

# Introduction

Philipp Grohs



October 2018

# Face Recognition



# Face Recognition



# Face Recognition



D. Trump



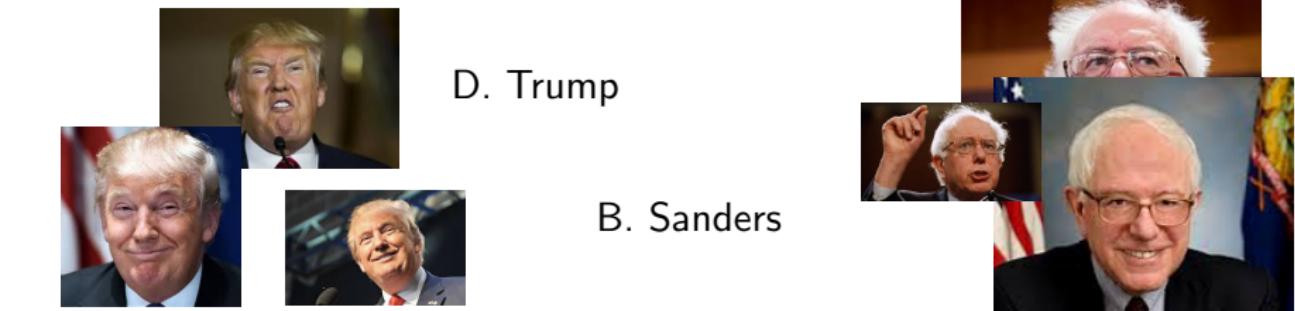
B. Johnson



A. Merkel



B. Sanders



# Describing the content of an image

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



A person riding a motorcycle on a dirt road.



Two dogs play in the grass.



A skateboarder does a trick on a ramp.



A dog is jumping to catch a frisbee.



A group of young people playing a game of frisbee.



Two hockey players are fighting over the puck.



A little girl in a pink hat is blowing bubbles.



A refrigerator filled with lots of food and drinks.



A herd of elephants walking across a dry grass field.



A close up of a cat laying on a couch.



A red motorcycle parked on the side of the road.



A yellow school bus parked in a parking lot.

Describes without errors

Describes with minor errors

Somewhat related to the image

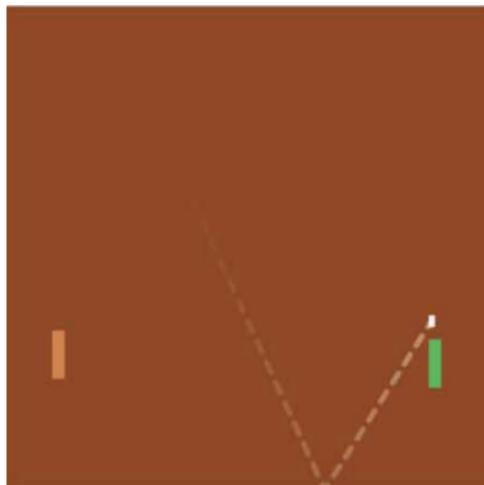
Unrelated to the image

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*

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Philipp,

# The Holy Grail

We seek a (high-dimensional) *function*



Philipp,

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

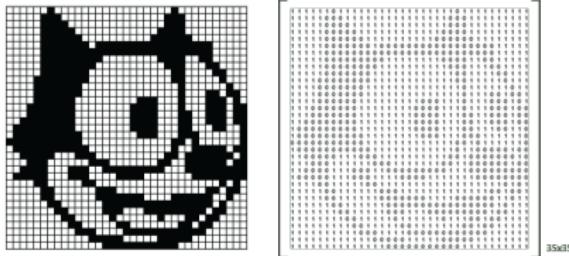
# The Holy Grail

We seek a (high-dimensional) *function*



Philipp,

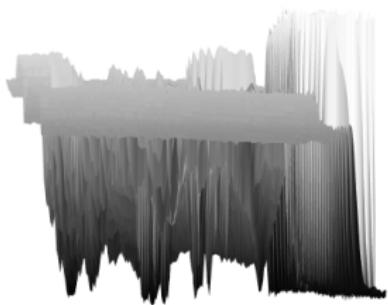
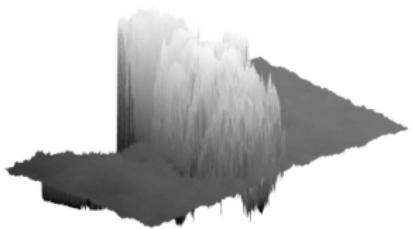
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Why is this hard?



