Please give me your feedback

Session ID: TB8558 **Speaker:** Sorin Cristian Cheran

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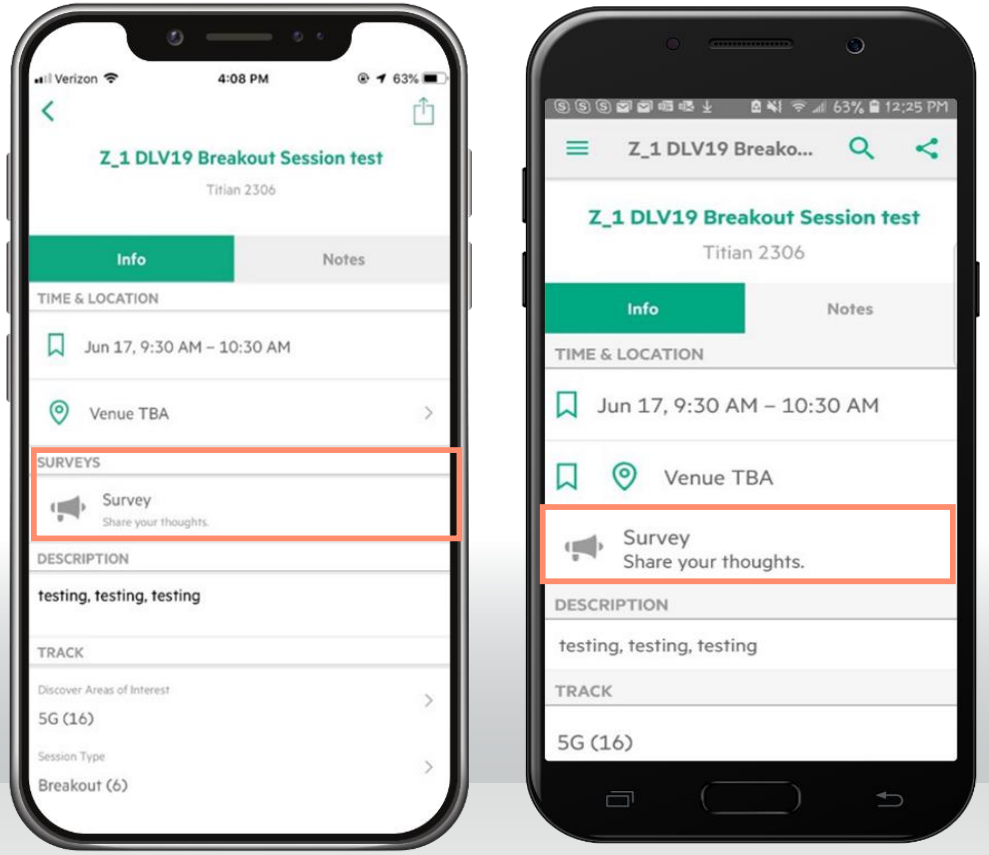

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Please note: Public Sector employees are not eligible

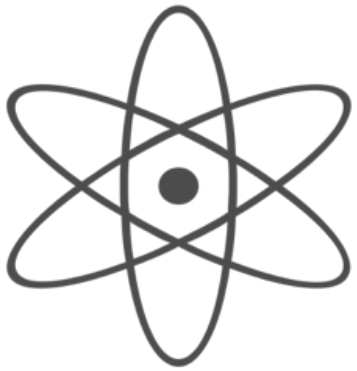
AI, the what and the how

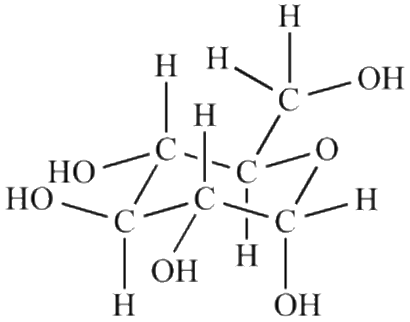
Sorin Cristian Cheran, AI Strategist, PhD, HPE

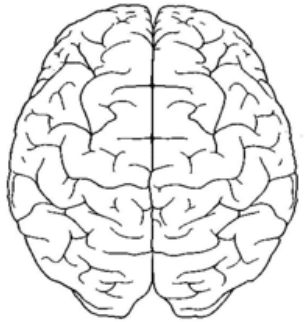
June 18 , 2019

HPE AI

A logical evolution





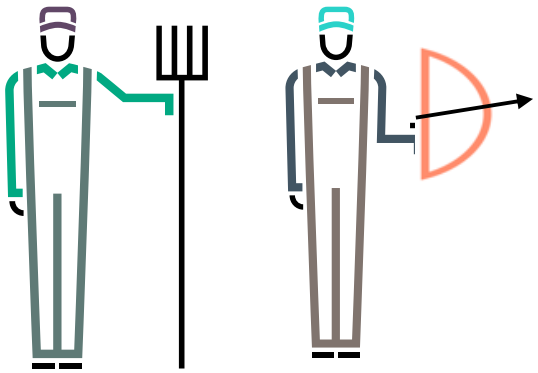


Physics **Chemistry** **Biology** **Neurology** **Technology**

Billions of years

A new revolution ?

Hunter/Gatherer



Millions of years

Agricultural

Thousands of years

Industrial

Couple of Centuries

Informational

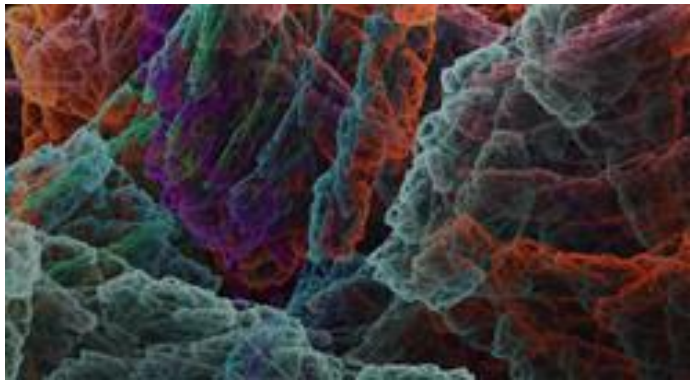
Decades

Welcome to Artificial Intelligence

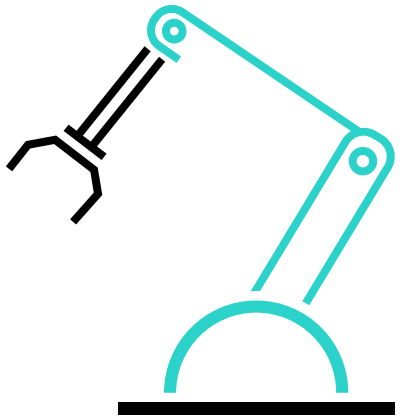
The augmented age

Think

Perceive



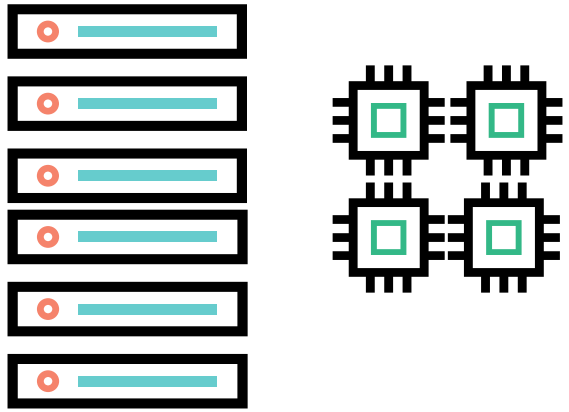
Make



So how did it cross the chasm now ?

Explosion of data
- We are generating more and more of it
- Some examples
  - Facebook up to 450M images/day
  - Snapchat 450 millions spans/day
  - Instagram doing a bit lower up to 65/day

Hardware
- GPUs allowed fast and correct turnaround results.
- NVIDIA became an AI company



Software
- It takes five minutes to set up a neural network
- We have seen advances in algorithms and networks

Caffe

theano

Keras

Microsoft CNTK

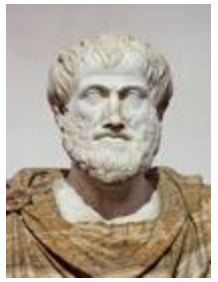
TensorFlow

So What is AI? By definition

Think humanly – The Cognitive Model approach

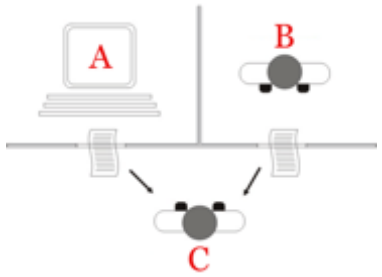
- Introspection
- Psychological Experiments
- Brain Imaging
- Others

Think rationally – The Laws of Thought approach



- The Laws of thought
- Codify " **right thinking**"
- Any problem can be put in logic
- Any logical problem can be solved

Act humanly , The Turing Test approach



- Natural language processing
- Knowledge representation
- Automated reasoning
- Machine learning
- Computer vision
- Robotics

Act rationally, the Rational Agent approach

- Obey the laws of thought when suitable
- Fulfill the Turing Test
- Find solutions when knowledge is uncertain

An agent that is able to solve a complex task/goal

Image Source:wikipedia.com/

So What is AI? By example AI as

INTERLOCUTOR CONVERSATION

- Hal, Siri, Cortana, Watson
- Conversional intelligence
- Limited reasoning

CONVERSATION ANDROID (or Take over the World)

- Machine in the form of a humanoid
- AI as mechanically embodied
- Examples would be the famous C-3PO

REASONER REASONING

- Early AI pioneers saw this as the ultimate goal
- Playing chess
- Solving logical proofs
- Planning complex tasks
- Alpha GO, Deep Blue

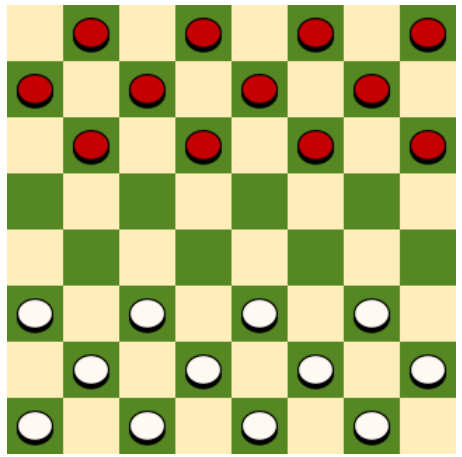
BIG DATA LEARNER DATA INSIGHTS

- Recent definition
- People talking about building AI models
- Deep learning

An agent that is able to solve a complex task/goal

So AI is here. What do we do? Challenge it?

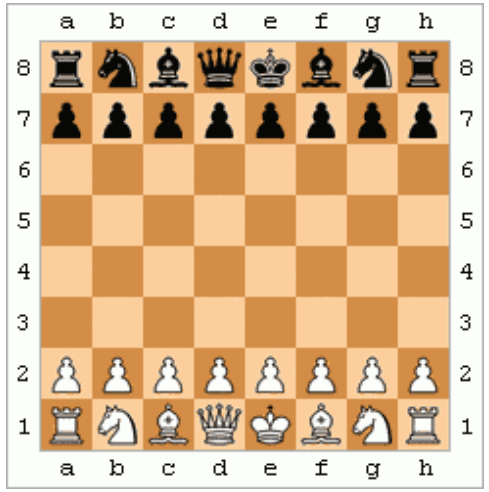
Checkers -1995



AI, UAlberta Chinook, white
Brain, Don Lafferty, red

10^{20}

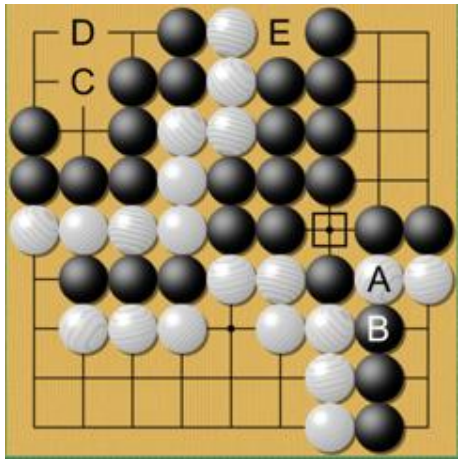
Chess -1997



AI, IBM Deep Blue, white
Brain, Garry Kasparov, black

10^{47}

Go - 2016



AI, Google AlphaGo, black
Brain, Lee Sedol, white

10^{171}

Poker - 2017

AI, HPE, CMU Liberatus
Brain, Kim, Les, Chou, MCAulay

10^{160}

All image source: Wikipedia.com

So AI is here? What do we do? challenge it ?

AI, IBM Deep Blue
Brain, Garry Kasparov

1996

Name	1	2	3	4	5	6	Score
Kasparov	0	**1**	½	½	**1**	**1**	**4**
Deep Blue	**1**	0	½	½	0	0	2

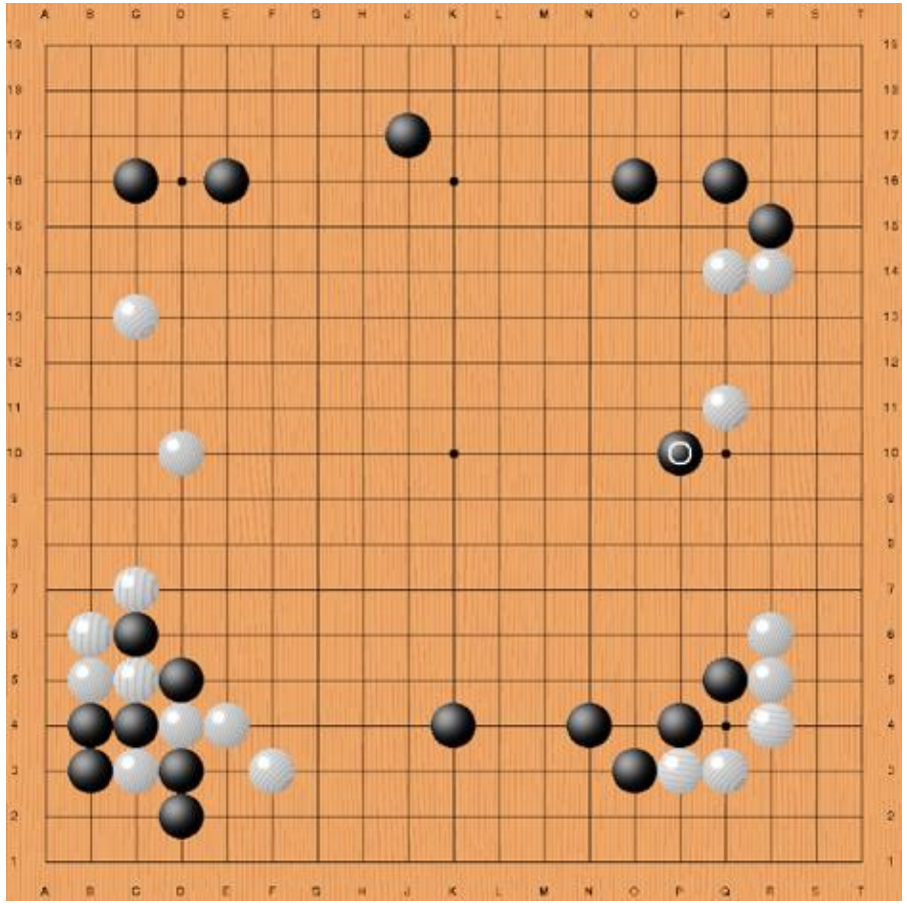
1997

Name	1	2	3	4	5	6	Score
Kasparov	**1**	0	½	½	½	0	2½
Deep Blue	0	**1**	½	½	½	**1**	**3½**

https://www.forbes.com/sites/davidewalt/2011/05/03/kasparov-vs-deep-blue/#6bd9698430f8

So AI is here? What do we do? challenge it ?

