it's just a very difficult

mathematical problem, right,

475

00:19:43,500 --> 00:19:45,150  
an optimization problem.

476

00:19:45,150 --> 00:19:47,473  
- Yeah, definitely,  
definitely, definitely.

477

00:19:47,473 --> 00:19:52,140  
So if it's not exactly solved,  
but approximately solved.

478

00:19:52,140 --> 00:19:55,640  
So for the financial case,  
what we are trying to do,

479

00:19:55,640 --> 00:19:58,440  
so the crucial part of our approach is

480

00:19:58,440 --> 00:20:02,370  
that we need to be able to  
model the financial problem

481

00:20:02,370 --> 00:20:05,650  
of derivative pricing as an optimization.

482

00:20:05,650 --> 00:20:08,120  
And then we can use quantum annealers.

483

00:20:08,120 --> 00:20:13,120  
We can use all kind of flavor  
of simulated annealing,

484

00:20:13,350 --> 00:20:15,880  
parallel tempering, whatever it is.

485

00:20:15,880 --> 00:20:18,030  
We can use variational annealing.

486

00:20:18,030 --> 00:20:21,990

We can use mem, just  
variational optimization

487

00:20:21,990 --> 00:20:23,470

with neural network.

488

00:20:23,470 --> 00:20:27,490

So that's where you really  
need the financial expertise

489

00:20:27,490 --> 00:20:30,890

to be able to cast it as  
an optimization problem.

490

00:20:30,890 --> 00:20:33,480

That's our approach, which is different

491

00:20:33,480 --> 00:20:37,300

from the approach people  
have been having before

492

00:20:37,300 --> 00:20:38,740

because we know for example,

493

00:20:38,740 --> 00:20:41,880

there are algorithms  
on the quantum computer

494

00:20:41,880 --> 00:20:43,840

to solve the price derivative,

495

00:20:43,840 --> 00:20:46,000

like quantum amplitude estimation

496

00:20:46,000 --> 00:20:49,000

on measurement-based quantum computers.

497

00:20:49,000 --> 00:20:52,800

But we could use measurement-based  
quantum computer as well,

498

00:20:52,800 --> 00:20:54,970

because we know that the techniques

499

00:20:54,970 --> 00:20:59,800

like QA, quantum approximate  
optimization algorithm

500

00:20:59,800 --> 00:21:02,010

can be used to solve an optimization

501

00:21:02,010 --> 00:21:05,480

from a CP-based or  
measurement-based quantum computer.

502

00:21:05,480 --> 00:21:08,920

But by looking at the current  
state of quantum device

503

00:21:08,920 --> 00:21:11,840

with the qubit bonds,  
with the noise level,

504

00:21:11,840 --> 00:21:14,700

we feel like for relevant  
real-world problems,

505

00:21:14,700 --> 00:21:15,700

we are not there.

506

00:21:15,700 --> 00:21:17,860

So our approach was mainly focused

507

00:21:17,860 --> 00:21:19,670

on an annealing-based approach,

508

00:21:19,670 --> 00:21:23,700  
plus physics inspired, plus  
machine learning techniques.

509

00:21:23,700 --> 00:21:26,950  
- And the name of your  
company is really interesting.

510

00:21:26,950 --> 00:21:29,320  
And I'm wondering if you'll  
share with us the story

511

00:21:29,320 --> 00:21:33,040  
of what the name means and  
how you came up with it.

512

00:21:33,040 --> 00:21:35,480  
- Definitely, so I like the PIQuIL so much

513

00:21:35,480 --> 00:21:38,350  
and the fact that our kind of motto

514

00:21:38,350 --> 00:21:39,740  
is kind of quantum intelligence.

515

00:21:39,740 --> 00:21:41,560  
So I wanted to have something similar,

516

00:21:41,560 --> 00:21:44,750  
but in my local language, to be innovative

517

00:21:44,750 --> 00:21:48,720  
and to differentiate  
self from everybody else.

518

00:21:48,720 --> 00:21:51,520  
But I don't speak my local  
language very well (laughs).

519

00:21:51,520 --> 00:21:53,670

So I kind of, I asked my whole family,

520

00:21:53,670 --> 00:21:57,670

my mom, my dad, my brothers  
and my uncle and aunts

521

00:21:57,670 --> 00:22:00,510

to come up with a name that  
means quantum intelligence

522

00:22:00,510 --> 00:22:02,210

in my local tongue called Basaa.

523

00:22:02,210 --> 00:22:04,721

First they told me that quantum,  
they don't know what it is,

524

00:22:04,721 --> 00:22:06,950

(Lauren laughing)  
even in English (laughs).

525

00:22:06,950 --> 00:22:08,690

So we kind of put it out of the picture.

526

00:22:08,690 --> 00:22:12,080

I told them, okay, something  
like shell intelligence,

527

00:22:12,080 --> 00:22:13,560

intelligence of the future,

528

00:22:13,560 --> 00:22:14,810

something like that.

529

00:22:14,810 --> 00:22:17,620

They came up with different  
names and my mom won.

530

00:22:17,620 --> 00:22:19,170

She came with yiyani.

531

00:22:19,170 --> 00:22:21,970

Yi, that means intelligence,  
and yani tomorrow,

532

00:22:21,970 --> 00:22:24,960

which means the intelligence  
of the future basically,

533

00:22:24,960 --> 00:22:26,400

and the Q at the end.

534

00:22:26,400 --> 00:22:28,760

- So intelligence, future, quantum,

535

00:22:28,760 --> 00:22:31,370

it seems like a pretty great  
name for what you're doing.

536

00:22:31,370 --> 00:22:33,130

- Yeah, yeah, definitely.  
- Yeah.

537

00:22:33,130 --> 00:22:36,640

- Do you remember any of the  
names that didn't make the cut?

538

00:22:36,640 --> 00:22:38,552

- No, my God, so many.

539

00:22:38,552 --> 00:22:41,277

(all laughing)

540

00:22:41,277 --> 00:22:44,760

- And so I know your company  
has grown a lot, as you alluded



541  
00:22:44,760 --> 00:22:48,100  
to through this Creative  
Destruction Lab program.

542  
00:22:48,100 --> 00:22:51,020  
Could you tell us a little  
bit more about this program?

543  
00:22:51,020 --> 00:22:55,130  
- Yes, so basically it  
is like an incubator

544  
00:22:55,130 --> 00:22:56,410  
for quantum companies.

545  
00:22:56,410 --> 00:22:57,670  
In fact, they had a number

546  
00:22:57,670 --> 00:23:02,520  
that about 25% of the  
quantum computing companies

547  
00:23:02,520 --> 00:23:04,010  
passed through their program,

548  
00:23:04,010 --> 00:23:05,223  
can you imagine, in the whole world.

549  
00:23:05,223 --> 00:23:08,560  
So it's really like one  
of the main incubators

550  
00:23:08,560 --> 00:23:10,610  
of quantum computing companies.

551  
00:23:10,610 --> 00:23:15,050  
I knew about it before, because  
Roger is very much involved.

552

00:23:15,050 --> 00:23:17,400

I think he's the academic director of CDL.

553

00:23:17,400 --> 00:23:18,780

So I already knew about that.

554

00:23:18,780 --> 00:23:20,350

And when I decided to create a company,

555

00:23:20,350 --> 00:23:21,980

I applied for the boot camp.

556

00:23:21,980 --> 00:23:24,410

So they have a boot camp  
usually during the summer

557

00:23:24,410 --> 00:23:27,620

for about a month half-ish.

558

00:23:27,620 --> 00:23:28,537

And so I went there.

559

00:23:28,537 --> 00:23:31,360

There are a lot of course fundamentals

560

00:23:31,360 --> 00:23:35,040

of quantum computing, quantum physics.

