Introduction

Philipp Grohs

October 2018

Face Recognition












Face Recognition

Face Recognition

D. Trump

B. Sanders

A. Merkel

B. Johnson

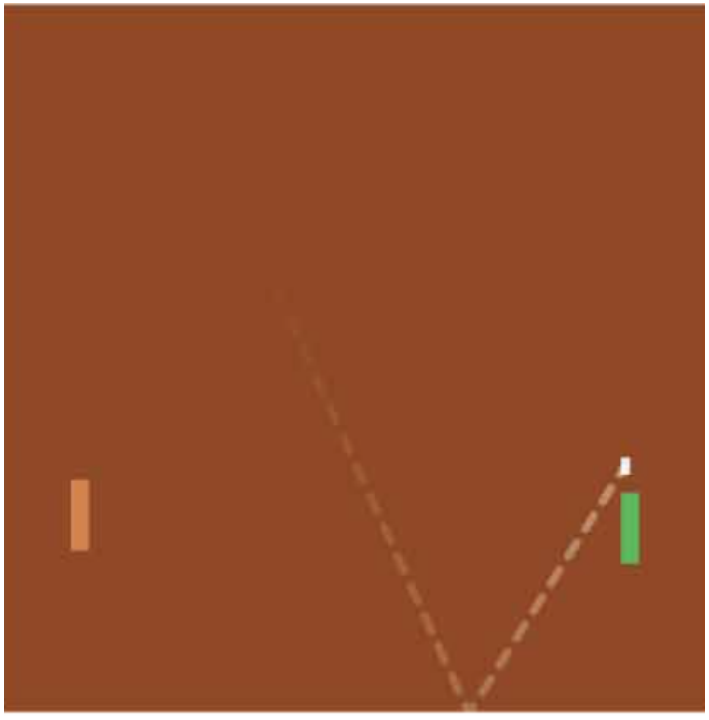
Describing the content of an image

AI generates sentences describing the content of an image [*Vinyals et al., 2015*]

Go!

AI beats Go-champion Lee Sedol [*Silver et al., 2016*]

Atari Games



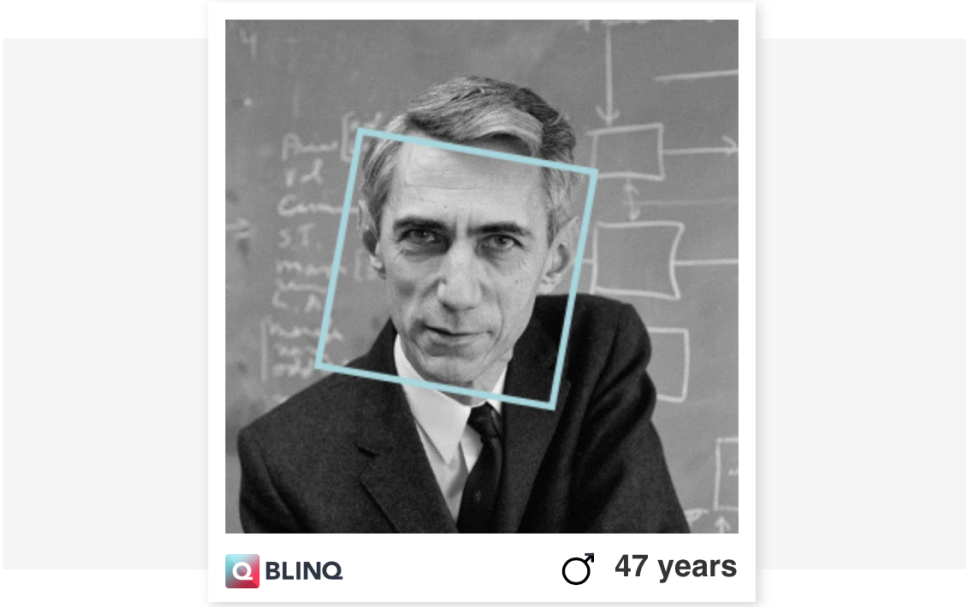
AI beats professional human Atari-players [*Mnih et al., 2015*]

Dating App

Swiss Dating App Blinq (developed in cooperation with ETHZ)

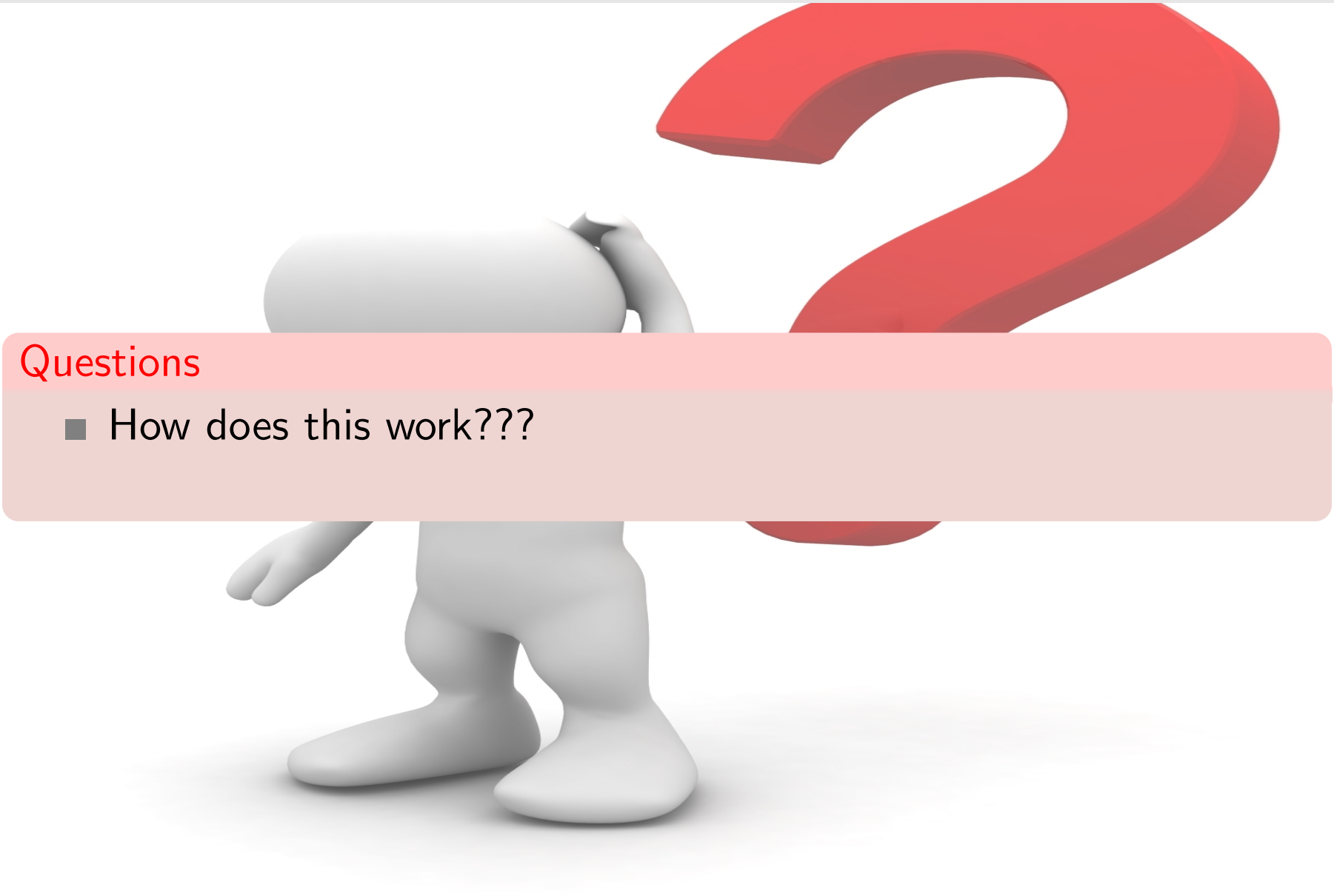
Let Artificial Intelligence guess your attractiveness and age