Famous move 37



2016

AI, Google AlphaGo
Brain, Lee Sedol

Images: youtube.com

AI vs Brain

1997

AI, IBM Deep Blue, white
Brain, Garry Kasparov, black

2016

AI, Google AlphaGo
Brain, Lee Sedol

https://www.forbes.com/sites/davidewalt/2011/05/03/kasparov-vs-deep-blue/#6bd9698430f8

Images: youtube.com

AI vs Brain

Logic

Short lifetime

Intuition

https://www.forbes.com/sites/davidewalt/2011/05/03/kasparov-vs-deep-blue/#6bd9698430f8

Images: youtube.com

Where would the road take us?

Advances in artificial intelligence will transform modern life by reshaping transportation, health, science, finance, and the military.

“High-level machine intelligence” (HLMI) is achieved when unaided machines can accomplish every task better and more cheaply than human workers.

Driving a truck, 2027

Retail, 2031

Surgeon, 2043

Writing a bestseller, 2049

Math research, 2060

Full automation of labor, 2140

Grace et al , When Will AI Exceed Human Performance? Evidence from AI Experts

So AI is here. What do we do?

An agent that is able to solve a complex task/goal

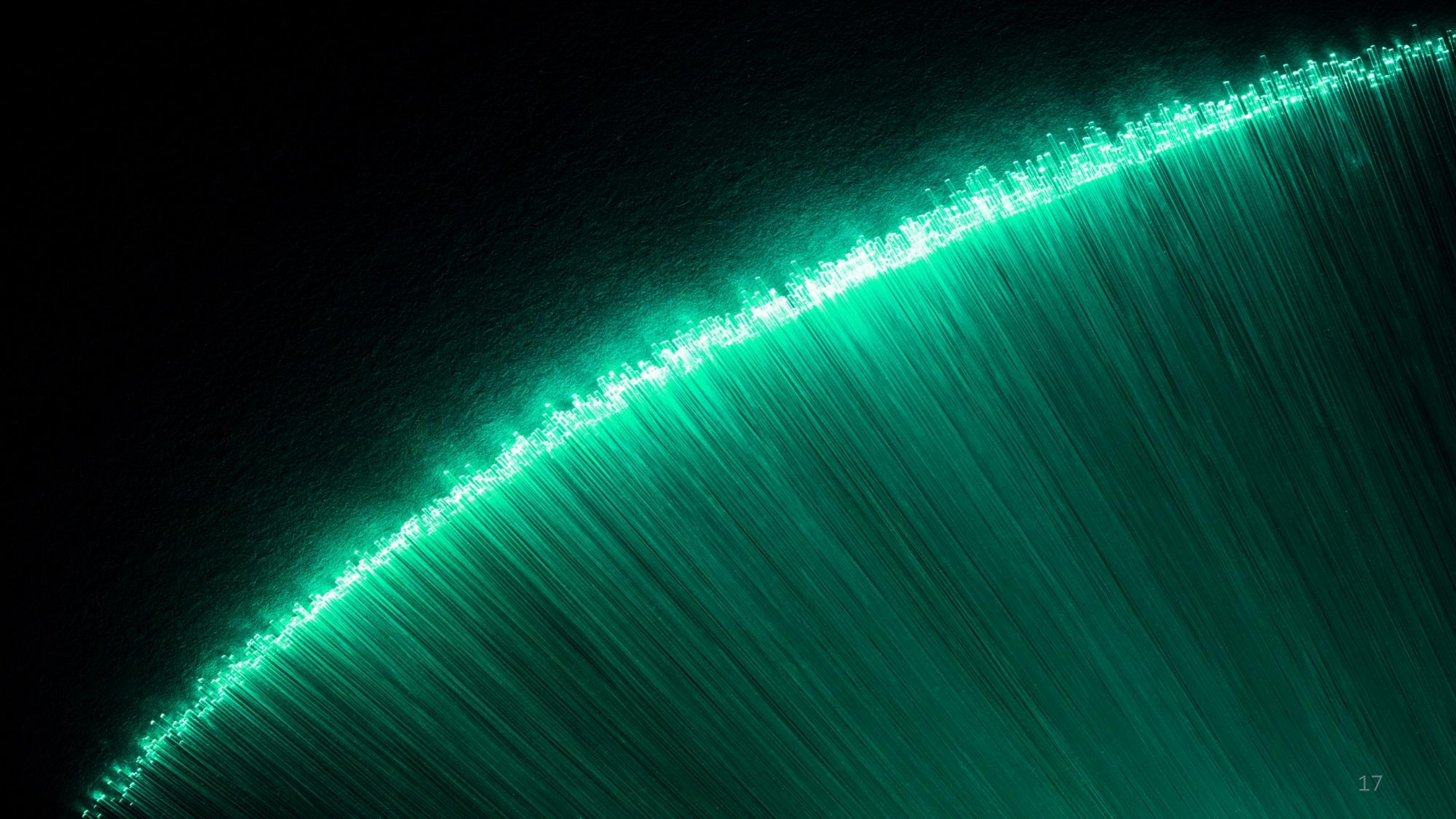
Even if we can keep the machine in a subservient position, for instance **by turning the power off** at certain moments we should, as a species, feel greatly humbled.

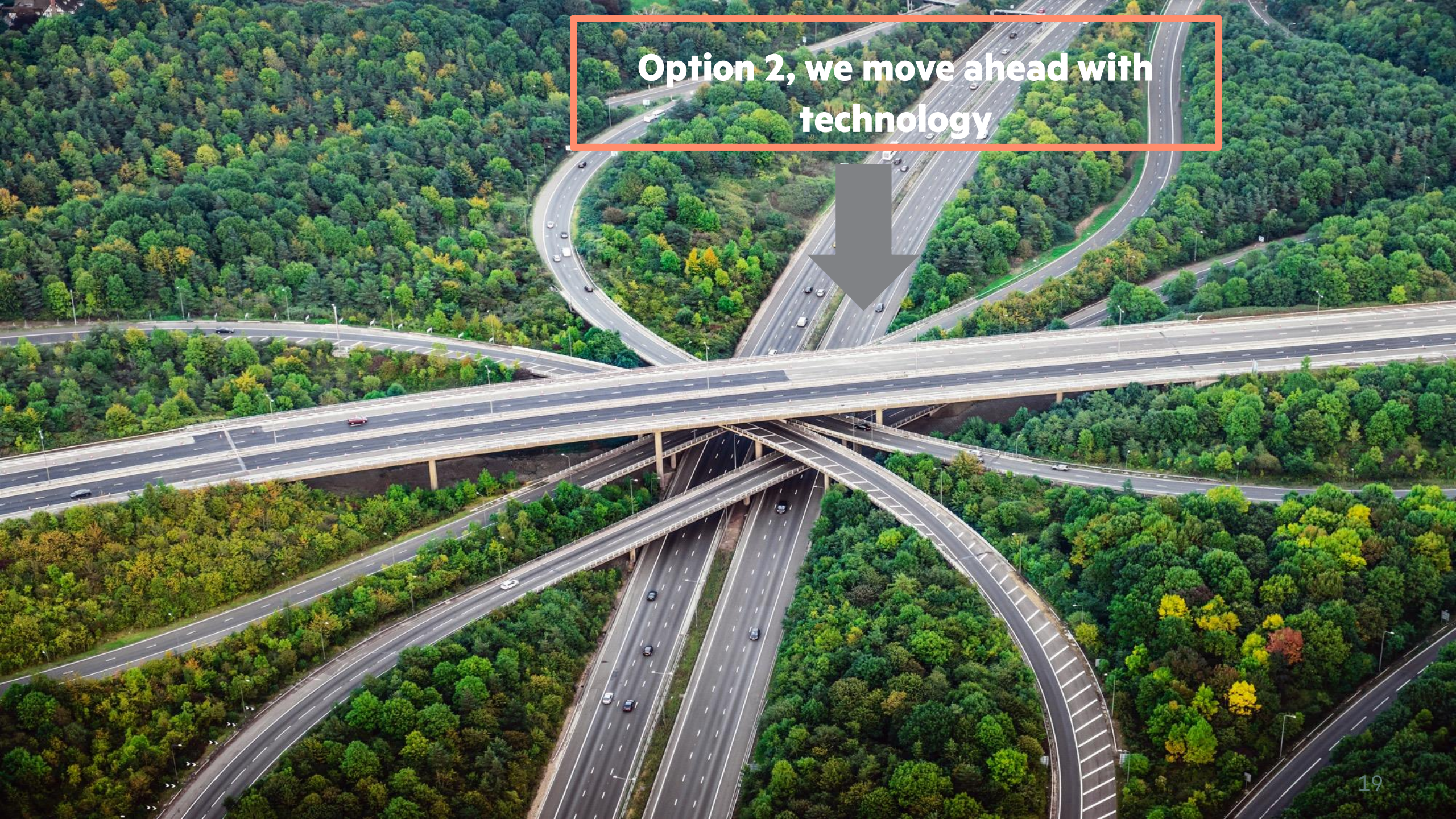
Alan Turing 1951

The first ultra-intelligent machine is **the last invention** that man need ever make, given that that machine is docile enough **to tell us how to keep it under control.**

Irving J Good 1965


Option 1, stop developing technology




Option 2, we move ahead with technology


Sc 4
SE/M
SI 7
FH 17 head
Sc 4
SE/M
SI 8
FH 23 head
Sc 4
SE/M
SI 9
FH 30 head
Sc 4
SE/M
SI 11
FH 36 head
Sc 4
SE/M
SI 12
FH 43 head

The spectrum of intelligence

Intelligence

Image source: wikipedia.org

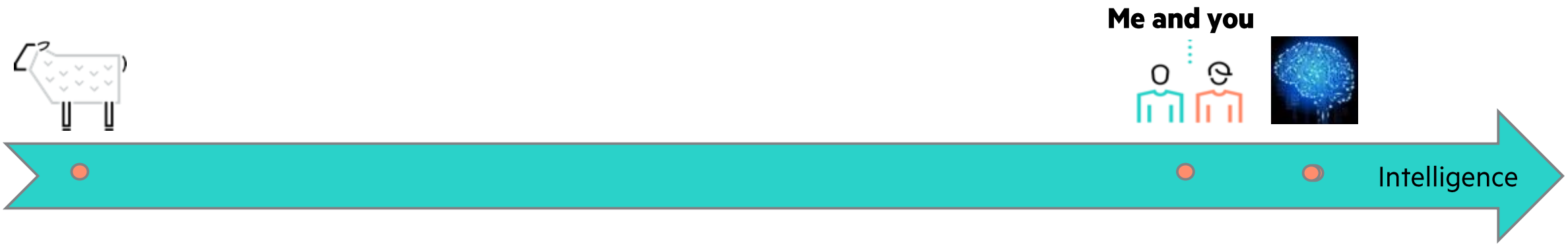
We start from human level intelligence

1.000.000 > Faster

Watson, 20.000 W	**Power**	20 W
Volta core, 1530000000 Hertz	**Speed**	**200 Hertz**
Fiber, 299,792,458 m/s	**Propagation**	**100 m/s**
Watson, 10 racks	**Size**	Human Skull
122 PetaFlops, 10^{17} 100 millions of billions operations	**Compute (FLOPS)**	0.01 FLOPS One operation every 100 seconds

Image source: princeton.edu

The spectrum of intelligence



Goal, ”Personal assistant, future Siri”

Sorin, your wife called about the dinner tonight.

Wait!!! Wait!!! Which dinner?

For your 10th Anniversary at 8 PM.

I can’t, I am meeting Donald at 19.30 for dinner to discuss strategy. How did this happen?

I did warn you but you overrode my recommendations!

What I am going to do? I can not tell him that I am busy. Has been planning this for months now. This is a disaster!

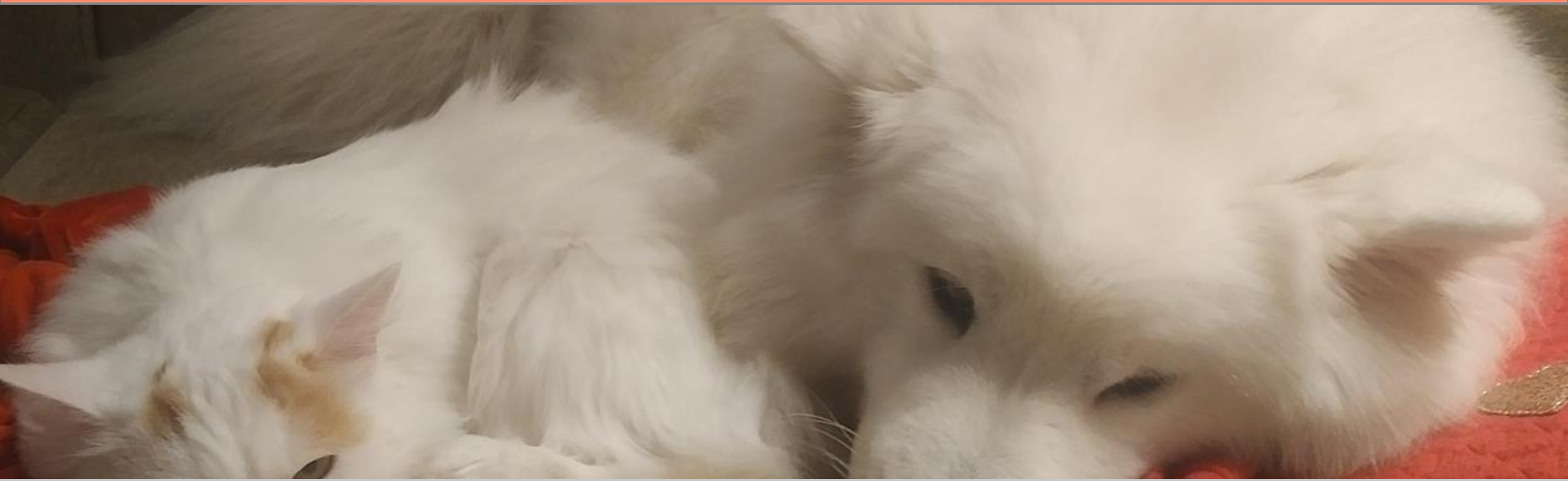
Do not worry I have arranged for his plane to be delayed. Some kind of computer malfunction.

Really? Can you do that?

He sends his apologies and is happy to meet you at lunch tomorrow.

Goal, ”Home Robot Assistant”

Breaking news



Deranged robot cooks kitty and dog for family dinner. End of domestic robots?

So what should we do? We can theorize about it

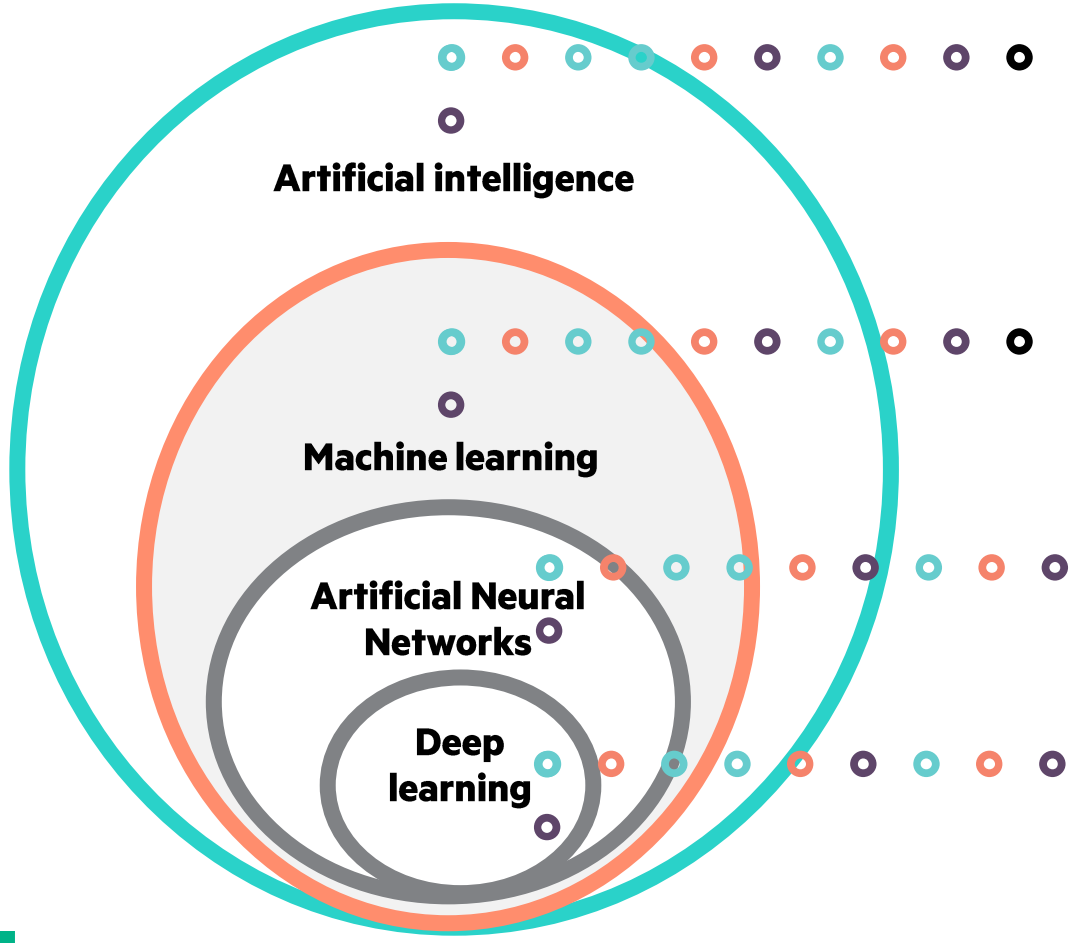
An agent that is able to solve a complex task/goal

We need to make sure that the AI goals are aligned with ours

- *Purely altruistic (realization of human values)*
- *With uncertain objectives*
- *Learn by observing humans*

What makes a machine intelligent?