561

00:23:35,040 --> 00:23:37,990

What are the current states  
of quantum architectures?

562

00:23:37,990 --> 00:23:41,480

There are so many different  
way of building a qubit.

563

00:23:41,480 --> 00:23:43,860

What are the current business cases?

564

00:23:43,860 --> 00:23:47,150

What are the potential  
advantages and things like that.

565

00:23:47,150 --> 00:23:51,450

And then you have a world  
core of quantum enthusiasts.

566

00:23:51,450 --> 00:23:52,830

You could start a company

567

00:23:52,830 --> 00:23:54,410

or you could, because  
some of them are startup,

568

00:23:54,410 --> 00:23:55,410

you could join a company.

569

00:23:55,410 --> 00:24:00,300

I got a lot like offers for  
example, during the bootcamp.

570

00:24:00,300 --> 00:24:03,370

But then yeah, so the idea of that is

571

00:24:03,370 --> 00:24:06,960

basically helping people who have ideas

572

00:24:06,960 --> 00:24:10,558

on using quantum computing technology

573

00:24:10,558 --> 00:24:12,060

to solve real-world problems,

574

00:24:12,060 --> 00:24:16,970

to basically groom them, help  
them navigating the landscape.

575  
00:24:16,970 --> 00:24:18,900  
- And I know you have a lot of experience

576  
00:24:18,900 --> 00:24:20,870  
working in the academic side.

577  
00:24:20,870 --> 00:24:22,810  
But probably working in industry,

578  
00:24:22,810 --> 00:24:24,800  
I guess there's a whole new skill set

579  
00:24:24,800 --> 00:24:27,030  
that comes with working in this new field.

580  
00:24:27,030 --> 00:24:28,650  
Were there any lessons

581  
00:24:28,650 --> 00:24:31,820  
that were particularly  
useful from this camp,

582  
00:24:31,820 --> 00:24:33,270  
as you tried to build this bridge

583  
00:24:33,270 --> 00:24:35,750  
between academia and industry?

584  
00:24:35,750 --> 00:24:39,400  
- Definitely, I still  
want to do research.

585  
00:24:39,400 --> 00:24:41,650  
For me, the most shocking truth

586  
00:24:41,650 --> 00:24:44,733  
is that businesses don't  
think like researchers.

587

00:24:45,610 --> 00:24:47,840

I learned that they don't  
care whether you're using

588

00:24:47,840 --> 00:24:49,740

state of art technology or new technology.

589

00:24:49,740 --> 00:24:52,070

They just want you to solve a problem.

590

00:24:52,070 --> 00:24:56,120

And so for me, when I think  
about, oh, if I, for example,

591

00:24:56,120 --> 00:24:59,276

improve an algorithm of an order

592

00:24:59,276 --> 00:25:02,100

or two order of magnitudes, I'm excited.

593

00:25:02,100 --> 00:25:06,140

If it does not translate  
into them earning more money,

594

00:25:06,140 --> 00:25:08,240

they don't care about  
that, (chuckles) right?

595

00:25:08,240 --> 00:25:12,810

So it makes me have a different approach

596

00:25:12,810 --> 00:25:16,300

on doing research for business.

597

00:25:16,300 --> 00:25:17,540

I have to do research, yes.

598

00:25:17,540 --> 00:25:21,580  
I need to think about using  
the best possible tools, yes.

599  
00:25:21,580 --> 00:25:22,550  
But at the same time,

600  
00:25:22,550 --> 00:25:25,593  
I need to think about  
potential business advantage,

601  
00:25:26,470 --> 00:25:28,010  
which we don't think about.

602  
00:25:28,010 --> 00:25:29,480  
Of course, we don't think about that.

603  
00:25:29,480 --> 00:25:32,183  
We are most interested in  
solving exciting problems.

604  
00:25:33,110 --> 00:25:35,140  
- It's like optimizing  
a different function.

605  
00:25:35,140 --> 00:25:36,219  
- Exactly.

606  
00:25:36,219 --> 00:25:37,334  
(Estelle and Lauren laughing)

607  
00:25:37,334 --> 00:25:39,260  
- Was the term boot camp applicable?

608  
00:25:39,260 --> 00:25:41,110  
Was it pretty intense?

609  
00:25:41,110 --> 00:25:44,670  
- Oh yeah, it was like, it was crazy.

610

00:25:44,670 --> 00:25:47,710

And in fact, the craziest  
time of the boot camp

611

00:25:47,710 --> 00:25:49,370

was it had a two day hackathon.

612

00:25:49,370 --> 00:25:51,920

I think I probably slept like three hours

613

00:25:51,920 --> 00:25:54,110

during those two days.

614

00:25:54,110 --> 00:25:56,810

You had to come up with an idea

615

00:25:56,810 --> 00:26:00,414

to solve a relevant business  
problem using a quantum.

616

00:26:00,414 --> 00:26:01,680

- In two days.

- In two days.

617

00:26:01,680 --> 00:26:04,260

- And any problem, or they  
told you a certain problem?

618

00:26:04,260 --> 00:26:05,290

- Any problem of your choice.

619

00:26:05,290 --> 00:26:08,300

So they had some problems,  
that maybe some hints,

620

00:26:08,300 --> 00:26:11,590

but any problem using  
some of the architectures

621  
00:26:11,590 --> 00:26:13,660  
that were made available to us.

622  
00:26:13,660 --> 00:26:16,140  
And yeah, program it and  
come up with results.

623  
00:26:16,140 --> 00:26:18,700  
So there was only, not  
only the scientific value.

624  
00:26:18,700 --> 00:26:21,140  
You need to come up with a business pitch,

625  
00:26:21,140 --> 00:26:23,710  
like do some quick market research,

626  
00:26:23,710 --> 00:26:25,360  
show that, come up with the numbers

627  
00:26:25,360 --> 00:26:27,327  
that this is a relevant problem

628  
00:26:27,327 --> 00:26:30,410  
and have a short video  
of making your pitch.

629  
00:26:30,410 --> 00:26:32,040  
- Hang on, you've got two days

630  
00:26:32,040 --> 00:26:33,850  
to develop quantum algorithms

631  
00:26:33,850 --> 00:26:35,920  
and a business pitch and a video.

632  
00:26:35,920 --> 00:26:36,753



- Yes.
- Okay.

633

00:26:36,753 --> 00:26:38,840

So when did you get those  
three hours of sleep?

634

00:26:38,840 --> 00:26:40,270

(all laughing)

635

00:26:40,270 --> 00:26:42,197

- I was working with  
Behnam until midnight,

636

00:26:42,197 --> 00:26:43,223

I think.

(Colin and Estelle laughing)

637

00:26:43,223 --> 00:26:44,920

- Did you just crash at the end?

638

00:26:44,920 --> 00:26:46,367

- It's when we stopped talking

639

00:26:46,367 --> 00:26:47,660

around maybe midnight or 1:00,

640

00:26:47,660 --> 00:26:50,550

and then I kept working till probably 3:00

641

00:26:50,550 --> 00:26:53,697

and got up at 6:00, and  
started working again.

642

00:26:53,697 --> 00:26:56,740

- And what did you  
actually end up developing?

643

00:26:56,740 --> 00:27:00,870

- Oh, we basically wrote a code on the D-Wave machine

644

00:27:00,870 --> 00:27:02,223  
to solve a portfolio optimization.

645

00:27:02,223 --> 00:27:04,340  
And we had to push it on GitHub.

646

00:27:04,340 --> 00:27:07,190  
So it's available on CDL GitHub.

647

00:27:07,190 --> 00:27:08,480  
- So hold on, not only did you have

648

00:27:08,480 --> 00:27:10,140  
to come up with an algorithm  
and a business plan,

649

00:27:10,140 --> 00:27:11,360  
but then you had to push this out

650

00:27:11,360 --> 00:27:13,040  
and make it available to other people.