#howhot



This Week

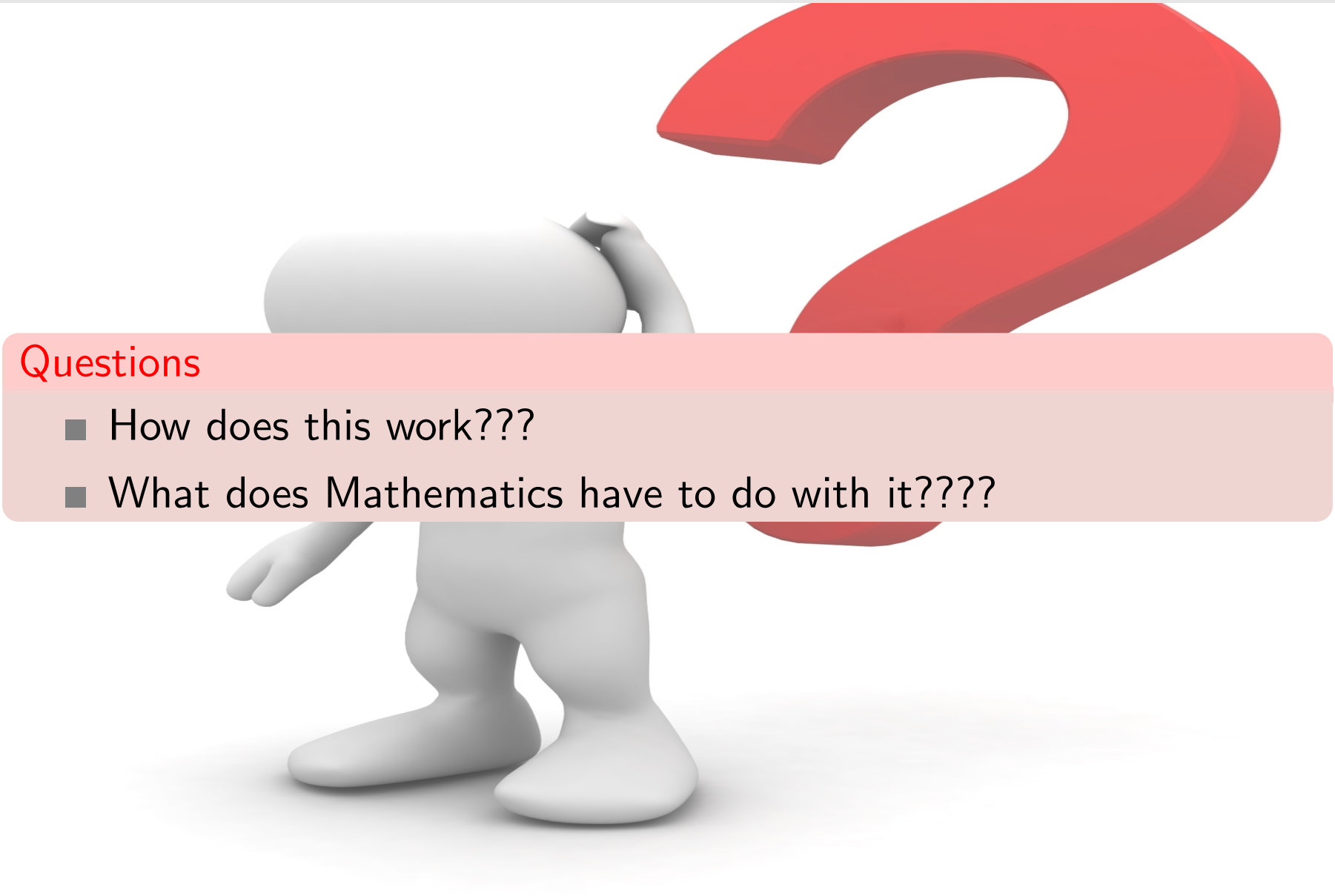
This Week



Questions

- How does this work???

This Week



Questions

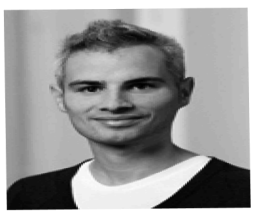
- How does this work???
- What does Mathematics have to do with it????

The Holy Grail

We seek a (high-dimensional) *function*

The Holy Grail

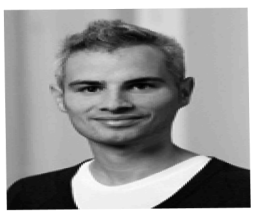
We seek a (high-dimensional) *function*



Philipp,

The Holy Grail

We seek a (high-dimensional) *function*



Philipp,

mapping an image, stored as *matrix*, to a label (my name).

The Holy Grail

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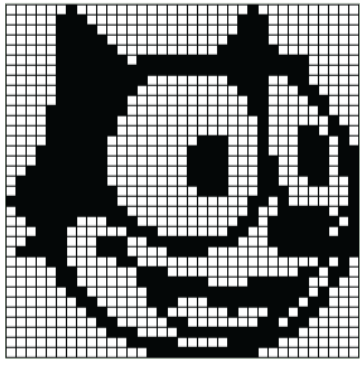

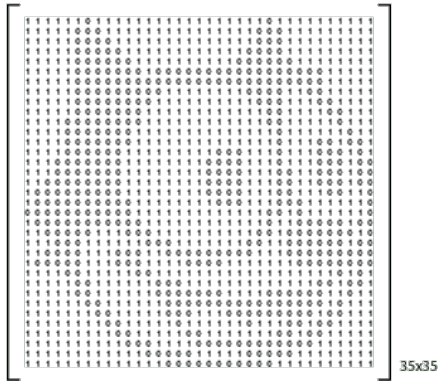

Why is this hard?

