Introduction to AI, practical approach

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AI Senior Expert

Date

What will you learn?

- What is AI?
- Identify what AI can and cannot do?
- AI vs. ML vs. DL
- ML vs. Data science
- How ML/DL works?
- Global ML/DL framework
- How to speak the language of AI team?
- What are the steps of an AI project?
- Limitations of AI
- What is the effect of AI on society?

Agenda

- Part 1: What is AI?
- Part 2: Working with an AI team
- Part 3: AI and the society
- Part 4: How it works?

Agenda

- Part 1: What is AI?

- Part 2: Working with an AI team

- Part 3: AI and the society

Where can we find AI today?

Social Media

Robotics

Computer Vision

Speech

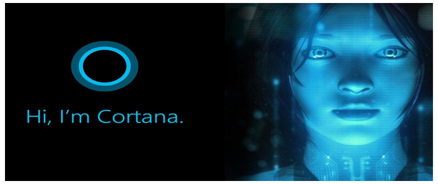
The AI revolution

IBM Pepper

Google now

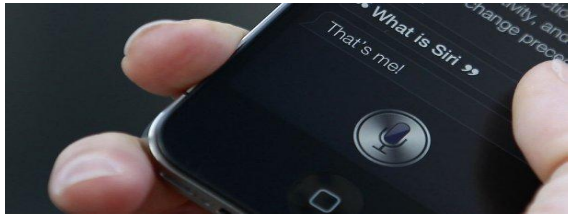
FB Chatbot

Social Media

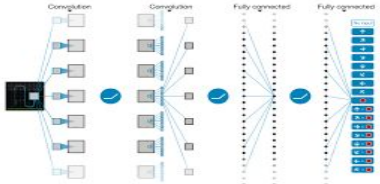


MS Cortana

Apple Siri



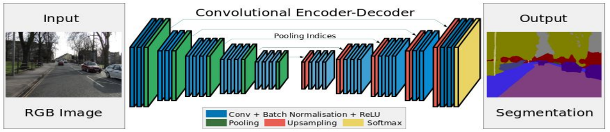
DeepMind
AlphaGo



Atari
DeepMind

Robotics

SegNet

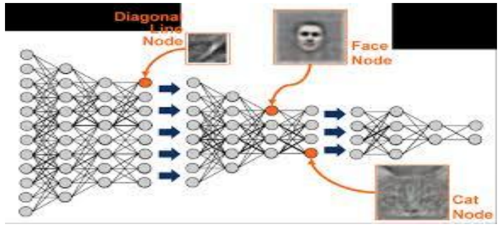


Computer
Vision

Speech

MS Speech

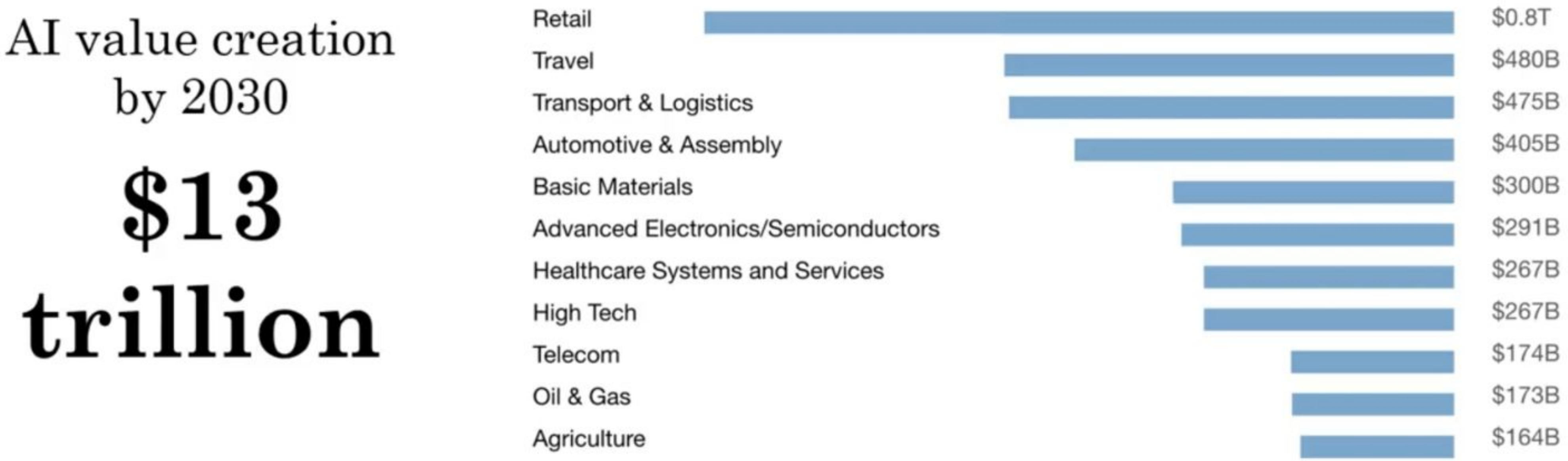
Comma.ai
HAD



AlexNet

DeepSpeech 2

What value AI is creating?

