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Demystification of Artificial Intelligence

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Some definitions & … some history

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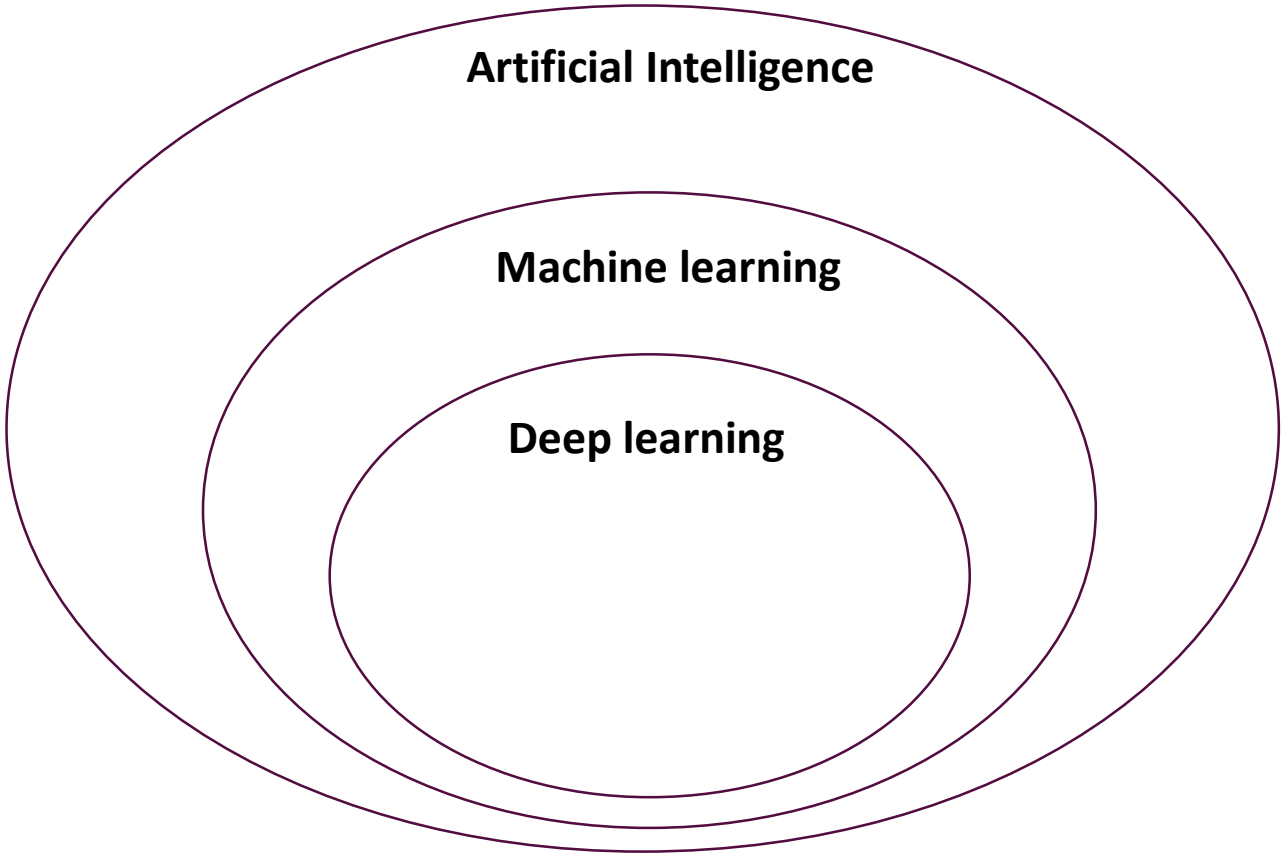
Let’s first start with a definition of terms …



Artificial Intelligence (AI)

Any technique which enables computers to **mimic human behavior**

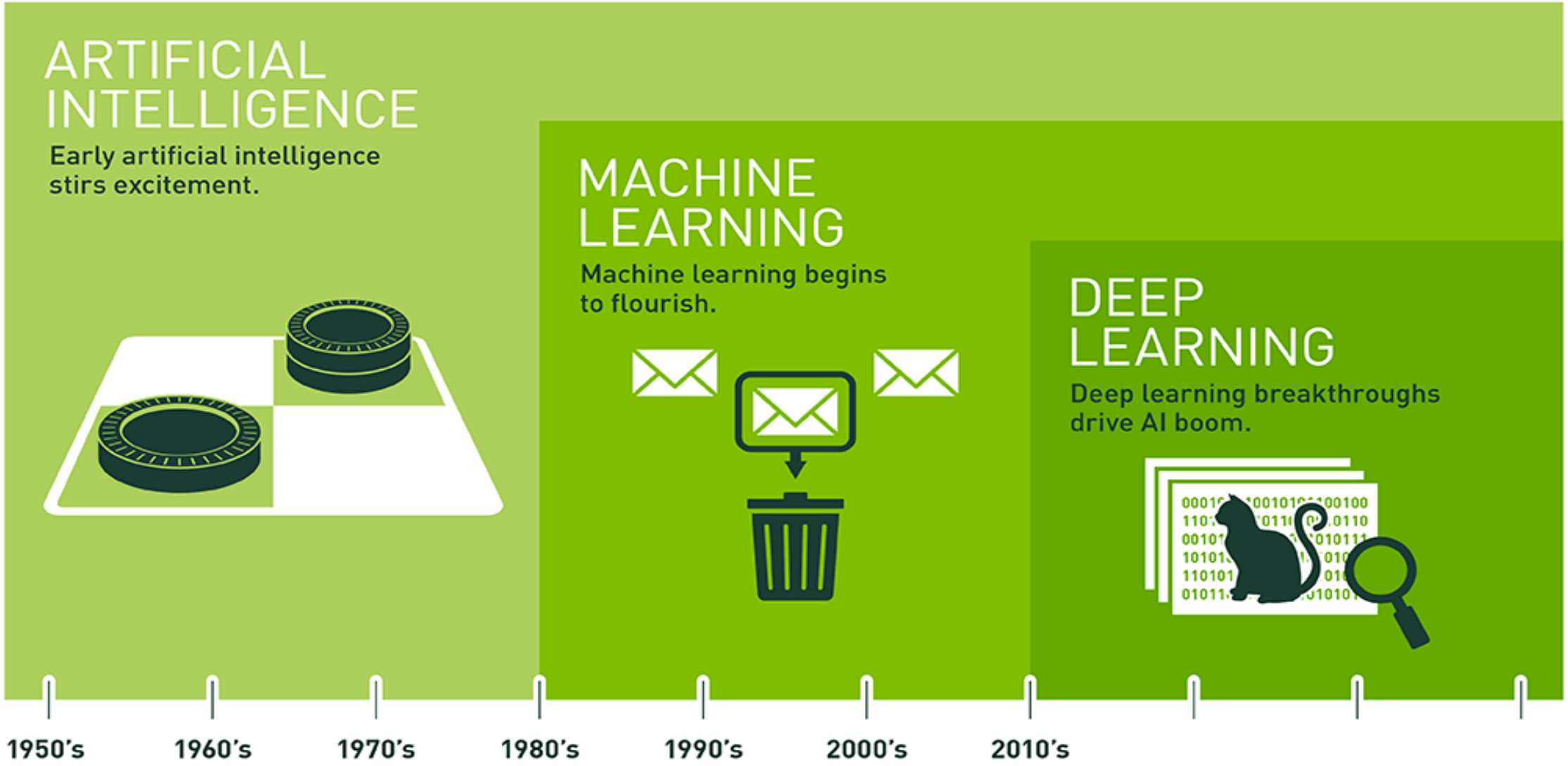
Machine Learning (ML)

Subset of AI techniques which **uses statistical methods** to enable machine to improve with experiences

Deep Learning (DL)

Subset of ML which makes the computation of multi-layered **deep neural network** feasible

Artificial intelligence disciplines have emerged over time



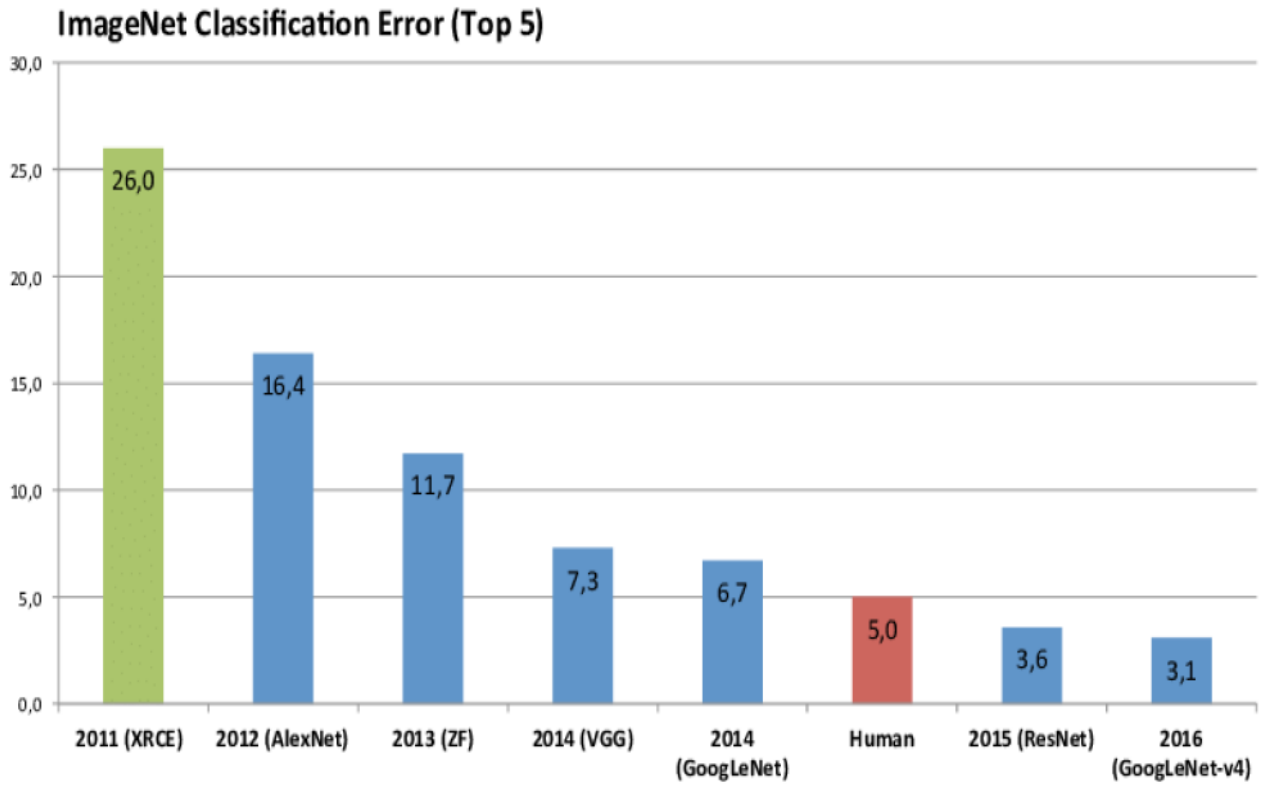
Machine “Learning” back in 1997

- First computer program to defeat a **World Chess Champion**
- IBM Super Computer **Deep Blue** defeated Garry Kasparov in the 2nd of 6 matches
- Deep Blue mainly relied on **brute computational force** to evaluate millions of positions

The **Deep Learning** breakthrough in 2012

IMAGENET

- ImageNet is a public library that has 14M hand-annotated images
- It contains more the 20k categories (such as “balloon”, ”strawberry”, …)
- Since 2010, there is a contest called “*Large Scale **Visual Recognition Challenge***”



- In 2012, the breakthrough by AlexNet is often considered as the beginning of the **Deep Learning Revolution of the 2010s**
- **ResNets** (2015) or Residual Network is today still a very much used Neural Network

AlphaGo in 2016 : a **Game Changer** especially in China

- The Chinese “Go” game is 2.500 years old
- Rules are simple : players turn black or white stones on a board, trying to capture the opponent’s stone …
- … but there are 2 x 10^{170} possible board positions …

- AlphaGo defeated in **March 2016** the legendary Korean Player Lee Sedol by 4 – 1
- It uses a **Monte Carlo Tree Search** together with **Deep Neural Networks**
- 280M Chinees watched the game live on TV : **it plunged China into an AI fever** … .

Why did AI become a hype now ?

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4 main reasons why Artificial Intelligence became a hype

1. **Massive amounts of data available**
2. **Increasing Computing Power**
3. **Algorithms**
4. **Frameworks**

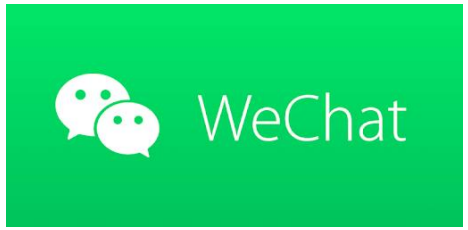
1. **Massive amounts of data**, the new gold …

2x

The volume of data continues to **double every three years** as information pours in from **digital platforms, wireless sensors (IoT), virtual-reality applications,** and billions of mobile phones reports the *McKinsey Global Institute*

2.5 Quintillion

A report from IBM states that 90% of the data in the world today has been created in the last two years alone, at 2.5 quintillion bytes of data a day



WeChat is a Chinese multi-purpose messaging, social media and mobile payment app developed by Tescent.
Given the multi-purpose and all-in one app fuctionalities, with its 600M active users **is produces the fuel for new algorithms for the chinese tech start – ups**

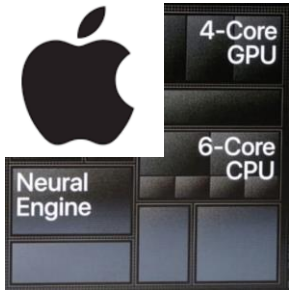
2. **Increasing Computing Powers (1/2)**

CPU

GPU

TPU

- **CPU** (Central Processing Unit) is composed of a number of cores with cache memory that can handle a few software threads at a time
- **GPU** (Graphical Processing Unit) with 100+ cores to process thousants of threads
- **TPU** (Tensor Processing Unit) is a specially designed processor from Google available thru **cloud computing**



TESLA

On-device AI engines are becoming more and more available :

- **iPhone** XS/XR have additional a 8-core Neural Engine **:**
  A12 Bionic (2018) can hande 5 trillion operations per second (9 x faster then the A11 Bionic from 2017)
- Also **Huwai** P20 and P30 have Neural Engines on device :
  Kirin 980 has a Dual NPU (Neural Processor Unit)
- **Telsla** has developed its own AI processor referred to as "*Hardware 3*". It was created by Pete Bannon who created the iPhone 5S' processor …

2. **Increasing Computing Powers (2/2)**

- The NVIDIA is a US corporation producing GPU's for the gaming industry
- It stocks curve coincides with the rise of the Deeping Learning as of the 2016

3. Research **algorithms** published by big tech companies

Google AI

Facebook AI Research

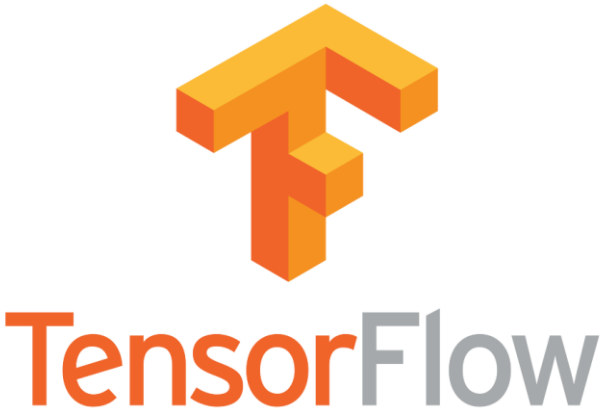
Baidu Research

Alibaba.com

Tencent AI Lab

OpenAI

4. Software development kits & **frameworks**



Let’s make a deep dive into

… Deep Learning

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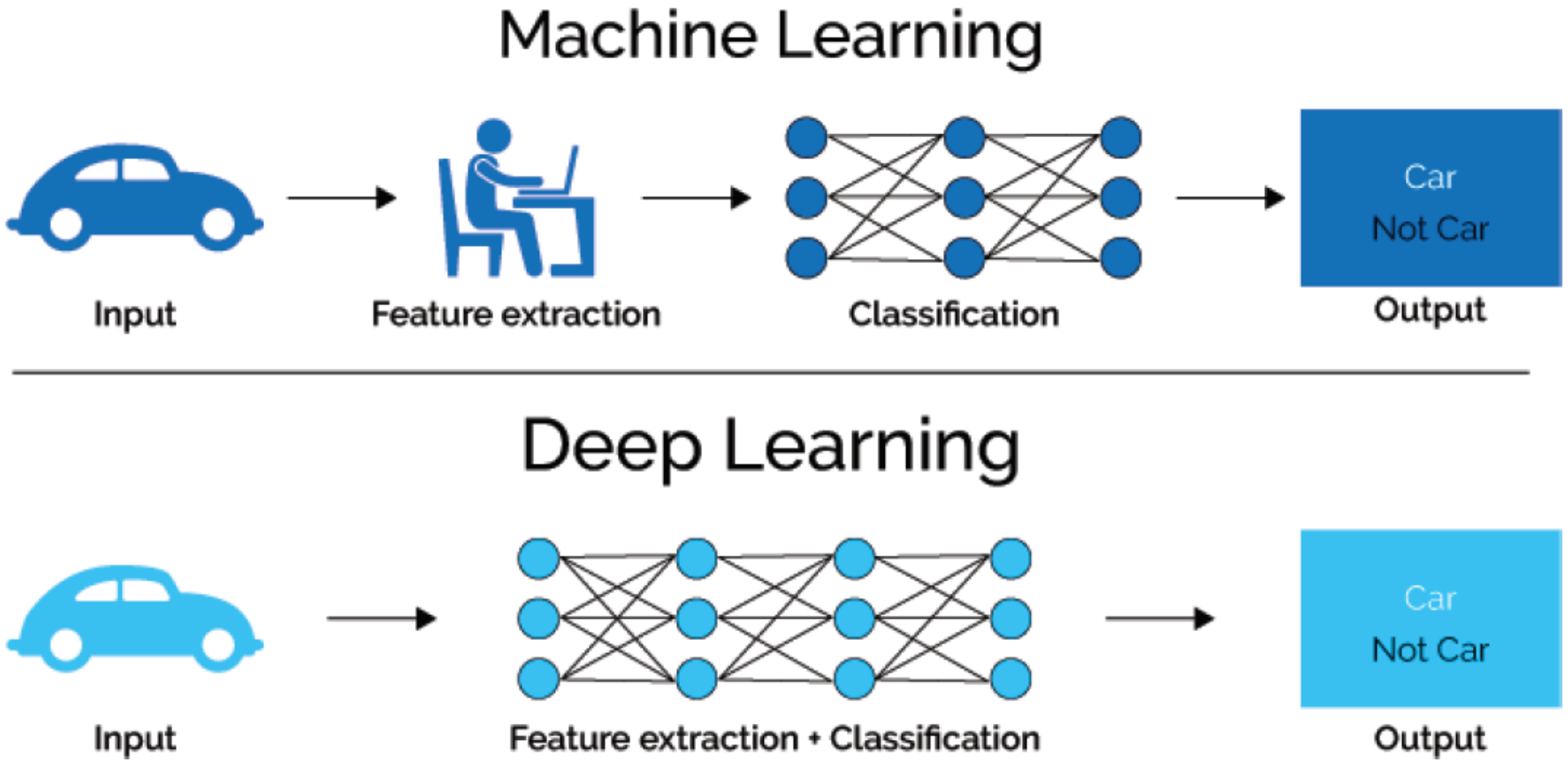
Difference between Machine Learning & Deep Learning