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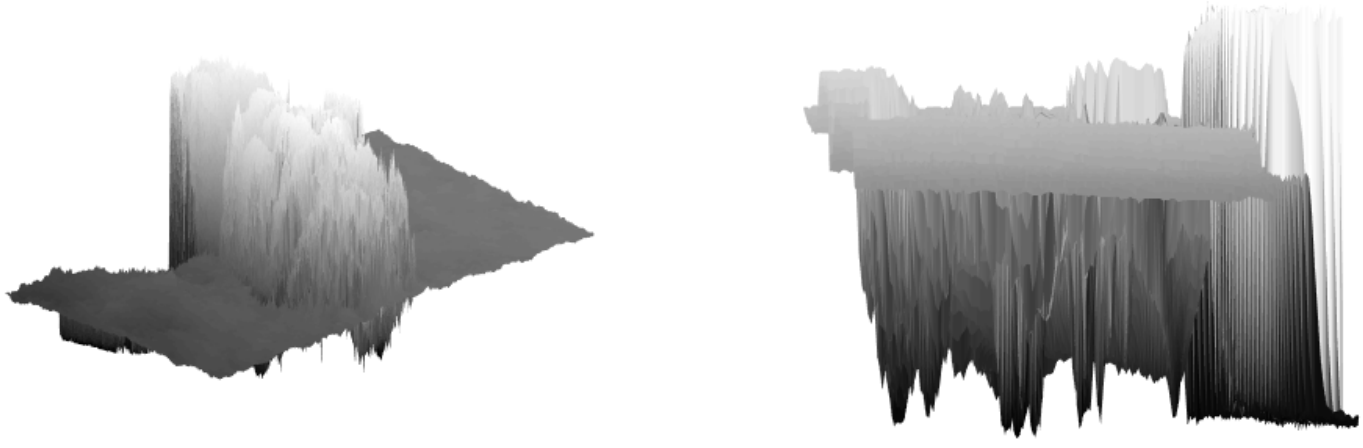


For us it is easy!

For us it is easy!

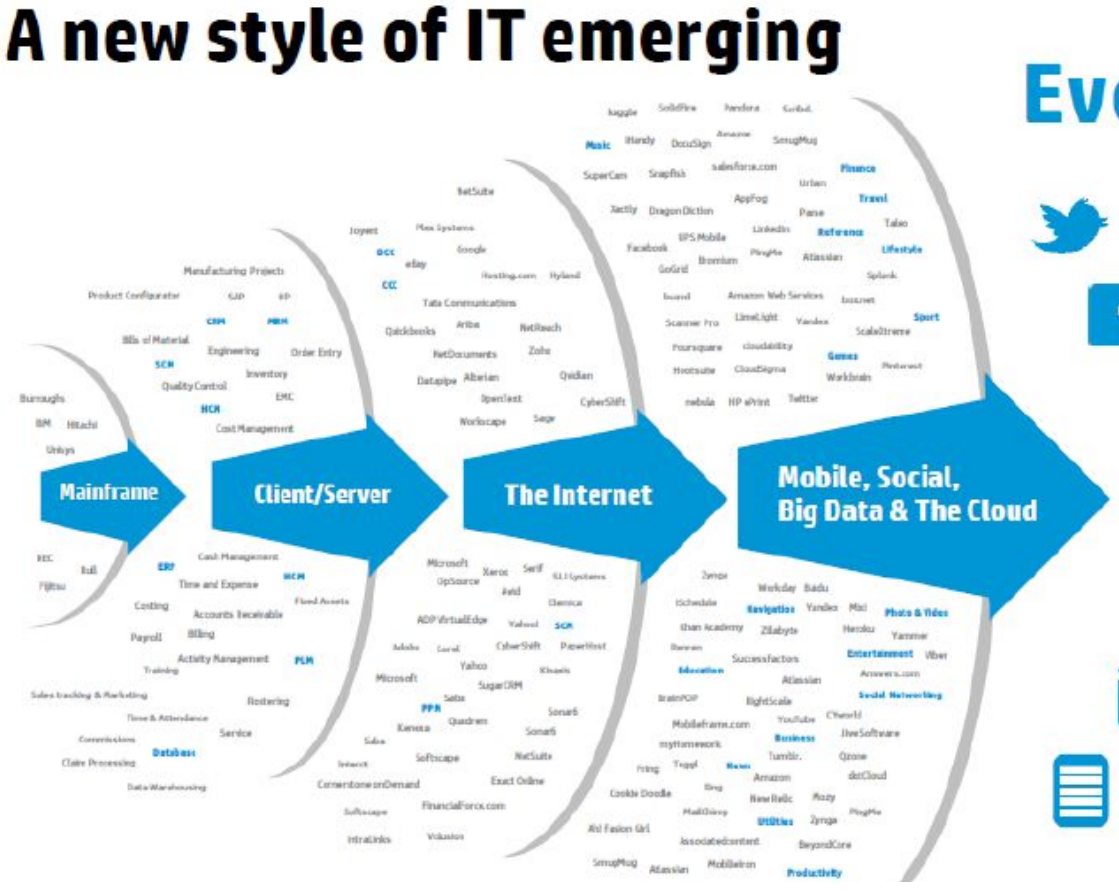
Philipp,

For us it is easy!

Philipp,

We have a brain which is capable of inferring this function from data (e.g., from having seen enough images)!

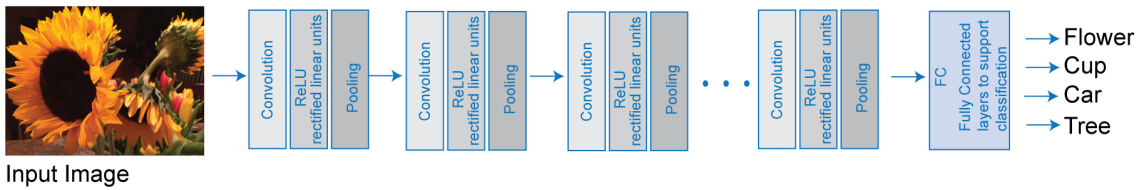
We generate more Data than ever!