651

00:27:13,040 --> 00:27:14,657  
- Yeah, publicly available, yeah.

652

00:27:14,657 --> 00:27:16,280  
- And you mentioned D-Wave.

653

00:27:16,280 --> 00:27:18,510  
Can you explain a little  
bit about what that is?

654

00:27:18,510 --> 00:27:21,073  
- Oh yes, so D-Wave is a  
quantum computing company.

655

00:27:21,073 --> 00:27:24,480

It was the first one to  
actually commercialize

656

00:27:24,480 --> 00:27:26,280

the quantum computer.

657

00:27:26,280 --> 00:27:29,270

And so they are mostly focused

658

00:27:29,270 --> 00:27:31,660

on annealing-based approach

659

00:27:31,660 --> 00:27:33,050

as is solving optimization.

660

00:27:33,050 --> 00:27:35,880

Even though recently, they  
announced that they are starting

661

00:27:35,880 --> 00:27:38,930

to build also CP-based quantum computers.

662

00:27:38,930 --> 00:27:41,097

So one of the cool thing that they did,

663

00:27:41,097 --> 00:27:44,220

and a lot of quantum computing  
companies are doing now

664

00:27:44,220 --> 00:27:47,910

is if I want to run simulations  
on a quantum computer,

665

00:27:47,910 --> 00:27:51,853

I don't need to go and buy 10  
million, whatever the cost is,

666

00:27:51,853 --> 00:27:52,917  
- Thank goodness.  
- And come

667  
00:27:52,917 --> 00:27:54,530  
and install it at Perimeter.

668  
00:27:54,530 --> 00:27:56,900  
You can have access to it through cloud.

669  
00:27:56,900 --> 00:27:58,330  
And so you have an API code

670  
00:27:59,290 --> 00:28:01,870  
and you just, yeah, pass in parameters

671  
00:28:01,870 --> 00:28:04,450  
and it spits you back  
basically the results.

672  
00:28:04,450 --> 00:28:06,770  
And you can even see which qubit

673  
00:28:06,770 --> 00:28:08,830  
you have been using the quantum processor

674  
00:28:08,830 --> 00:28:10,210  
to basically solve your problem.

675  
00:28:10,210 --> 00:28:13,660  
- So you can implement  
your algorithms on D-Wave,

676  
00:28:13,660 --> 00:28:16,253  
but in the cloud you  
can do it from anywhere?

677  
00:28:17,490 --> 00:28:18,555  
- Definitely, yeah.

678

00:28:18,555 --> 00:28:19,912

- It's amazing.

- Oh, not anywhere.

679

00:28:19,912 --> 00:28:22,980

It depends on where they

have the clouds deployed.

680

00:28:22,980 --> 00:28:26,610

I think now you can do it

in North America and Europe.

681

00:28:26,610 --> 00:28:28,440

South America, I'm not so sure.

682

00:28:28,440 --> 00:28:29,390

Africa, I'm not so sure.

683

00:28:29,390 --> 00:28:30,830

Probably in Japan as well.

684

00:28:30,830 --> 00:28:34,780

So as they are expanding, they

provide that cloud service.

685

00:28:34,780 --> 00:28:36,090

- And as you've said, Estelle,

686

00:28:36,090 --> 00:28:38,920

it seems like there's just

so many different priorities

687

00:28:38,920 --> 00:28:41,170

that you have to balance

when you're doing this work

688

00:28:41,170 --> 00:28:44,130

at kind of the intersection

of academia and industry.

689

00:28:44,130 --> 00:28:46,800

And we had a grad student  
from here in Waterloo

690

00:28:46,800 --> 00:28:48,503

send in a question about that.

691

00:28:49,779 --> 00:28:50,660

- This is Matthew Duschenes,

692

00:28:50,660 --> 00:28:52,760

a student at IQC and Perimeter.

693

00:28:52,760 --> 00:28:53,593

I'm wondering, how do you balance

694

00:28:53,593 --> 00:28:55,520

coming up with novel research ideas

695

00:28:55,520 --> 00:28:59,170

versus staying focused on your  
specific startup objectives?

696

00:28:59,170 --> 00:29:00,883

- Nice question, very,  
very important question.

697

00:29:01,940 --> 00:29:04,137

I ask myself that  
question every single day.

698

00:29:04,137 --> 00:29:05,990

(Estelle and Lauren laughing)

699

00:29:05,990 --> 00:29:07,650

- Are you able to balance these things

700

00:29:07,650 --> 00:29:09,260  
or is it always a juggling act?

701

00:29:09,260 --> 00:29:11,560  
- In the beginning, it was so hard.

702

00:29:11,560 --> 00:29:13,660  
It was really, really, really very hard.

703

00:29:13,660 --> 00:29:17,030  
Now I'm kind of equilibrating roles,

704

00:29:17,030 --> 00:29:19,070  
dividing my time half, half,

705

00:29:19,070 --> 00:29:22,940  
not every week, but yeah,  
that's what I'm trying to do.

706

00:29:22,940 --> 00:29:27,910  
Because for the company,  
definitively I'm doing

707

00:29:27,910 --> 00:29:30,830  
like an application of my techniques,

708

00:29:30,830 --> 00:29:34,830  
but we are in a very fast-paced milieu,

709

00:29:34,830 --> 00:29:39,510  
whereby you need to be aware  
of whatever is state of art.

710

00:29:39,510 --> 00:29:41,680  
So you need to be on top of your game

711

00:29:41,680 --> 00:29:43,670  
as far as research is concerned.

712

00:29:43,670 --> 00:29:45,480

So I need to keep an open eye

713

00:29:45,480 --> 00:29:47,173

on the research world as well. That's why.

714

00:29:47,173 --> 00:29:48,850

- Must be changing every day.

715

00:29:48,850 --> 00:29:51,500

- Exactly. So it's not as before

716

00:29:51,500 --> 00:29:54,550

that I could read archive  
paper every morning.

717

00:29:54,550 --> 00:29:55,683

I cannot do that anymore.

718

00:29:55,683 --> 00:29:56,840

(Estelle and Colin laughing).

719

00:29:56,840 --> 00:29:59,760

I can attend journal  
clubs, attend conferences,

720

00:29:59,760 --> 00:30:02,730

and I talk to collaborators

721

00:30:02,730 --> 00:30:05,340

to keep in touch with what is happening

722

00:30:05,340 --> 00:30:07,030

as far as research is concerned.

723

00:30:07,030 --> 00:30:09,970

I was groomed as a PhD student



724

00:30:09,970 --> 00:30:13,820

that a problem is  
interesting when it's hard.

725

00:30:13,820 --> 00:30:17,180

I mean, if it is not hard,  
what's the point (laughs)?

726

00:30:17,180 --> 00:30:21,020

So I really like taking  
on very hard problems

727

00:30:21,020 --> 00:30:23,943

and if they're relevant  
to an everyday person.

728

00:30:24,790 --> 00:30:27,173

- When you get stuck on  
a really hard problem,

729

00:30:28,030 --> 00:30:30,000

what do you do to push through it,

730

00:30:30,000 --> 00:30:31,923

to get past that obstacle?

731

00:30:33,390 --> 00:30:37,022

- I do it very badly, usually  
(laughs), almost depressed.

732

00:30:37,022 --> 00:30:41,940

Anyhow, but yeah, typically  
just take a step back

733

00:30:41,940 --> 00:30:45,300

and try to do something else.

734

00:30:45,300 --> 00:30:47,890

I mean, go boxing.  
- Boxing?

735  
00:30:47,890 --> 00:30:52,740  
- Go swimming or running,  
something different.