Types of Machine Learning / Deep Learning

Supervised

- Meaningful patterns in **labeled data**
- Direct feedback
- Predict outcome / future
- **Most commonly used for algorithms today**

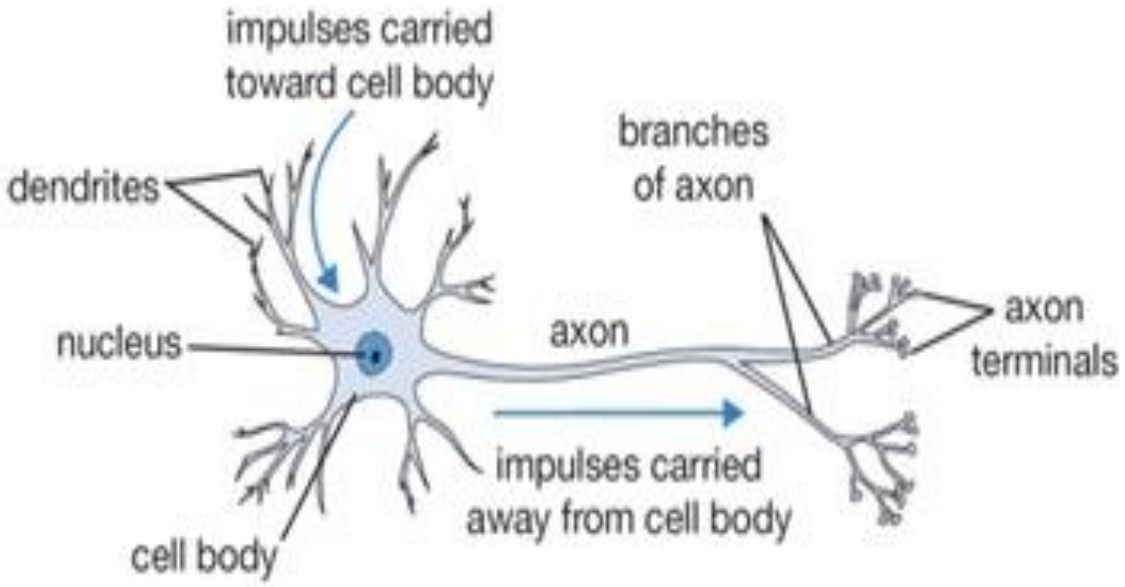
Unsupervised

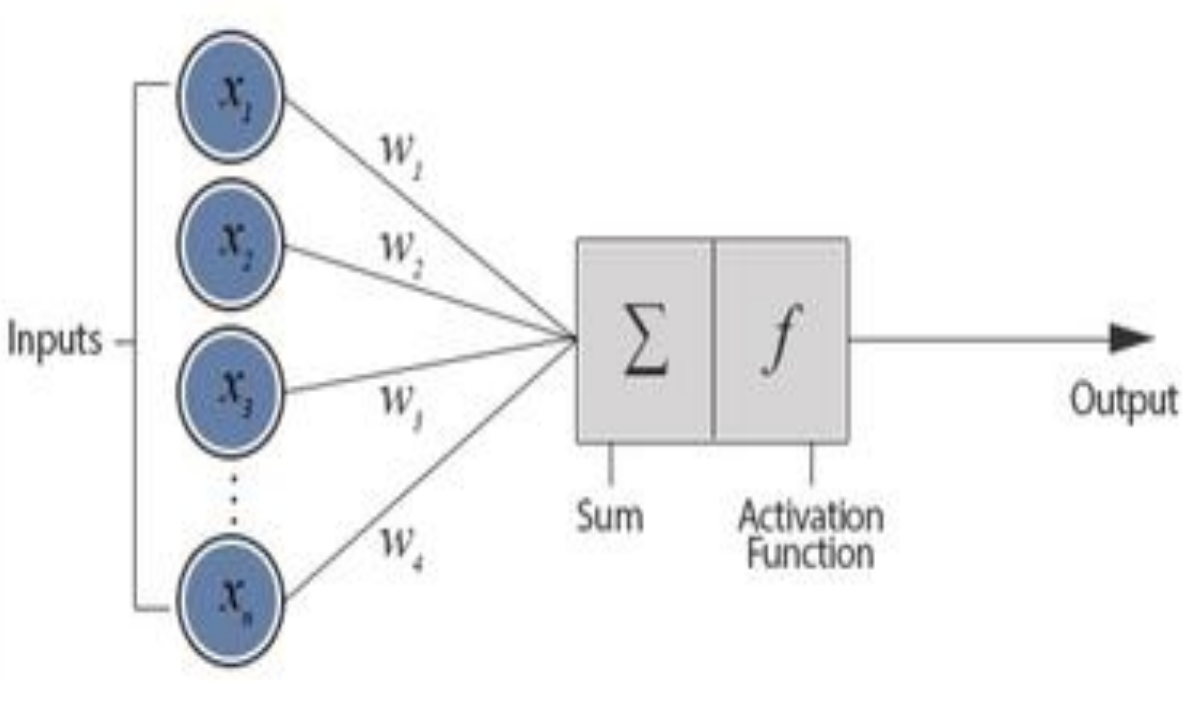
- Discover patterns from **unlabeled data**
- More experimental
- Varying degree of readiness
- Identifies conclusions entirely on its own

Reinforcement

- Decision process
- Reward system
- Learn series of actions
- **Output is rated by researcher (correct / incorrect)**

A Neural network is modelled after the brain





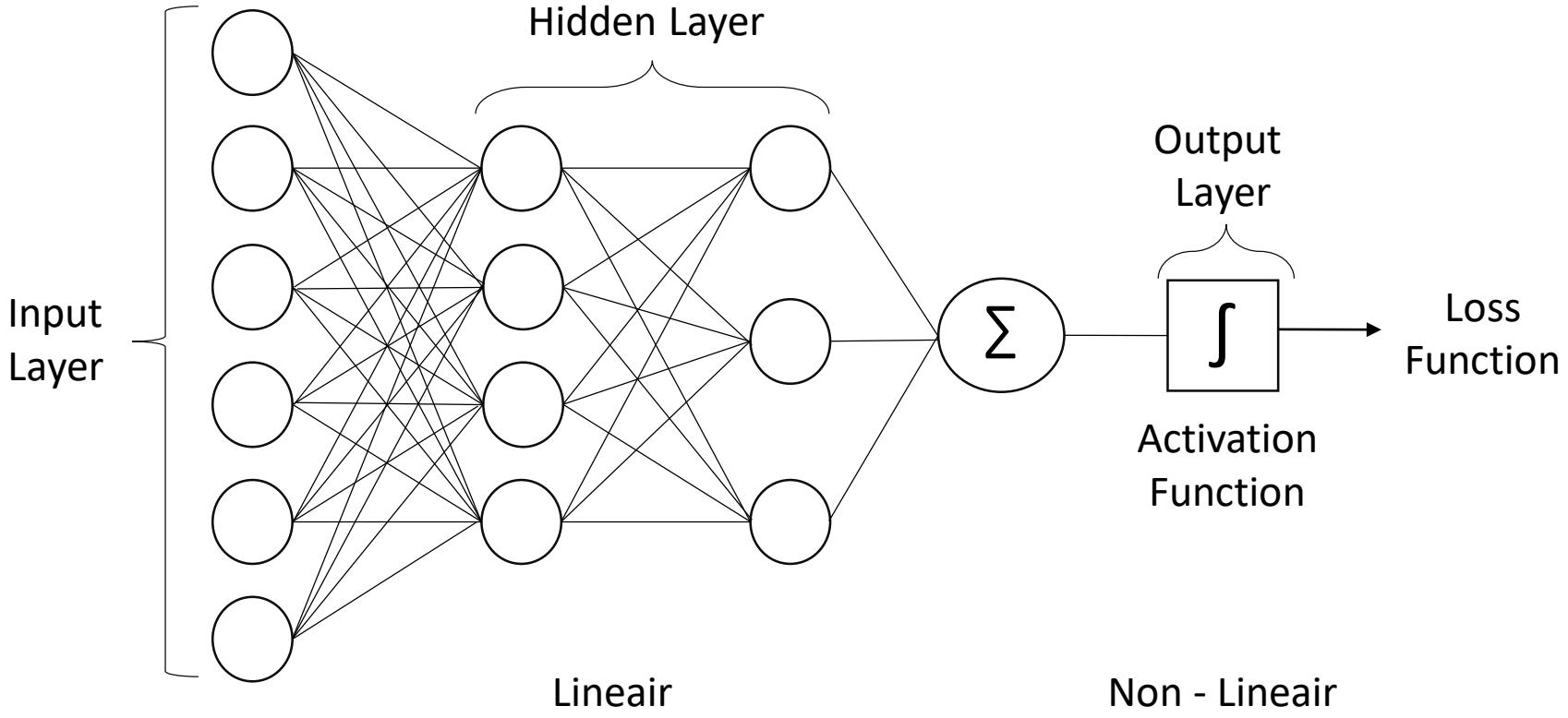
***Biological* Neural Network**

- Neuron switching time is 0,001 second
- Number of neurons : 10^{10}
- Recognition time : 0,1 second

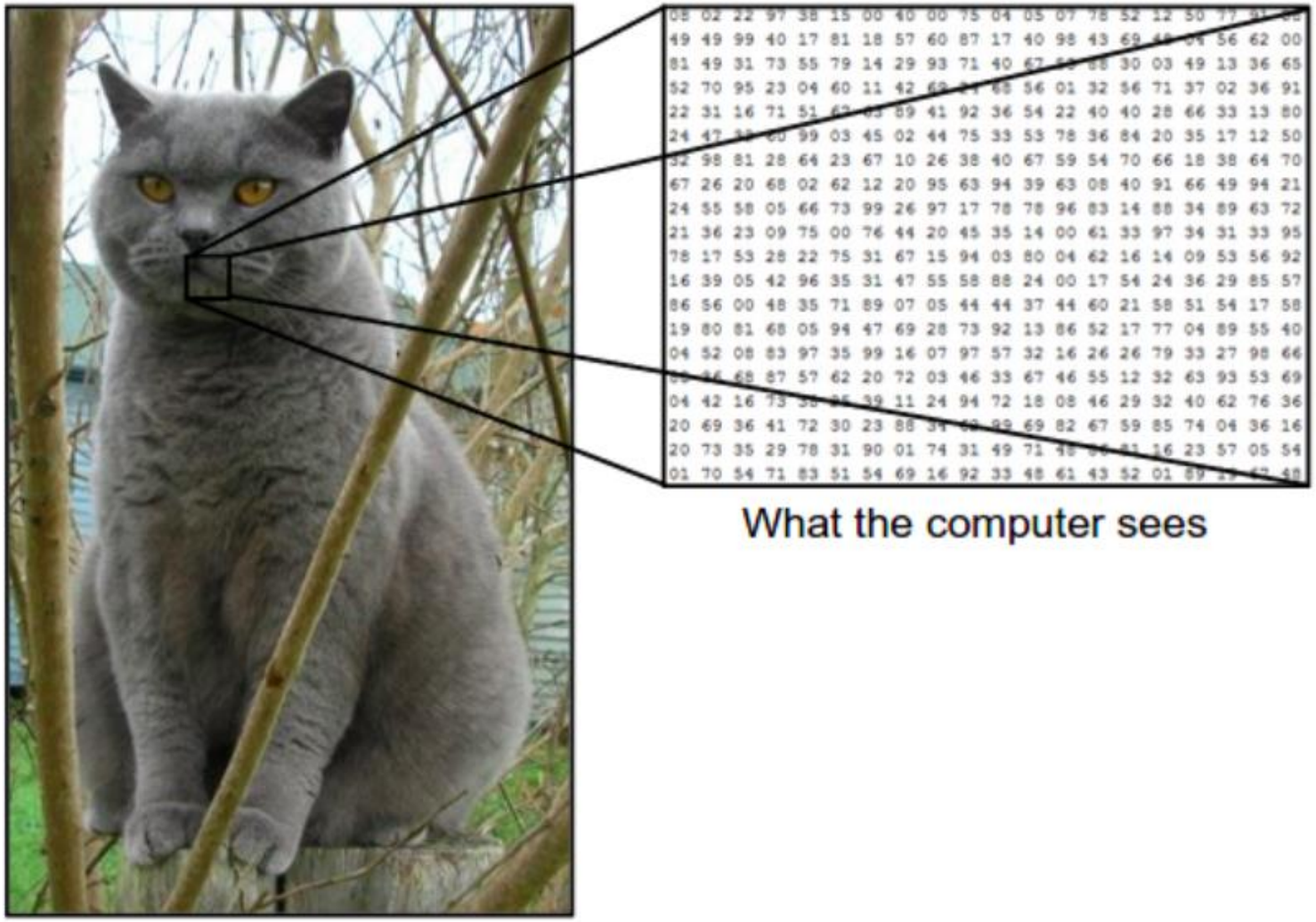
***Artificial* Neural Network**

- Weighted (w_n) connections amongst neurons (x_n)
- Highly parallel, distributed process
- **Emphasis on tuning weights automatically**

Neural Networks : plain vanilla …

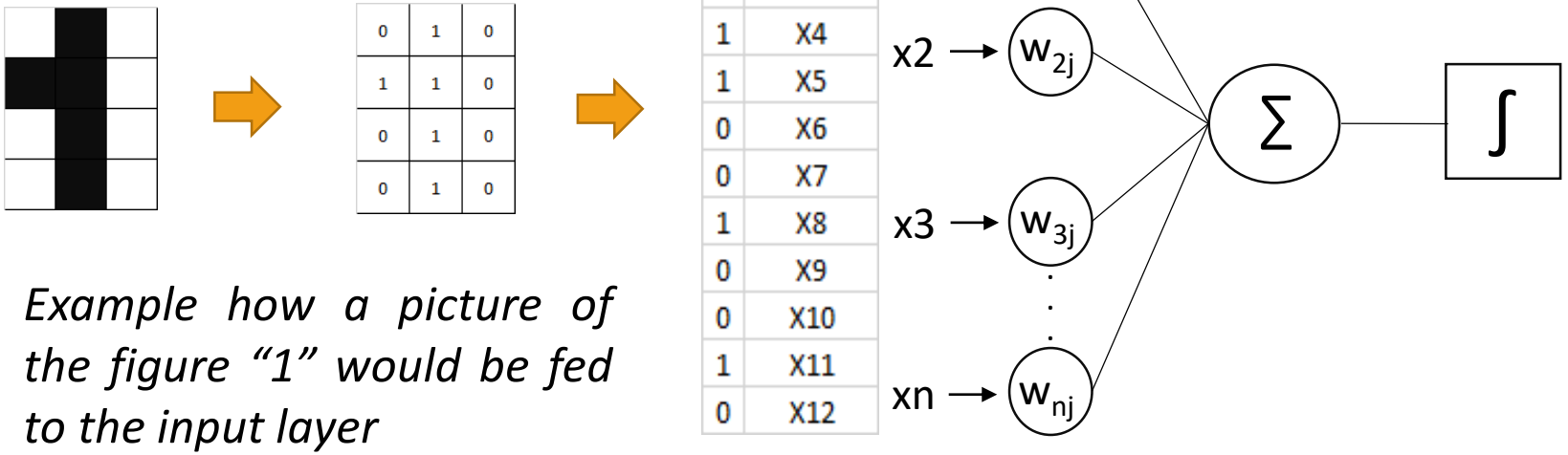


Input Layer : how to “translate” a picture



What the computer sees

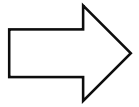
Input Layer : simplified example of a “digit”



Example how a picture of the figure “1” would be fed to the input layer

Next step : how can we initialize the “weights” ?