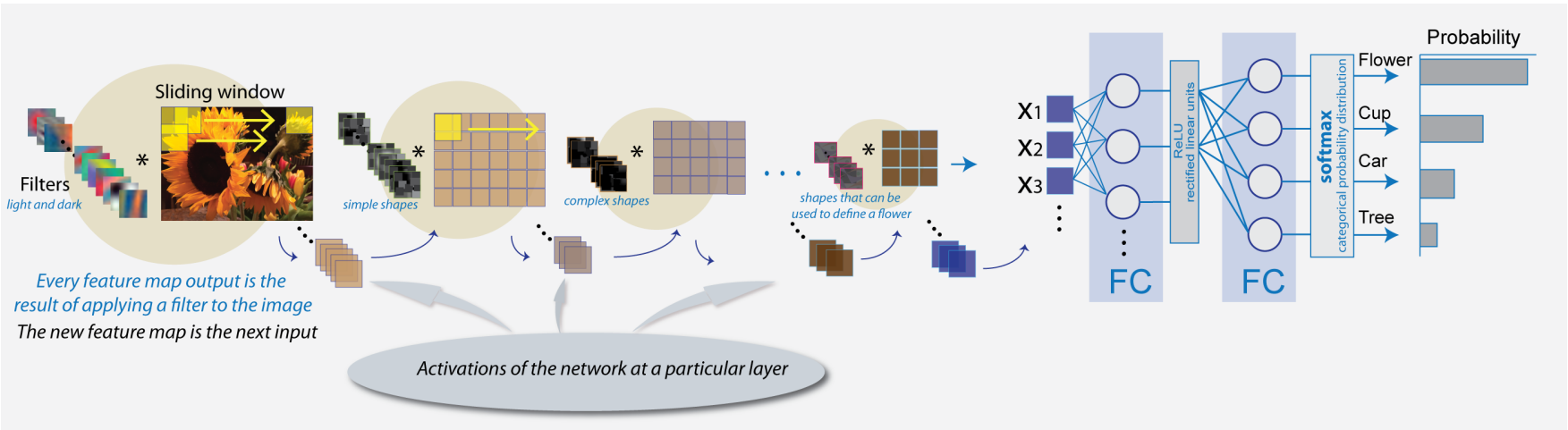


Every 60 seconds

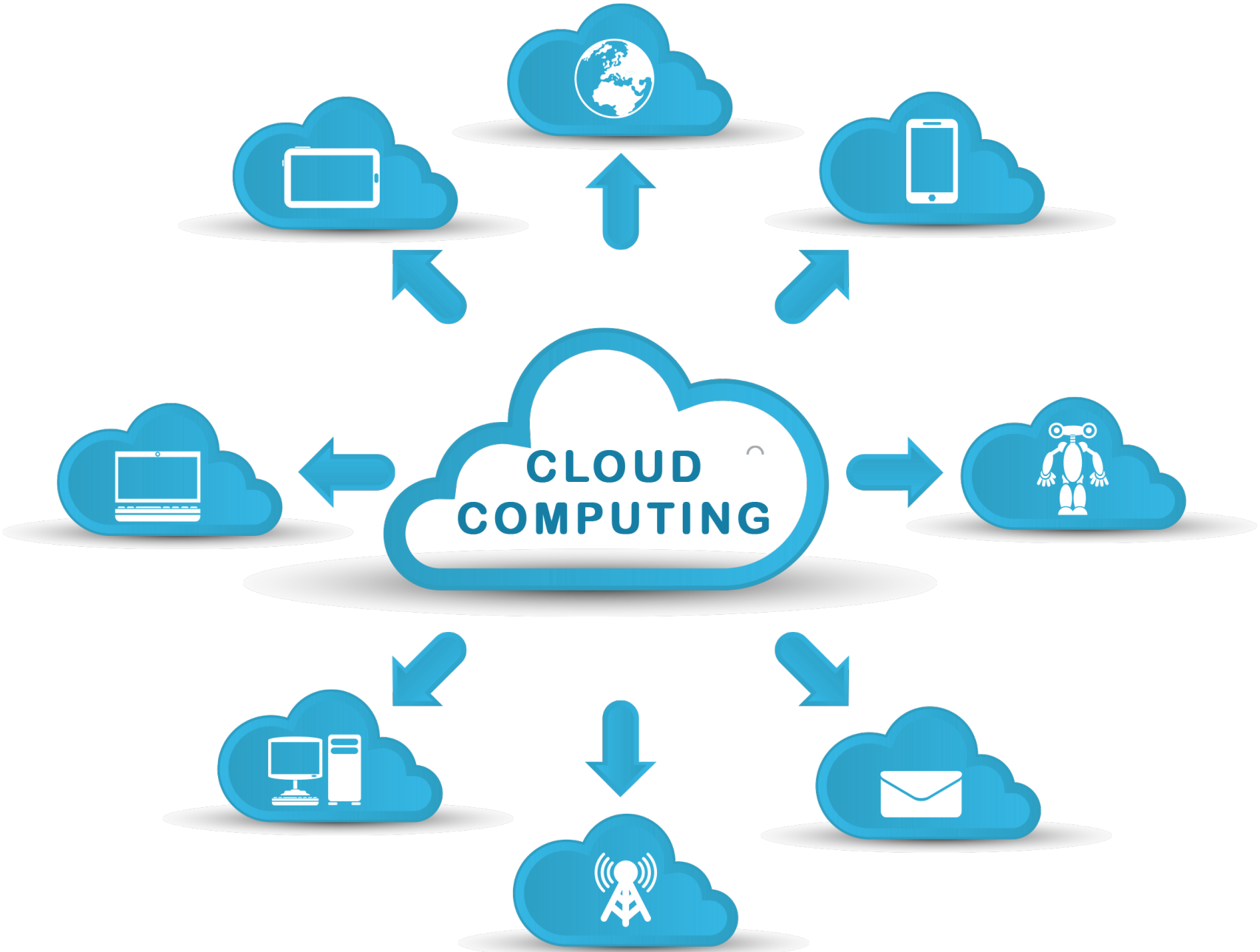
- **98,000+** tweets
- **695,000** status updates
- **11million** instant messages
- **698,445** Google searches
- **168 million+** emails sent
- **1,820TB** of data created
- **217** new mobile web users

Deep Neural Networks serve as the 'Brain'!





Cloud Computing Operates the Brain!