AI intra-relationships



Artificial Intelligence (AI)

Mimics human behavior. Any techniques that enable machines to solve a task in a way like humans do.

Machine learning (ML)

Algorithms that allow computers to learn from examples *without* being explicitly programmed.

Artificial Neural Networks

Brain inspired Machine learning models

Deep learning

Subset of Artificial Neural Networks that is able to automatically build a hierarchy of data representation (features)

Rule-based AI, traditional ML and DL

Task, predict house prices best on school rating (s), # of bedrooms (be), # of bathrooms (ba), ft^2 (f)

Rule-based AI

SME defines a set of rules, these rules are explicitly programmed

```
if (s==9 and be==2
   and ba==2 and f==1000)
then
   price = $1000000;

Else if (...) then ...
Else if (...) then ...
```

Traditional ML

Collect a "labeled dataset": example of houses with prices

House 1, s = 9, be = 2,
ba = 2, f = 1000,
price = $1000000

House 1, s = 4, be = 2,
ba = 1, f = 700,
price = $600000

Define a function (model)

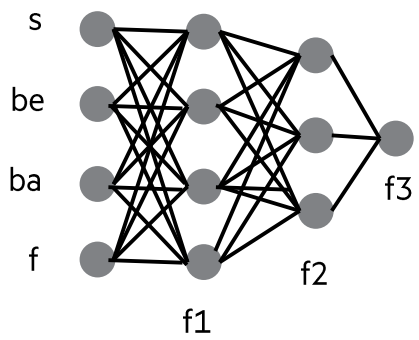
F, (s,be,ba,f) -> price

price = F(s,be,ba,f) =
w1*s + w2*be + w3*ba + w4*f

Train a model: run a program to find the best values of w1, w2, w3, w4

Deep learning

As traditional ML, but a function is more complex, a function of functions

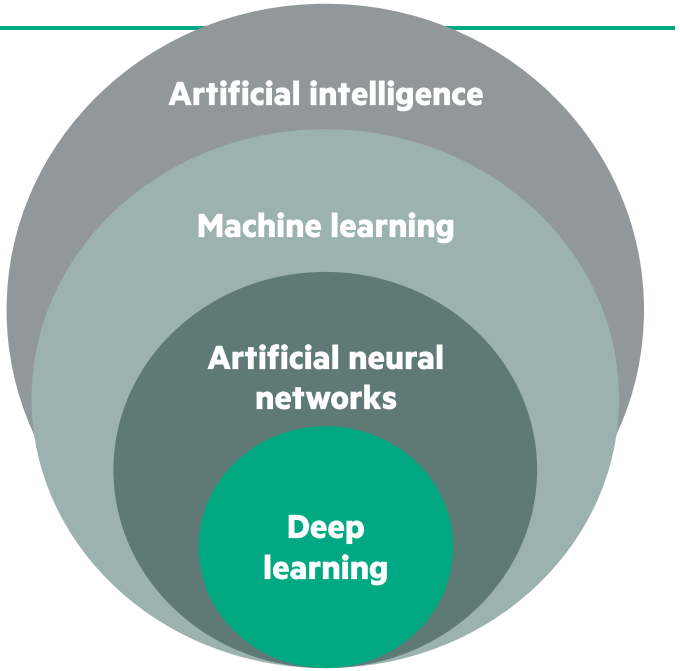


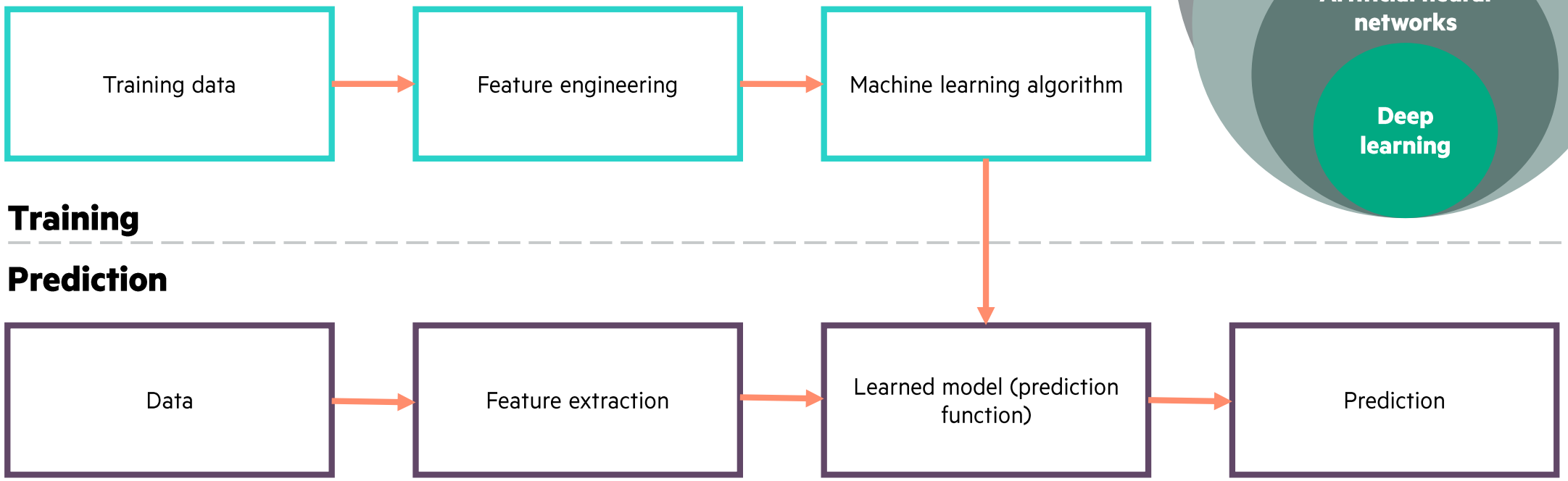
F, (s,be,ba,f) -> price

price = F(s,be,ba,f) =
f3(f2(f1(s,be,ba,f)))