736  
00:30:52,740 --> 00:30:55,990  
Sometimes involves  
talking to collaborators

737  
00:30:55,990 --> 00:30:58,920  
to get some of the ideas that they have

738  
00:30:58,920 --> 00:31:02,780  
and coming back to it with fresh eyes.

739  
00:31:02,780 --> 00:31:04,390  
- So you've been telling  
us a lot of stories

740  
00:31:04,390 --> 00:31:07,150  
of things that have happened  
in the last few years.

741  
00:31:07,150 --> 00:31:08,450  
And I'm wondering if we can maybe go

742  
00:31:08,450 --> 00:31:09,500  
back a little bit further.

743  
00:31:09,500 --> 00:31:11,330  
Could you tell us the story

744  
00:31:11,330 --> 00:31:13,990  
of how you first got  
into being a scientist

745  
00:31:13,990 --> 00:31:16,640

or how you first decided to pursue that type of path?

746

00:31:17,673 --> 00:31:21,490  
- I have a very non-typical path

747

00:31:21,490 --> 00:31:23,470  
to becoming a scientist.

748

00:31:23,470 --> 00:31:26,588  
Yeah, so right away I should make a disclaimer.

749

00:31:26,588 --> 00:31:29,730  
I didn't plan to be a physicist (laughs).

750

00:31:29,730 --> 00:31:31,990  
- This wasn't the lifelong dream.

751

00:31:31,990 --> 00:31:35,350  
- Nope, it wasn't a lifelong one.

752

00:31:35,350 --> 00:31:37,240  
Yeah. Well, I wanted to do naval architecture.

753

00:31:37,240 --> 00:31:40,570  
So I was advised during my high school

754

00:31:41,440 --> 00:31:43,210  
that for me to do naval architecture,

755

00:31:43,210 --> 00:31:45,090  
I needed to have a bachelor in physics.

756

00:31:45,090 --> 00:31:46,920  
So I got.  
- Sorry, naval architecture

757

00:31:46,920 --> 00:31:48,780

is designing ships?

- Ships.

758

00:31:48,780 --> 00:31:49,613

- Okay.

- Yeah.

759

00:31:49,613 --> 00:31:50,780

It's very, very different.

760

00:31:50,780 --> 00:31:53,460

- But maybe you're gonna use your methods

761

00:31:53,460 --> 00:31:55,210

for naval architecture next?

762

00:31:55,210 --> 00:31:56,228

I guess we'll see.

763

00:31:56,228 --> 00:31:58,234

- Yeah, why not?

764

00:31:58,234 --> 00:31:59,708

- Maybe there's an optimization problem

765

00:31:59,708 --> 00:32:00,541

in naval architecture.

766

00:32:00,541 --> 00:32:02,110

- Oh, naval architecture, I don't know,

767

00:32:02,110 --> 00:32:06,400

but definitely in the maritime  
industry on ship route,

768

00:32:06,400 --> 00:32:08,740

there is an opportunity for that.

769

00:32:08,740 --> 00:32:10,450

I even thought about that,

770

00:32:10,450 --> 00:32:12,480

either ship route or ship loading.

771

00:32:12,480 --> 00:32:15,550

For example, imagine I have a big cargo.

772

00:32:15,550 --> 00:32:18,920

It has to load on thousands  
of different containers

773

00:32:18,920 --> 00:32:19,820

on the cargo.

774

00:32:19,820 --> 00:32:22,480

What is the best way for you to do that

775

00:32:22,480 --> 00:32:23,400

to optimize the space?

776

00:32:23,400 --> 00:32:27,010

I actually wrote an  
algorithm that, VNA, yeah.

777

00:32:27,010 --> 00:32:28,630

- Shipbuilding and ship architecture,

778

00:32:28,630 --> 00:32:30,260

where did this come from?

779

00:32:30,260 --> 00:32:32,380

- Since my mom worked in  
the maritime industry,

780

00:32:32,380 --> 00:32:34,860

I was very much influenced by her.

781

00:32:34,860 --> 00:32:36,850

So I wanted to do a job

782

00:32:36,850 --> 00:32:40,710

that was related to sea, ocean, right?

783

00:32:40,710 --> 00:32:42,870

But I wanted to do a technical job,

784

00:32:42,870 --> 00:32:45,867

something that I could  
use some of the things

785

00:32:45,867 --> 00:32:48,640

I was interested in, mathematics, physics.

786

00:32:48,640 --> 00:32:51,440

So I found that naval  
architecture was the best,

787

00:32:51,440 --> 00:32:53,560

but I was not well-advised.

788

00:32:53,560 --> 00:32:56,790

I found out that you cannot  
do naval architecture

789

00:32:56,790 --> 00:32:58,470

with a bachelor in physics.

790

00:32:58,470 --> 00:33:00,500

Then I wanted to do computer science

791

00:33:00,500 --> 00:33:04,050

after when I found out I  
couldn't be a naval architect.

792

00:33:04,050 --> 00:33:07,290

But unfortunately that  
year in my homeschool,

793

00:33:07,290 --> 00:33:10,980

they didn't open up a  
master in computer science.

794

00:33:10,980 --> 00:33:13,000

The only available master was in physics.

795

00:33:13,000 --> 00:33:16,200

So I was like, okay, I  
need to go to school.

796

00:33:16,200 --> 00:33:18,310

Let me just really start  
for the master in physics.

797

00:33:18,310 --> 00:33:19,450

And I like it.

798

00:33:19,450 --> 00:33:21,190

It was very easy for me to do,

799

00:33:21,190 --> 00:33:23,340

and I think I got first class

800

00:33:23,340 --> 00:33:26,656

and then I got a scholarship  
to go to Italy to do it.

801

00:33:26,656 --> 00:33:28,020

- It sounds like you're still interested

802

00:33:28,020 --> 00:33:29,730

in shipping and ships.

803

00:33:29,730 --> 00:33:31,900  
Is that an ongoing fascination for you,

804  
00:33:31,900 --> 00:33:33,700  
the maritime industry?

805  
00:33:33,700 --> 00:33:38,610  
- No, I think it after I was  
so disappointed, I should say.

806  
00:33:38,610 --> 00:33:41,650  
I was really, really, really disappointed

807  
00:33:41,650 --> 00:33:44,960  
when I found out I was just missing that,

808  
00:33:44,960 --> 00:33:46,360  
so that kind of died out.

809  
00:33:46,360 --> 00:33:48,577  
But for computer science, yeah,

810  
00:33:48,577 --> 00:33:50,720  
I'm mostly programming now.

811  
00:33:50,720 --> 00:33:53,240  
Almost all of my day I'm writing code.

812  
00:33:53,240 --> 00:33:55,980  
I kind of brought together my interest

813  
00:33:55,980 --> 00:34:00,200  
in computer science and  
programming in my physics job.

814  
00:34:00,200 --> 00:34:02,040  
- Well, we actually got a question

815



00:34:02,040 --> 00:34:06,050  
about how to combine programming  
with research in physics.

816  
00:34:06,050 --> 00:34:08,043  
So could we play the next question?

817  
00:34:09,180 --> 00:34:12,100  
- Hi, so I'm Hassan Conser from India,

818  
00:34:12,100 --> 00:34:15,660  
and my question is a  
little more career-related.

819  
00:34:15,660 --> 00:34:17,850  
How do the fields of  
programming and physics

820  
00:34:17,850 --> 00:34:20,800  
mix like simulation machine learning,

821  
00:34:20,800 --> 00:34:23,330  
and is it necessary to learn programming

822  
00:34:23,330 --> 00:34:25,243  
when going into field of physics?

823  
00:34:26,740 --> 00:34:28,310  
- From the first part of your question,

824  
00:34:28,310 --> 00:34:31,880  
if you think about machine  
learning for physics,

825  
00:34:31,880 --> 00:34:35,130  
you definitely need  
programming for that, right?