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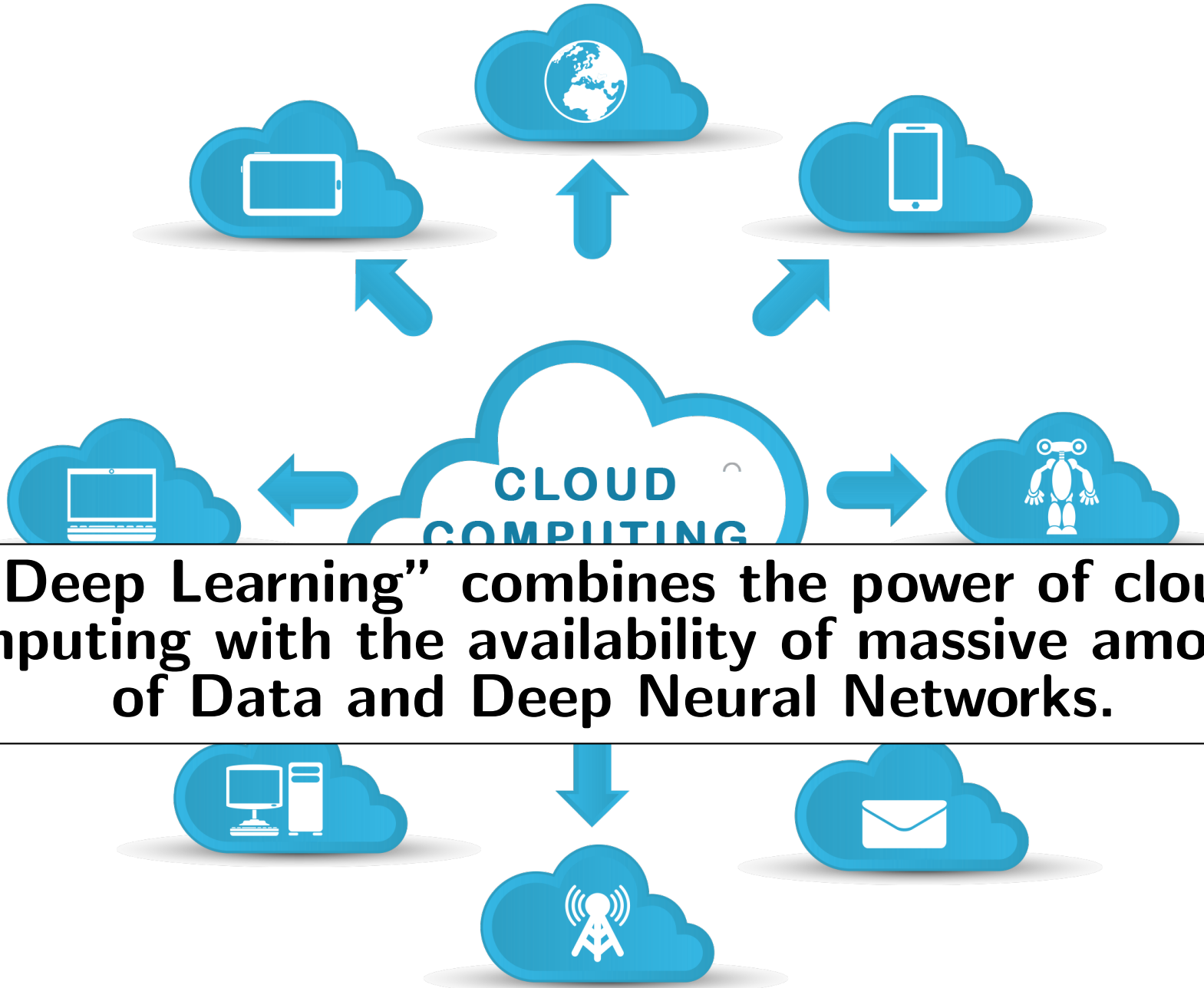

"Deep Learning" combines the power of cloud computing with the availability of massive amounts of Data and Deep Neural Networks.

Why Interested in Mathematical Analysis?

It is the guiding principle of many applied mathematicians that if something mathematical works really well, there must be a good underlying mathematical reason for it, and we ought to be able to understand it.

[Ingrid Daubechies. *Big Data's Mathematical Myteries*, Quanta Magazine (2015)]

Why Interested in Mathematical Analysis?

It is the guiding principle of many applied mathematicians that if something mathematical works really well, there must be a good underlying mathematical reason for it, and we ought to be able to understand it.