Traditional machine learning

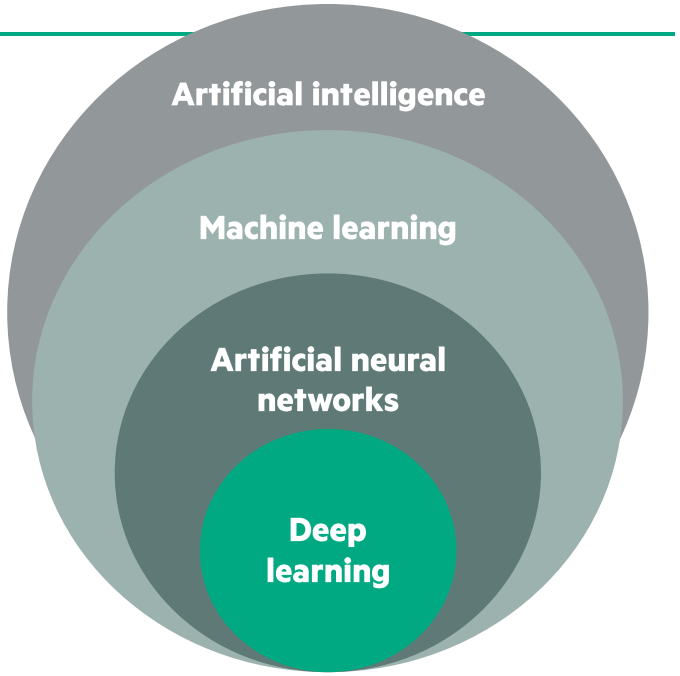
Requires feature engineering

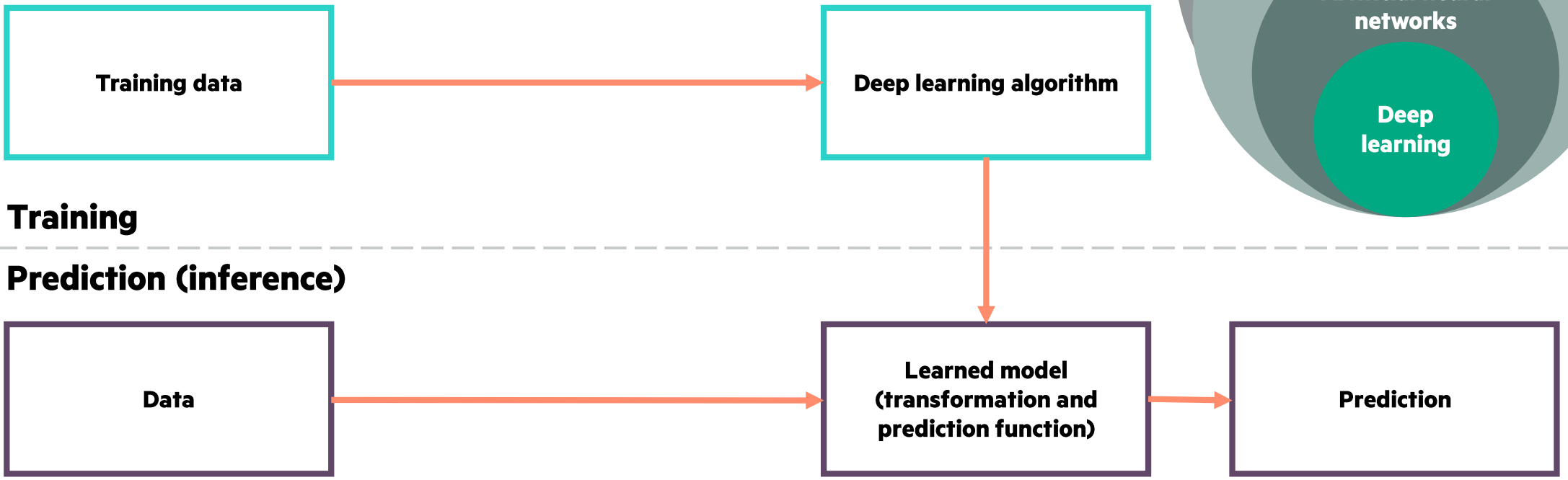




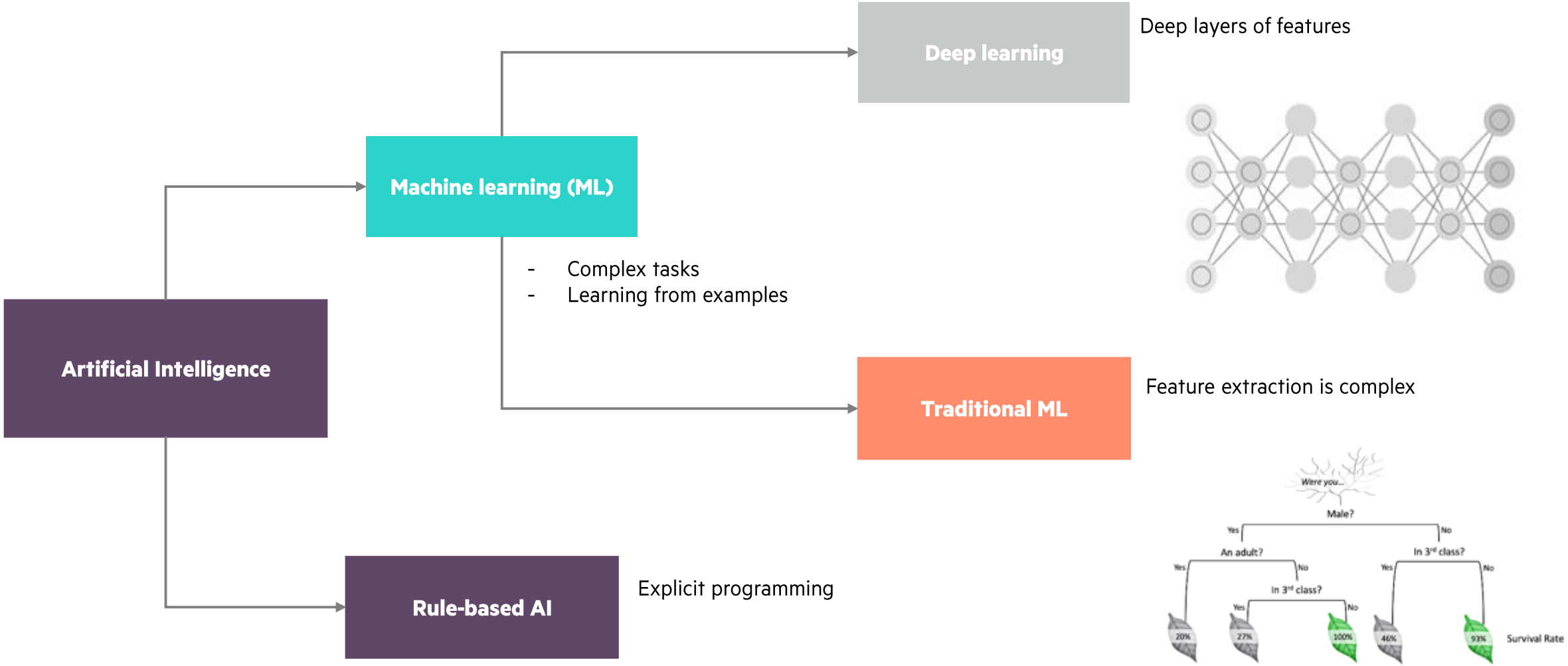
Deep learning

Efficient data representations, no more feature engineering



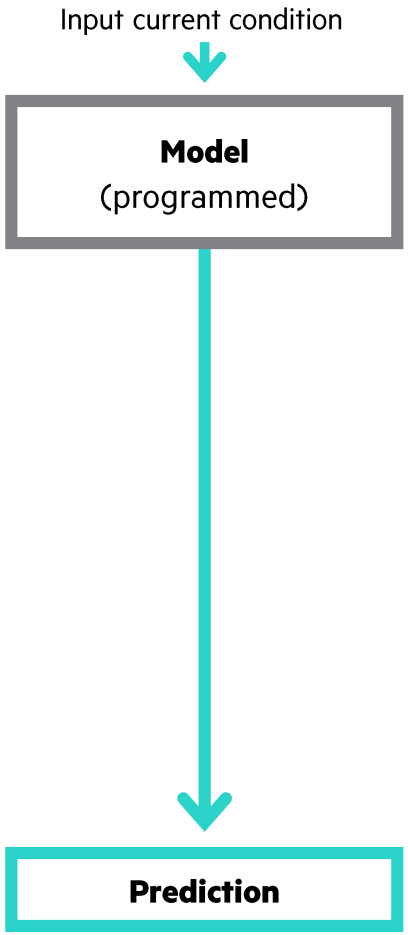


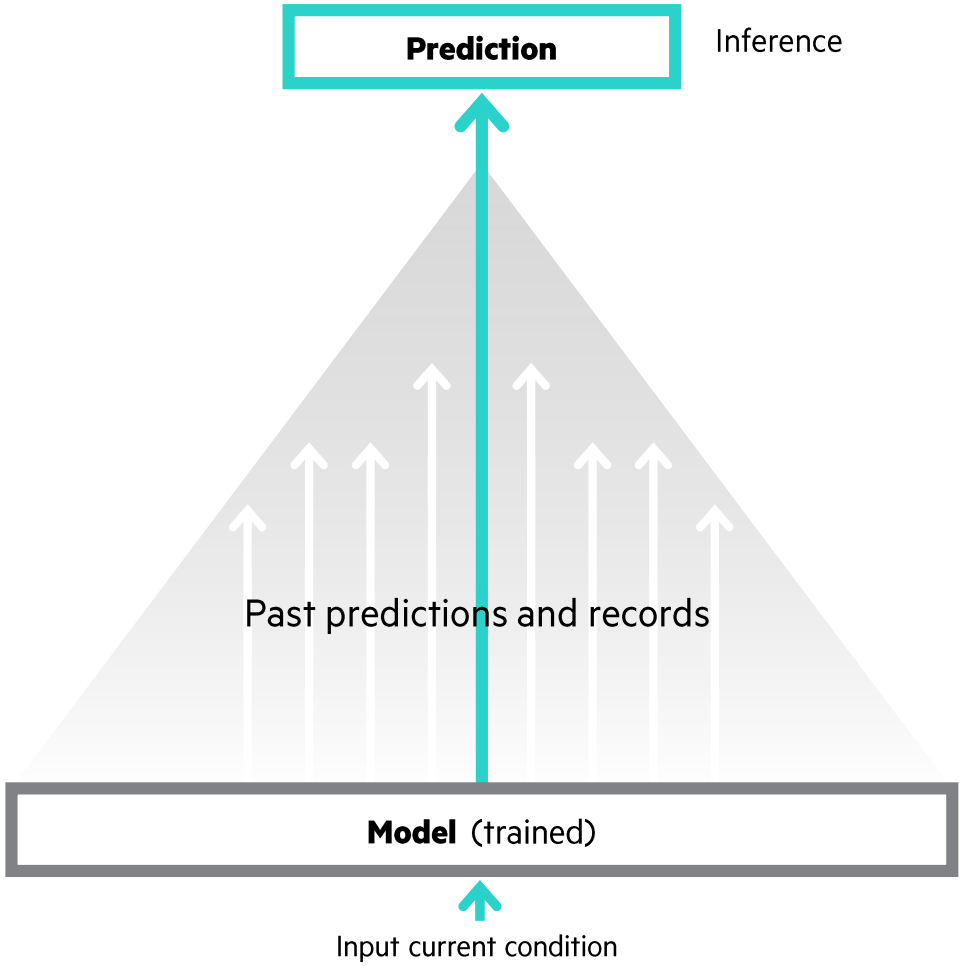
Rule-based AI, traditional ML and DL, (summary)



Artificial Intelligence, two approaches

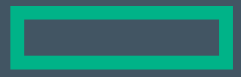
Top down
Deductive



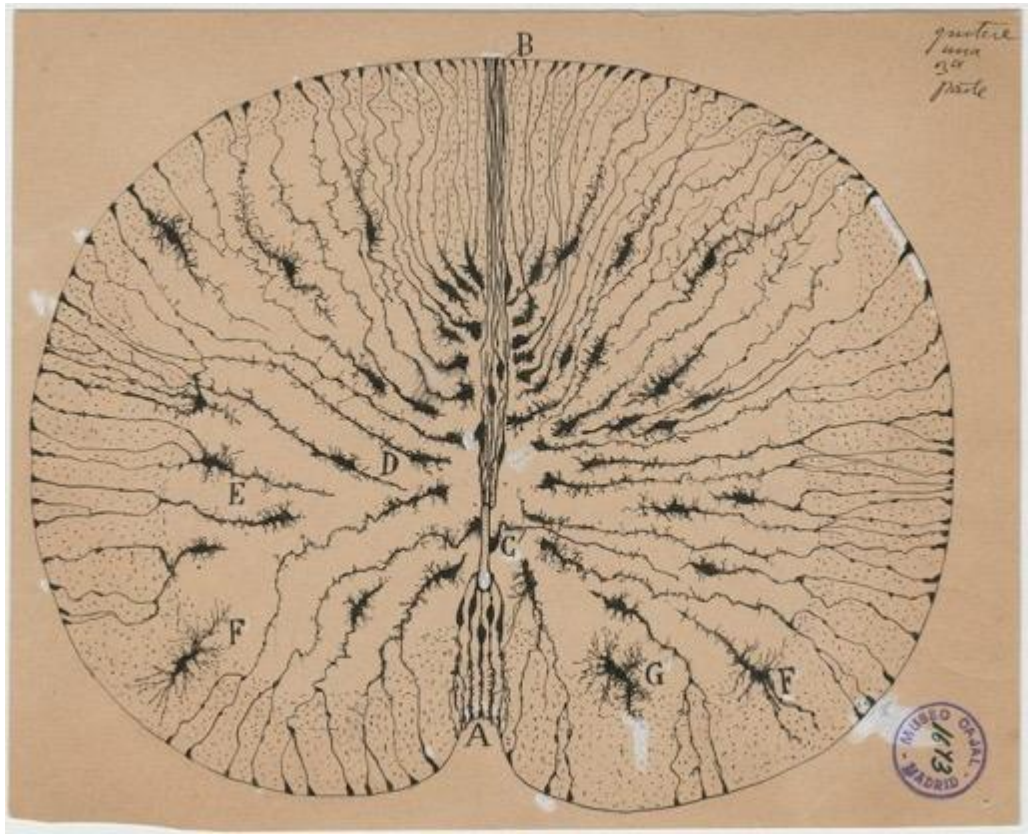


Bottom up
Inductive

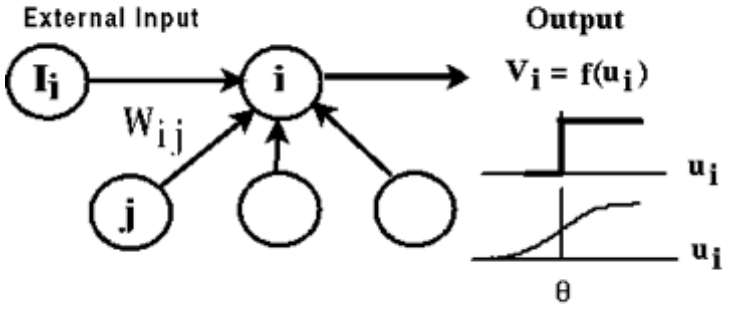
Copying the brain



Ramon y Cajal and Mcculloch-Pitts



$$u_i = \sum_j W_{ij} V_j + I_i$$



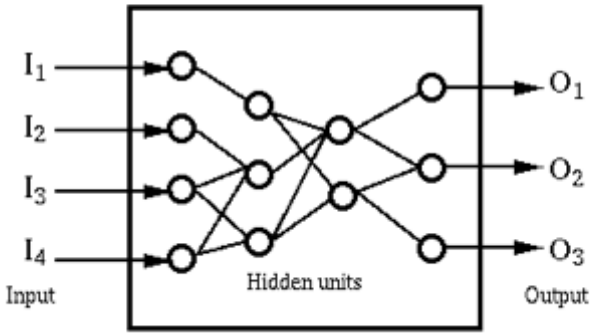
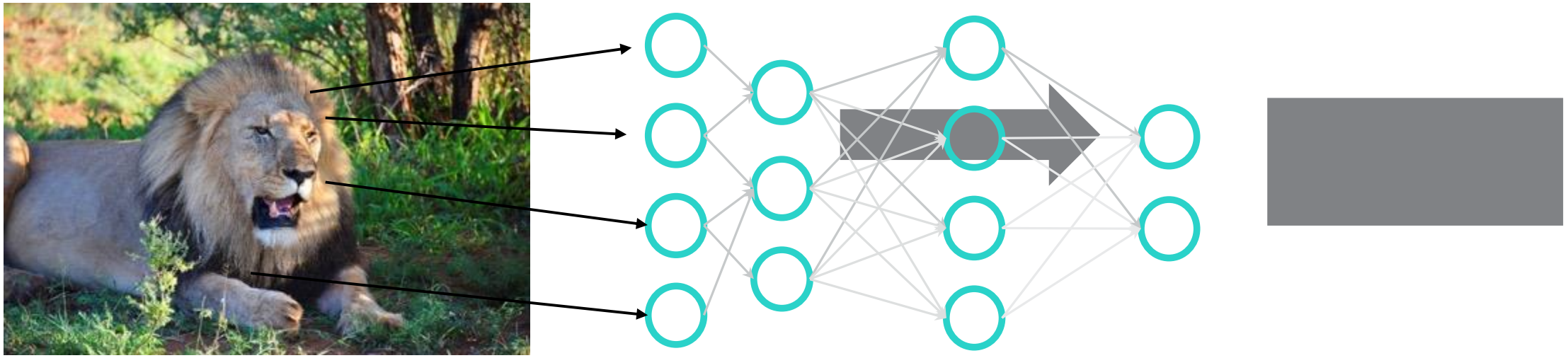


Image Source: https://ackland.org/exhibition/beautiful-brain-drawings-santiago-ramon-y-cajal/
http://ecee.colorado.edu/~ecen4831/lectures/NN1review.gif

The basic task of perception



What do you see?

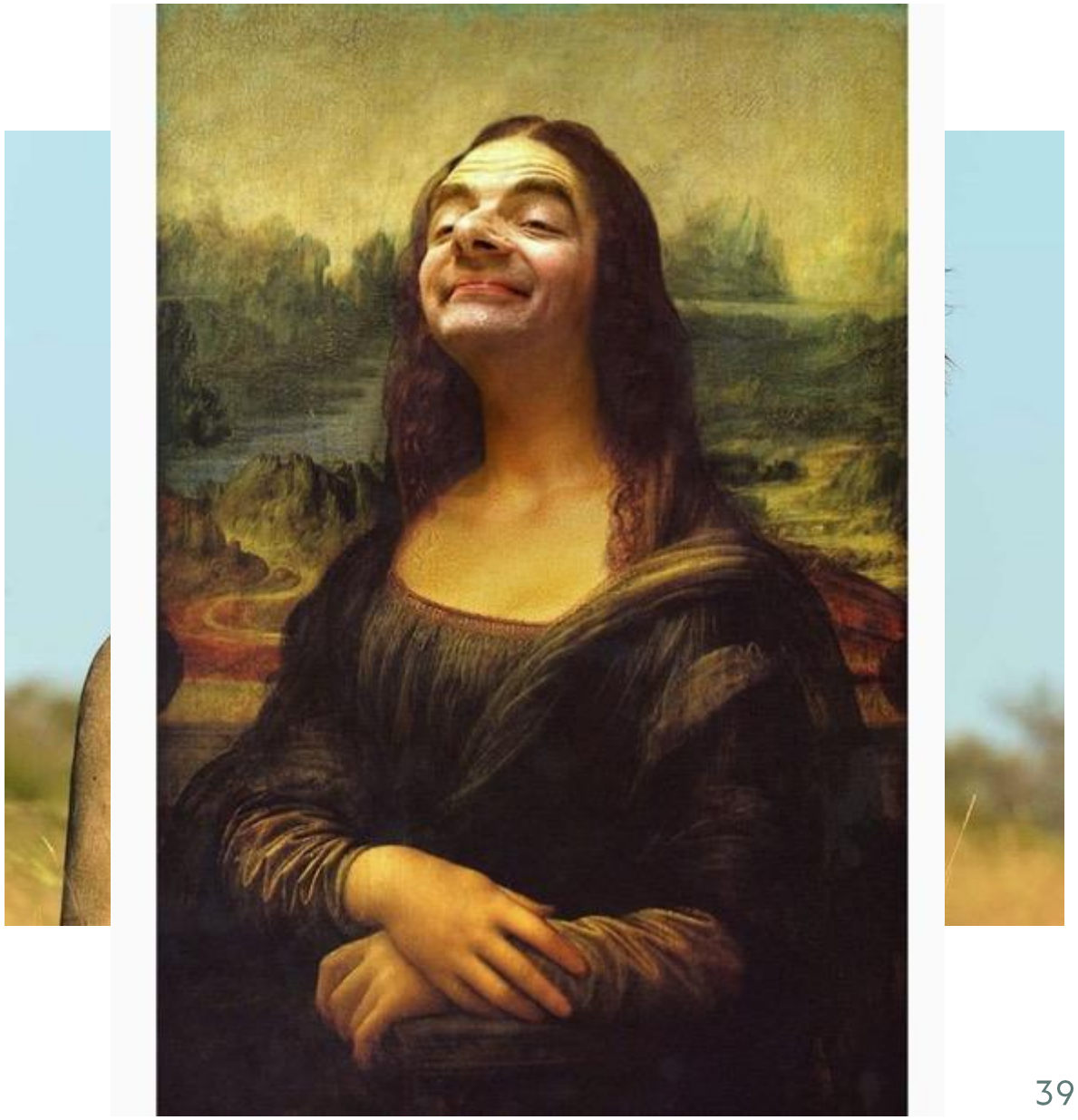
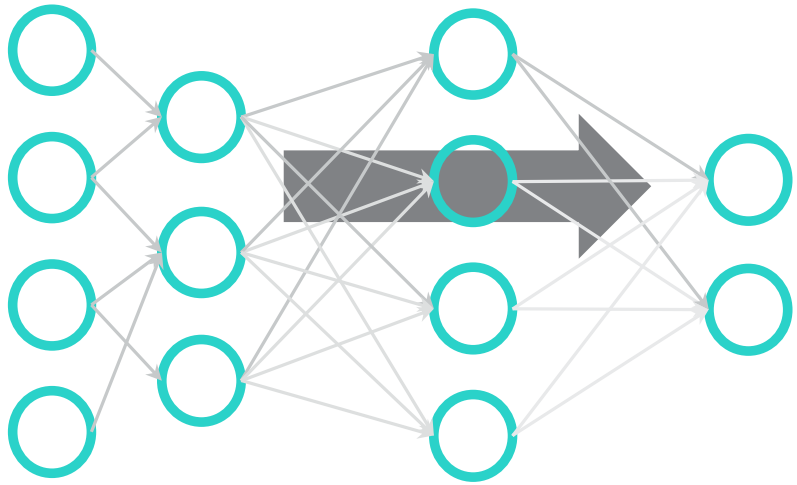
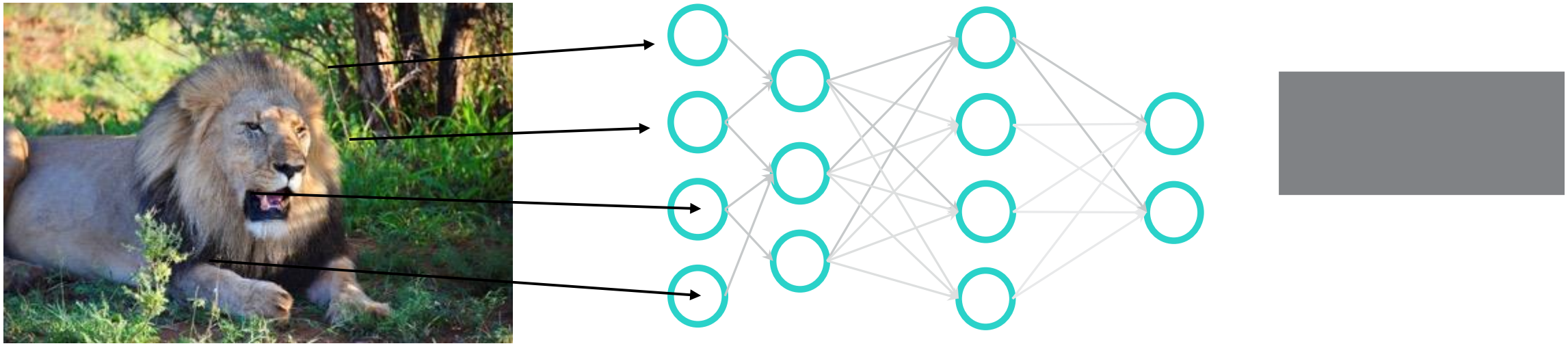