826  
00:34:35,130 --> 00:34:38,220

But if you have to think  
about physics in general,

827

00:34:38,220 --> 00:34:40,520  
it really depends on  
which field of physics.

828

00:34:40,520 --> 00:34:41,850  
There are some fields of physics

829

00:34:41,850 --> 00:34:46,350  
where not a heavy amount  
of programming is needed,

830

00:34:46,350 --> 00:34:48,390  
some even none, just need to do

831

00:34:48,390 --> 00:34:50,830  
some kind of analytical work.

832

00:34:50,830 --> 00:34:53,780  
But when you think about  
the field of physics,

833

00:34:53,780 --> 00:34:55,970  
generally as a rule,

834

00:34:55,970 --> 00:34:59,020  
my feeling is that little bit skill

835

00:34:59,020 --> 00:35:03,250  
on just knowing how to plot  
functions is important.

836

00:35:03,250 --> 00:35:05,480  
Just knowing Python, which  
is very easy to learn,

837

00:35:05,480 --> 00:35:07,490

should be sufficient to get by.

838

00:35:07,490 --> 00:35:11,990

But if you want in field of  
computational physics, yes,

839

00:35:11,990 --> 00:35:15,230

you need to know how to  
program a little bit more.

840

00:35:15,230 --> 00:35:16,790

And nowadays it's really easy.

841

00:35:16,790 --> 00:35:18,120

For example, for machine learning,

842

00:35:18,120 --> 00:35:21,060

there are a lot of  
libraries you can just use,

843

00:35:21,060 --> 00:35:22,210

I think about 10 or so,

844

00:35:23,130 --> 00:35:24,790

to write prototype of your model

845

00:35:24,790 --> 00:35:27,230

and to test it very quickly.

846

00:35:27,230 --> 00:35:28,197

You have things like Google Colab.

847

00:35:28,197 --> 00:35:32,207

You can use GPUs to  
simulate very fast things

848

00:35:32,207 --> 00:35:33,720

and even get some results.

849

00:35:33,720 --> 00:35:36,960

So I feel like it shouldn't be seen

850

00:35:36,960 --> 00:35:39,530

as a very huge barrier.

851

00:35:39,530 --> 00:35:41,007

Programming is actually very fun.

852

00:35:41,007 --> 00:35:44,100

But my advice is that you  
shouldn't lose sight of the fact

853

00:35:44,100 --> 00:35:46,400

that at the end of the  
day you're a physicist.

854

00:35:46,400 --> 00:35:49,920

So you need to sharpen  
your physical intuition.

855

00:35:49,920 --> 00:35:52,050

I give you the advice

856

00:35:52,050 --> 00:35:54,730

one of my lecturer gave me  
when I was doing my PhDs.

857

00:35:55,740 --> 00:35:58,600

You first of all need to  
take your pen and paper

858

00:35:58,600 --> 00:36:01,920

and figure out the physics  
behind the problem.

859

00:36:01,920 --> 00:36:05,320

And once you do that, then  
yeah, you can take your computer

860

00:36:05,320 --> 00:36:06,790  
and write some code.

861

00:36:06,790 --> 00:36:09,960  
- You've used the term physical  
intuition a couple of times.

862

00:36:09,960 --> 00:36:13,080  
I'm hoping you can explain  
what you mean by that.

863

00:36:13,080 --> 00:36:16,460  
- Physical intuition  
is based, I would say,

864

00:36:16,460 --> 00:36:21,000  
on the understanding on how nature works

865

00:36:21,000 --> 00:36:25,093  
and the understanding of  
some physical principle.

866

00:36:25,980 --> 00:36:29,240  
Take like the Heisenberg  
principle for quantum mechanics.

867

00:36:29,240 --> 00:36:32,250  
If you know exactly the  
position of a particle,

868

00:36:32,250 --> 00:36:36,110  
you cannot know exactly  
momentum of that particle.

869

00:36:36,110 --> 00:36:37,530  
So when you think about a problem,

870

00:36:37,530 --> 00:36:40,080

you need to have these kind of things

871

00:36:40,080 --> 00:36:41,780

on the back of your mind,

872

00:36:41,780 --> 00:36:45,120

and that will help you not  
only interpret results.

873

00:36:45,120 --> 00:36:46,840

It will help you design models

874

00:36:46,840 --> 00:36:50,563

to maybe benchmark something  
specific about the model.

875

00:36:51,417 --> 00:36:55,270

It's very, very important  
to do top class research.

876

00:36:55,270 --> 00:36:56,700

That's my impression.

877

00:36:57,630 --> 00:36:59,790

- You've attended workshops in Africa

878

00:36:59,790 --> 00:37:01,870

about promoting women in science

879

00:37:01,870 --> 00:37:05,070

and just promoting  
science in Africa overall.

880

00:37:05,070 --> 00:37:07,510

Can you tell us why you  
wanted to attend those

881

00:37:07,510 --> 00:37:11,110

and what you hope people

got out of your presentation

882

00:37:11,110 --> 00:37:12,060

or your attendance?

883

00:37:13,730 --> 00:37:17,420

- I always find myself

living in a superposition

884

00:37:17,420 --> 00:37:21,203

of two almost orthogonal worlds.

885

00:37:22,210 --> 00:37:25,170

Unfortunately we know

that science in Africa

886

00:37:25,170 --> 00:37:28,070

is a little bit lagging

compared to the West,

887

00:37:28,070 --> 00:37:29,943

but for women it's even worse.

888

00:37:29,943 --> 00:37:31,860

It's like this really was

889

00:37:31,860 --> 00:37:36,000

because a lot of cultural apprehension.

890

00:37:36,000 --> 00:37:40,430

It's changing, it's really

changing, but still sending women

891

00:37:40,430 --> 00:37:43,520

to do what is called hard skills,

892

00:37:43,520 --> 00:37:44,740

typically people think

893  
00:37:44,740 --> 00:37:49,030  
that, okay, math, physics,  
it's just for men,

894  
00:37:49,030 --> 00:37:51,543  
even when they're trying  
to be progressive.

895  
00:37:52,890 --> 00:37:54,120  
Even here in the West for women,

896  
00:37:54,120 --> 00:37:56,870  
we see that as you go up the ladder,

897  
00:37:56,870 --> 00:37:59,210  
we see less and less women.

898  
00:37:59,210 --> 00:38:00,990  
It's even stronger in Africa

899  
00:38:00,990 --> 00:38:04,740  
because there's more  
commitment that is demanded.

900  
00:38:04,740 --> 00:38:09,740  
And the role of the woman in family,

901  
00:38:09,860 --> 00:38:11,920  
it demands a lot of your time.

902  
00:38:11,920 --> 00:38:16,303  
That makes it very hard for  
you to do top class research.

903  
00:38:17,400 --> 00:38:19,480  
Starting to have these conversations,

904  
00:38:19,480 --> 00:38:21,190



one of the feeling that I've been having,

905

00:38:21,190 --> 00:38:25,100

that it has to start first  
with women scientists,

906

00:38:25,100 --> 00:38:27,000

African women scientists, the mindset,

907

00:38:27,910 --> 00:38:30,800

to kind of recalibrate the  
mindset that it is possible

908

00:38:30,800 --> 00:38:32,470

for me to do science.

909

00:38:32,470 --> 00:38:35,750

I don't necessarily need to create.

910

00:38:35,750 --> 00:38:38,010

It is possible, and from there,

911

00:38:38,010 --> 00:38:41,560

like put together policies.

912

00:38:41,560 --> 00:38:43,560

I feel like this is very important.

913

00:38:43,560 --> 00:38:47,190

Also educate our male counterparts,

914

00:38:47,190 --> 00:38:51,193

starting with our families to  
really change that mindset.