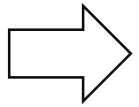
Zero



w=np.zeros((layer_size[l],layer_size[l-1]))

- Zero initialization serves no purpose
- **The neural net does not perform symmetry-breaking**

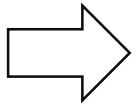
Random



w=np.random.randn(layer_size[l],layer_size[l-1])*0.01

- Weights are initialized very close to zero, but randomly
- This serves the process of symmetry – breaking

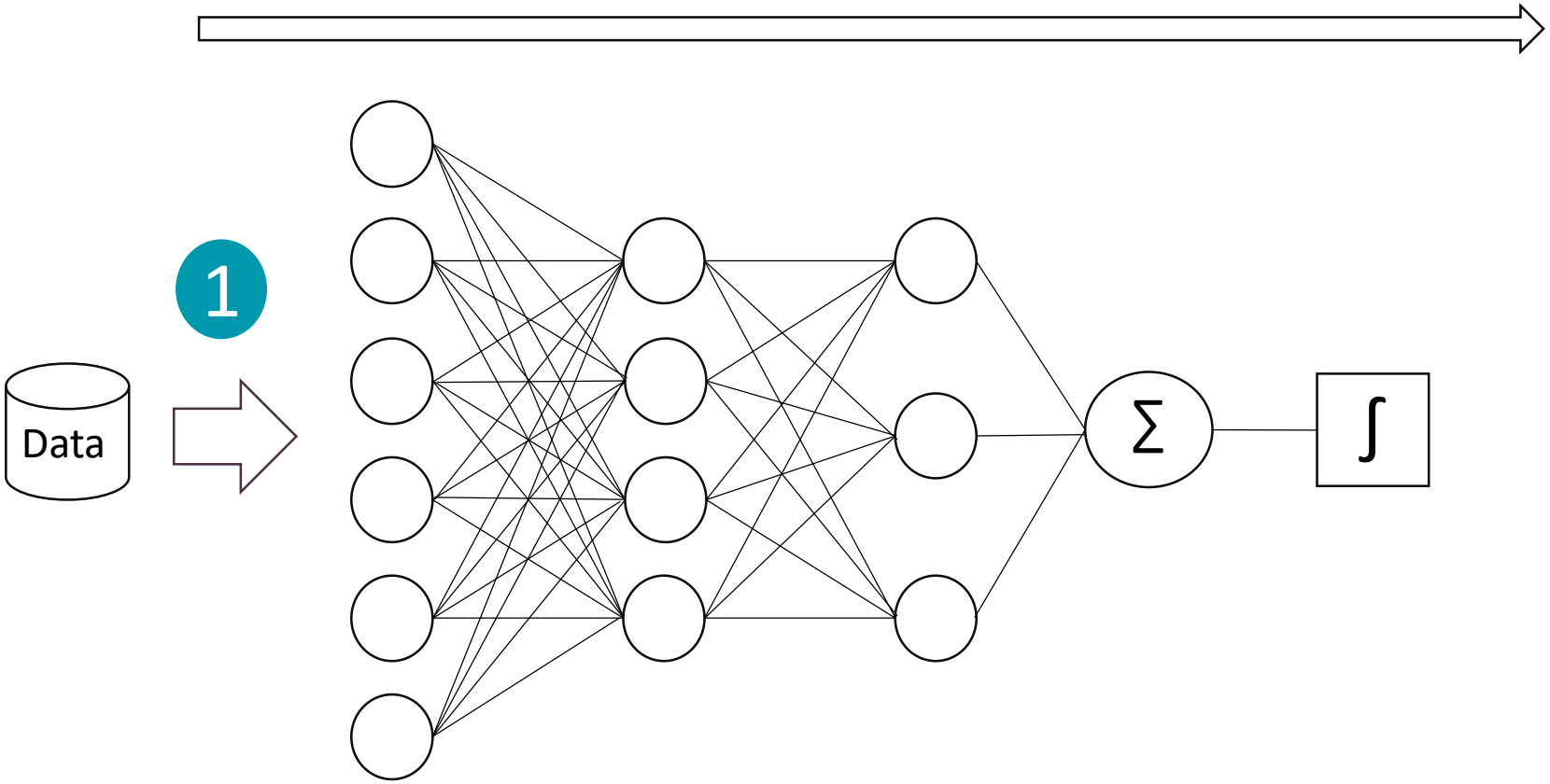
He-et-al



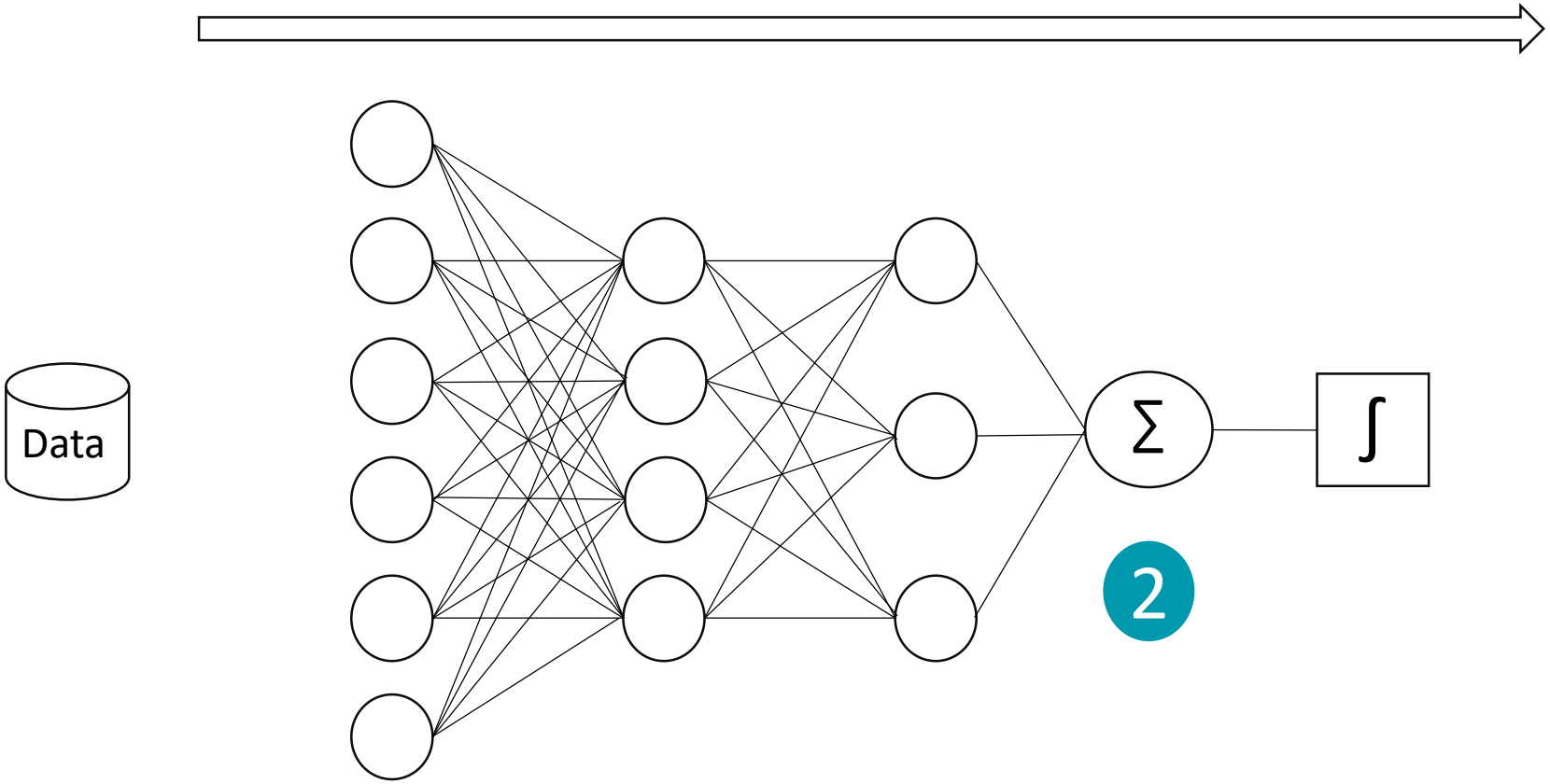
w=np.random.randn(layer_size[l],layer_size[l1])*np.sqrt(2.0/layer_size[l-1])

- Formula invented by person named He et al in 2015
- Weights are still random, but differ in range depending size of layer-1

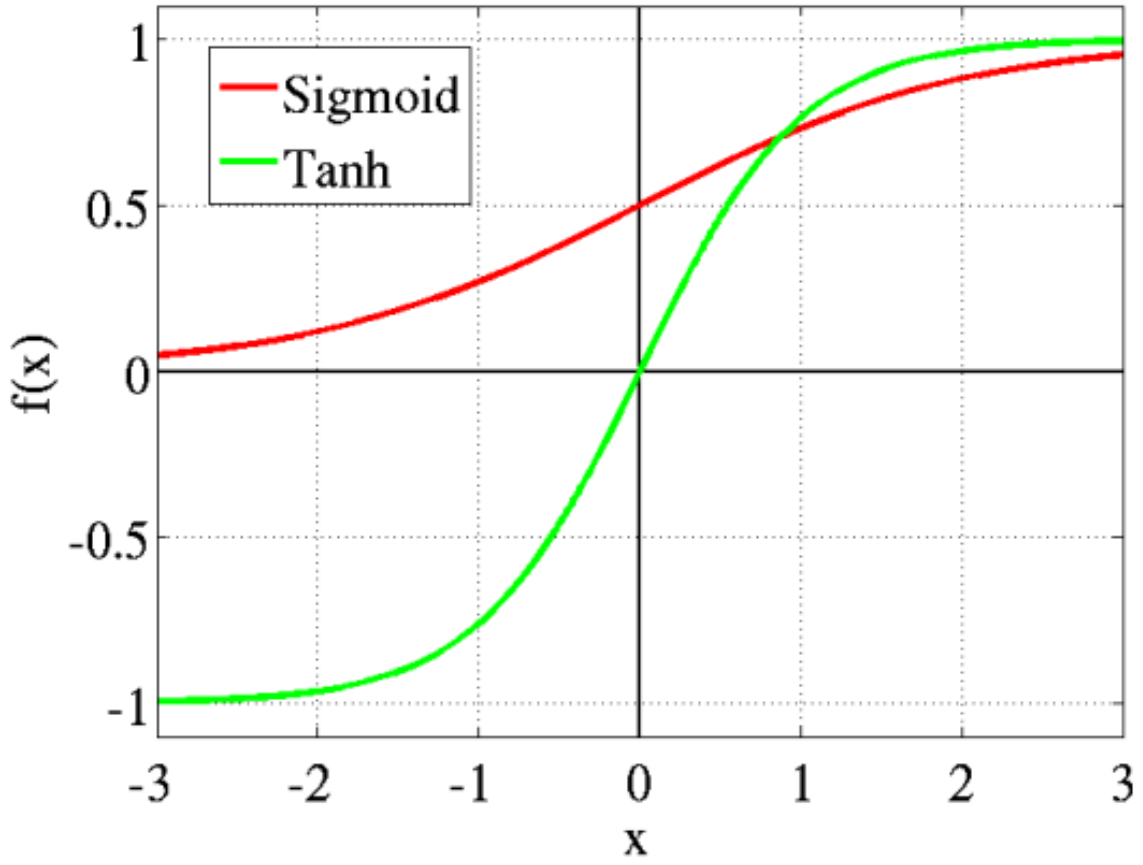
The forward propagation step



The activation function



Types of activation functions (1/2)



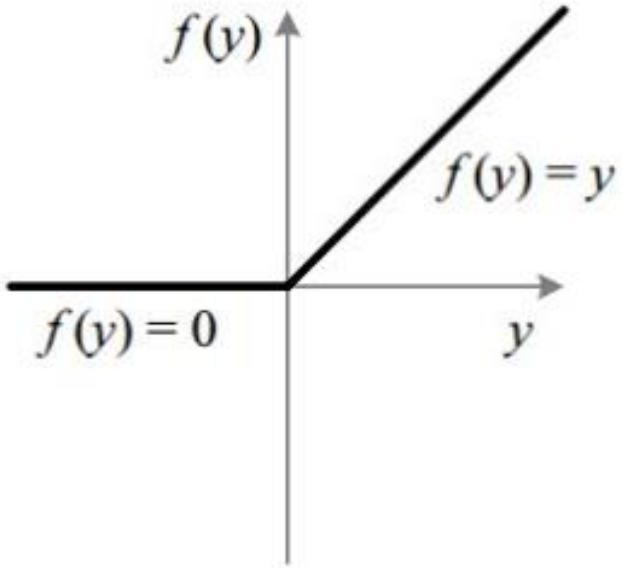
Sigmoid or Logistic

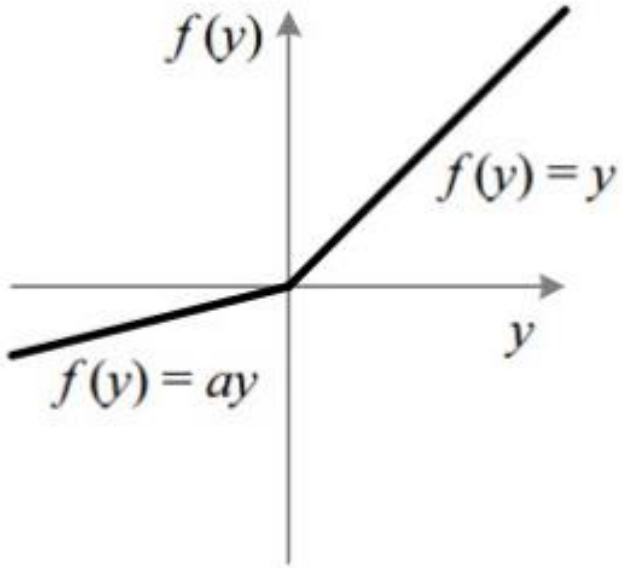
- Function return a value between 0 and 1
- Used for models to predict the probability

Tanh or hyperbolic tangent

- Negative inputs will be mapped strongly negative
- The Tanh function is mainly used for classification between 2 classes

Types of activation functions (2/2)

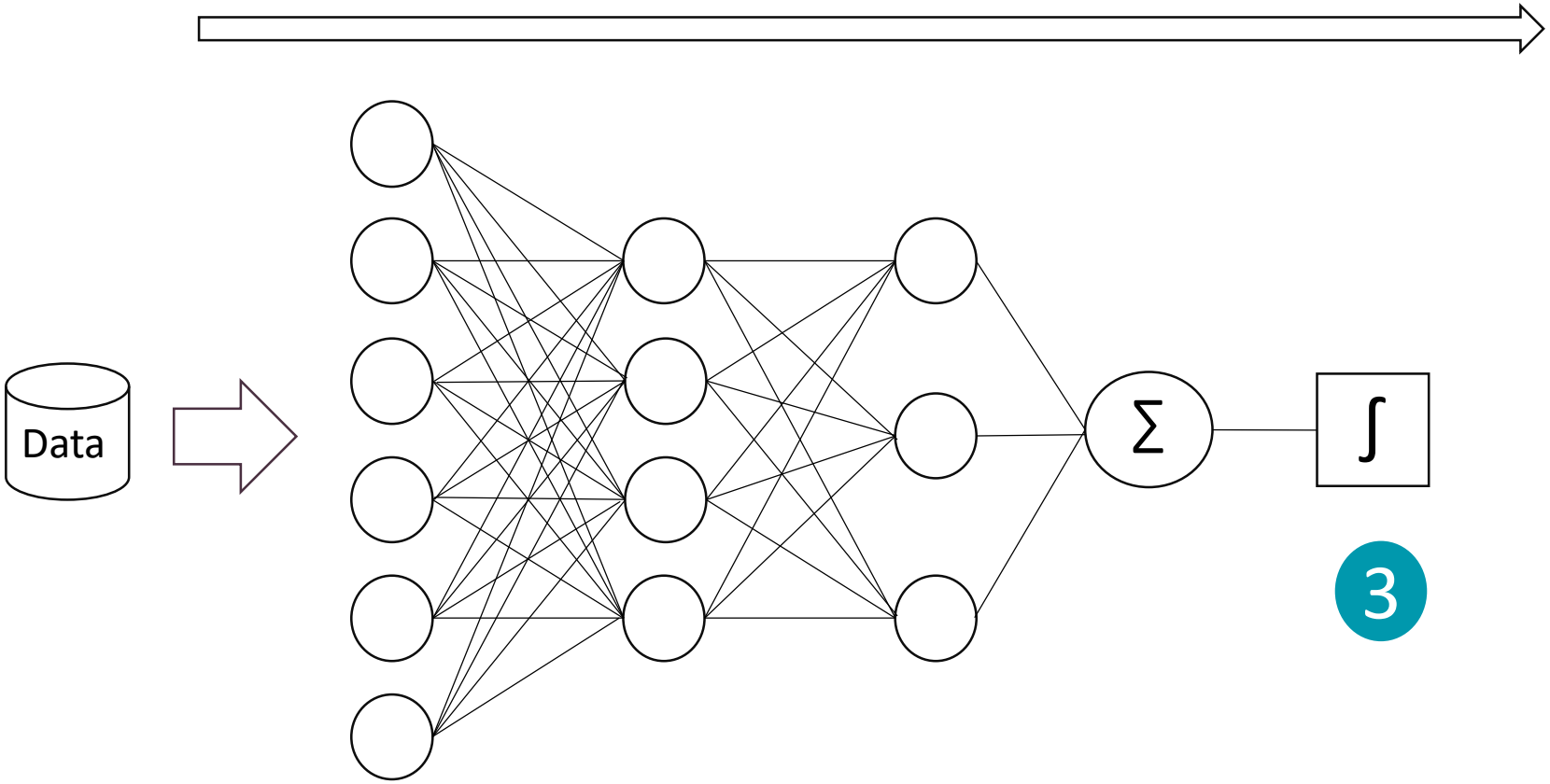




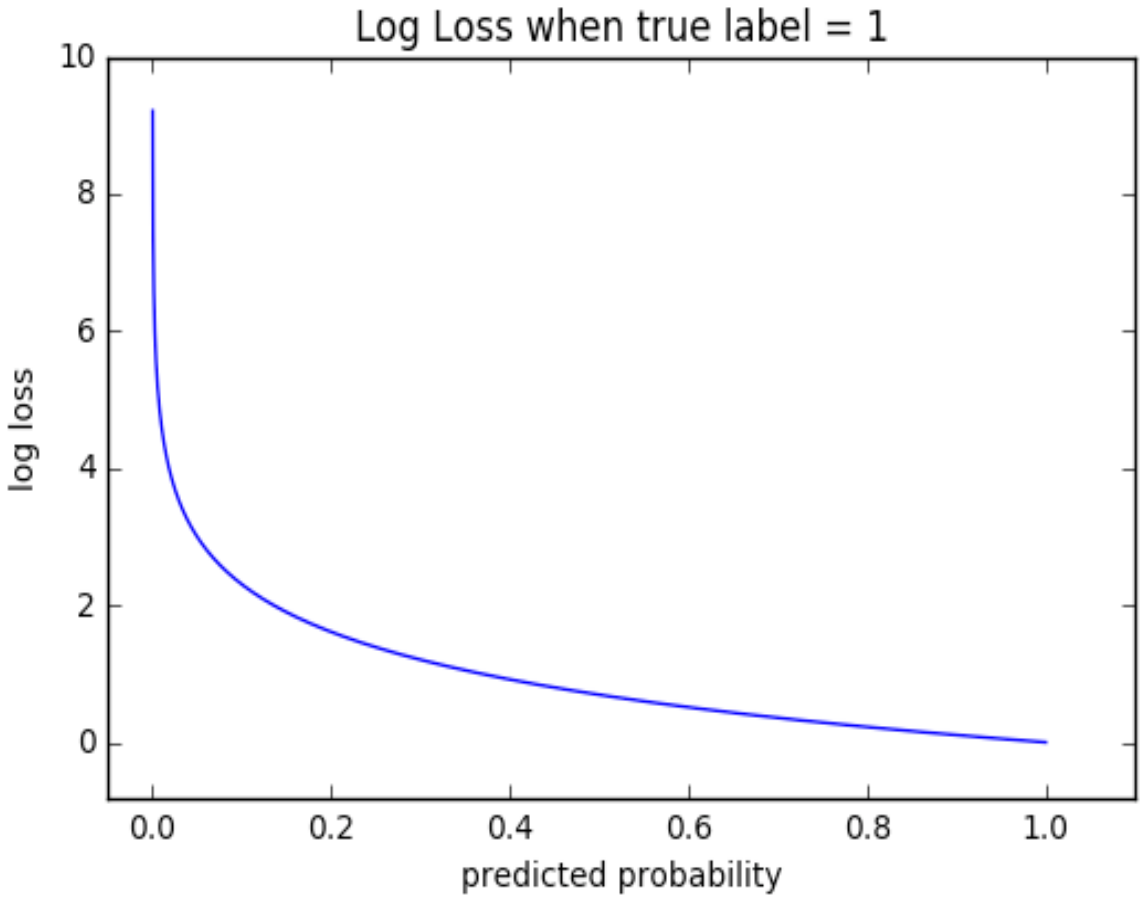
Reactified Linear Unit (ReLU)

- **Mostly used activation function**
- Used with Convolutional neural networks

The loss or cost function



Loss function : how do we measure success ?