Image source: wikipedia.com
heraldie.blogspot.com

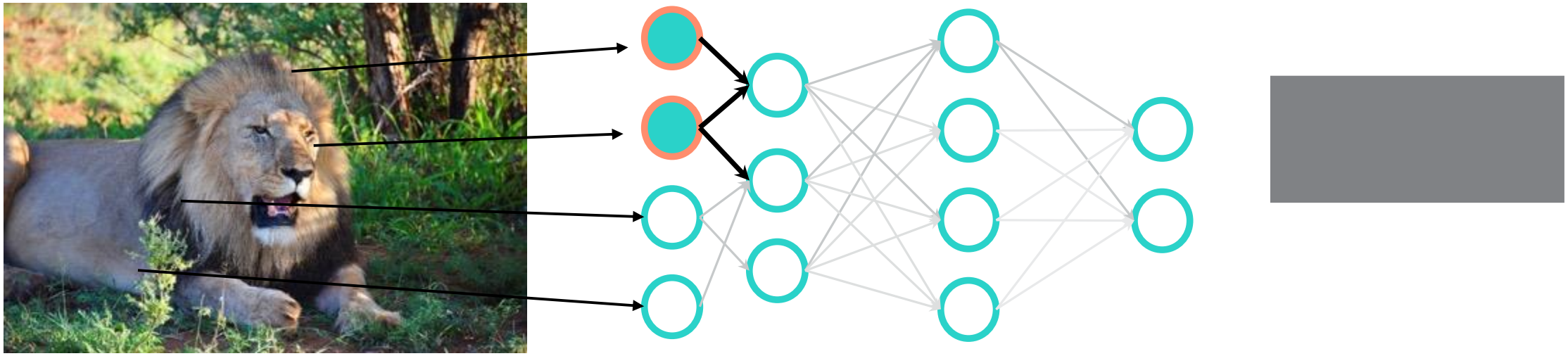
The basic task of perception



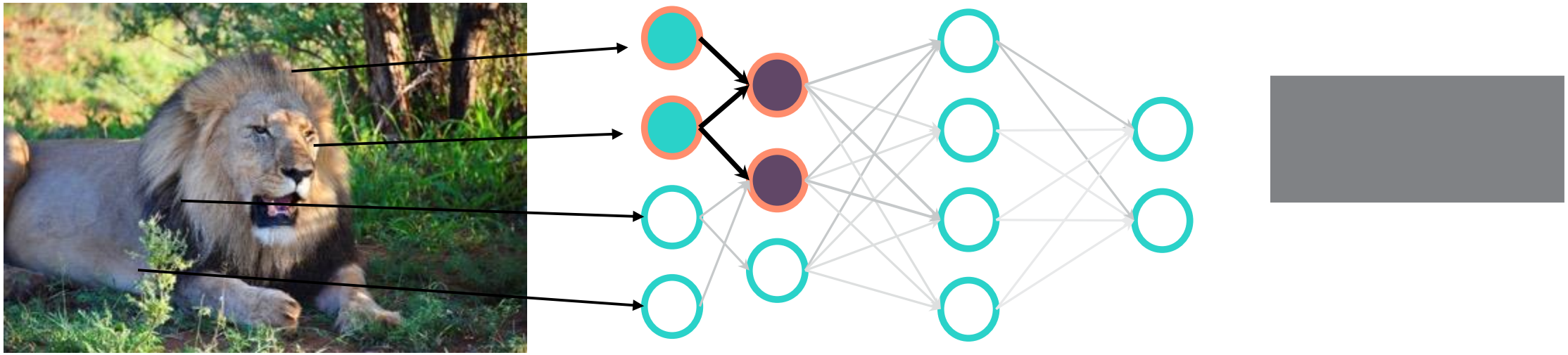
The basic task of perception



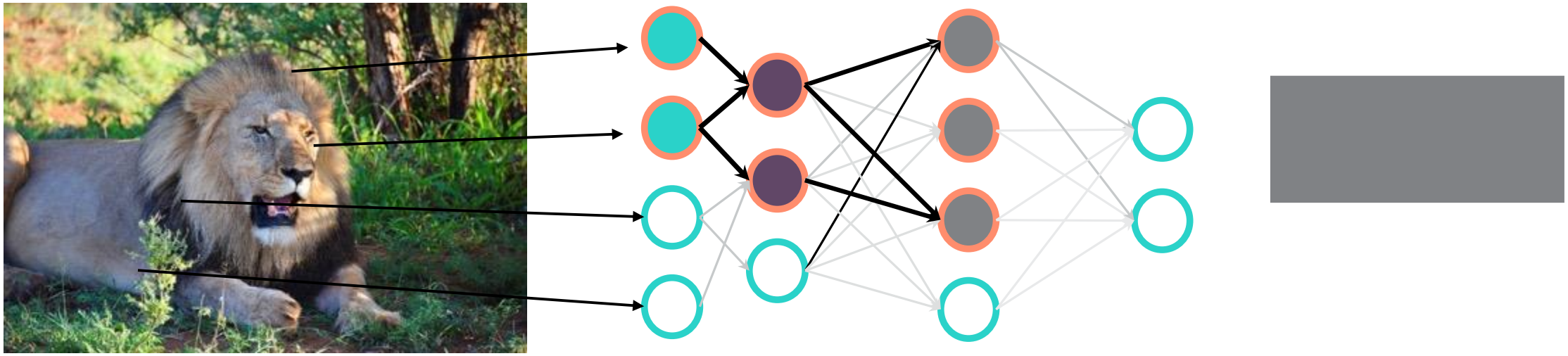
The basic task of perception



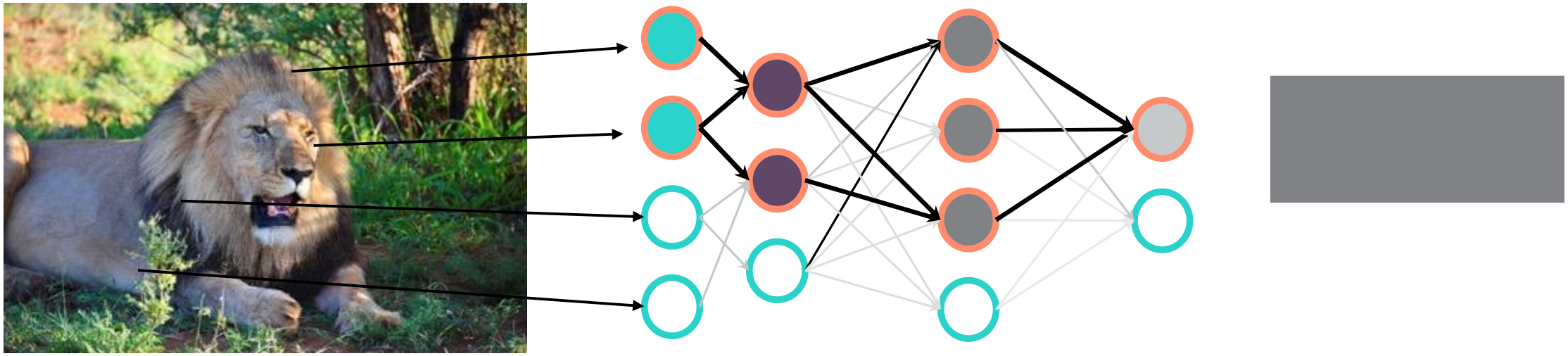
The basic task of perception



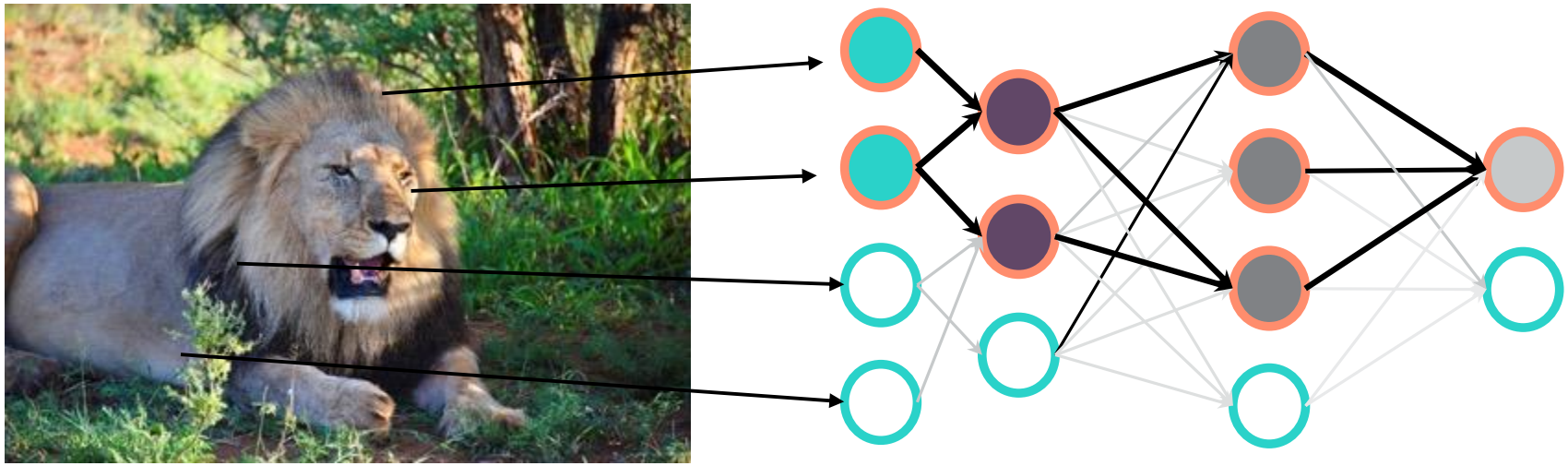
The basic task of perception



The basic task of perception

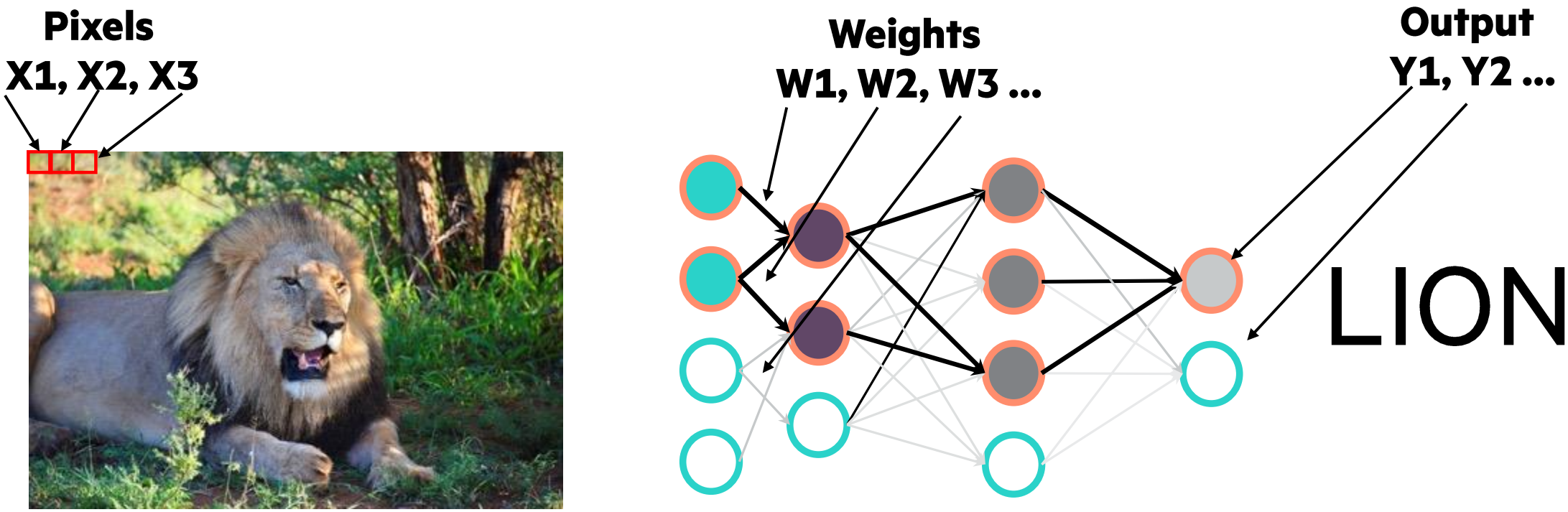


The basic task of perception



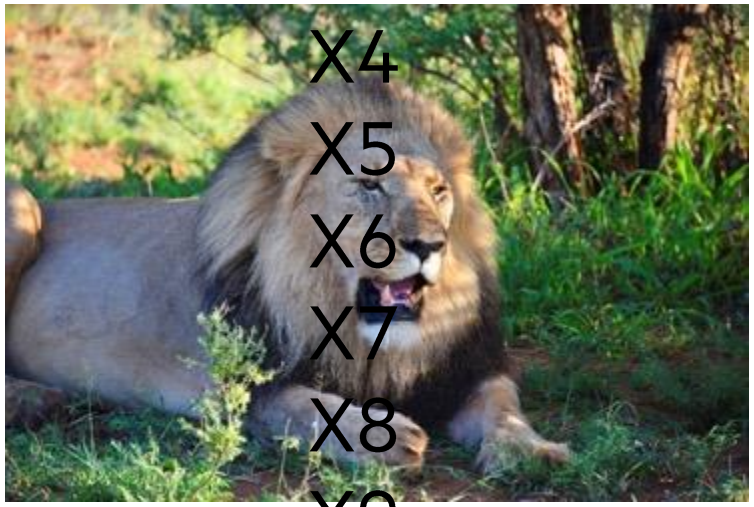
LION

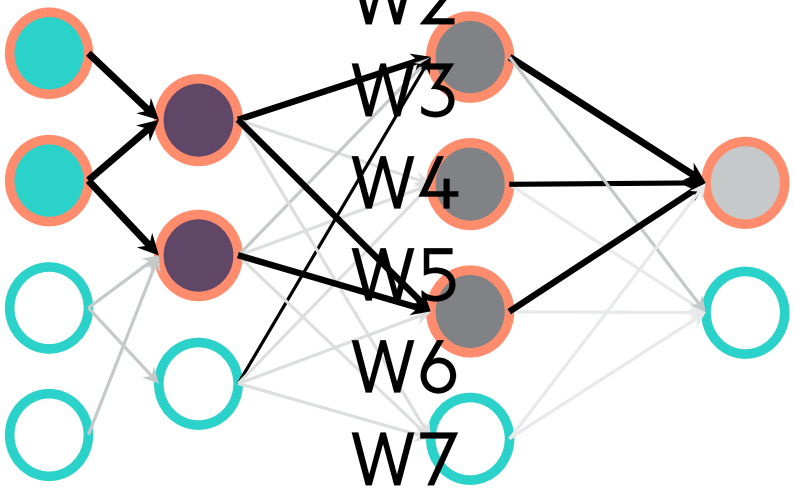
The basic task of perception



The basic task of perception

X1
X2
X3
X4
X5
X6
X7
X8
X9
X10
X12
X13
…



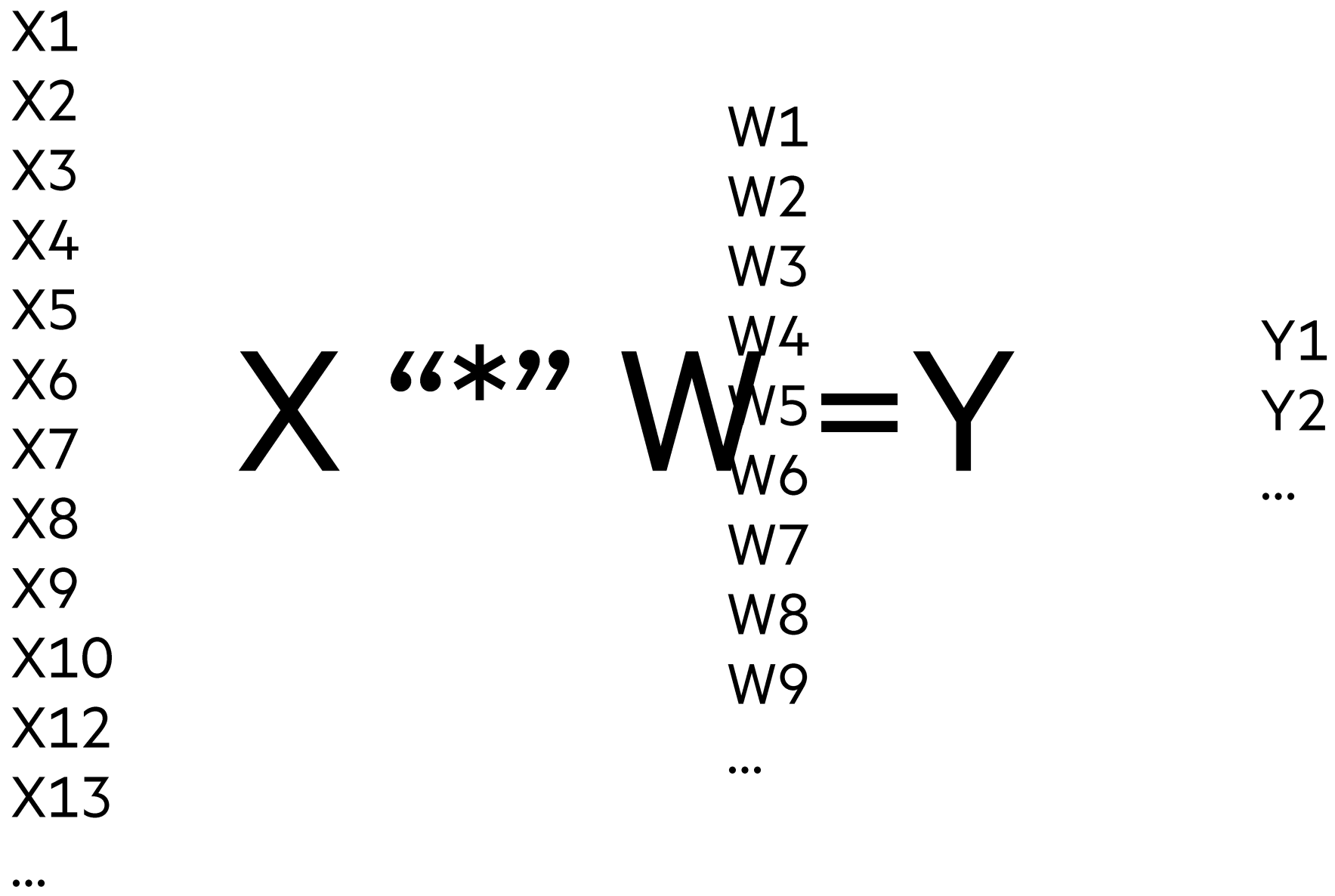


W1
W2
W3
W4
W5
W6
W7
W8
W9
…

X1
X2
-…

LION

The basic task of perception



The basic task of perception

$$X \text{ “*” } W = Y$$

One equation
Three variables
1 unknown

Inference

X “*” W =Y

Known. known Unknown

Inference

$$Y = X \text{ “*” } W$$

Suppose “*” is *

$$Y = 2 * 3$$

Training, learning

$$X \text{ “*” } W = Y$$

Known. Unknown Known

Training, learning

$$X \text{ “*” } W = Y$$

$$2 * W = 6$$

$$W = 6/2$$