915

00:38:52,120 --> 00:38:54,530

But me in my career, I  
had a lot of instances

916

00:38:54,530 --> 00:38:56,730  
of people telling me that,  
why are you doing your PhD?

917

00:38:56,730 --> 00:38:59,030  
You should be married and having kids

918

00:38:59,030 --> 00:39:01,800  
and preparing for your husband, (laughs)

919

00:39:01,800 --> 00:39:03,130  
right, this kind of a thing.

920

00:39:03,130 --> 00:39:06,190  
But I was educated in the  
house when my mom told me

921

00:39:06,190 --> 00:39:09,100  
that as a female, you can  
do whatever a man can do.

922

00:39:09,100 --> 00:39:10,510  
I already had that in my mindset,

923

00:39:10,510 --> 00:39:14,410  
but other people, they don't  
hear that kind of thought.

924

00:39:14,410 --> 00:39:16,190  
It can really affect them.

925

00:39:16,190 --> 00:39:18,700  
But starting to have this conversation,

926

00:39:18,700 --> 00:39:20,913  
we hope to see change.

927

00:39:22,360 --> 00:39:24,210

- Is that what you're trying to do when you go there?

928

00:39:24,210 --> 00:39:25,130  
You're trying to help

929

00:39:25,130 --> 00:39:28,683  
with this recalibration process for individuals.

930

00:39:29,560 --> 00:39:31,360  
- Even not necessarily when I go there.

931

00:39:31,360 --> 00:39:33,950  
Whenever I happen to interact

932

00:39:33,950 --> 00:39:37,210  
with female scientists from Africa,

933

00:39:37,210 --> 00:39:39,697  
which happened once in a while, yes,

934

00:39:39,697 --> 00:39:44,490  
trying to have those conversations, change of the mindset.

935

00:39:44,490 --> 00:39:46,040  
It doesn't have to be this way.

936

00:39:46,950 --> 00:39:48,590  
- I read that your father,

937

00:39:48,590 --> 00:39:51,050  
he'd wanted to get a PhD in physics,

938

00:39:51,050 --> 00:39:54,830  
but he didn't 'cause there are more practical paths.

939

00:39:54,830 --> 00:39:56,480

He chose engineering, I believe?

940

00:39:56,480 --> 00:40:01,380

- Yes, actually it was not  
too much of his willing.

941

00:40:01,380 --> 00:40:03,410

So my father was, he is still very smart.

942

00:40:03,410 --> 00:40:04,243

He was very smart.

943

00:40:04,243 --> 00:40:08,500

So he had a government grant  
after his high school degree

944

00:40:08,500 --> 00:40:11,260

to go to France, to basically to study.

945

00:40:11,260 --> 00:40:12,850

He was studying physics.

946

00:40:12,850 --> 00:40:14,603

And then he wanted to do a PhD in physics,

947

00:40:14,603 --> 00:40:17,840

but the government was paying his stipend.

948

00:40:17,840 --> 00:40:19,370

It's like, we don't need physicists.

949

00:40:19,370 --> 00:40:20,753

We need engineers.

950

00:40:20,753 --> 00:40:23,080

For him not to lose his scholarship,

951  
00:40:23,080 --> 00:40:25,580  
he had to move to engineering.

952  
00:40:25,580 --> 00:40:30,486  
But then he really encouraged  
me a lot to do physics.

953  
00:40:30,486 --> 00:40:31,540  
- So what was his reaction

954  
00:40:31,540 --> 00:40:33,593  
when you obtained your PhD in physics?

955  
00:40:34,838 --> 00:40:35,740  
- He was very happy.

956  
00:40:35,740 --> 00:40:40,170  
In fact, he told a story  
during my PhD party

957  
00:40:40,170 --> 00:40:42,030  
of the fact that when I was doing

958  
00:40:42,030 --> 00:40:45,670  
first year bachelor in physics back home.

959  
00:40:45,670 --> 00:40:48,870  
So I did in high school, French education.

960  
00:40:48,870 --> 00:40:49,760  
I studied in French.

961  
00:40:49,760 --> 00:40:53,520  
And naturally I'm like French speaker,

962  
00:40:53,520 --> 00:40:55,410  
my mother tongue, willing God.

963

00:40:55,410 --> 00:40:59,700

But then I moved in English in  
the Western part of Cameroon.

964

00:40:59,700 --> 00:41:01,240

It was very, very hard.

965

00:41:01,240 --> 00:41:02,930

I needed first to understand the English

966

00:41:02,930 --> 00:41:04,323

before understanding the physics.

967

00:41:04,323 --> 00:41:06,530

It was, I had a dictionary all the time

968

00:41:06,530 --> 00:41:07,680

when I was going to the lecture.

969

00:41:07,680 --> 00:41:09,400

So it was really, really bad.

970

00:41:09,400 --> 00:41:12,980

One month after starting  
my bachelor in physics,

971

00:41:12,980 --> 00:41:16,170

I passed an engineering concours

972

00:41:16,170 --> 00:41:17,770

in the French side of Cameroon

973

00:41:17,770 --> 00:41:19,600

to become an engineer.

974

00:41:19,600 --> 00:41:20,433

So I called my dad.

975  
00:41:20,433 --> 00:41:21,840  
I was like "I'm stopping this thing.

976  
00:41:21,840 --> 00:41:24,850  
It's not going; I need to  
go and do engineering."

977  
00:41:24,850 --> 00:41:28,780  
My dad told me that "No,  
Francophones have been able

978  
00:41:28,780 --> 00:41:30,550  
to go to that school and graduate.

979  
00:41:30,550 --> 00:41:31,450  
You're gonna stay there."

980  
00:41:31,450 --> 00:41:33,140  
I was so mad at my dad.

981  
00:41:33,140 --> 00:41:34,153  
I was so angry.

982  
00:41:35,210 --> 00:41:37,870  
But after a couple of months,  
I picked up the English

983  
00:41:37,870 --> 00:41:39,080  
and I did very well.

984  
00:41:39,080 --> 00:41:41,650  
And he told the story during my PhD party

985  
00:41:41,650 --> 00:41:44,840  
that I hold strong and now  
she's a PhD; she's a doctor.

986  
00:41:44,840 --> 00:41:46,051

So that was sweet.

987

00:41:46,051 --> 00:41:47,600

- That's beautiful.

988

00:41:47,600 --> 00:41:50,200

- And Estelle, you've told  
us so many nice pieces

989

00:41:50,200 --> 00:41:52,740

of your story starting in childhood.

990

00:41:52,740 --> 00:41:55,230

And I know you kind of  
have alluded to the fact

991

00:41:55,230 --> 00:41:57,740

of how you made the decision  
to come here to Perimeter

992

00:41:57,740 --> 00:41:59,720

for a postdoc after your PhD.

993

00:41:59,720 --> 00:42:02,370

But I know that you actually  
had a lot of options

994

00:42:02,370 --> 00:42:04,250

for what to do after you had a PhD.

995

00:42:04,250 --> 00:42:06,130

And I always look back fondly

996

00:42:06,130 --> 00:42:07,370

when you were making that decision

997

00:42:07,370 --> 00:42:10,570

'cause you and I actually  
talked before you came here.



998

00:42:10,570 --> 00:42:12,160

And so I always like to tell people

999

00:42:12,160 --> 00:42:14,630

I was one of the first to  
meet you here at Perimeter.

1000

00:42:14,630 --> 00:42:16,250

So could you tell us a little bit more

1001

00:42:16,250 --> 00:42:18,430

about how you made that decision?

1002

00:42:18,430 --> 00:42:19,910

- Yes, definitely.