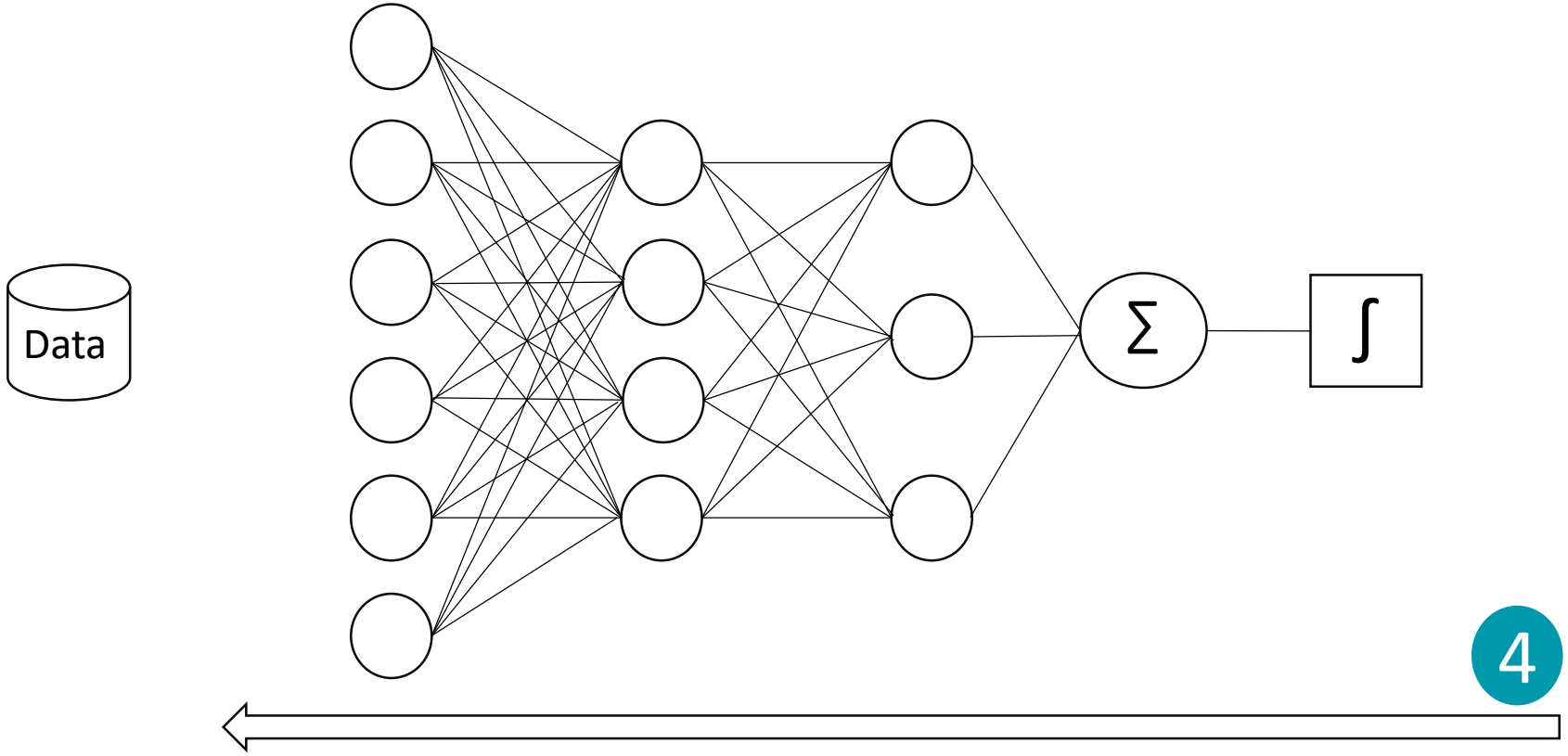
Log Loss function

- Graph with a true observation (isCat = 1)
- **Log Loss penalizes both types of errors, but especially those predications that are confident and wrong !**

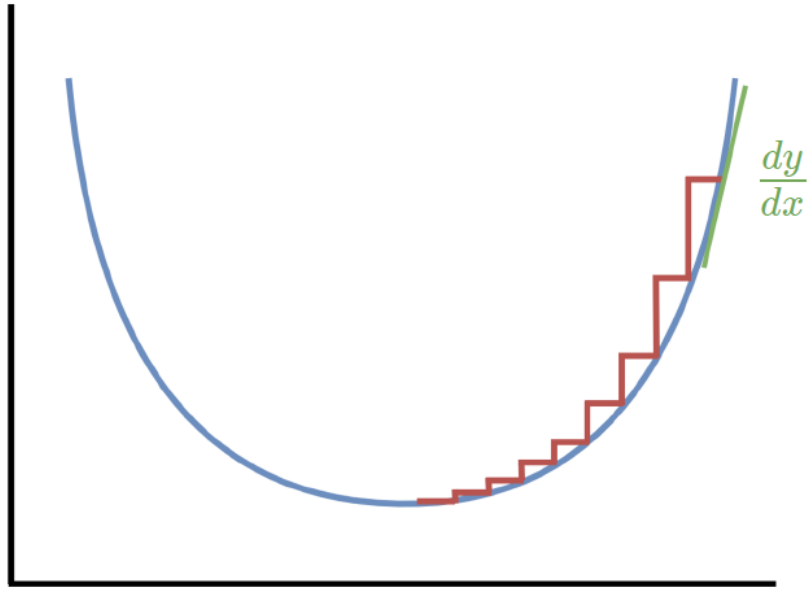
Other loss function :

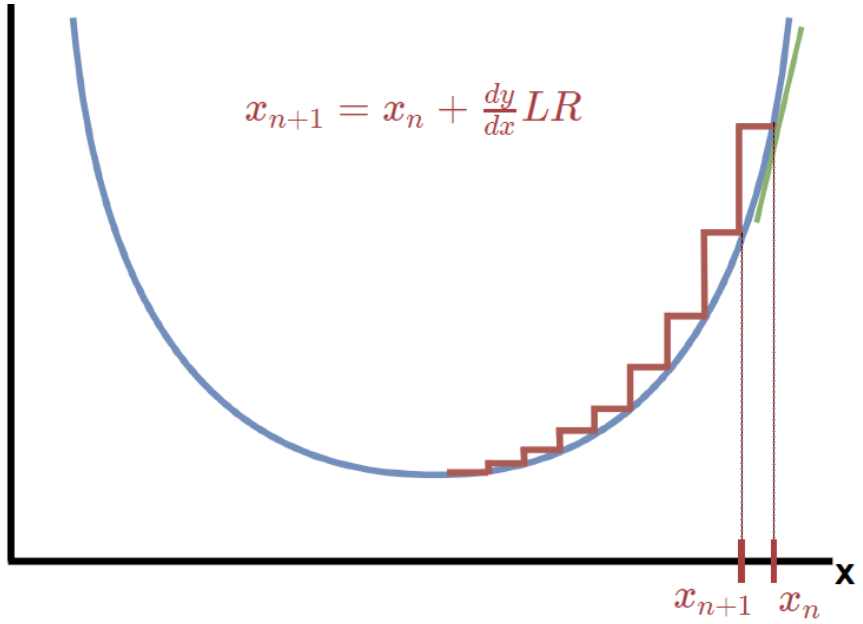
- Square Loss
- Hinge Loss
- Generalized Smooth Hinge Loss
- Exponential Loss

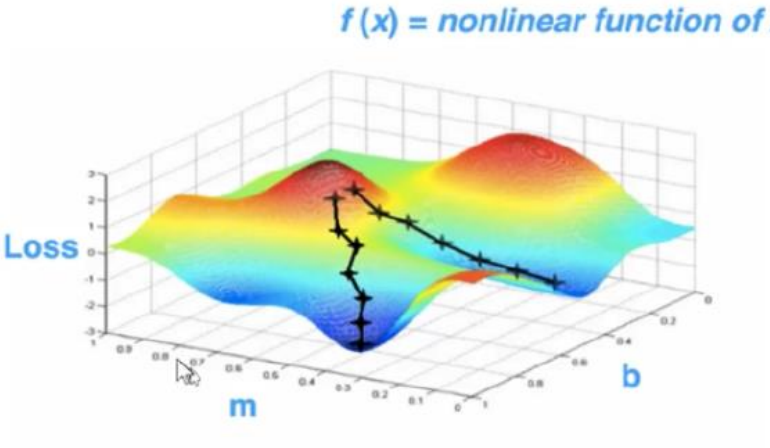
The Backward pass : gradient descent / learning rate



Gradient descent & learning rate (LR)

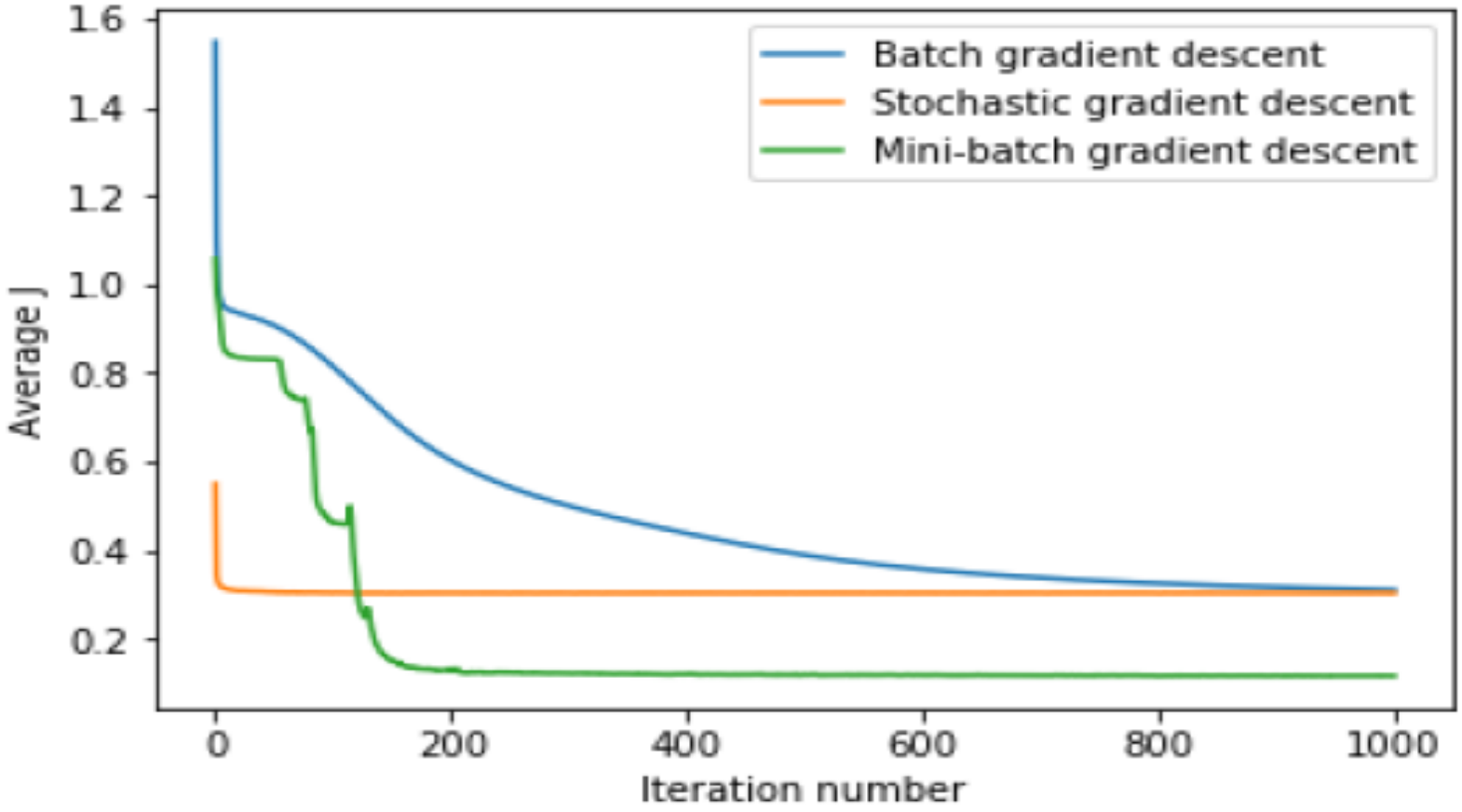






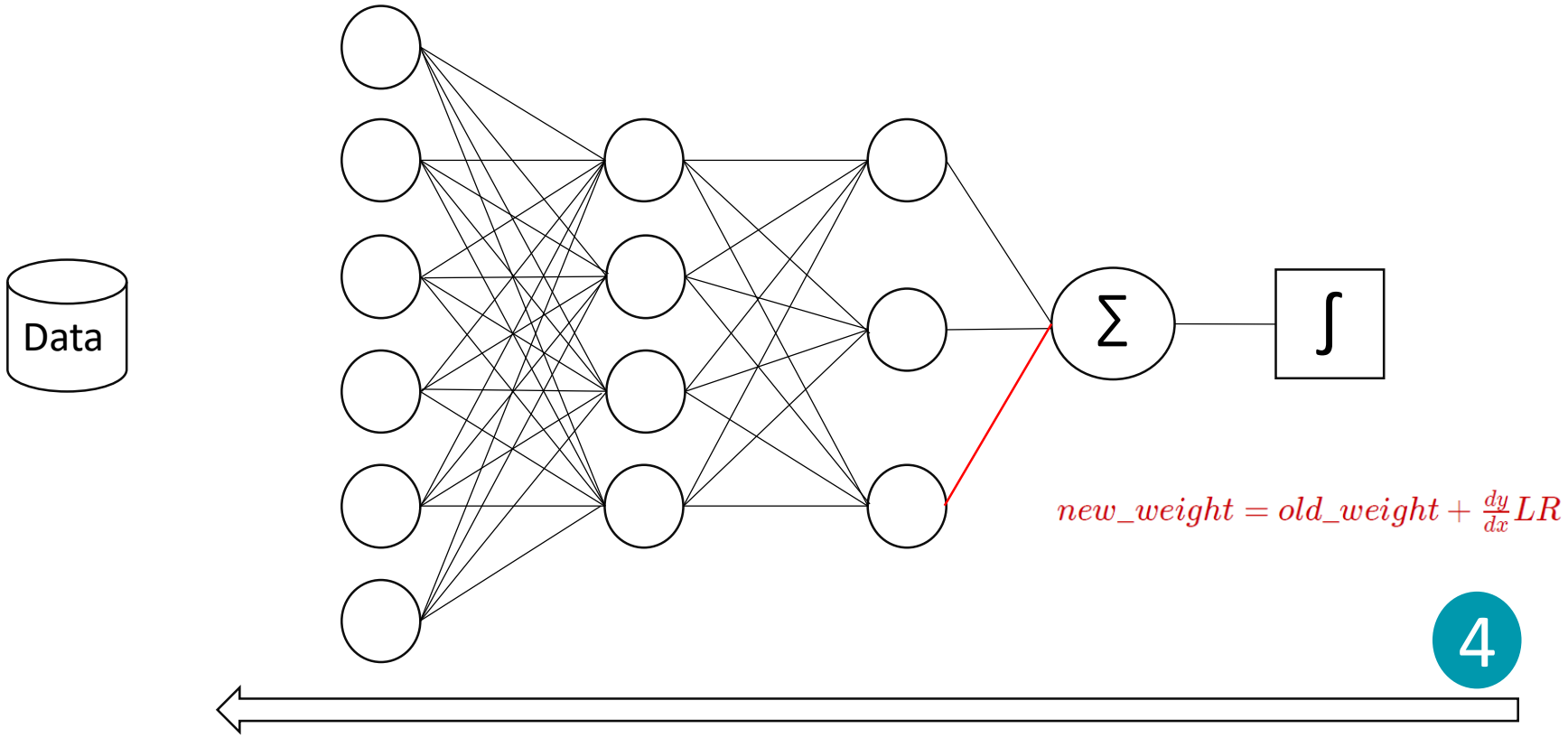
- In the above example we only have 1 outcome (yes or no)
- In real live, there are more outcomes (see graph left)
- Some models have 1.000 or even more outcomes

Gradient descent variations

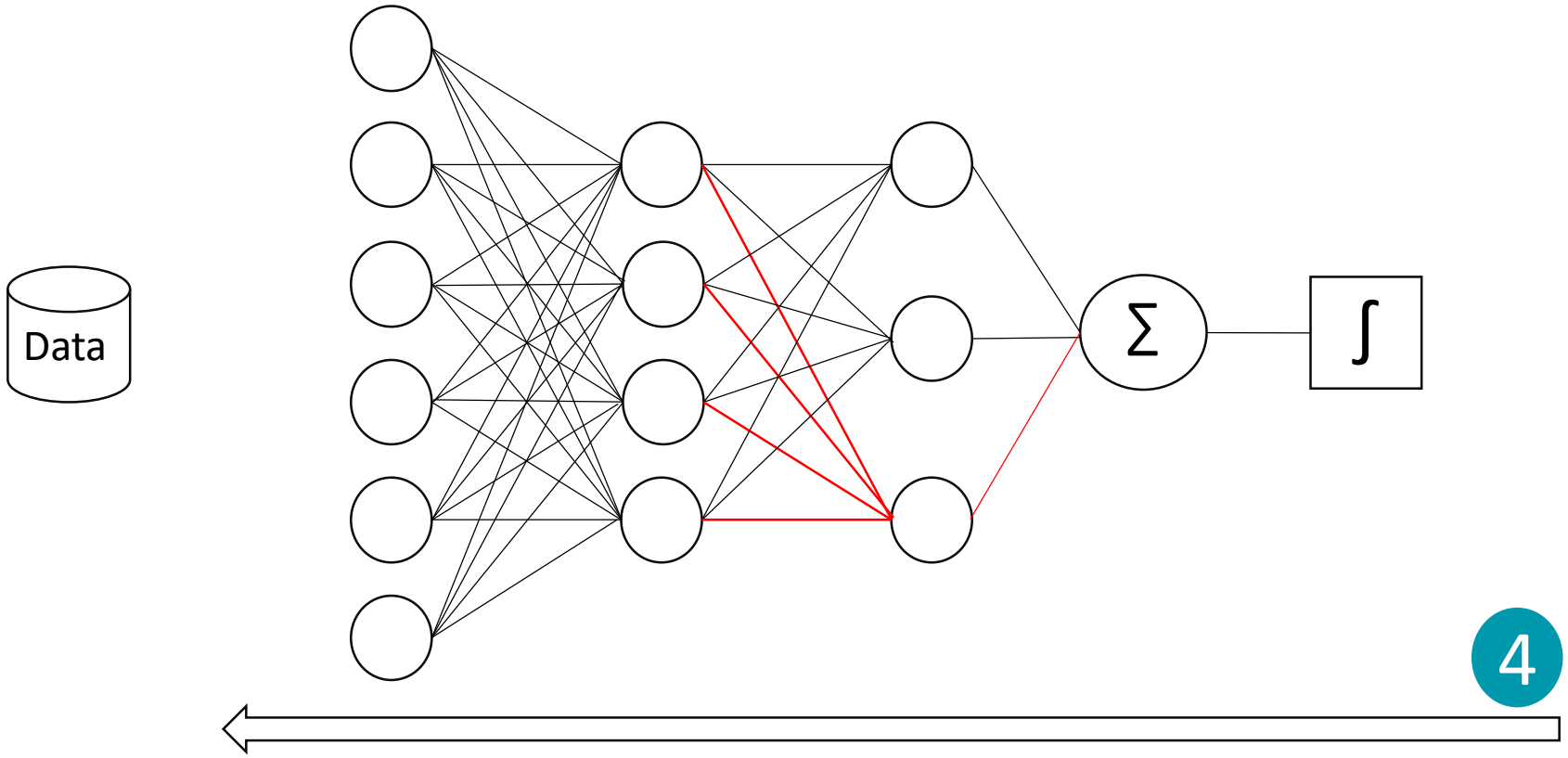


How many cases are handled at once in 1 forward propagation pass is called **epoch**