Training, learning

$$X \text{ “*” } W = Y$$

$$2 * W = 6$$

$$0 = 2 * W - 6$$

Training, learning

$$0 = 2 * W - 6$$

$$Error = |2 * W - 6|$$

Training, perception

$$Error = |2 * W - 6|$$

W=0 Error = 6

W=-1 Error = 8

W=1.3 Error = 3.4

W=2.2 Error = 1.6

W=2.6 Error = 0.8

W=2.7 Error = 0.6

W=2.999 Error = 0.002

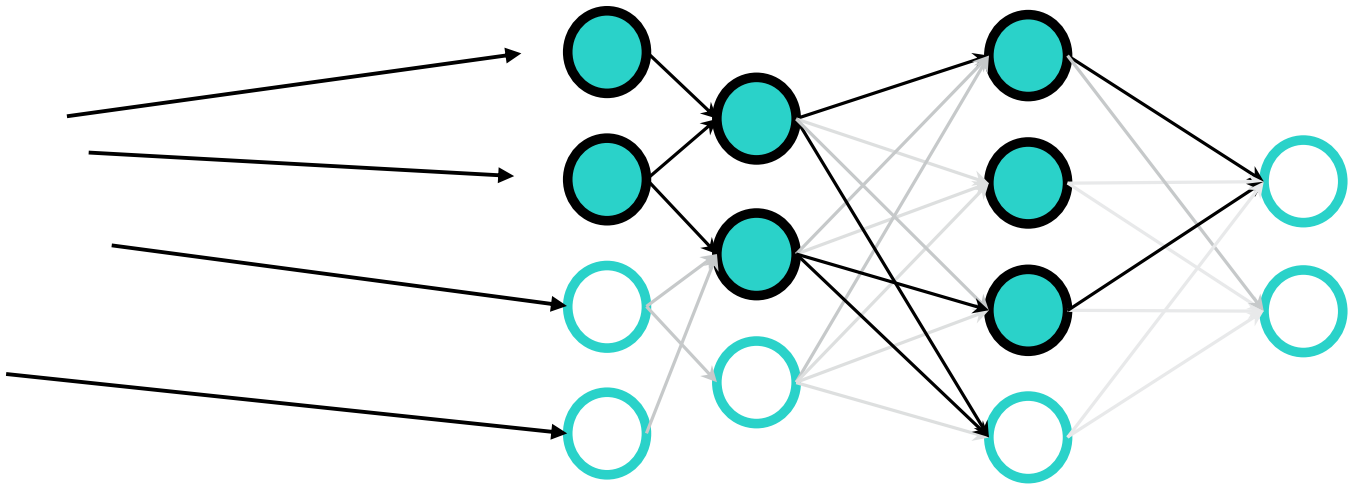
Solving for what?

$$X \text{ “*” } W = Y$$

Solving for Y = Every day Perception/Inference
Solving for W = Learning/Training
Solving for X?

Creativity

X



Bird

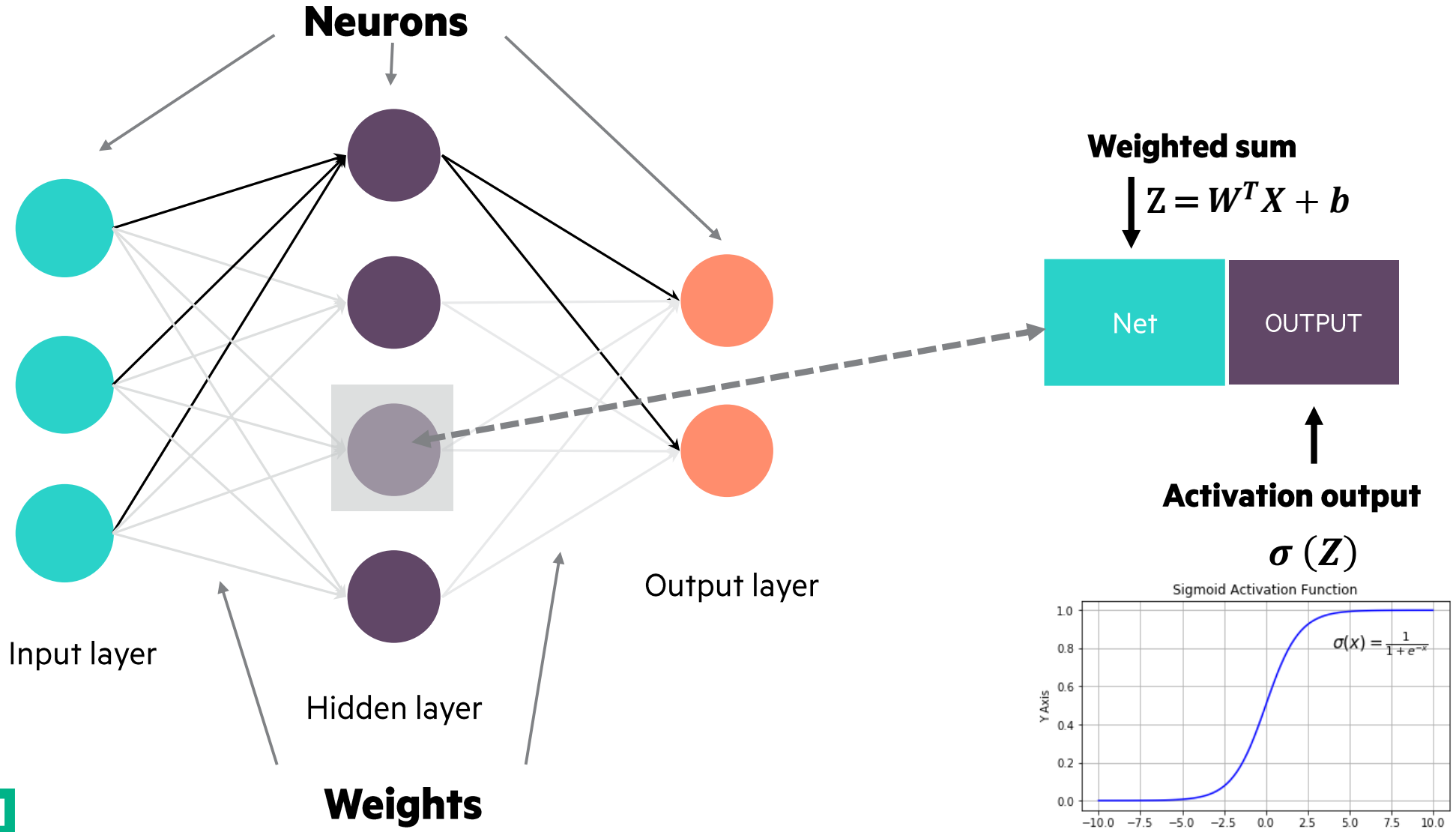
Image source: https://news.artnet.com/art-world/rutgers-artificial-intelligence-art-1019066

Portrait of Edmond Belamy

Image source: Wikepedia.org

So a neural network?

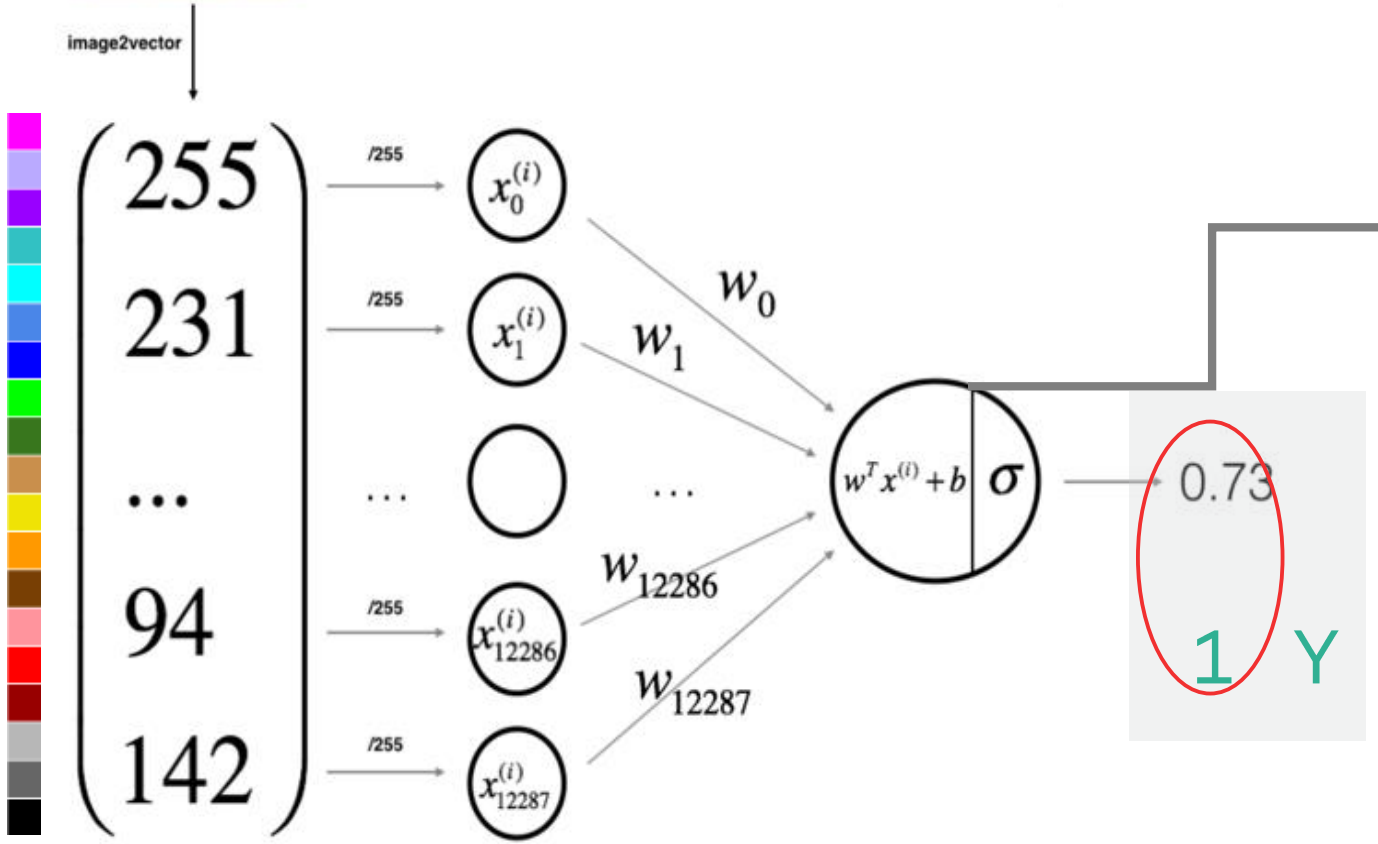
Many weighted sums

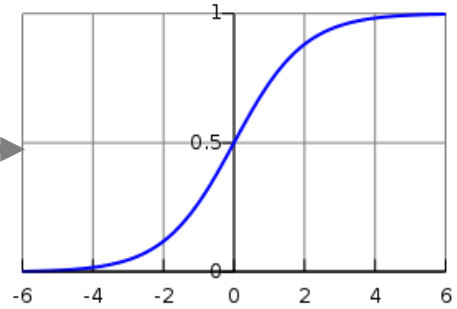


A simple example

Loss Function

$$\mathcal{L}^{(i)} = \mathcal{L}\left(Y'^{(i)}, Y^{(i)}\right) = \frac{1}{2}\left(Y'^{(i)} - Y^{(i)}\right)^2$$



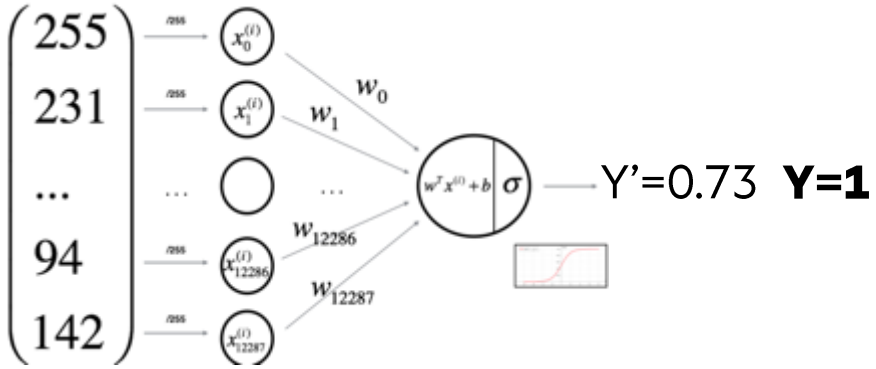


$$Y' = \sigma(Z) = \frac{1}{1 + e^{-Z}} \quad where\ Z = W^T X + b$$

Image source: http://www.image-net.org/
http://www.vision.caltech.edu/visipedia/CUB-200.html