1003

00:42:19,910 --> 00:42:22,930

So one thing I wanted to make sure is

1004

00:42:23,890 --> 00:42:28,318

that people I would be working  
with, especially Roger Melko,

1005

00:42:28,318 --> 00:42:30,347

I already knew he is a great scientist,

1006

00:42:30,347 --> 00:42:32,930

but I wanted to know that he's  
a good person to work with.

1007

00:42:32,930 --> 00:42:34,910

So I wrote to you and sent you an email

1008

00:42:34,910 --> 00:42:38,420

and you were very nice to have  
a Skype discussion with me.

1009

00:42:38,420 --> 00:42:39,590  
And I was just convinced.

1010  
00:42:39,590 --> 00:42:42,220  
There's also Giacomo who sent me an email,

1011  
00:42:42,220 --> 00:42:43,230  
who replied to my email.

1012  
00:42:43,230 --> 00:42:46,384  
He told me that it's  
amazing to work with Roger.

1013  
00:42:46,384 --> 00:42:49,030  
That convinced me that  
PI is a great place,

1014  
00:42:49,030 --> 00:42:52,050  
but at the same time I had  
opportunities, one in Alberta,

1015  
00:42:52,050 --> 00:42:55,240  
but they called, canceled it out.

1016  
00:42:55,240 --> 00:42:56,910  
There was one at Microsoft,

1017  
00:42:56,910 --> 00:43:00,500  
which was actually the  
most interesting one.

1018  
00:43:00,500 --> 00:43:03,810  
I had one also in California,  
which was kind of interesting

1019  
00:43:03,810 --> 00:43:06,790  
because we have collaboration  
with people at NASA,

1020

00:43:06,790 --> 00:43:10,220  
but then I'd be working  
mostly on developing further

1021  
00:43:10,220 --> 00:43:12,680  
the algorithms that I  
learned during my PhD.

1022  
00:43:12,680 --> 00:43:15,360  
At Microsoft, I would've  
been applying the algorithm

1023  
00:43:15,360 --> 00:43:17,080  
I developed during my  
PhD on WeWork programs.

1024  
00:43:17,080 --> 00:43:19,720  
That was extremely exciting for me,

1025  
00:43:19,720 --> 00:43:21,540  
but I wouldn't have learned

1026  
00:43:23,130 --> 00:43:24,780  
something really new,

1027  
00:43:24,780 --> 00:43:26,410  
would have been mostly application.

1028  
00:43:26,410 --> 00:43:27,670  
Whereas here at Perimeter,

1029  
00:43:27,670 --> 00:43:30,870  
I would have enlarged my research interest

1030  
00:43:30,870 --> 00:43:34,600  
to include machine learning  
and neural networks.

1031  
00:43:34,600 --> 00:43:38,990

So that is basically the reason  
why I chose to come to PI.

1032

00:43:38,990 --> 00:43:41,163  
And I don't regret that at all.

1033

00:43:42,180 --> 00:43:44,390  
- And Estelle, now at Perimeter,

1034

00:43:44,390 --> 00:43:46,510  
your title is Research Scientist,

1035

00:43:46,510 --> 00:43:48,290  
but when you first came here,

1036

00:43:48,290 --> 00:43:51,010  
you had the title of  
a post-doctoral fellow

1037

00:43:51,010 --> 00:43:54,894  
under the name Francis  
Kofi Allotey Fellowship.

1038

00:43:54,894 --> 00:43:57,370  
Can you tell us a little  
bit about this fellowship

1039

00:43:57,370 --> 00:43:59,120  
and how it was named?

1040

00:43:59,120 --> 00:44:01,930  
- So Francis Kofi Allotey,

1041

00:44:01,930 --> 00:44:06,120  
unfortunately he passed  
away about five years ago.

1042

00:44:06,120 --> 00:44:10,840  
He was really a monument

of an African scientist

1043

00:44:10,840 --> 00:44:15,580  
who literally inspired and  
trained generations of physicists

1044

00:44:15,580 --> 00:44:17,640  
on the African continent.

1045

00:44:17,640 --> 00:44:21,510  
So he actually did a graduate degree

1046

00:44:21,510 --> 00:44:23,940  
at the Imperial College London

1047

00:44:23,940 --> 00:44:27,450  
under the Nobel Prize Winner, Abdus Salam,

1048

00:44:27,450 --> 00:44:29,300  
who later on created

1049

00:44:29,300 --> 00:44:32,000  
this famous, the Abdus  
Salam International Center

1050

00:44:32,000 --> 00:44:33,890  
for Theoretical Physics.

1051

00:44:33,890 --> 00:44:35,480  
And then he did his PhD

1052

00:44:35,480 --> 00:44:37,890  
at Princeton under Robert Oppenheimer.

1053

00:44:37,890 --> 00:44:40,550  
- He did his PhD with Robert Oppenheimer.

1054

00:44:40,550 --> 00:44:43,800

- Yeah, so he was the first Ghanaian

1055

00:44:43,800 --> 00:44:44,950

to do almost everything,

1056

00:44:44,950 --> 00:44:48,490

the first Ghanaian to earn a  
PhD in mathematical physics,

1057

00:44:48,490 --> 00:44:49,740

the first full professor

1058

00:44:49,740 --> 00:44:52,580

in mathematical physics in Ghana.

1059

00:44:52,580 --> 00:44:55,110

And as far as research is concerned,

1060

00:44:55,110 --> 00:44:59,380

he is mostly known for  
this Allotey formalism,

1061

00:44:59,380 --> 00:45:03,570

which is basically a way  
to detect soft x-rays

1062

00:45:03,570 --> 00:45:08,510

in material like lithium or  
other alkaline materials.

1063

00:45:08,510 --> 00:45:11,260

And yeah, so he kind of, I mean, he has

1064

00:45:11,260 --> 00:45:14,960

a single authored paper on  
that, which is pretty neat.

1065

00:45:14,960 --> 00:45:17,490

And he got, I think, a medal for that.

1066

00:45:17,490 --> 00:45:21,380

But beside his research  
contribution he had,

1067

00:45:21,380 --> 00:45:26,380

he was member of a lot  
of international bodies.

1068

00:45:26,610 --> 00:45:28,660

He created, was one of the founding member

1069

00:45:28,660 --> 00:45:30,860

of the African Physical Society.

1070

00:45:30,860 --> 00:45:33,007

He was a board member at ICTP

1071

00:45:33,007 --> 00:45:35,300

and a lot of other institutions.

1072

00:45:35,300 --> 00:45:38,500

And he did a lot of work as well in Ghana,

1073

00:45:38,500 --> 00:45:40,670

like creating institutes

1074

00:45:40,670 --> 00:45:44,540

and fostering like  
science in the continent.

1075

00:45:44,540 --> 00:45:47,130

So it was quite an honor for me

1076

00:45:47,130 --> 00:45:50,193

to have a fellowship named after him,

1077

00:45:51,500 --> 00:45:55,420

almost more than my  
shoulders could bear, right?

1078

00:45:55,420 --> 00:46:00,280  
But it was good also for  
people in the West to see that,

1079

00:46:00,280 --> 00:46:02,220  
because typically you're not familiar

1080

00:46:02,220 --> 00:46:03,397  
with that kind of a name.

1081

00:46:03,397 --> 00:46:06,700  
You think more like Einstein,

1082

00:46:06,700 --> 00:46:08,890  
Dirac, Schrodinger,

1083

00:46:08,890 --> 00:46:12,580  
but it's good to see that  
we also have, if you want,

1084

00:46:12,580 --> 00:46:16,100  
we can groom up top class scientists.

1085

00:46:16,100 --> 00:46:17,890  
So to how did I come up with the name?

1086

00:46:17,890 --> 00:46:21,260  
So when I was coming to PI,  
Neil Turok actually gave me

1087

00:46:21,260 --> 00:46:23,420  
the choice, interestingly enough,

1088

00:46:23,420 --> 00:46:26,570  
to choose which name I wanted.