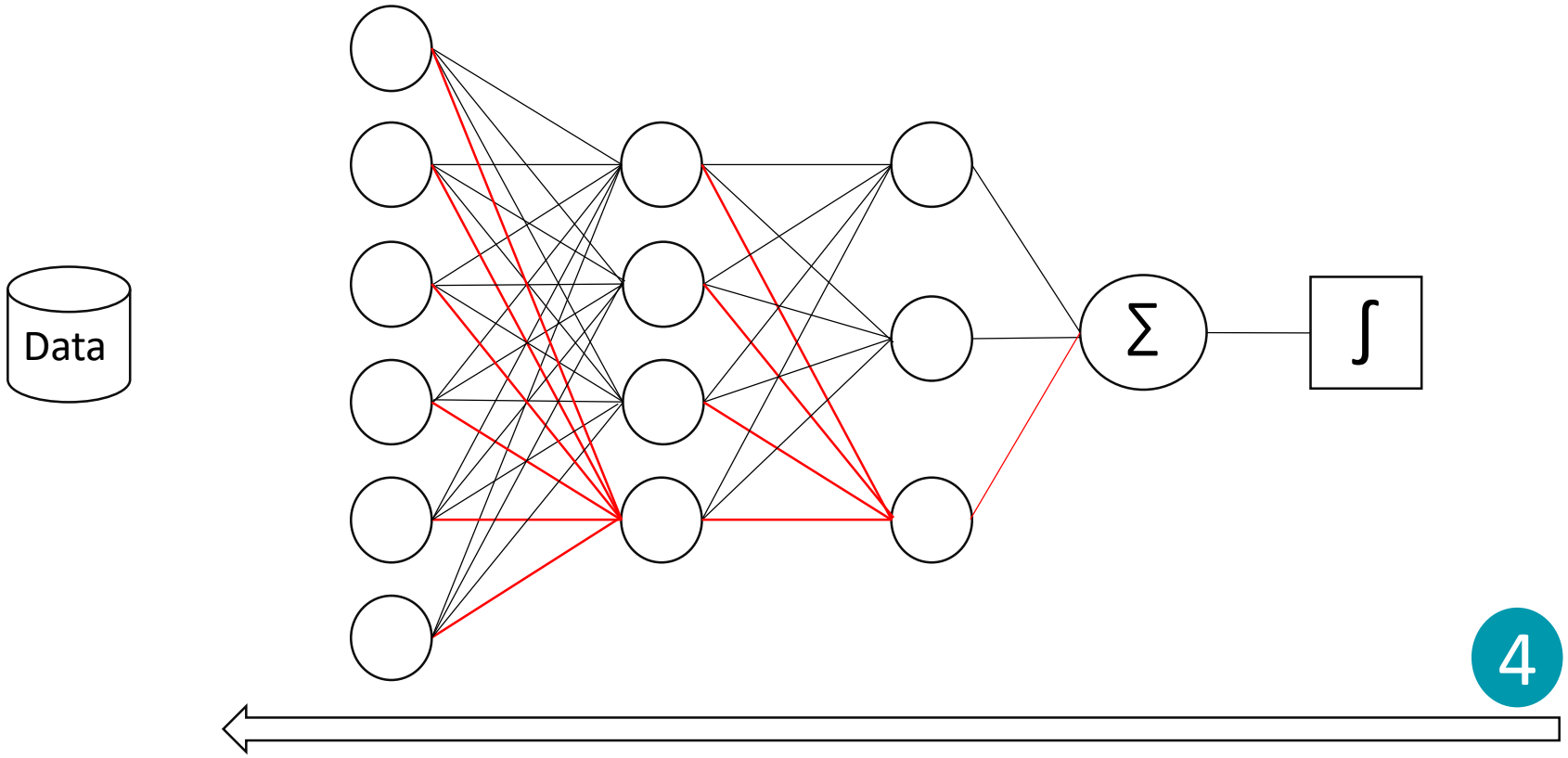
The Backward pass : gradient descent / learning rate



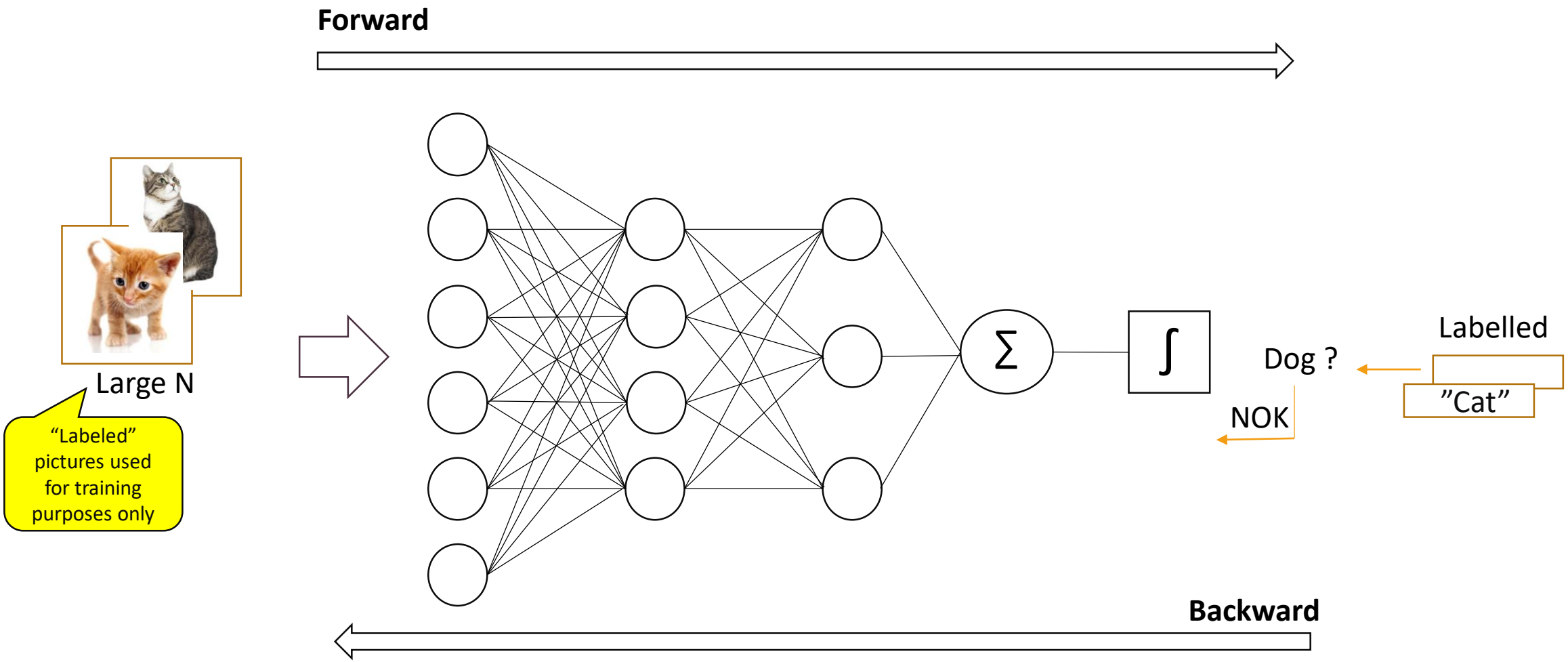
The Backward pass : gradient descent / learning rate



The Backward pass : gradient descent / learning rate



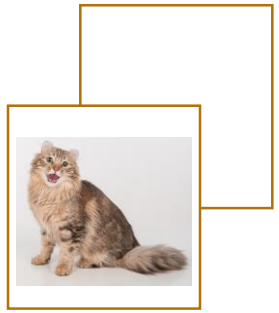
The training of a Neural Network



2 excellent videos with a step by step explanation of Neural Networks

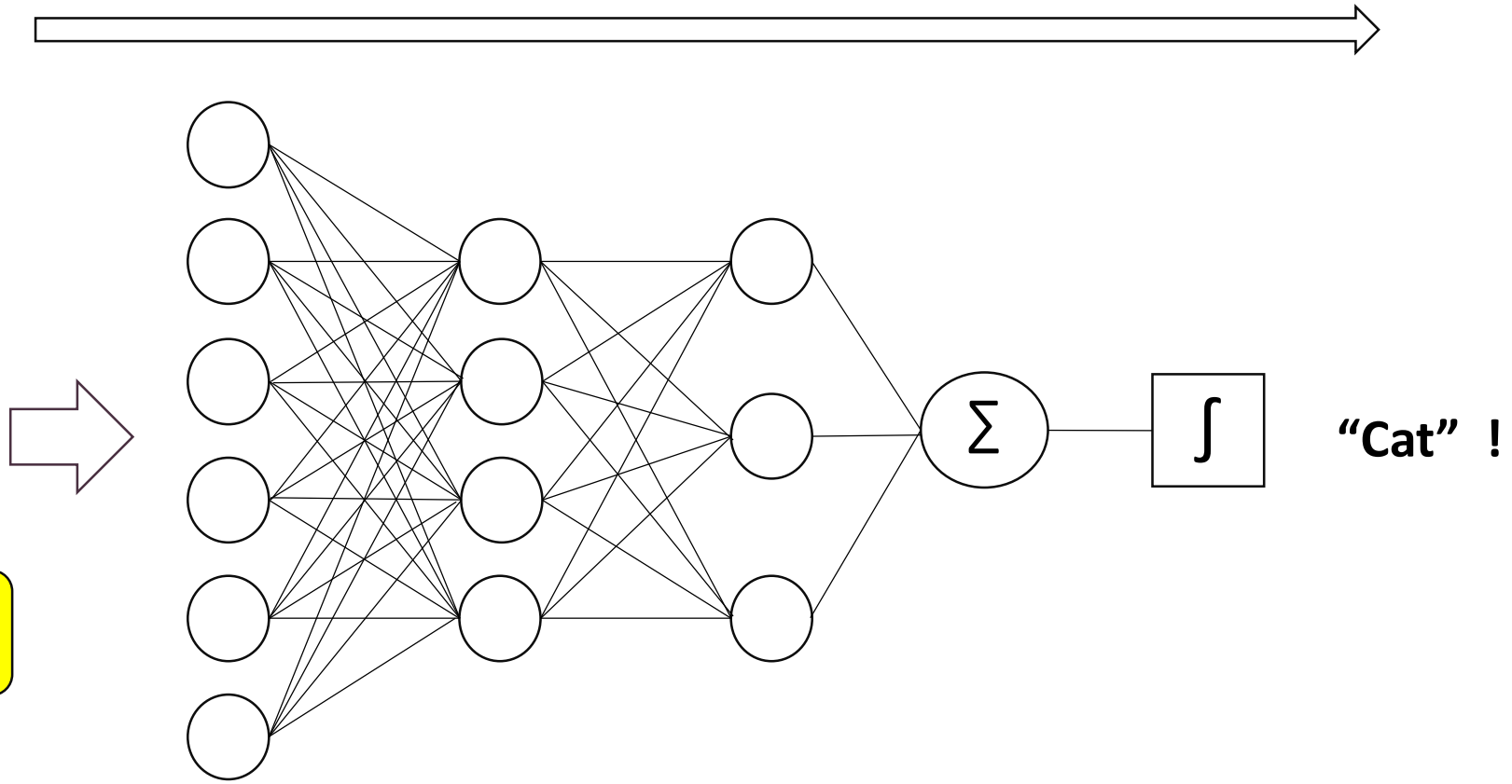
https://www.youtube.com/watch?v=aircAruvnKk
https://www.youtube.com/watch?v=IHZwWFHWa-w

The Interference of a Neural Network



Smaller,
Varied N

When “testing”, we used labeled pictures that have never been seen by the neural network



“Cat” !

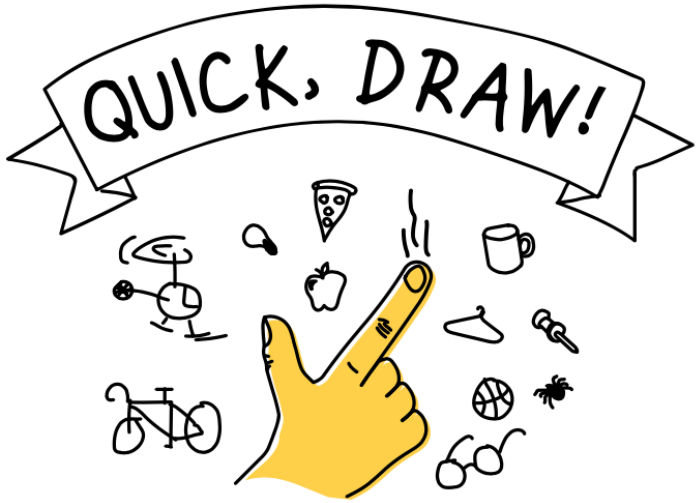
An example of a **Deep** Neural Network for NLP

- Meet BERT (**B**idirectional **E**ncoder **R**epresentations from **T**ransformers) :
  - is the first ***deeply bidirectional***, *unsupervised* language representation, pre-trained using only a plain text corpus (in this case Wikipedia) **on 11 languages**
  - For example, in the sentence "*I accessed the bank account*," a unidirectional contextual model would represent "*bank*" based on "*I accessed the*" but not "*account*." However, BERT represents "*bank*" using both its **previous and next context** — "*I accessed the ... account*" — starting from the very bottom of a deep neural network, making it deeply bidirectional

- It was developed by Google AI and published on 2nd of November 2018 with 104 pre-trained languages including dutch

- **BERT is a huge model, with 24 Transformer blocks, 1.024 hidden layers, and 340M parameters**. The model is pre-trained on 40 epochs over a 3.3 billion word corpus, including Books Corpus (800 million words) and English Wikipedia (2.5 billion words). The model runs on 16 TPU pods for training.

Doodle example from Google



Can a neural network learn to recognize doodling?

Help teach it by adding your drawings to the world's largest doodling data set, shared publicly to help with machine learning research.

Let's Draw!

https://quickdraw.withgoogle.com

Working with text

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Working with text : how to present text in a Neural Net ?

- **Computer vision**: images are represented by the corresponding RGB (*) values (or values obtained from other filters), so they are essentially matrices of integers

- **Language** was more arbitrary because traditionally there was no formal method (or globally accepted standard) for **representing words with numerical values**

*(*) The **RGB** color model is an additive color model in which red, green and blue light are added together in various ways to reproduce a broad array of colors*.

Working with text : how to present text in a Neural Net ?

One hot encoding

"Winter is Coming" =

$$\begin{bmatrix} \mathbf{1} & 0 & 0 \\ 0 & \mathbf{1} & 0 \\ 0 & 0 & \mathbf{1} \end{bmatrix}$$

- Sparse
- Binary
- Highly Dimensional

Dense Word Vectors

"Winter is Coming" =

$$\begin{bmatrix} 1.1 & 0.2 & 0.1 \\ 0.34 & 1.6 & 0.9 \\ 0.56 & 0.34 & 1.67 \end{bmatrix}$$

- Contextual
- Floating Point
- Low dimensional

Word embeddings are a type of word representation that allows words with similar meanings to have a similar representation

Some of the pre-trained Word embedding models

code.google.com/archive/p/word2vec/

- Created by **Google** in 2013
- The **word2vec** tool takes a text corpus as input and produces the word vectors as output.
- Using the **word2vec** tool, it is possible to train models on huge data sets (up to hundreds of billions of words).

GloVe

nlp.stanford.edu/projects/glove/

- Created by **Stanford University** in 2015
- The model is an unsupervised learning algorithm for for obtaining vector representations for words
- 12 languages including Dutch

fasttext.cc

- fastText is a library for learning of word embeddings created by **Facebook** AI Research (FAIR) lab
- Facebook makes available pre-trained models for 294 languages (since 2018). Models can later be reduced in size to even fit on mobile devices.