Error or the cost function

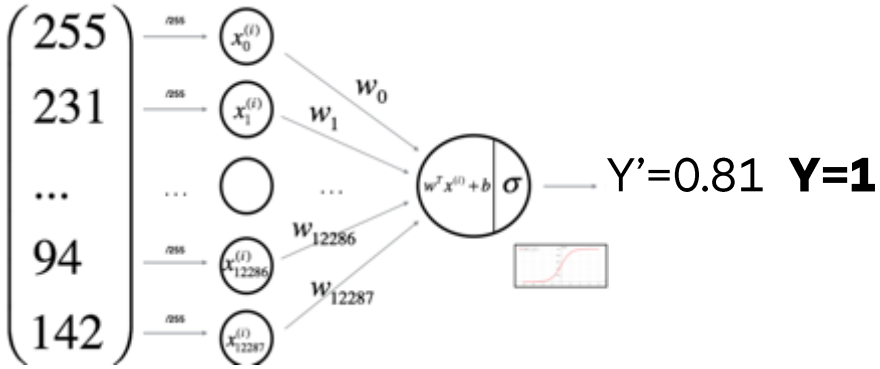
Training example #1



Y'=0.73 **Y=1**

$$\mathcal{L}^{(1)} = \frac{1}{2}(0.73 - 1)^2 = 0.0364$$

Training example #2



Y'=0.81 **Y=1**

$$\mathcal{L}^{(2)} = \frac{1}{2}(0.81 - 1)^2 = 0.018$$

"Cost"

or

"Global Loss"

"Mean Squared Error" (MSE)

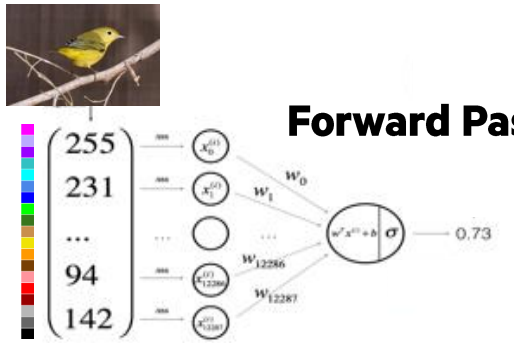
$$J(W) = \frac{1}{m}\sum_{i=1}^{m} \mathcal{L}^{(i)}$$

m = 2: $$J(W) = \frac{1}{2}\left(\mathcal{L}^{(1)} + \mathcal{L}^{(2)}\right) = 0.0272$$

Image source: http://www.image-net.org/
http://www.vision.caltech.edu/visipedia/CUB-200.html

Training

Make a prediction



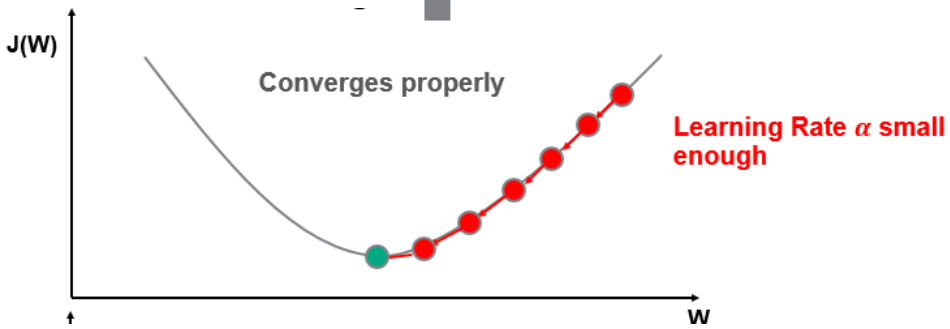
Forward Pass

How wrong is the network? Global Loss

Loss Function

$$\mathcal{L}^{(i)} = \mathcal{L}\left(Y'^{(i)}, Y^{(i)}\right)$$

$$= \frac{1}{2}\left(Y'^{(i)} - Y^{(i)}\right)^2$$



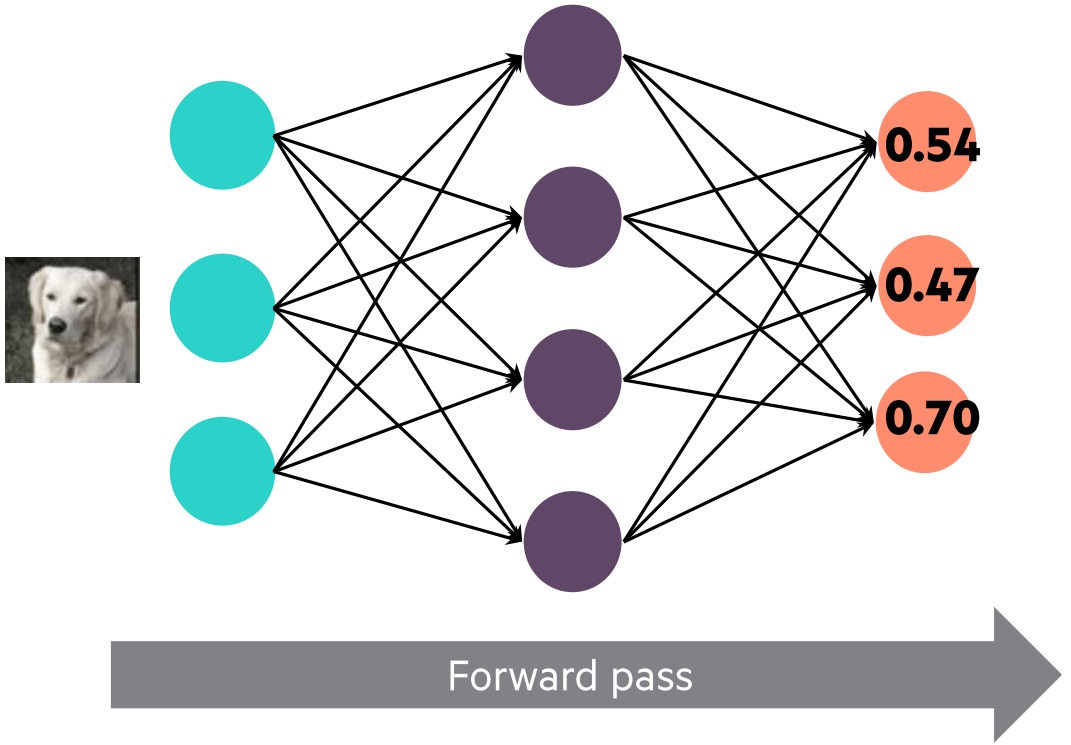
Weights correction

Gradient descent

Image source: http://www.image-net.org/
http://www.vision.caltech.edu/visipedia/CUB-200.html

A more difficult one

Three classes

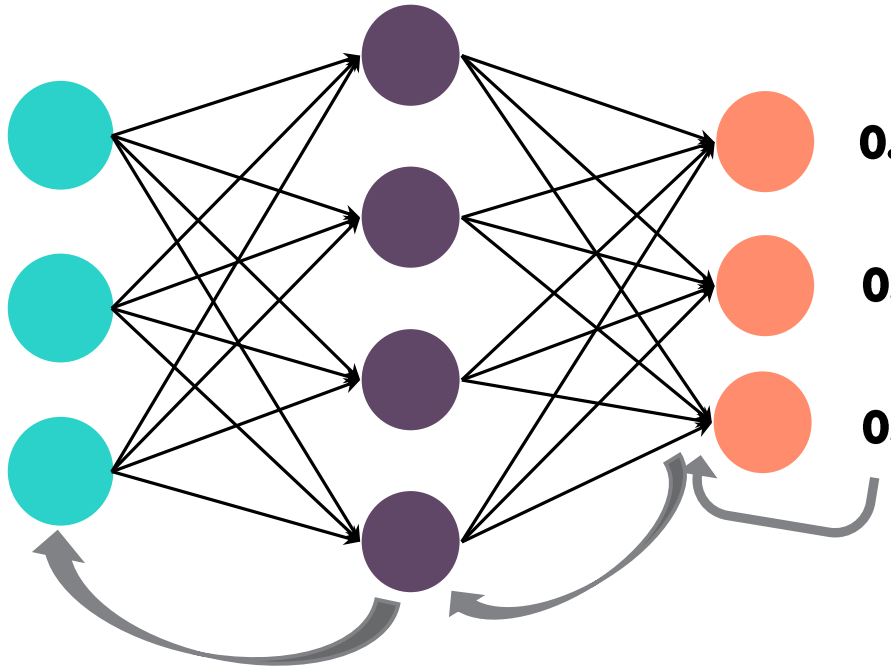


We compute each values on neurons based on the initial input (the image) and all the parameters (weights)

Image source: http://www.image-net.org/
http://www.vision.caltech.edu/visipedia/CUB-200.html

Processing data though the network

Training ‘labelled’ data



$0.5*(1- 0.54)^2$ **DOG** Expecting 1

$0.5*(0- 0.47)^2$ **CAT** Expecting 0

$0.5*(0- 0.70)^2$ **BIRD** Expecting 0

Input label says ‘DOG’

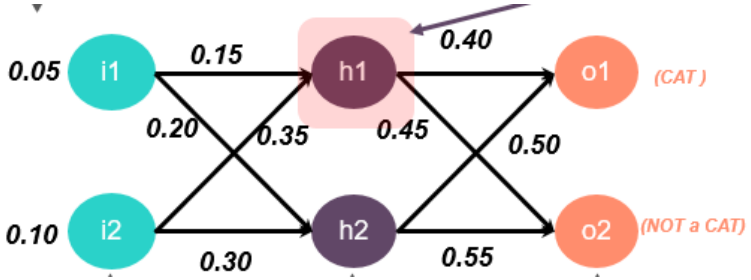
Back propagation pass

The back propagation will update all weights to get closer to the expected result

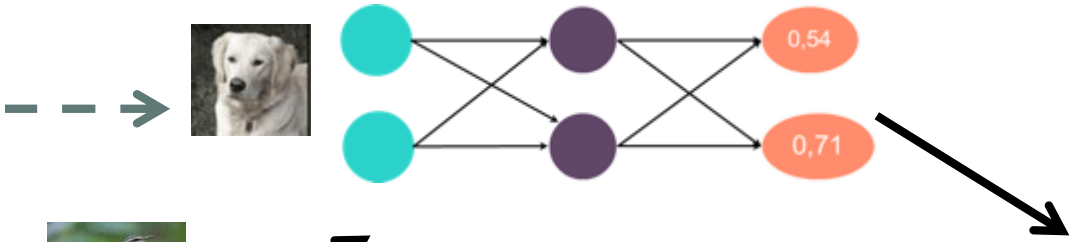
Image source: http://www.image-net.org/
http://www.vision.caltech.edu/visipedia/CUB-200.html

Training summary

1) Network initialization

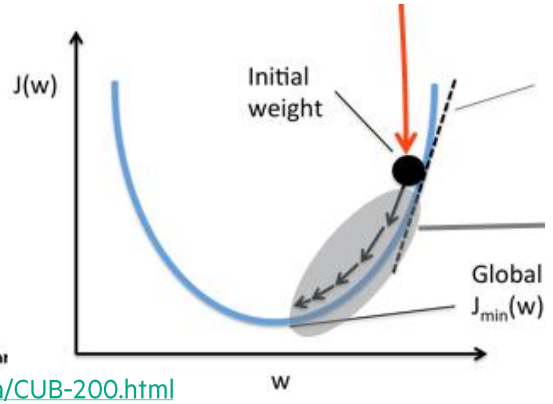


2) Forward pass



3) Measure and minimize error

$$\text{Cost} = J = \frac{1}{2}\sum(target - output)^2$$



4) Back propagation

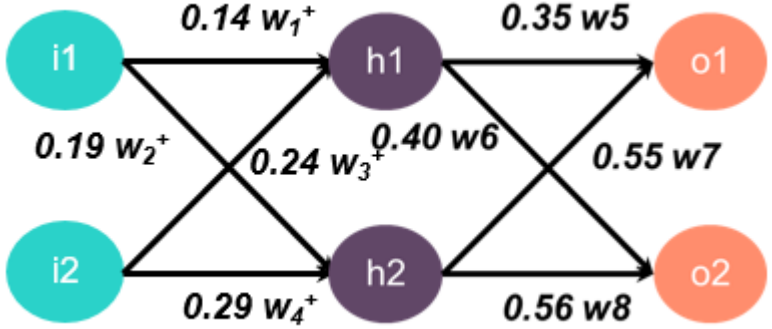


Image source: http://www.image-net.org/
http://www.vision.caltech.edu/visipedia/CUB-200.html

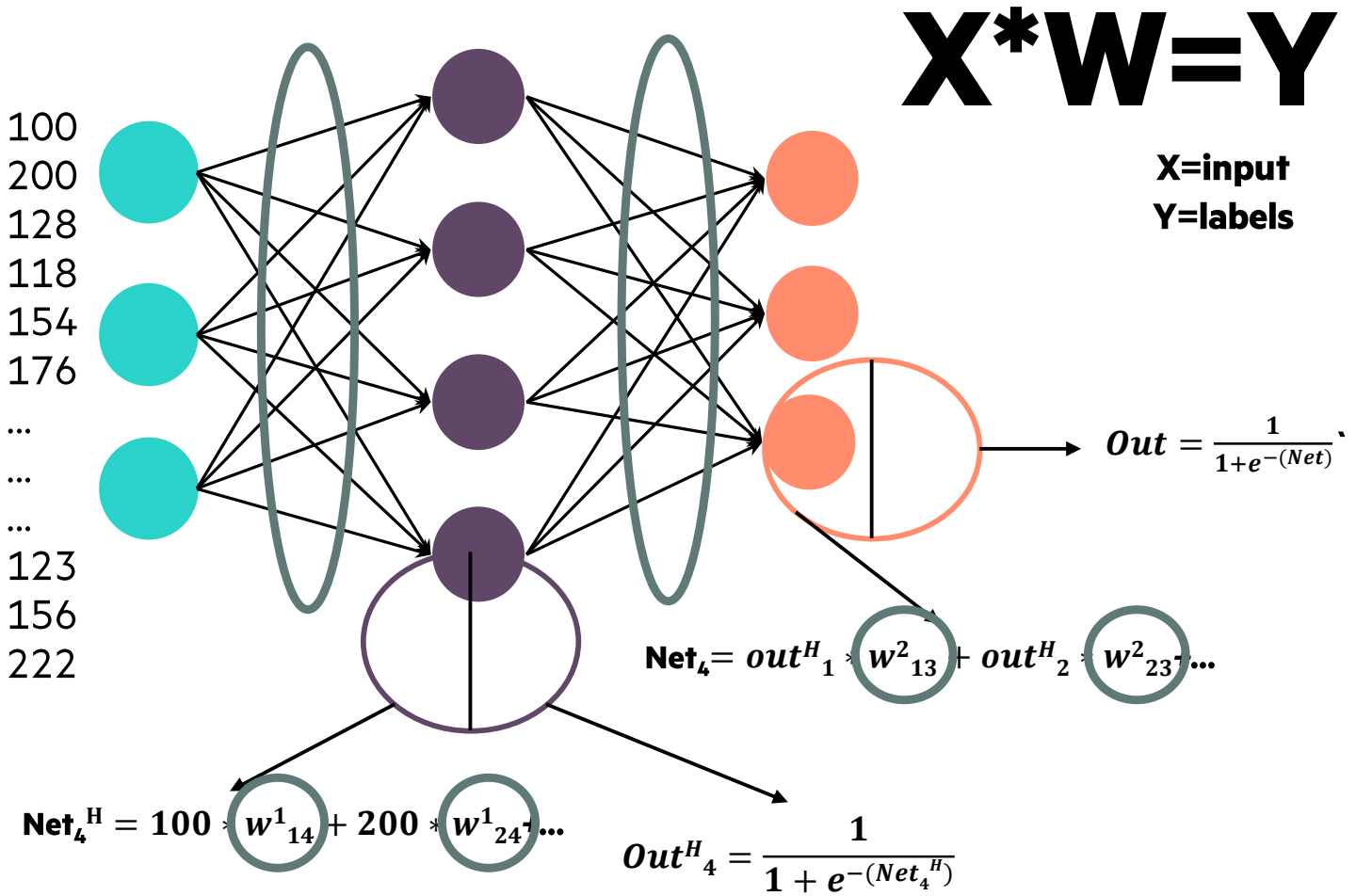
But how this work?