1089  
00:46:26,570 --> 00:46:28,363  
And yeah, I chose him.

1090  
00:46:29,410 --> 00:46:32,690  
- Now, you've kind of  
expanded this set of tools

1091  
00:46:32,690 --> 00:46:34,030  
that you have through your postdoc.

1092  
00:46:34,030 --> 00:46:35,210  
And now you're getting to work

1093  
00:46:35,210 --> 00:46:38,430  
on maybe some of these  
real-world applications.

1094  
00:46:38,430 --> 00:46:41,320  
And I really liked the  
thing you said earlier

1095  
00:46:41,320 --> 00:46:43,870  
about how often in papers  
academics are claiming

1096  
00:46:43,870 --> 00:46:45,750  
that their methods could be applicable

1097  
00:46:45,750 --> 00:46:48,830  
to all of these potential,  
huge, real-world problems,

1098  
00:46:48,830 --> 00:46:51,640  
but maybe people don't  
always really put the effort

1099  
00:46:51,640 --> 00:46:52,473  
into solving those.

1100

00:46:52,473 --> 00:46:55,370  
And it seems like that's really  
what you're trying to do now

1101

00:46:55,370 --> 00:46:57,340  
in your work, which is really impressive.

1102

00:46:57,340 --> 00:46:59,920  
And I'm just curious  
what other real problems

1103

00:46:59,920 --> 00:47:01,713  
you have in mind to look at next?

1104

00:47:02,720 --> 00:47:05,213  
- Oh yeah, maybe not to look at next.

1105

00:47:05,213 --> 00:47:08,190  
Kind of the biggest problem  
I have in mind to solve

1106

00:47:08,190 --> 00:47:09,163  
is protein folding.

1107

00:47:10,190 --> 00:47:11,560  
- Protein folding?  
- Yes.

1108

00:47:11,560 --> 00:47:13,780  
- What is protein folding (chuckles)?

1109

00:47:13,780 --> 00:47:16,900  
- So basically a protein  
to be functioning,

1110

00:47:16,900 --> 00:47:19,850  
it has to have a certain conformation.

1111

00:47:21,020 --> 00:47:24,660  
It can take millions  
different conformation.

1112  
00:47:24,660 --> 00:47:26,330  
When you're doing protein design,

1113  
00:47:26,330 --> 00:47:29,687  
you need to find a  
configuration white box.

1114  
00:47:29,687 --> 00:47:32,999  
They call it like when  
the protein is native,

1115  
00:47:32,999 --> 00:47:36,480  
in its native state or  
in its folded state.

1116  
00:47:36,480 --> 00:47:39,317  
And usually it starts  
from an unfolded state.

1117  
00:47:39,317 --> 00:47:42,009  
And the path through the folded state

1118  
00:47:42,009 --> 00:47:43,840  
is like you going through the Himalayas,

1119  
00:47:43,840 --> 00:47:46,450  
is a very, very hard path.  
- Peaks and valleys?

1120  
00:47:46,450 --> 00:47:48,640  
- Exactly, exactly,

1121  
00:47:48,640 --> 00:47:51,680  
with a lot of like local  
minimal saddle points.

1122

00:47:51,680 --> 00:47:54,223

It's very hard, and not  
only is it a hard problem,

1123

00:47:54,223 --> 00:47:57,210

it's very relevant, drug design

1124

00:47:57,210 --> 00:48:00,313

to help us like have better drugs

1125

00:48:00,313 --> 00:48:02,400

and help in the health sector.

1126

00:48:02,400 --> 00:48:06,150

So this is also, it's  
having a very strong impact,

1127

00:48:06,150 --> 00:48:08,200

but it's also very hard to solve.

1128

00:48:08,200 --> 00:48:11,310

So this is one of the  
problems that I'm thinking.

1129

00:48:11,310 --> 00:48:15,010

I know that the approach  
we are having now is

1130

00:48:15,010 --> 00:48:18,160

really to develop state of  
optimization algorithms,

1131

00:48:18,160 --> 00:48:20,610

that of course, in the company right now

1132

00:48:20,610 --> 00:48:23,100

we apply it in the financial domain,

1133

00:48:23,100 --> 00:48:26,030  
but that we can easily  
export to other domains,

1134  
00:48:26,030 --> 00:48:27,680  
like in the domain of protein folding

1135  
00:48:27,680 --> 00:48:30,150  
where the only subroutine or function

1136  
00:48:30,150 --> 00:48:33,210  
we will have to change  
is just the Hamiltonian.

1137  
00:48:33,210 --> 00:48:37,330  
But then we will need to  
have domain knowledge.

1138  
00:48:37,330 --> 00:48:40,310  
And how do you write the  
protein folding Hamiltonian?

1139  
00:48:40,310 --> 00:48:44,440  
And that actually is not  
a minimalistic model,

1140  
00:48:44,440 --> 00:48:45,590  
is not an easy model,

1141  
00:48:45,590 --> 00:48:50,050  
but it's really a model  
of a real-world model.

1142  
00:48:50,050 --> 00:48:53,300  
I cannot; you really  
need somebody who works

1143  
00:48:53,300 --> 00:48:55,000  
in either quantum chemistry

1144  
00:48:55,000 --> 00:48:59,200  
or biotechnological  
sector and things to be.

1145  
00:48:59,200 --> 00:49:00,470  
- Just to see if I'm understanding,

1146  
00:49:00,470 --> 00:49:01,810  
right now when you're working,

1147  
00:49:01,810 --> 00:49:03,910  
Behnam, your co-founder

1148  
00:49:03,910 --> 00:49:06,580  
is kind of bringing this  
expertise of the finance side.

1149  
00:49:06,580 --> 00:49:07,840  
So you would kind of need

1150  
00:49:07,840 --> 00:49:10,386  
someone analogous to Behnam for this

1151  
00:49:10,386 --> 00:49:12,380  
protein folding problem.  
- Exactly, definitely.

1152  
00:49:12,380 --> 00:49:15,710  
So we even talked about that with Behnam,

1153  
00:49:15,710 --> 00:49:20,140  
that once we will be able to create value

1154  
00:49:20,140 --> 00:49:22,730  
with those algorithms, we start exploring

1155  
00:49:22,730 --> 00:49:25,863  
what we call in business

jargon other verticals.

1156

00:49:26,710 --> 00:49:29,610  
- Well, it seems like there's  
a lot of potential options

1157

00:49:29,610 --> 00:49:32,080  
for the future, and I'm  
really excited to see

1158

00:49:32,080 --> 00:49:34,277  
what you're gonna optimize next.

1159

00:49:34,277 --> 00:49:35,660  
- Thanks.

1160

00:49:35,660 --> 00:49:37,300  
- Thanks for chatting with us today.

1161

00:49:37,300 --> 00:49:38,700  
It was really fun.

1162

00:49:38,700 --> 00:49:39,831  
- My pleasure.

1163

00:49:39,831 --> 00:49:42,414  
(upbeat music)

1164

00:49:43,510 --> 00:49:46,300  
- Thanks so much for stepping  
inside the Perimeter.

1165

00:49:46,300 --> 00:49:49,420  
Be sure to subscribe so you  
don't miss a conversation.

1166

00:49:49,420 --> 00:49:52,480  
We've interviewed a lot of  
really brilliant scientists

1167

00:49:52,480 --> 00:49:55,570

whose research spans from  
the quantum to the cosmos.

1168

00:49:55,570 --> 00:49:58,080

And we can't wait for you to hear more.

1169

00:49:58,080 --> 00:49:59,390

And if you like what you hear,

1170

00:49:59,390 --> 00:50:01,070

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1172

00:50:03,470 --> 00:50:06,943

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