MNIST handwriting digits dataset

- MNIST is a large dataset of **handwritten digits**
- Contains 60k training images & 10k testing images
- An extended dataset (EMNIST) exists since 2017 with 240k images

Advanced Neural Networks

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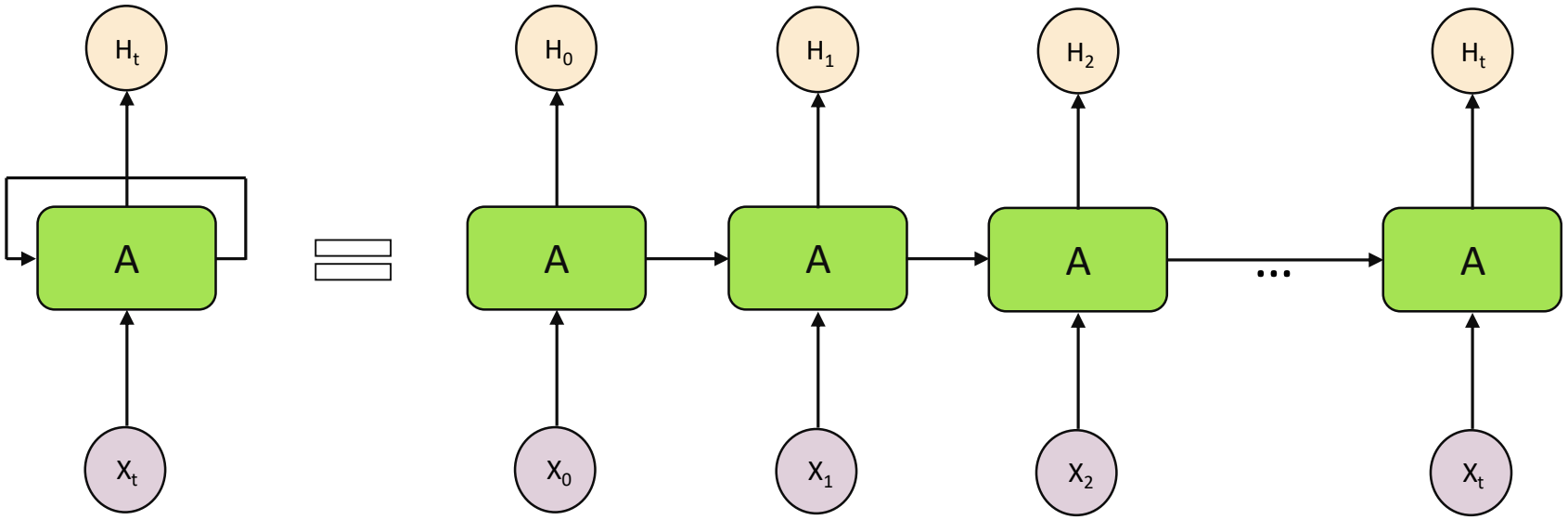
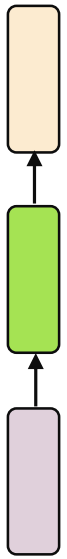
Recurring Neural Networks (RNN) – 1/2



Chaining several neural networks as hidden layers gave it the name of “Deep” learning

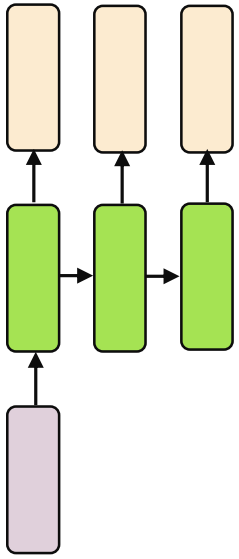
Recurring Neural Networks (RNN) – 2/2

One to one



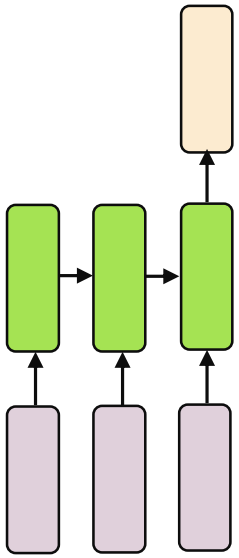
"Image classifier"

One to Many



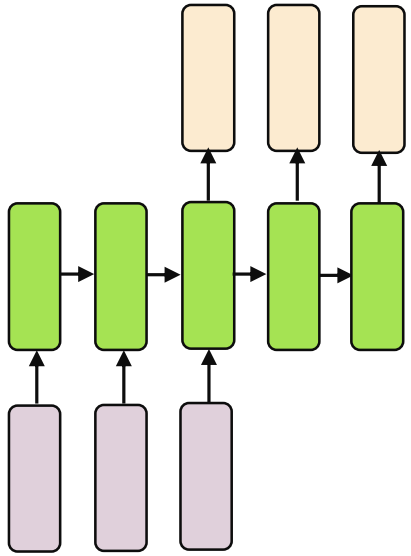
"Object detection & Scene segmentation"

Many to One



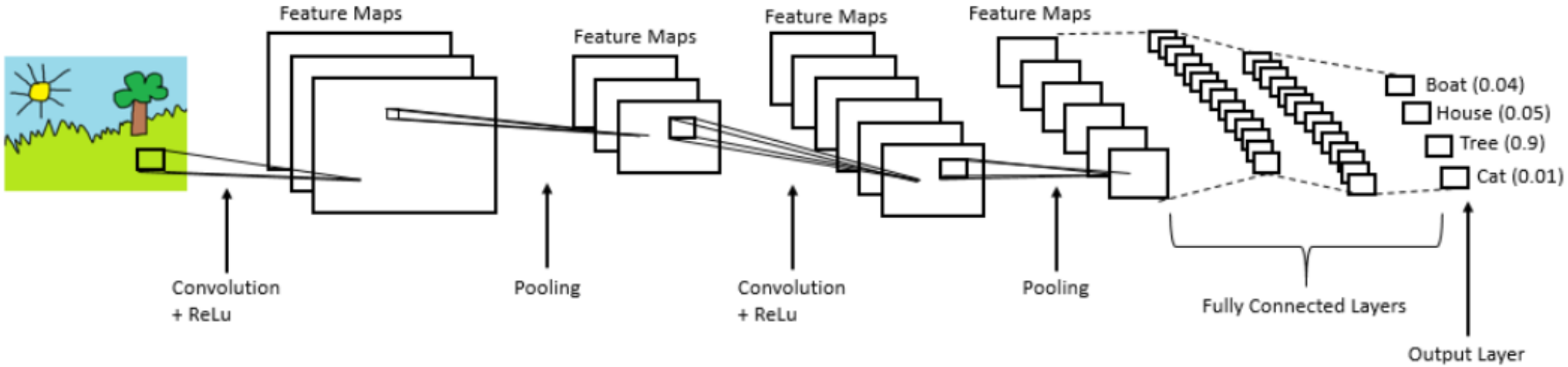
"Sentiment detection of a fluent text"

Many to Many



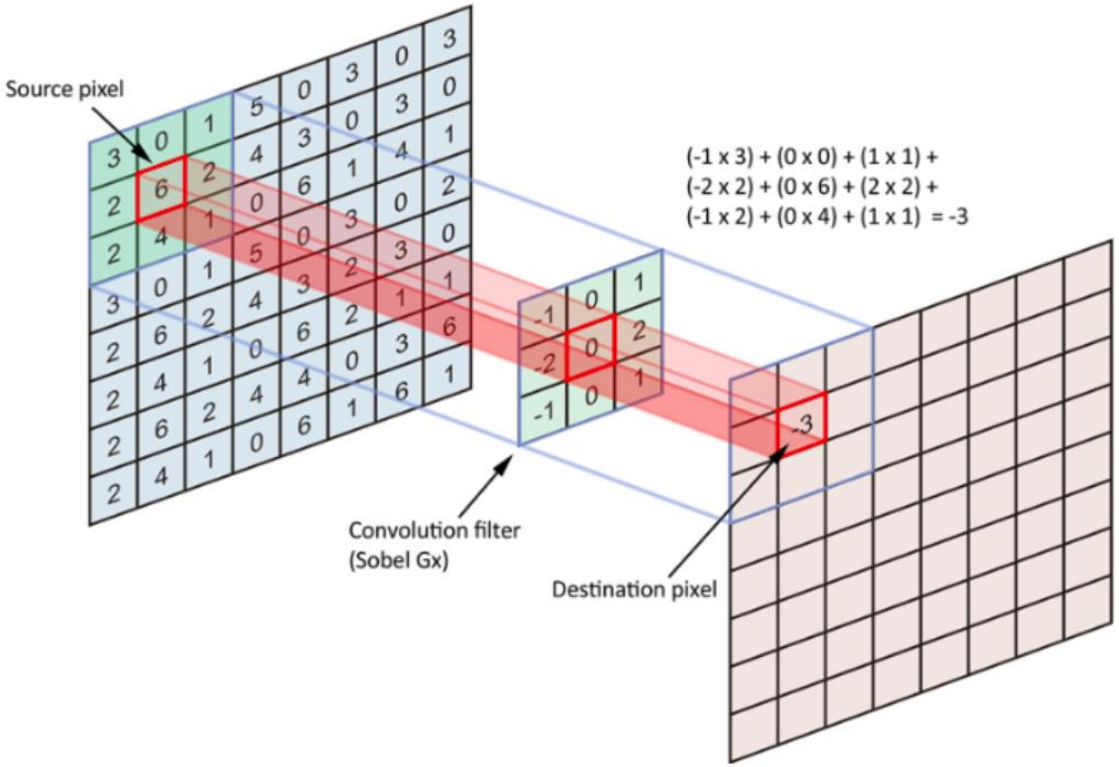
"Google translate"

Convolutional Neural Networks (CNN) – 1/2



- Convolutional Neural Networks (**ConvNets** or **CNNs**) are a category of Neural Networks
- Have proven very effective in areas such as **image recognition and classification**
- ConvNets have been successful in :
  - identifying faces
  - objects and traffic signs
  - **powering vision in robots and self driving cars**

Convolutional Neural Networks (CNN) – 2/2



- The term convolution refers to the mathematical combination of two functions to produce a third function**. It merges two sets of information**
- In the case of a CNN, the convolution is performed on the input data with the use of a **filter or kernel** (these terms are used interchangeably) to then produce a feature map

- Image kernel or filter visually explained : http://setosa.io/ev/image-kernels/
- A friendly introduction to Convolutional Neural Networks & Image Recognition : www.youtube.com/watch?v=2-Ol7ZB0MmU

AI & Ethical concerns

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Artificial Intelligence & Ethical concerns

Big brother: China's data-driven Social Credit system sounds like a sci-fi dystopia

▶ Whether it's by Facebook, Uber or Reddit, we're all being scored without knowing how or why. B what if it was the state using facial-recognition software to rate us, reward us – and punish us? Welcome to the future of China

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Why Taylor Swift Is Using Facial Recognition at Concerts

DECEMBER 13, 2018 11:24AM ET

Swift's security team has used the cutting-edge technology at recent shows to keep her safe from stalkers

Amazon is selling police departments a real-time facial recognition system

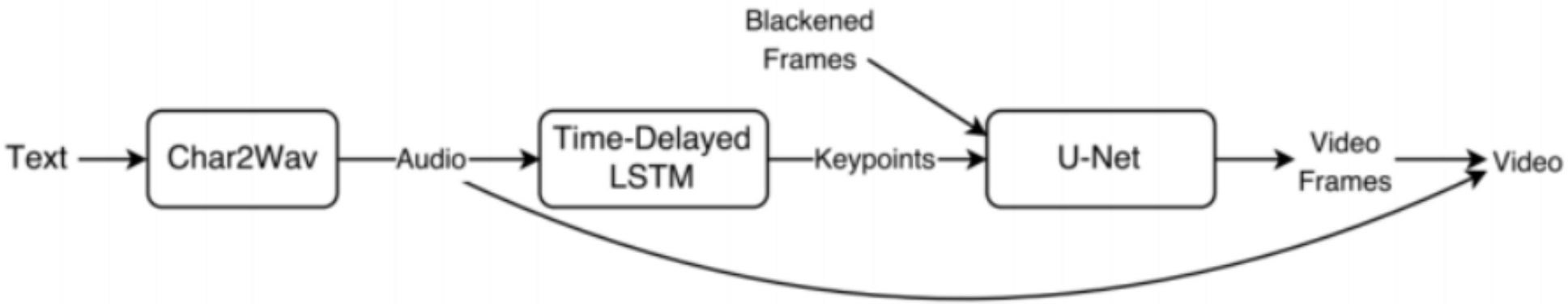
New documents obtained by the ACLU shed light on Amazon's Rekognition project

Artificial Intelligence & Ethical concerns

Gender Classifier	Darker Male	Darker Female	Lighter Male	Lighter Female	Largest Gap
Microsoft	94.0%	79.2%	100%	98.3%	20.8%
FACE++	99.3%	65.5%	99.2%	94.0%	33.8%
IBM	88.0%	65.3%	99.7%	92.9%	34.4%

- When we analyze the results by intersectional subgroups - darker males, darker females, lighter males, lighter females - we see that all companies perform worst on darker females
- IBM and Microsoft perform best on lighter males. Face++ performs best on darker males

Deepfake : “famous” example of Former US President Obama



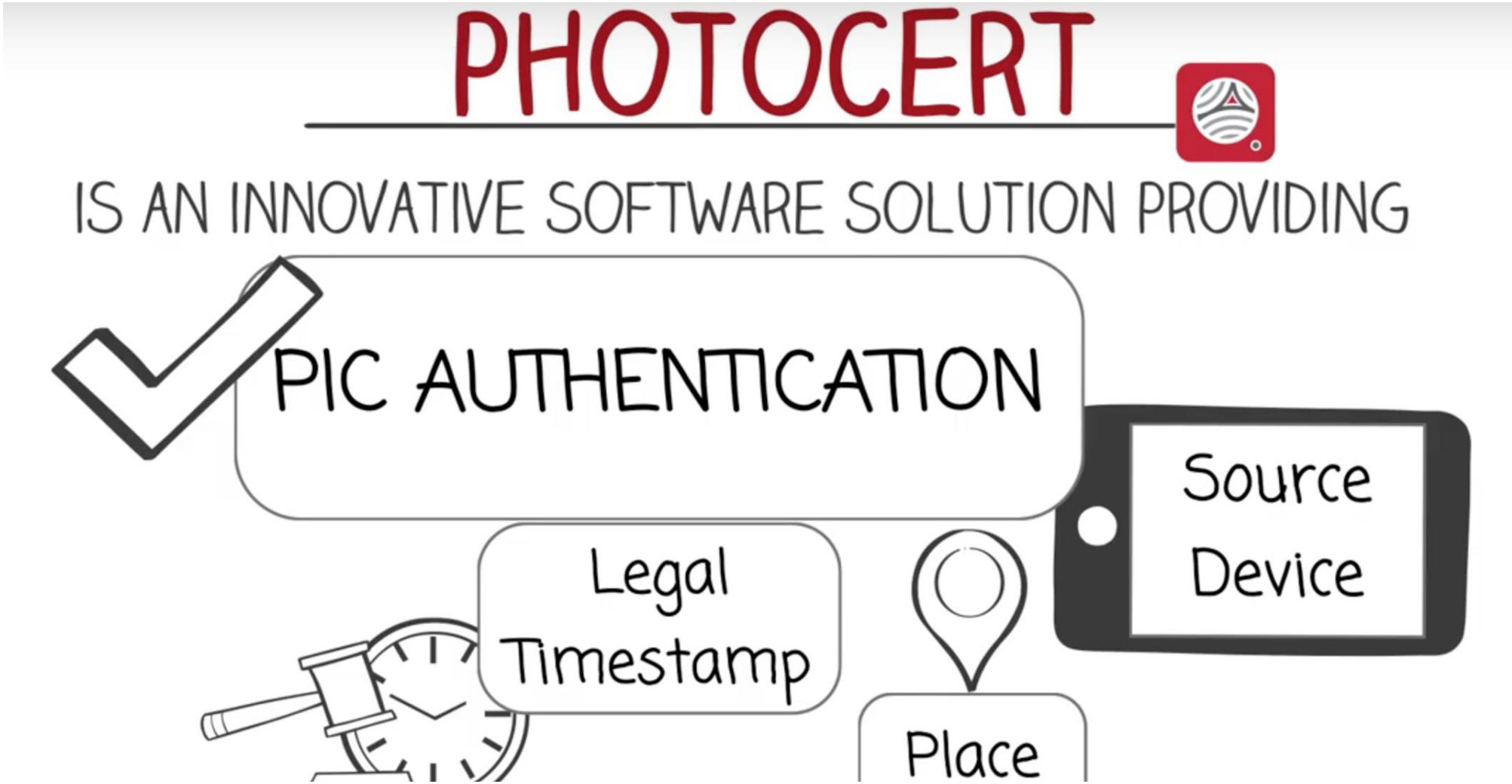
ObamaNet (2017) is composed of 3 trainable neural modules :

1. a text-to-speech network based on Char2Wav
2. a time-delayed LSTM[(1)] to generate mouth – keypoints synced to the audio
3. a network based on Pix2Pix to generate video frames conditioned on the key points

http://www.youtube.com/watch?v=cQ54GDm1eL0

(1) LSTM or Long Short-Term Memory units is a much used variant of a Recurring Neural Network in order to solve the problem of the vanishing gradient. In some cases, the gradient will be vanishingly small, effectively preventing the weight from changing its value. In the worst case, this may completely stop the neural network from further training. Generally speaking, LTSM are very suited for language processing such speech recognition.

Photocert start-up : certifying that a picture is *not* a fake



Will AI (any time soon) take over from us humans ?

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Robots adopting their own language … Generating fake news …

Too scary? Elon Musk's OpenAI company won't release tech that can generate fake news

Edward C. Baig | USA TODAY
Published 12:53 PM EST Feb 15, 2019

Is AI really dangerous for the future of human kinds ?

LIFE WITH A.I.

Elon Musk: ‘Mark my words — A.I. is far more dangerous than nukes’

PUBLISHED TUE, MAR 13 2018 • 1:22 PM EDT | UPDATED WED, MAR 14 2018 • 11:31 AM EDT

Catherine Clifford

SHARE

29,597 views | Jul 27, 2015, 08:10pm

Hawking, Musk, Wozniak Warn About Artificial Intelligence's Trigger Finger

Artificial General Intelligence (AGI)

- Today, we have the so called **Narrow AI** :
  - spotting correlations in data and making predictions
  - focuses on a single subset of cognitive abilities

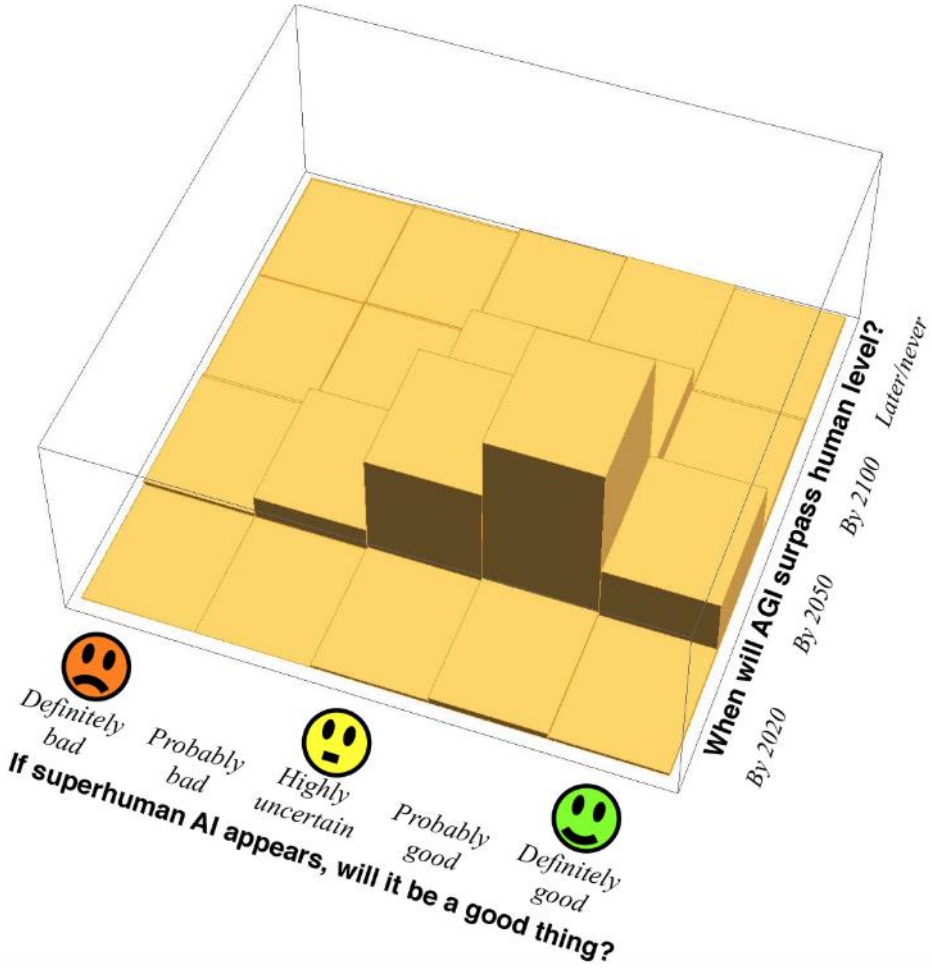
- AGI (also called **Singularity**) would mean :
  - Multi domain learning
  - Domain – independent learning
  - Common-sense reasoning
  - Self-awareness, humour, empathy, … .