Why is this hard?

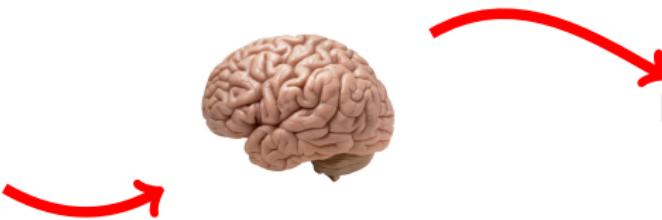


For us it is easy!

For us it is easy!



Philipp,



For us it is easy!



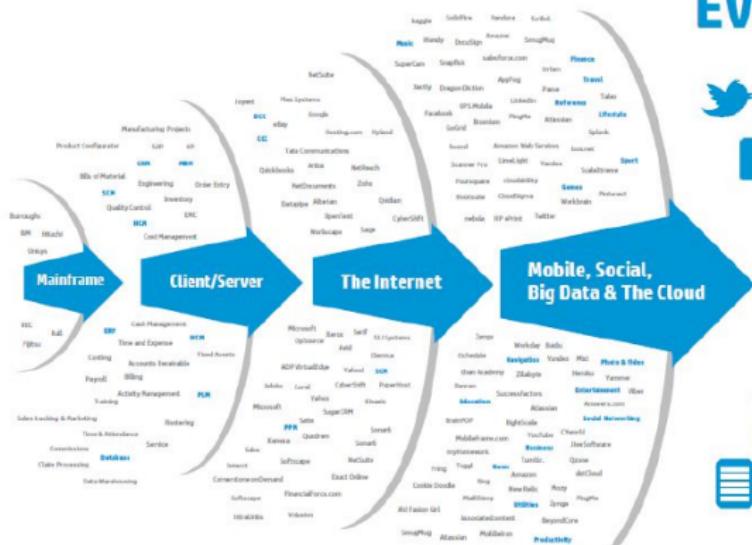
Philipp,



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!