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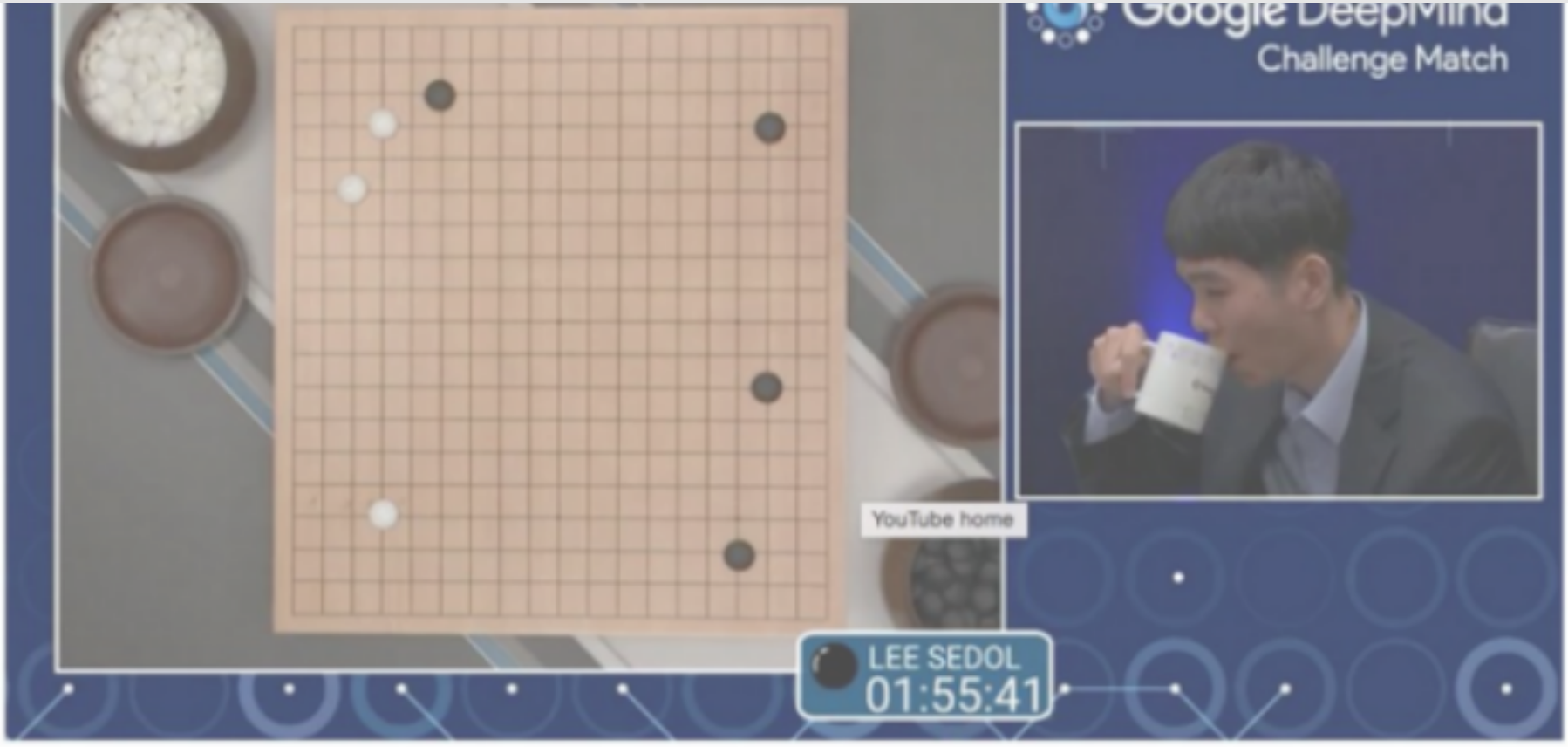
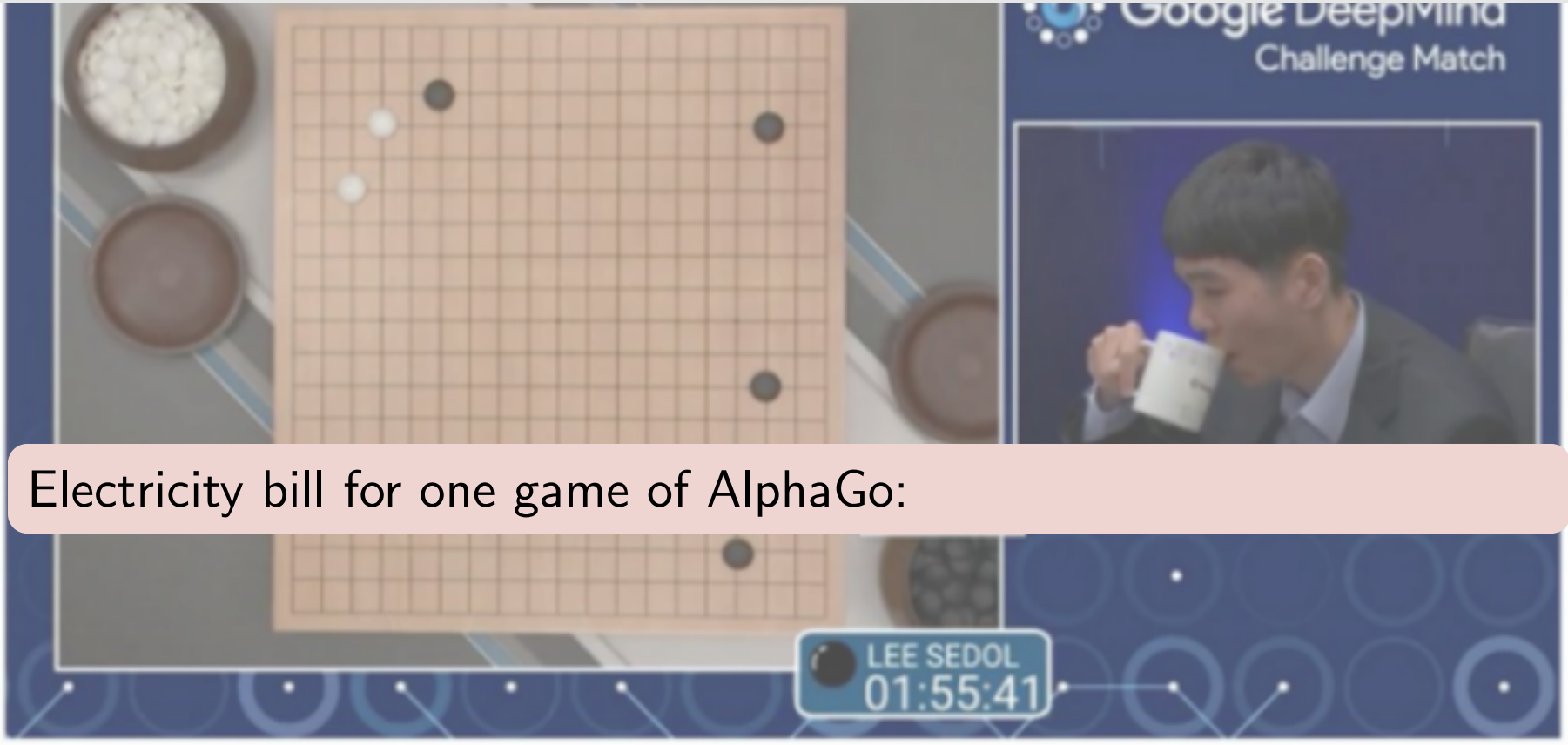
Futurists advocate submitting our economy to AI
$\rightsquigarrow$ moral responsibility to obtain an understanding!

Efficiency



AlphaGO	Lee Se-dol
1202 CPUs, 176 GPUs,	1 Human Brain,
100+ Scientists.	1 Coffee.

Efficiency



Electricity bill for one game of AlphaGo:

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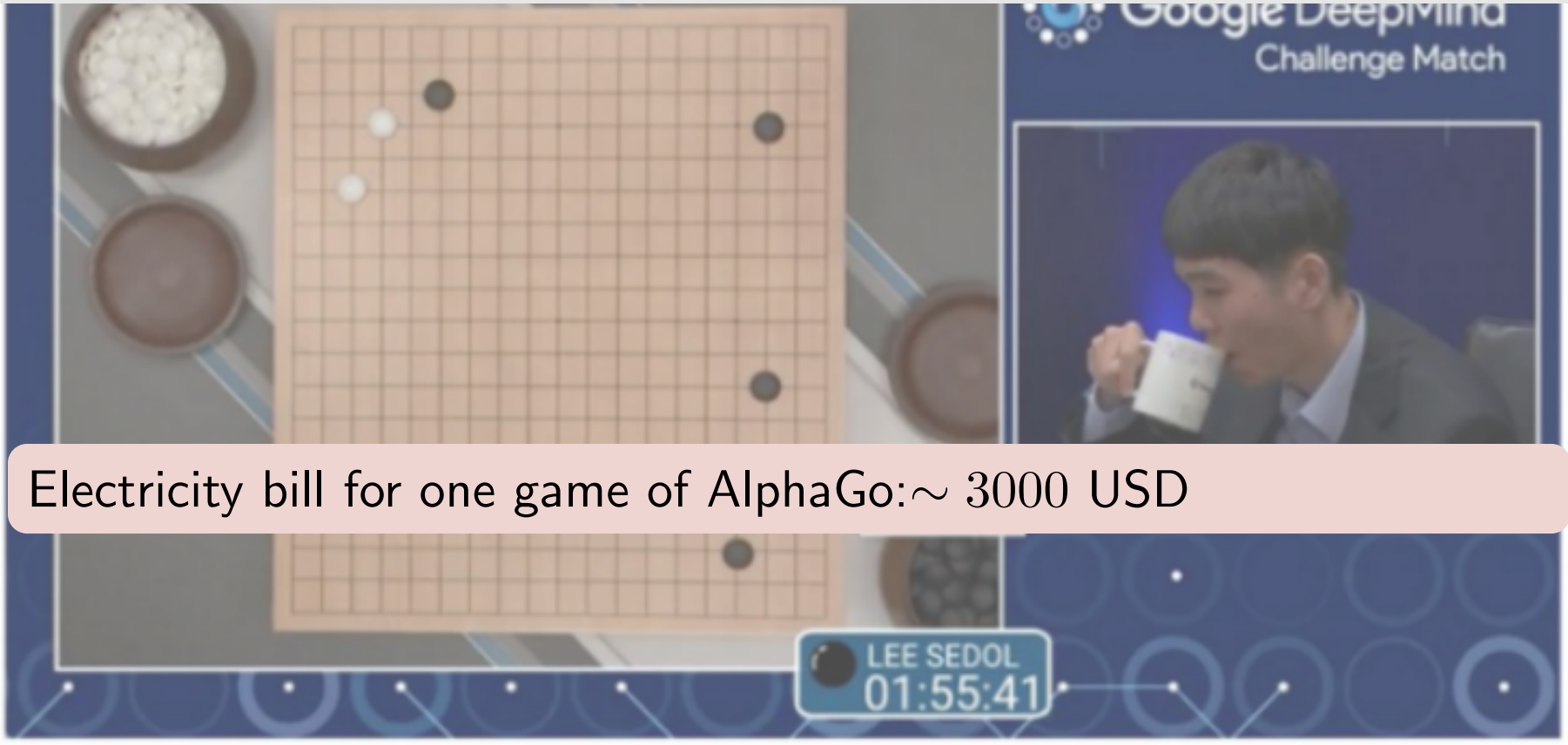
Efficiency