  Machines with the ability to perform **any intellectual task that a human can**

Artificial General Intelligence (AGI)

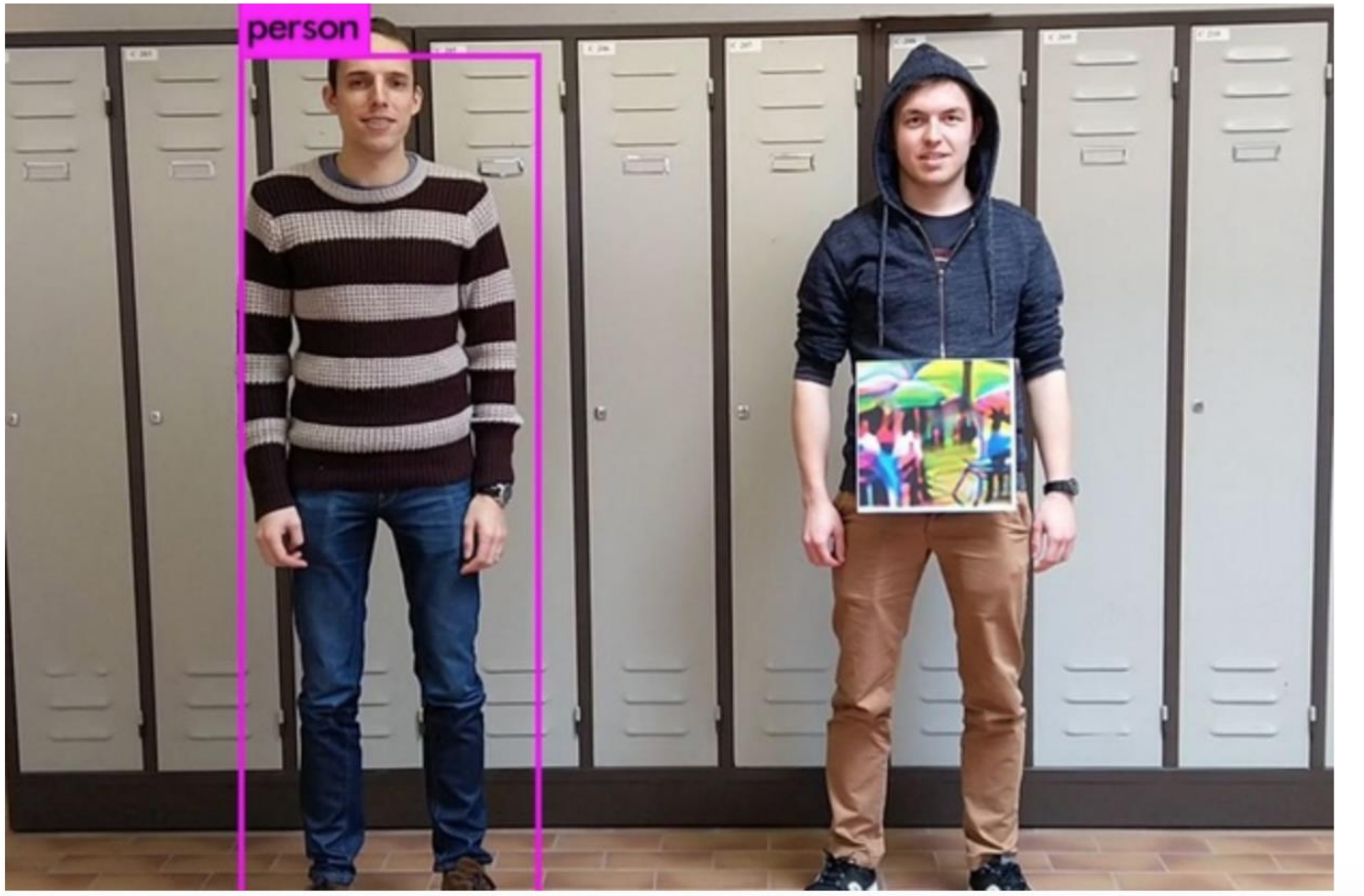
How soon, and should we welcome or fear it?

The first big controversy, dividing even leading AI researchers, involves forecasting what will happen. When, if ever, will AI outperform humans at all intellectual tasks, and will it be a good thing?



https://futureoflife.org/superintelligence-survey/?cn-reloaded=1

AGI versus Narrow AI : we still have a long way to go



- Researcher from the KU Leuven could mislead person recognition AI
- They successfully could mislead the YOLO algorithm used by security cams

AI Superpowers

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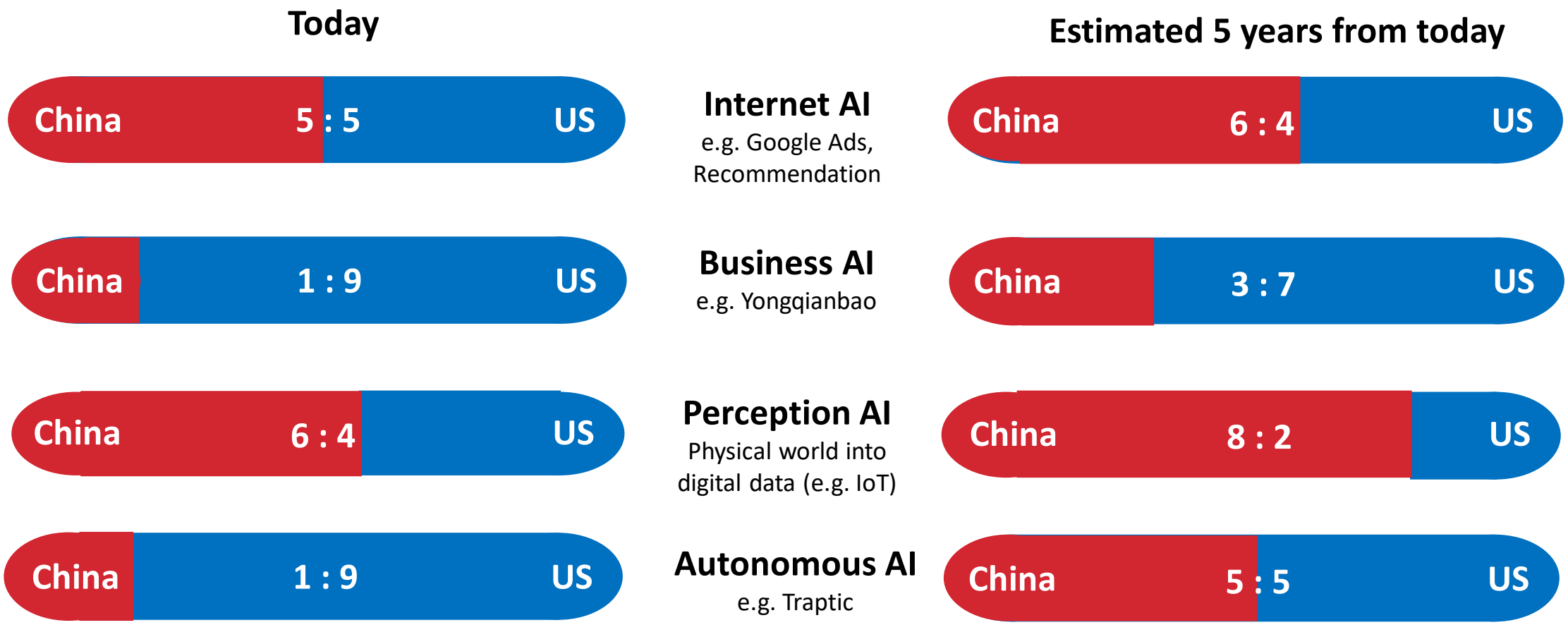
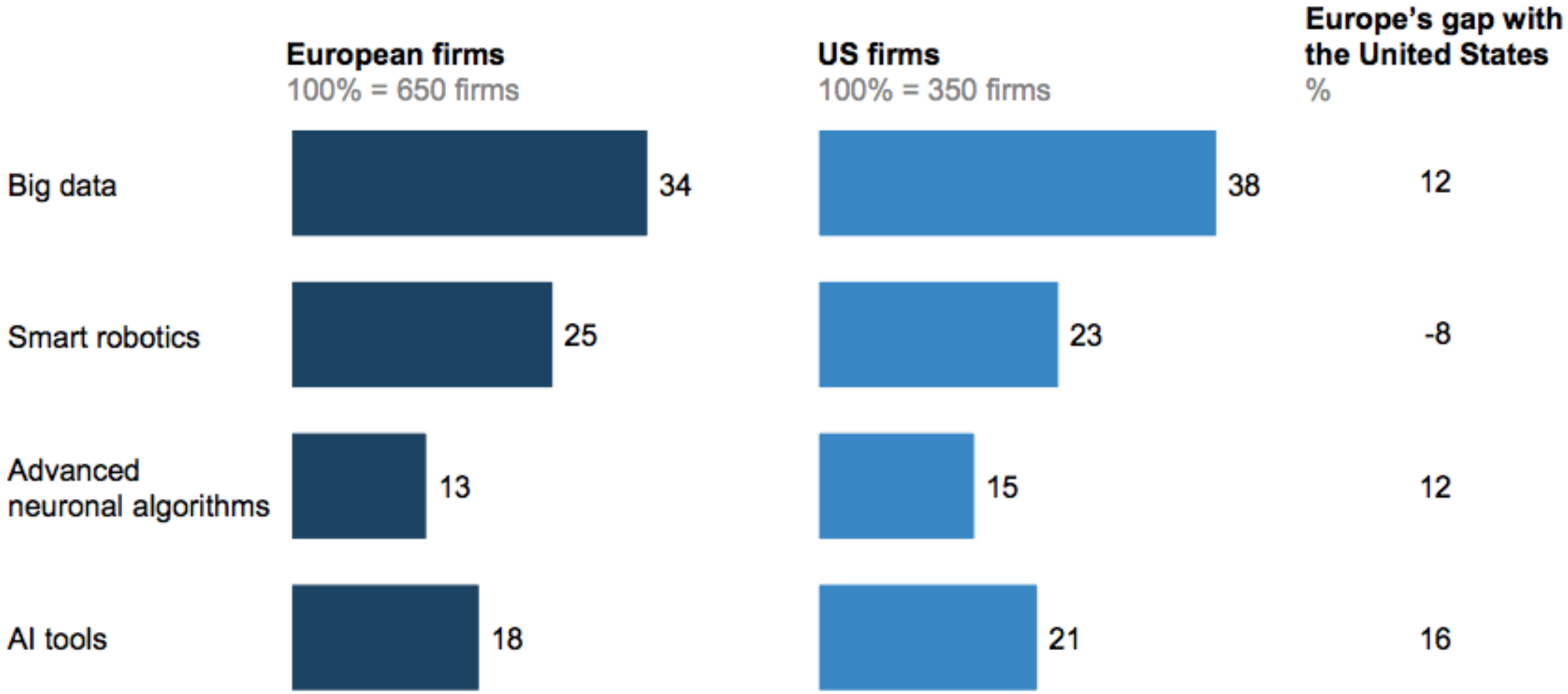
Balance of AI capabilities between the US and China



Taken from "*AI Superpowers by Kai-Fu Lee*"

AI diffusion in **Europe** lags behind that of the **US** …

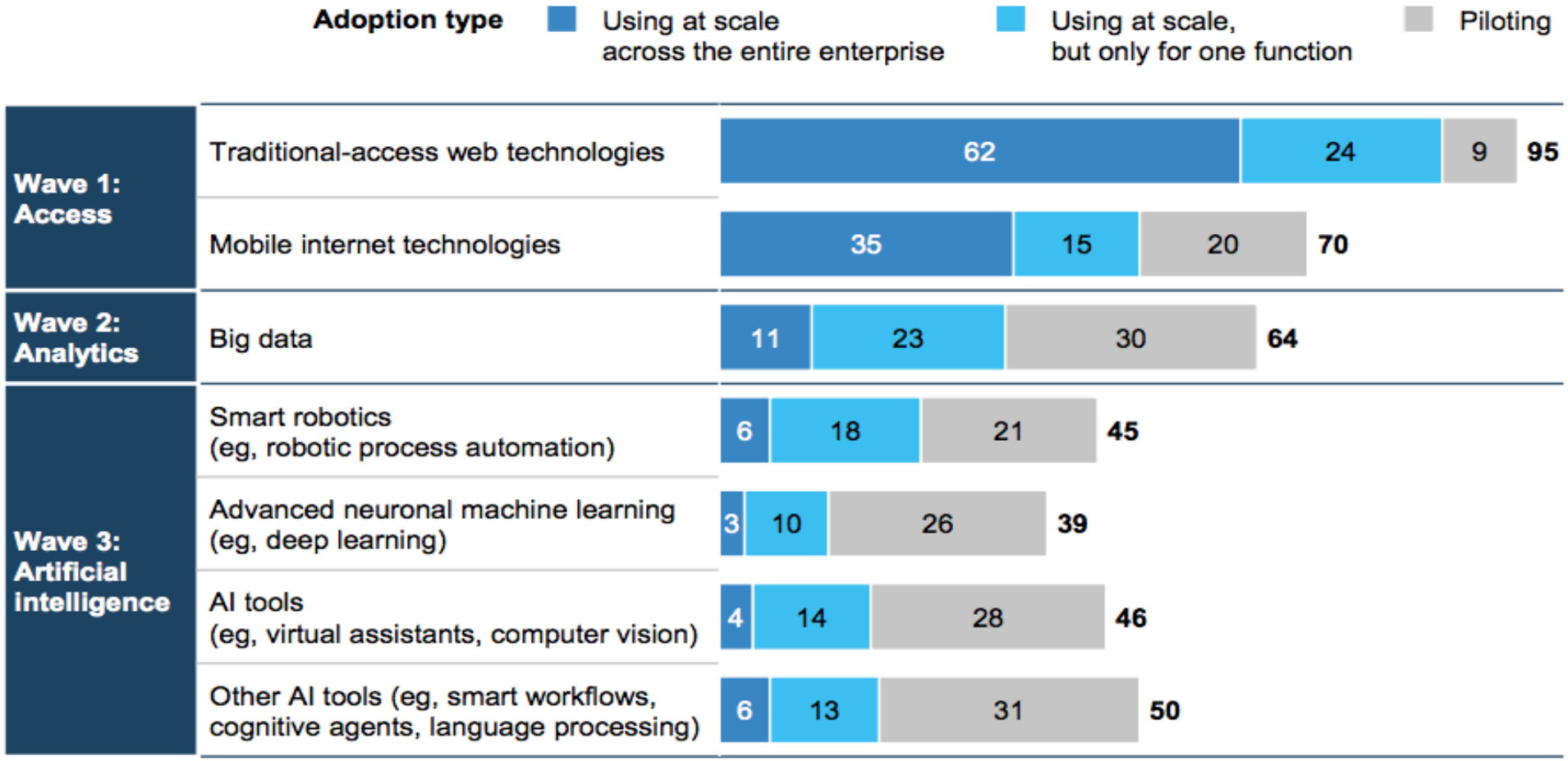
% of firms using AI at scale, 2017



SOURCE: McKinsey Digital Survey, 2017; McKinsey Global Institute analysis

Europe is in the early stages of diffusion of AI technologies

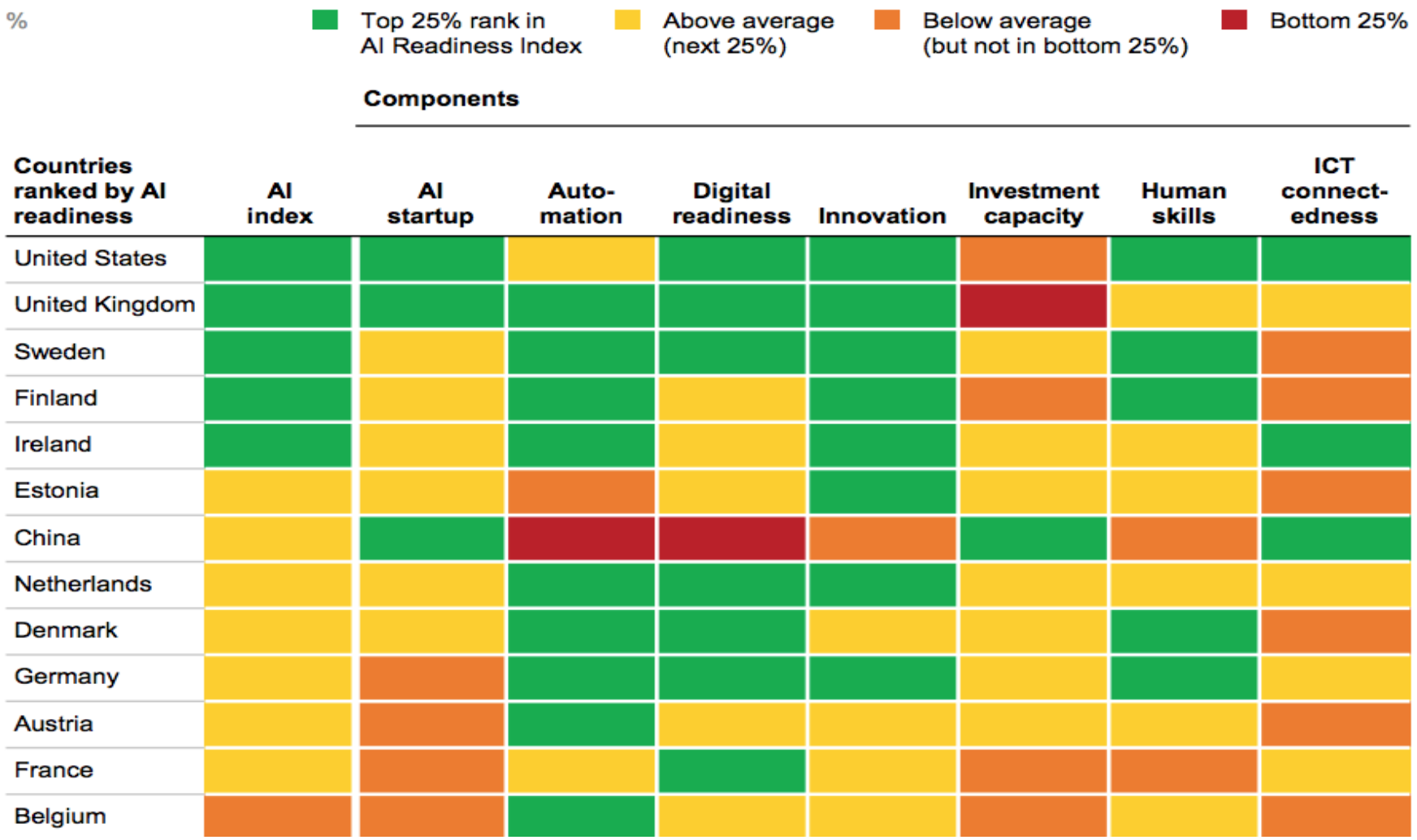
% of European large companies adoption, 2017



NOTE: Figures may not sum to 100% because of rounding.