## A new style of IT emerging



## Every 60 seconds

98,000+ tweets

695,000 status updates

11million instant messages

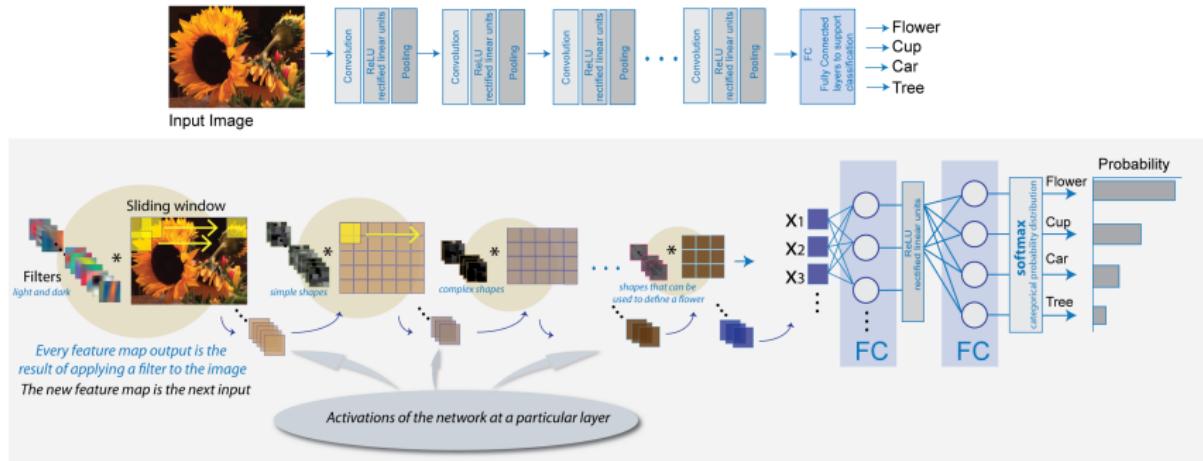
698,445 Google searches

168 million+ emails sent

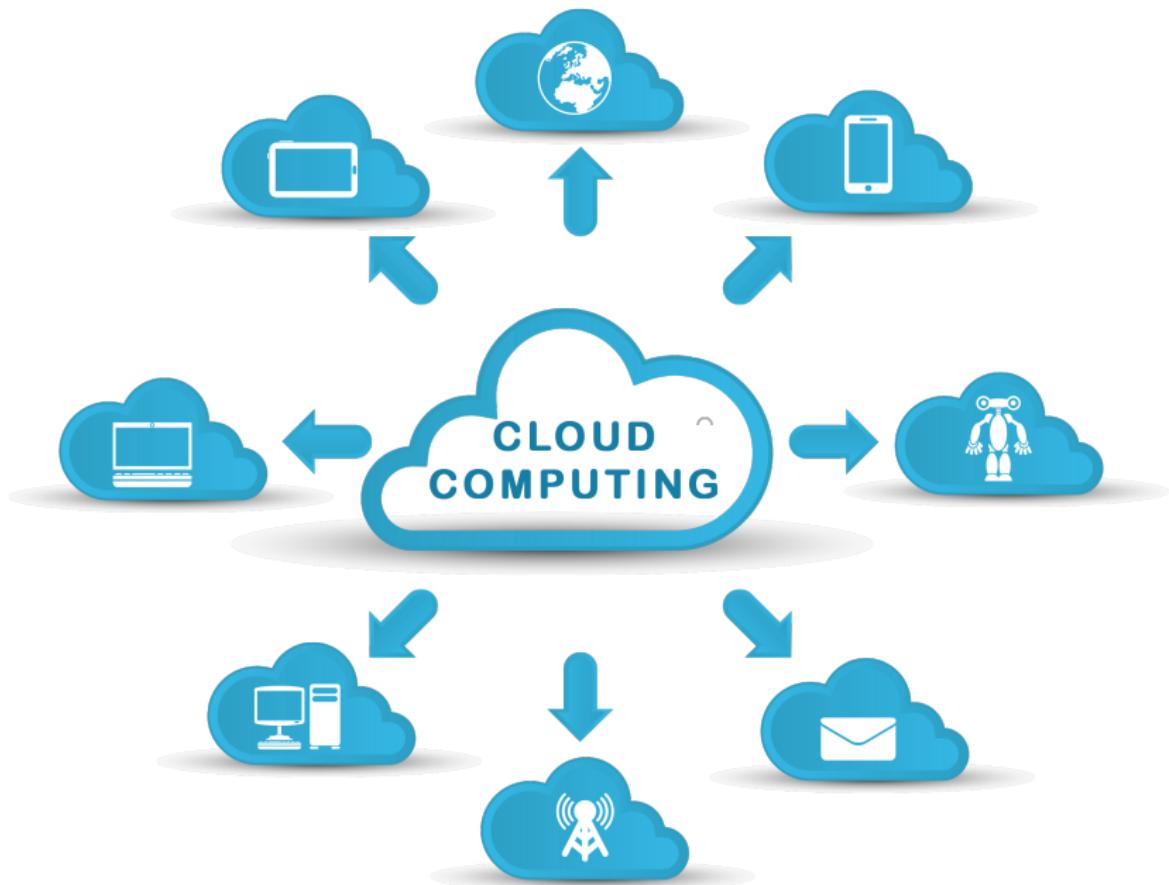
1,820TB of data created

217 new mobile web users

# Deep Neural Networks serve as the ‘Brain’!



# Cloud Computing Operates the Brain!



# Cloud Computing Operates the Brain!



**"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?



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**Futurists advocate submitting our economy to AI  
~~ moral responsibility to obtain an understanding!**

# Efficiency



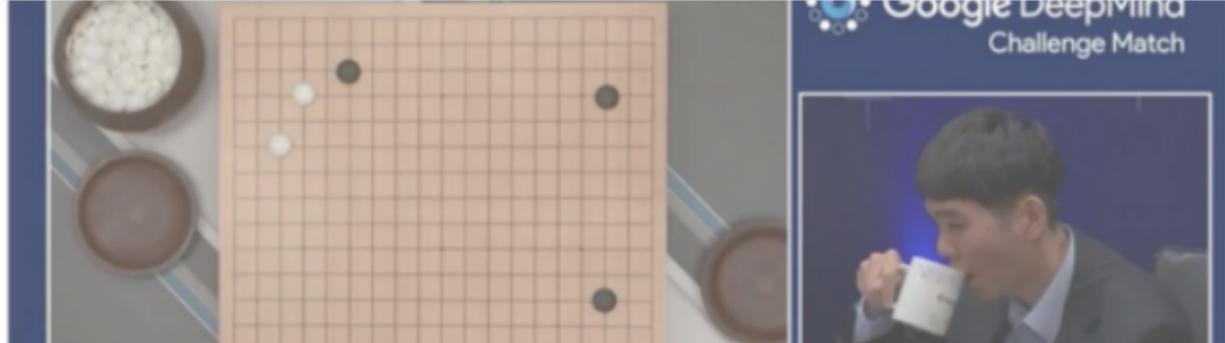
**AlphaGO**

1202 CPUs, 176 GPUs,  
100+ Scientists.

**Lee Se-dol**

1 Human Brain,  
1 Coffee.

## Efficiency



Electricity bill for one game of AlphaGo:



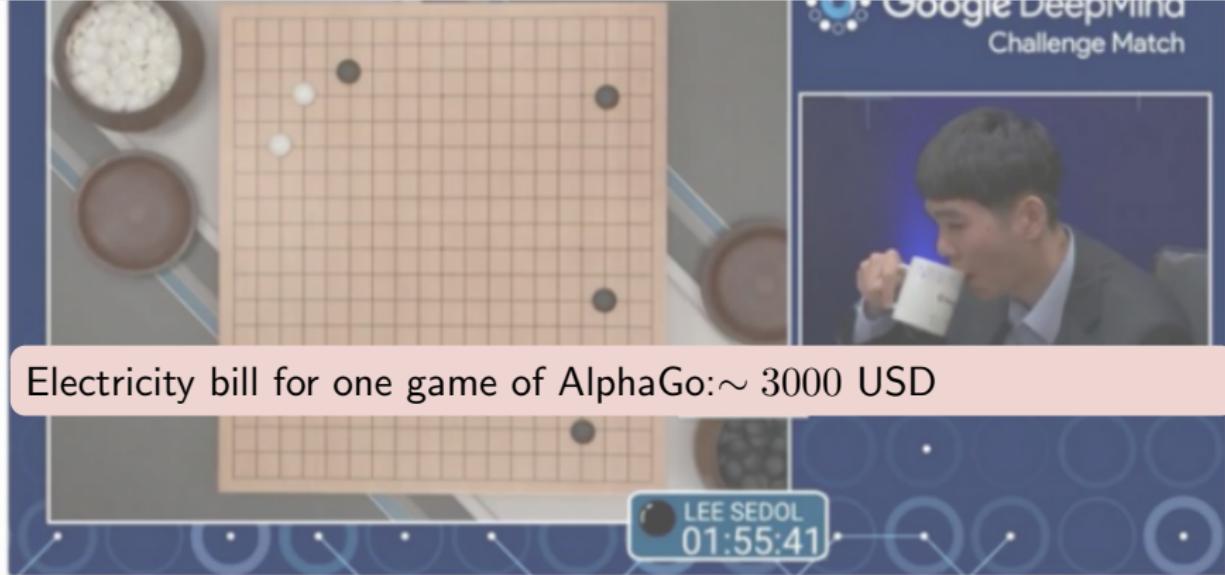
**AlphaGO**

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## Efficiency



Electricity bill for one game of AlphaGo: ~ 3000 USD

**AlphaGO**

1202 CPUs, 176 GPUs,  
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**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

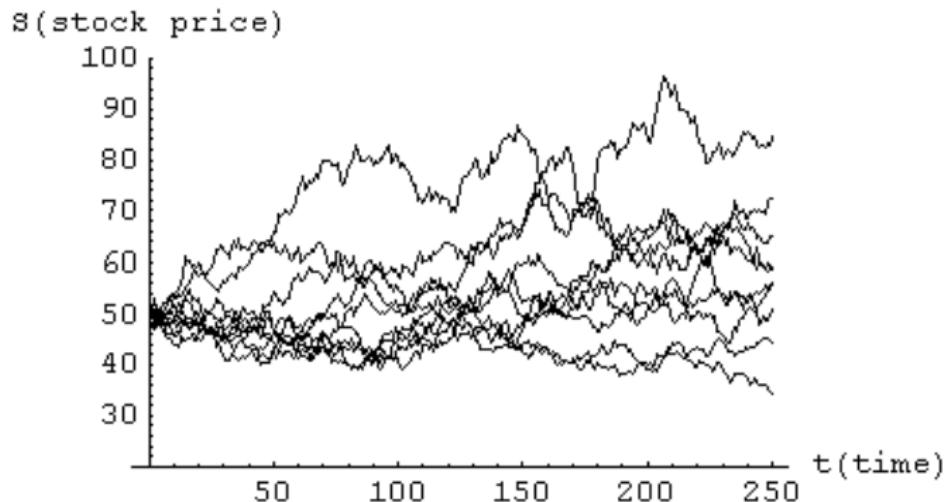
What can I help you with?

Sorry, I'm having trouble

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

Sorry, I'm not able to connect  
right now.

# Tackle Problems with Mathematical Structure



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

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

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