[R G B]

[100,220,128]

[100, 200, 128, 118,154,176.....]

Pixel 1 Pixel 2



What are the unkowns above ?

Image source: http://www.image-net.org/
http://www.vision.caltech.edu/visipedia/CUB-200.html

Inference

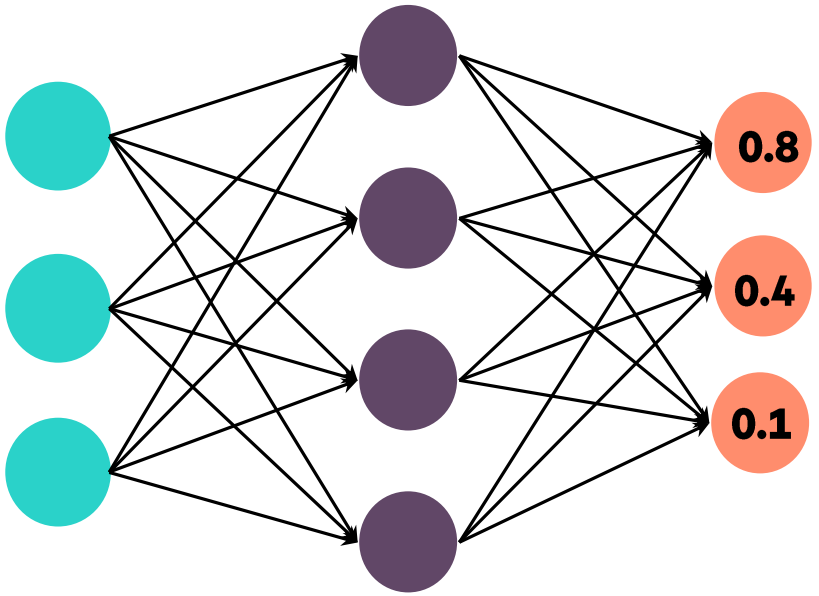
Once the model is created, let's play

Once the model has been trained, using it is called **inference**

It does not require as much as computing power as training and could be done **on smaller devices**

- Your mobile phone already uses inference (face recognition, google Gboard)

New data

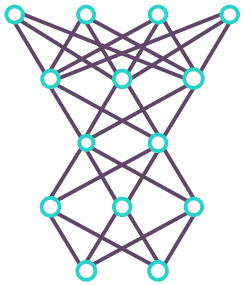


Trained model

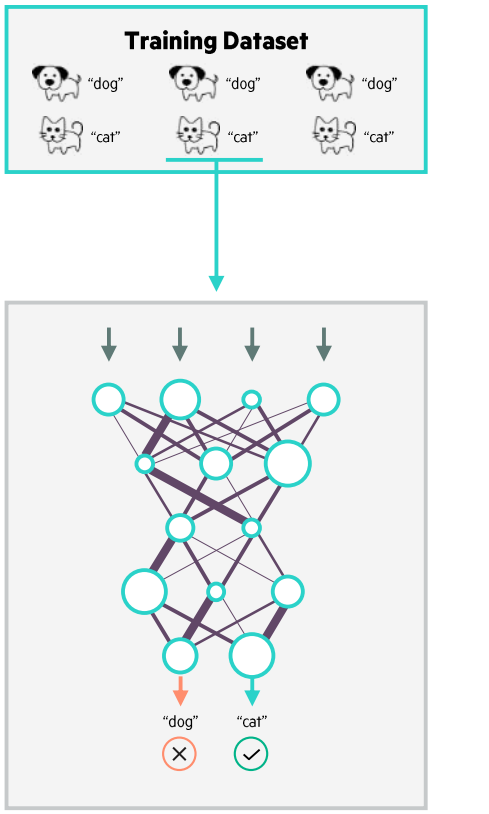
Image source: http://www.image-net.org/
http://www.vision.caltech.edu/visipedia/CUB-200.html

Summary

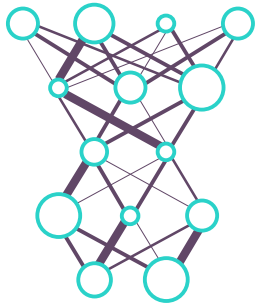
Untrained
Neural Network Model



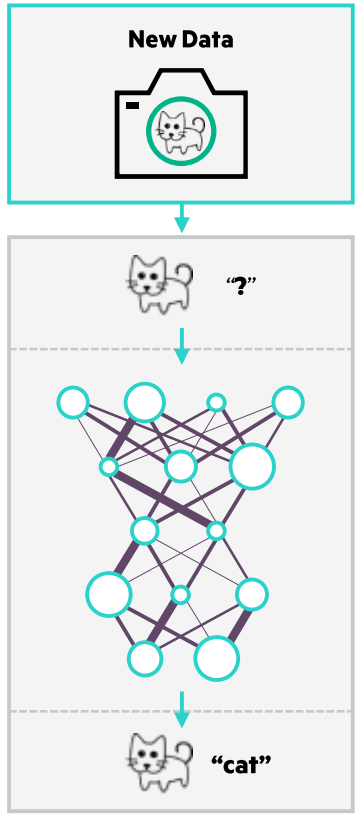
Training
Learning a new capability from existing data



Trained Model
New capability optimized for performance



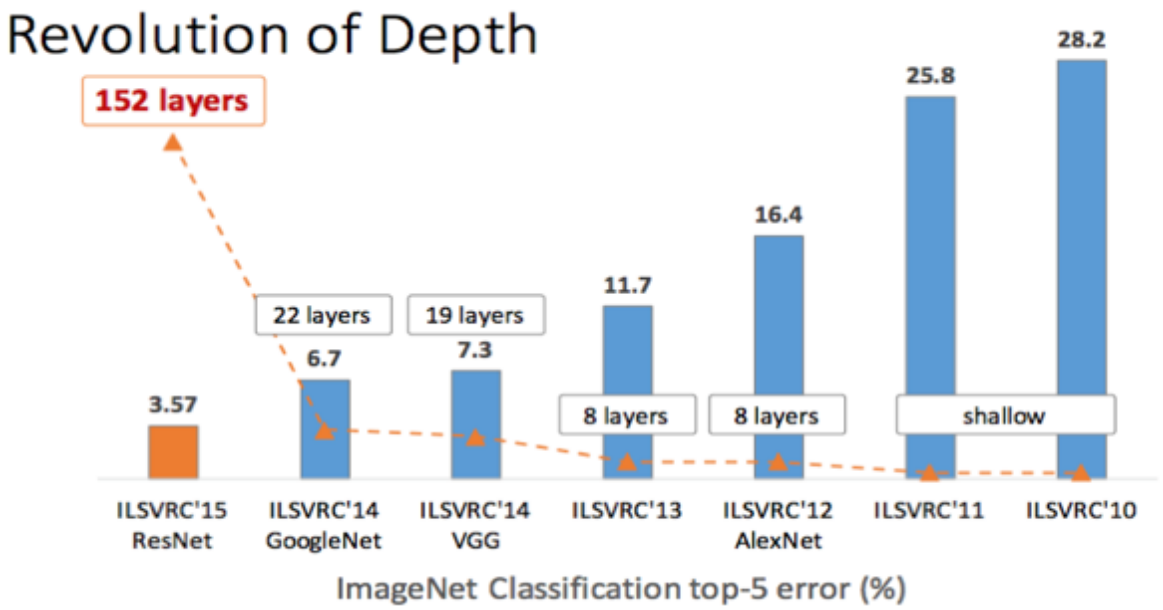
Inference
Applying this capability to new data

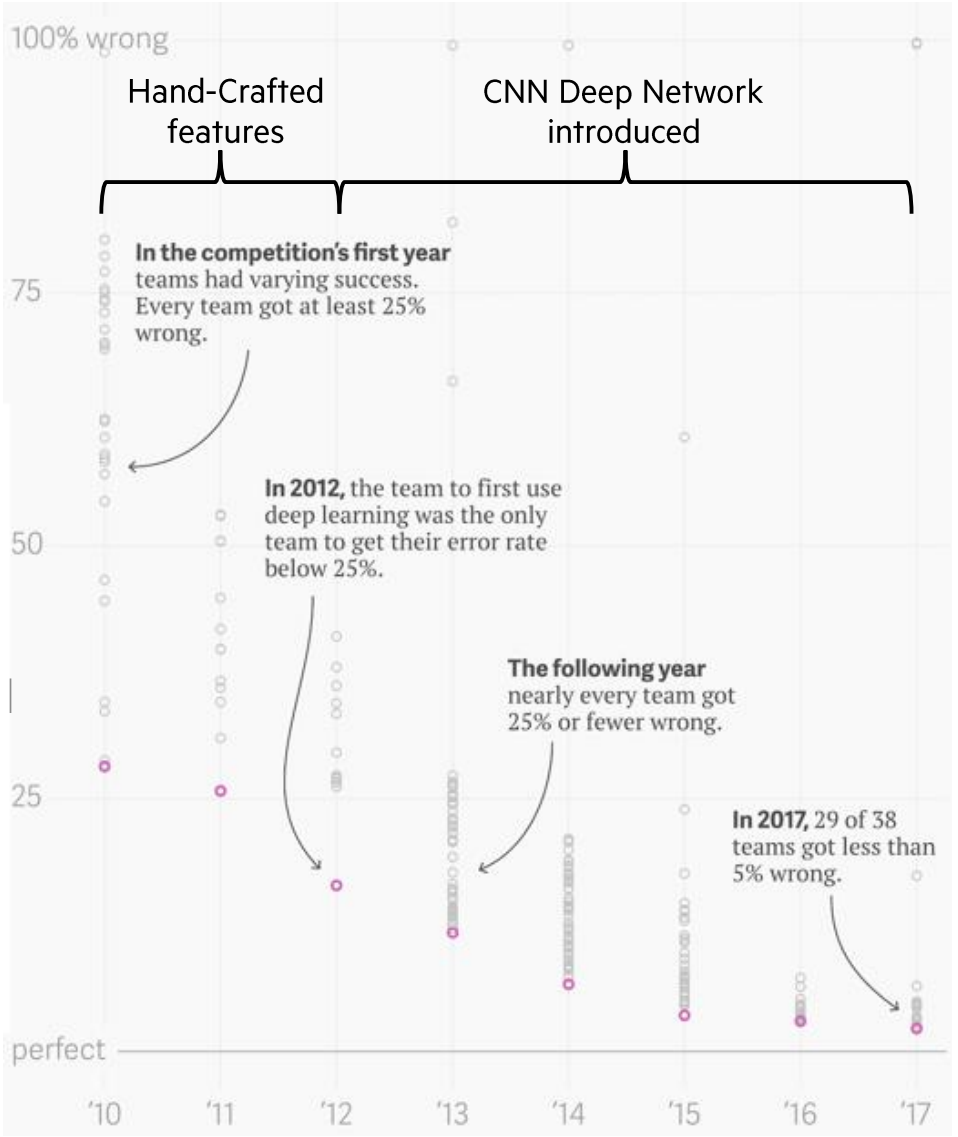


App or service
Featuring Capability

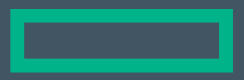
So what happened 6 years ago? Convolution

Image net
- Created by Professor Li Fei Fei (Stanford)
- dataset of 14.197.122 images
- Contains 21841 categories





Well, nice but



First solutions ready

Autonomous driving Connected cars

HAD

- Implementation of level 3 and level 4 of autonomous driving

Surveillance using video analytics

Airport surveillance

- Facial recognition
- Queue monitoring
- Unattended items

Speech To Text Natural Language Processing

Communication surveillance

- Speech to Text
- Biometric search
- Live Call monitoring

Quality control and prescriptive maintenance

Manufacturing quality control

- Identify defects

Prescriptive industrial maintenance

- based on equipment condition

Get more information

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- **SL9662**: A new gold rush: AI, Blockchain and IoT working together to uncover the ultimate in riches, real-time intelligence **(Wed. 9:00)**
- **B9807:** Accelerating Autonomous Vehicle Development with DXC Robotic Drive **(Wed. 9:00)**
- **TB8561**: PSC and HPE team up to significantly contribute to the scientific breakthroughs of tomorrow **(Wed. 10:30)**
- **B8511**: Developing complex AI architectures the easy way **(Thurs. 10:30)**

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- **DEMO 1301**: Artificial intelligence in action: LEGO challenge for machines and humans
- **DEMO 1302**: Unlock data with AI and analytics

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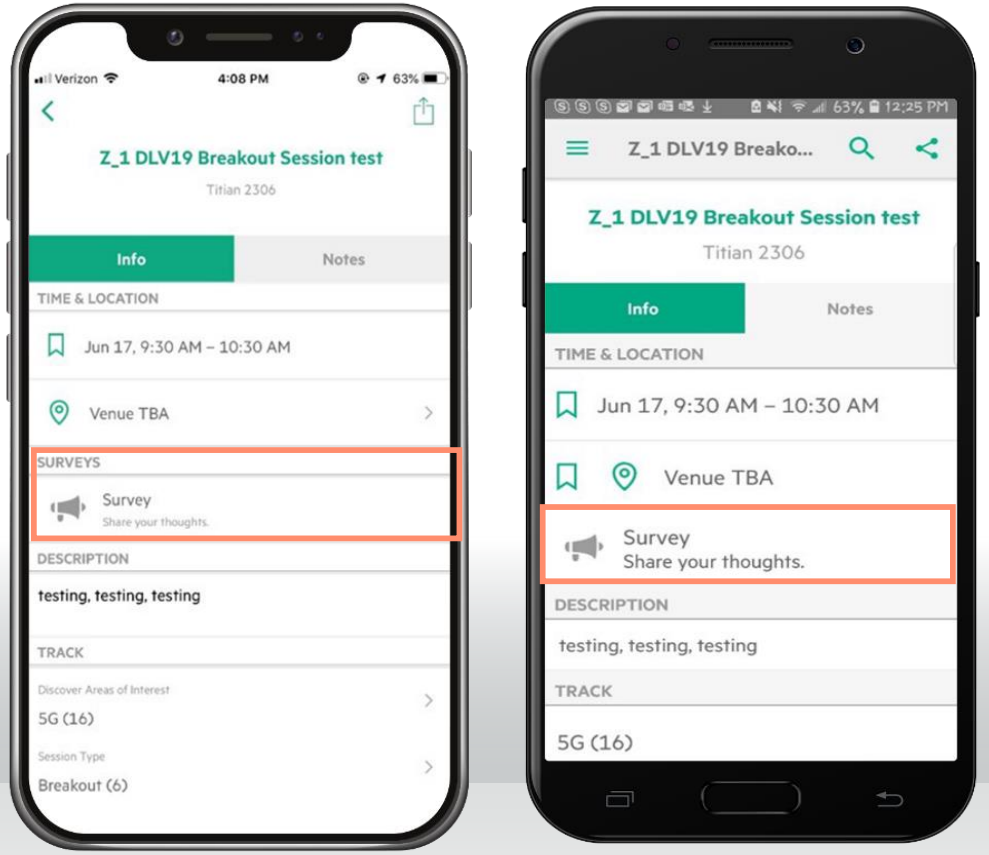

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