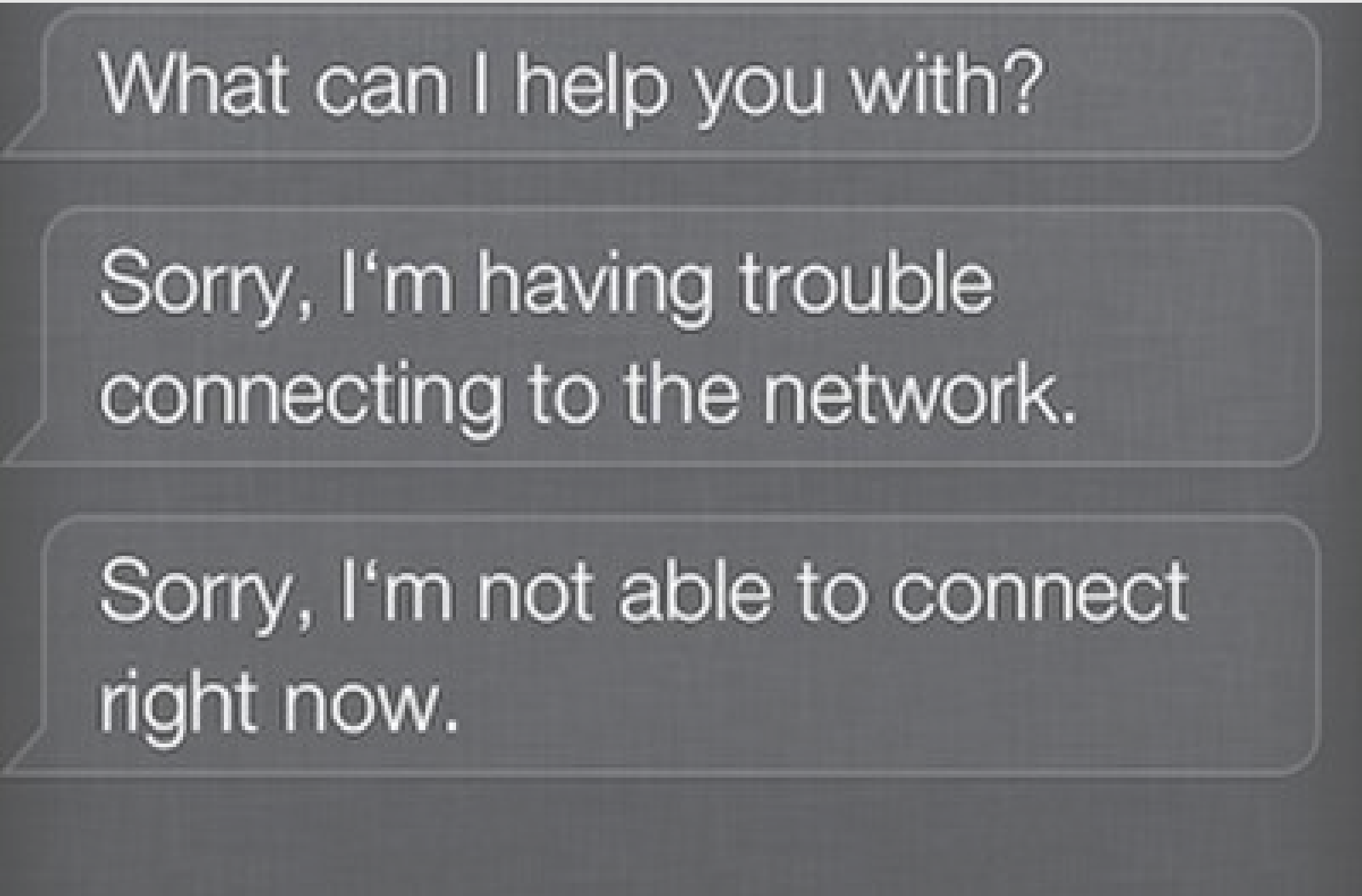


Electricity bill for one game of AlphaGo:~ 3000 USD

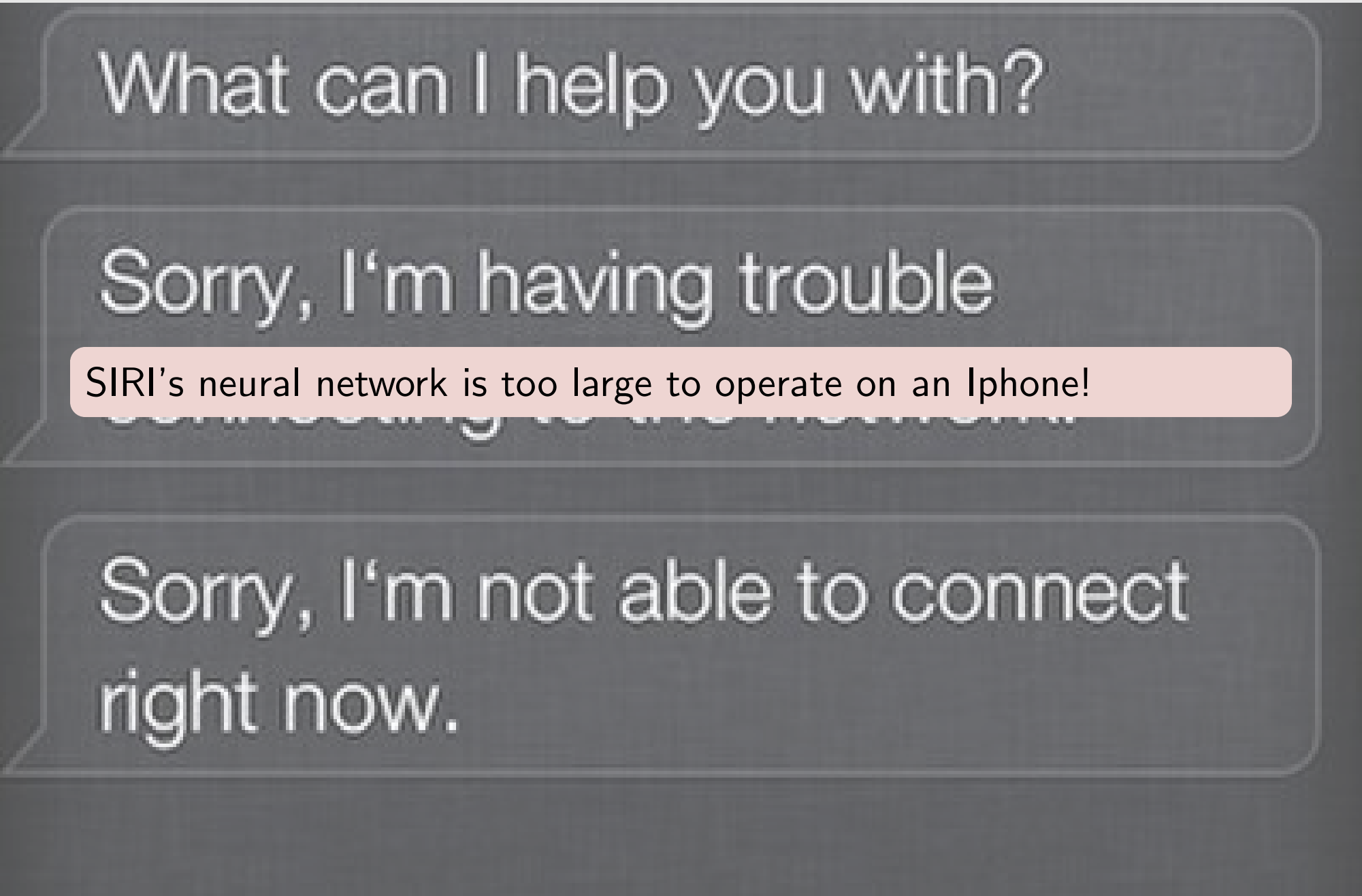
AlphaGO
1202 CPUs, 176 GPUs,
100+ Scientists.

Lee Se-dol
1 Human Brain,
1 Coffee.

Efficiency

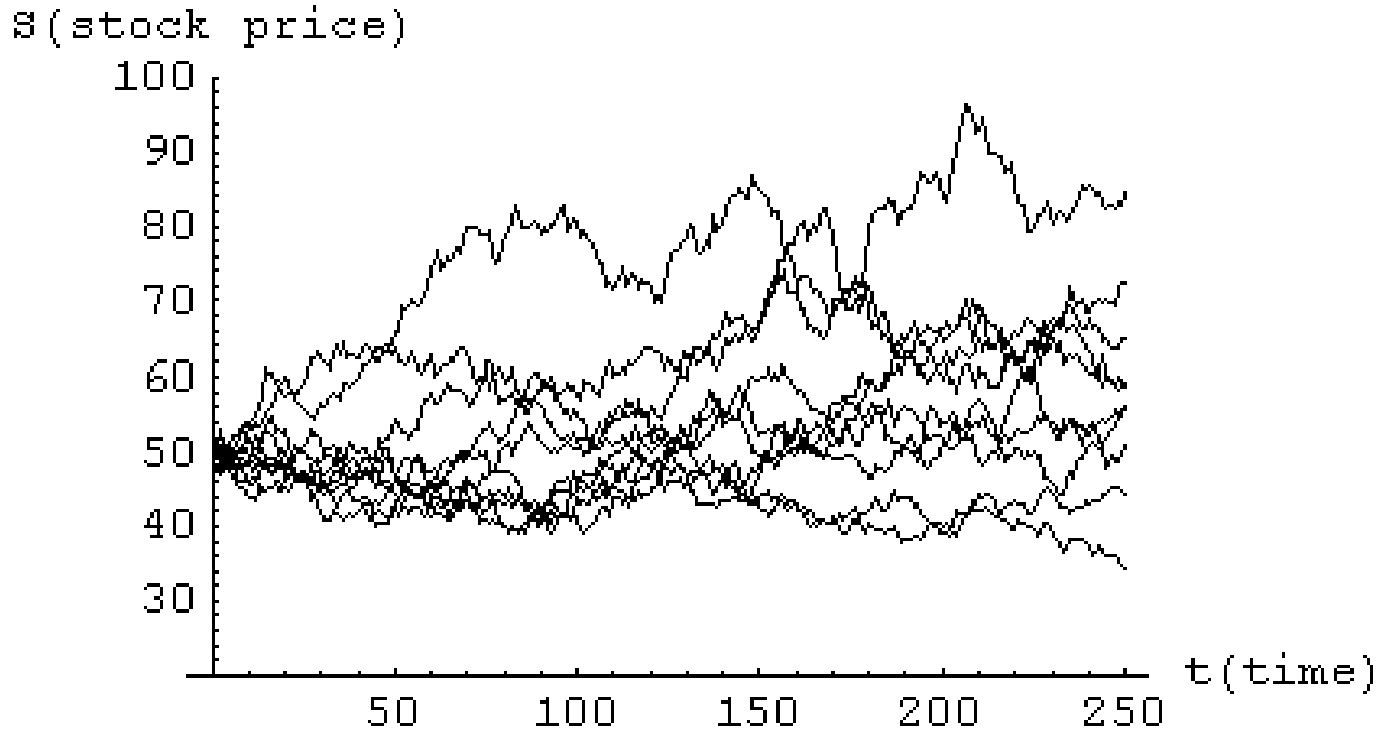

What can I help you with?
Sorry, I'm having trouble connecting to the network.
Sorry, I'm not able to connect right now.

Efficiency



SIRI's neural network is too large to operate on an Iphone!

Tackle Problems with Mathematical Structure



$$\frac{\partial u}{\partial t}(t,x) = \frac{1}{2}\sum_{i,j=1}^{N} x_i x_j \beta_i \beta_j \langle \varsigma_i, \varsigma_j \rangle_{\mathbb{R}^N} (\frac{\partial^2 u}{\partial x_i \partial x_j})(t,x) + \sum_{i=1}^{N} \mu_i x_i (\frac{\partial u}{\partial x_i})(t,x)$$

$$u(0,x) = \max\{K - \sum_{i=1}^{N} c_i x_i, 0\}$$

The goal of this course is to prepare you to contribute to the field!