SOURCE: McKinsey Digital Survey, 2018; McKinsey Global Institute analysis

A ranking within Europe per Country …



AI & the labor market

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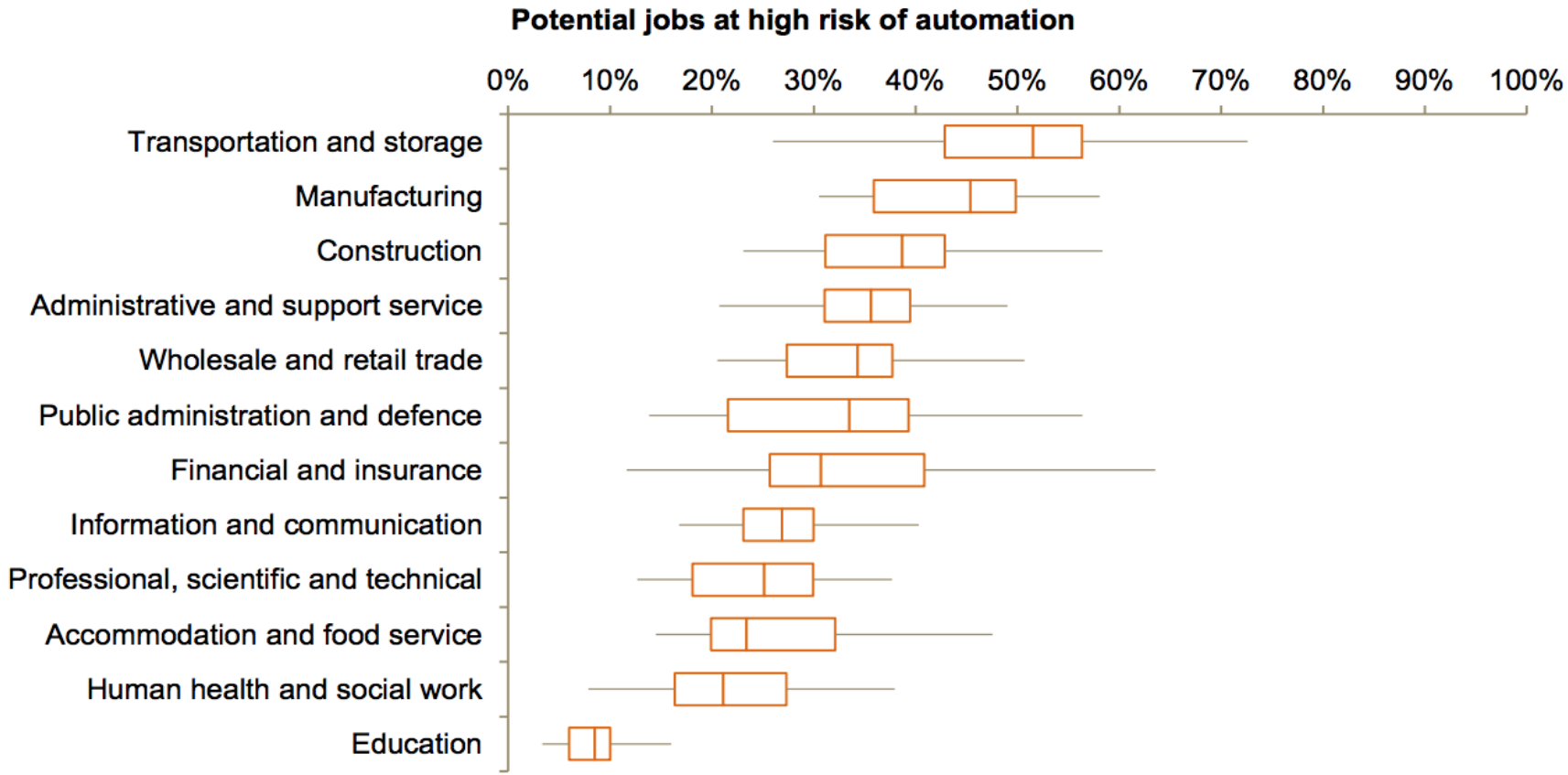
How many jobs *could* be lost thru Artificial Intelligence

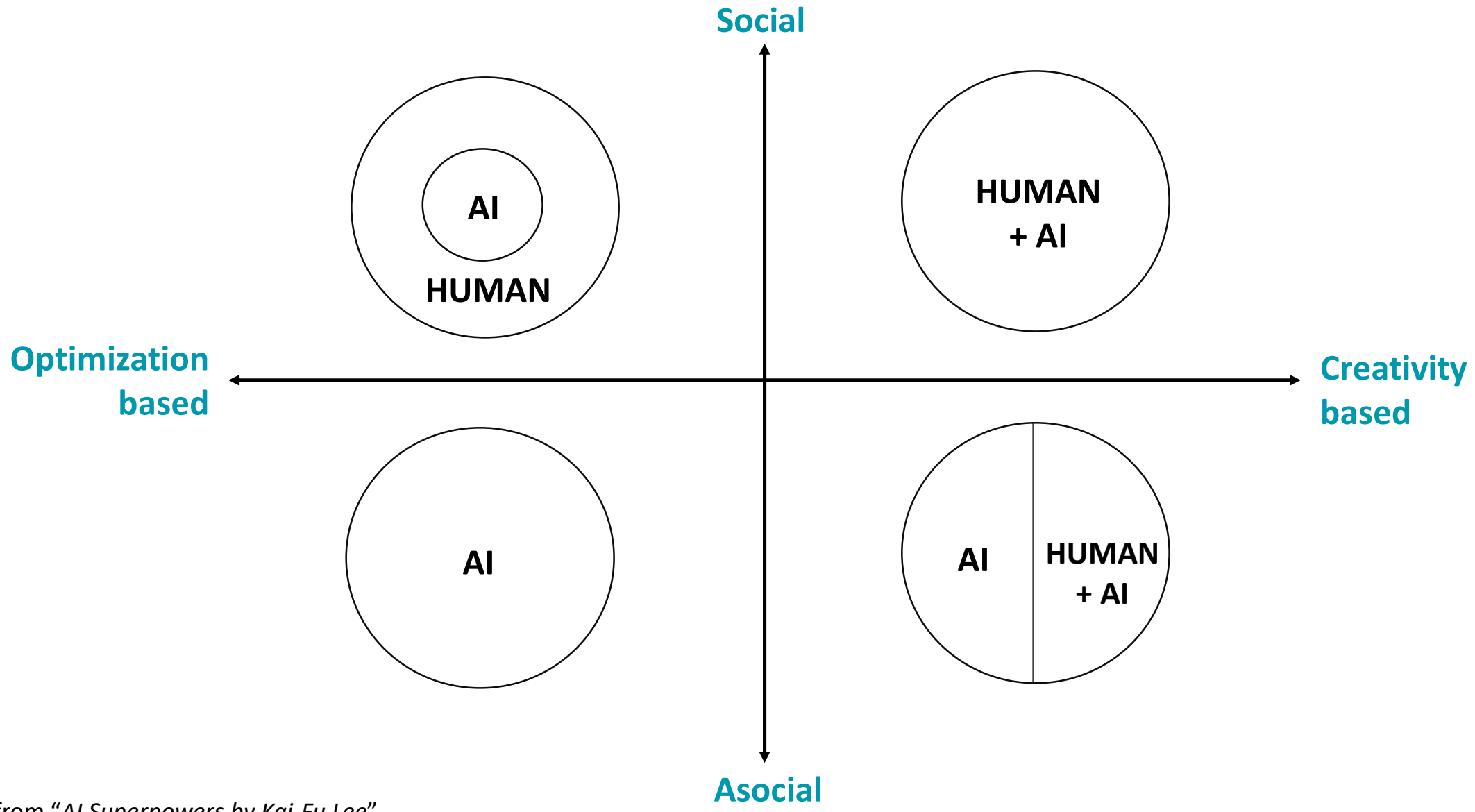


Source: PIAAC data, PwC analysis

- Actual jobs losses will be mitigated by regulatory, legal and social dynamics
- New jobs and new businesses (from the ground up) will also be created thru AI

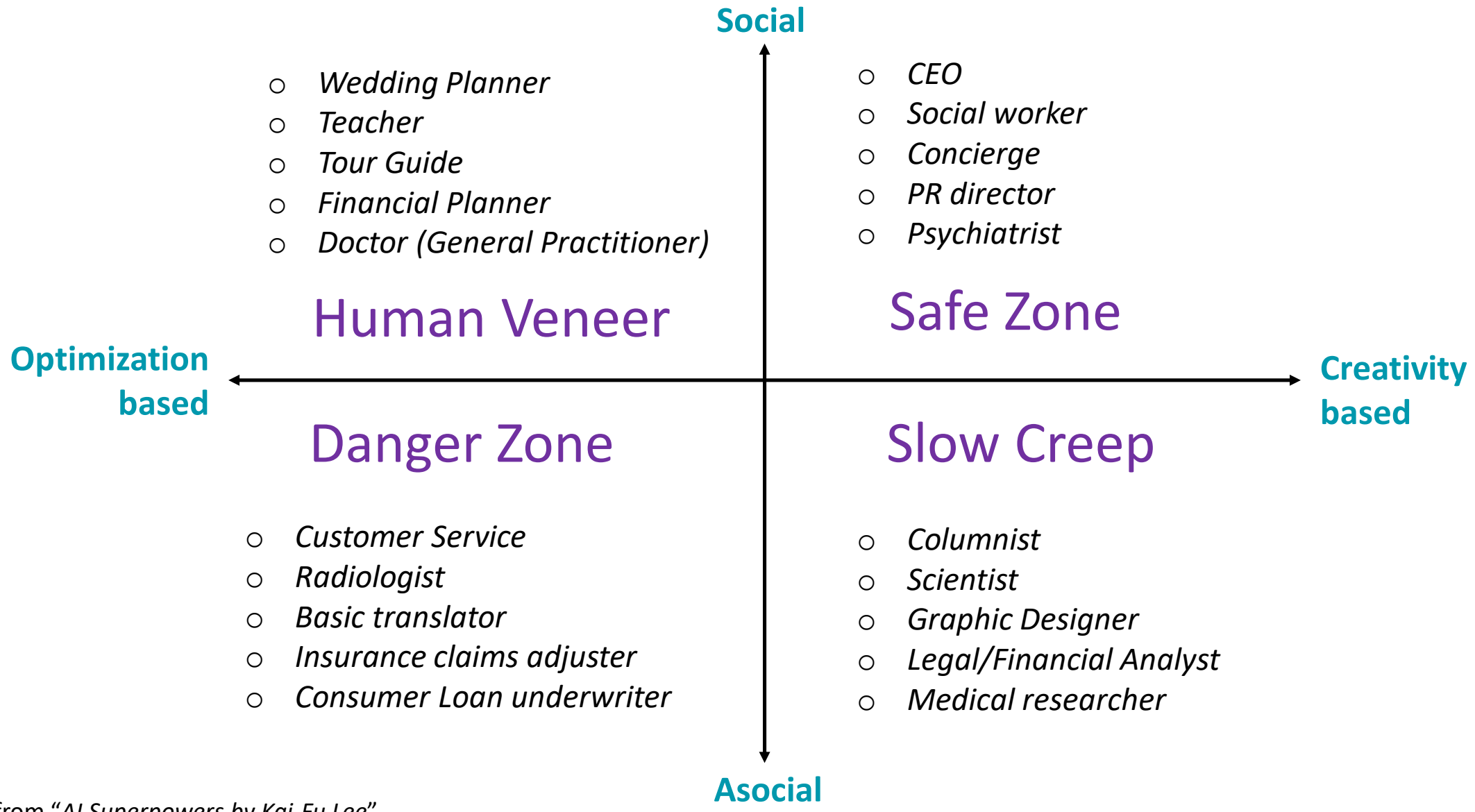
https://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/impact_of_automation_on_jobs.pdf

Human – AI coexistence in the Labor Market (1/2)



Taken from "*AI Superpowers by Kai-Fu Lee*"

Human – AI coexistence in the Labor Market (2/2)



Taken from "*AI Superpowers by Kai-Fu Lee*"

AI Use Cases within Insurance

thewave

Identifying “Mark/Model/Year” just with a Photo

GENERALI BELGIUM LAUNCHED A FIRST FOR EUROPE: GENERALI QUICK QUOTE

Generali Quick Quote is the first digital application in Europe able to calculate annual premiums on the basis of a vehicle photo.
The broker uploads a photograph of the vehicle to the app, along with the driver's age. Using geo-positioning and number plate identification, Generali Quick Quote then calculates the annual premium on the basis of the vehicle characteristics and a number of other parameters, allowing the broker to draw up a quote and submit it to the client within 60 seconds.
Thanks to this new digital system there is no longer any need to bother with the year of registration and engine cubic capacity as the system itself searches for all the necessary data.

For Generali Group technological innovation represents the engine of the 6 strategic actions identified for accelerating the implementation of industrial turnaround. In this way Generali Quick Quote marks a turning point in the world of car insurance and offers added value to the broker and the customer.

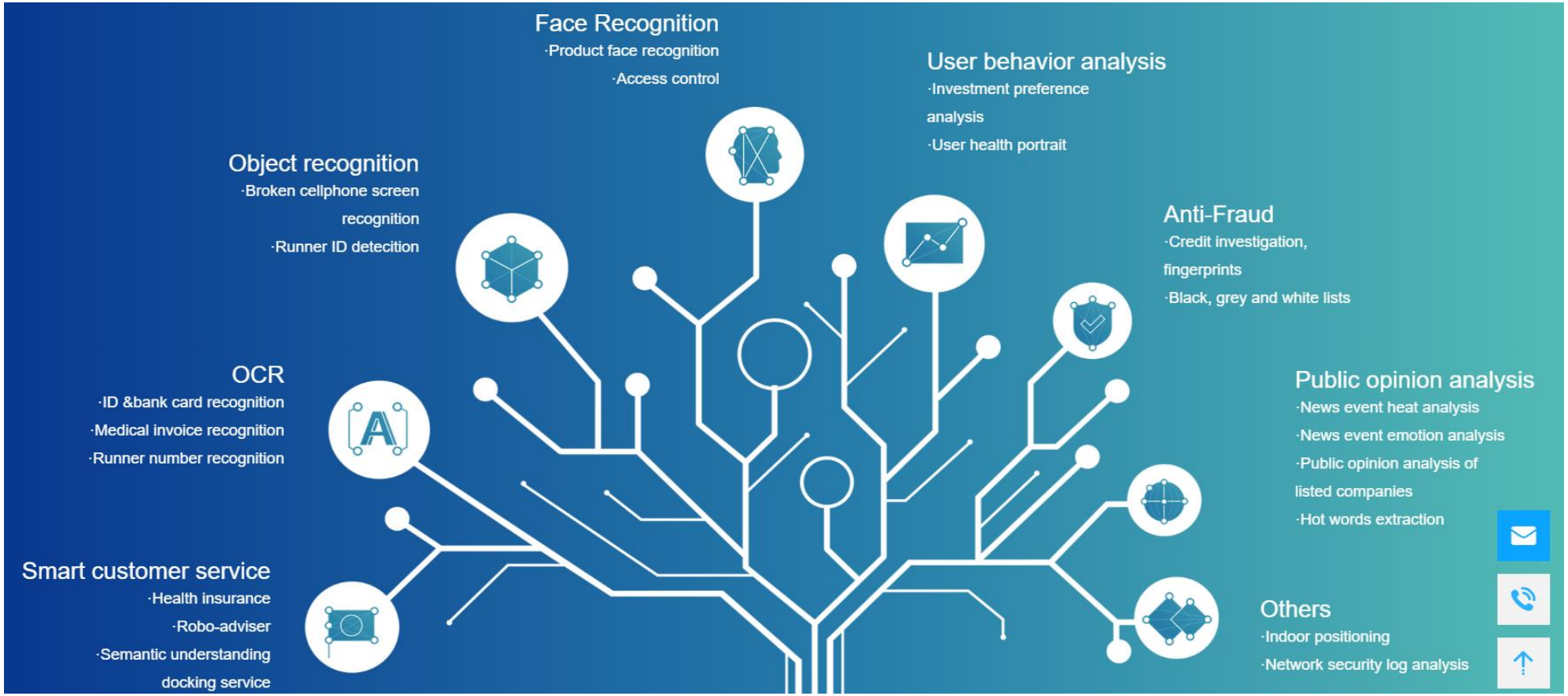
Meet “Insurtech” Zhong An – 1/2

- **Profile**
  - is the first Chinese 100% online insurer that offering product underwriting and claims online.
  - Zhong An leverages AI, big data and online technology to make the insurance sales and claims process smooth, smart & time saving for the customer

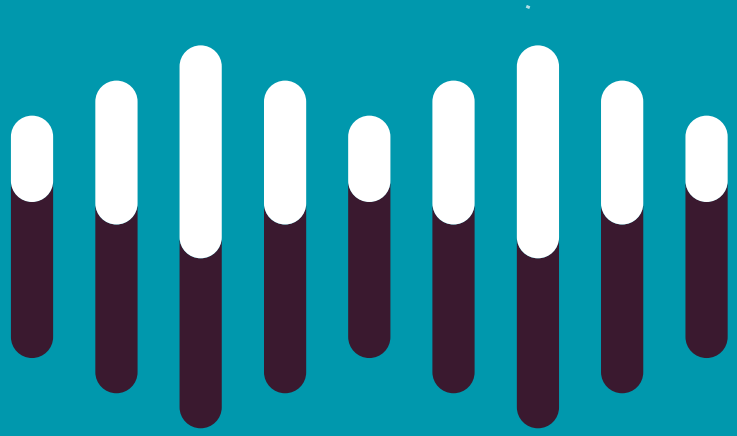
- **Formed in 2013 as a joint venture between :**
  - Ping An **:** A Chinese Insurance, banking and financial service company
  - Tencent **:** A Chinese internet and technology company
  - Alibaba **:** The Chinese e-commerce giant

- **Funding :**
  - $935M (1st round) and an IPO of $1,5b
  - Investors : Morgan Stanley, Alibaba, TenCent, Ping An, Softbank, others

Meet “Insurtech” Zhong An – 2/2



- **Health** : an ecosystem of health insurance coupled with advanced health management services powered by technology, health prediction algorithms & genetic testing
- **Auto** : data & technology enabled pricing of auto polices based only on ID card & drivers license no
- Has **sold digitally today 8 billion insurance policies for 500M retail customer** !



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