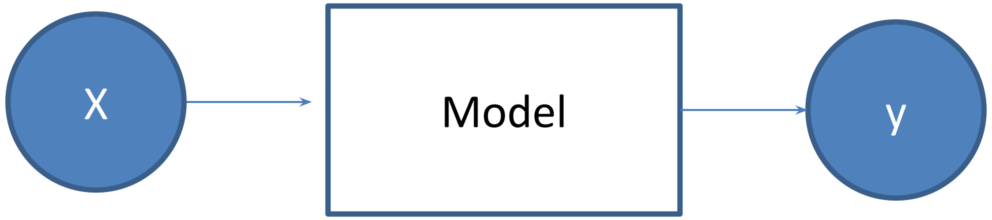


[Source: McKinsey Global Institute.]

deeplearning.ai Andrew Ng

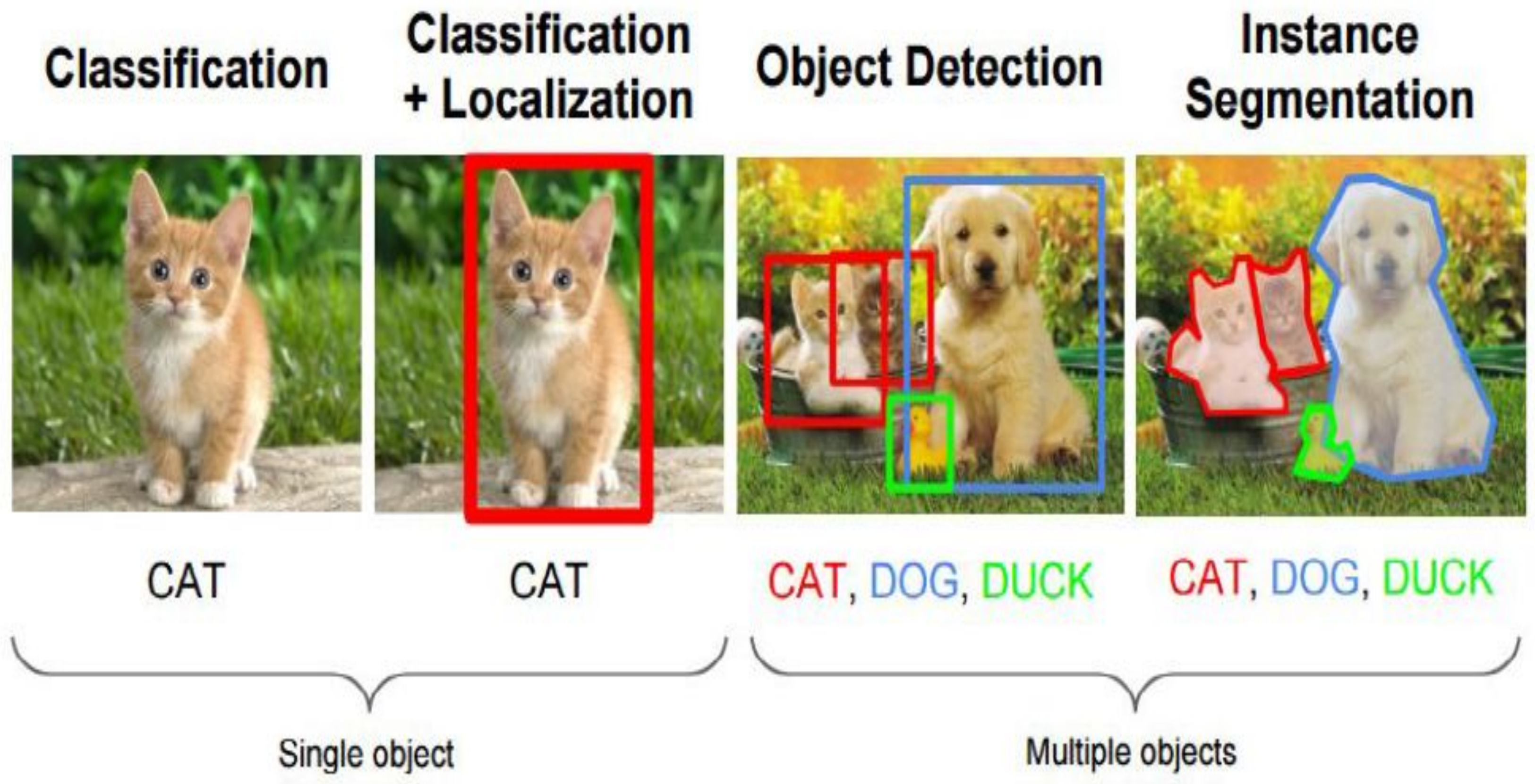
AI is in many fields, MOSTLY not software!

What AI can do?



Simple mappings

Computer vision possible tasks



Source: Fei-Fei Li, Andrej Karpathy & Justin Johnson (2016) cs231n, Lecture 8 - Slide 8, *Spatial Localization and Detection* (01/02/2016). Available: http://cs231n.stanford.edu/slides/2016/winter1516_lecture8.pdf

What AI can do?

Structured data

Price	Floor space	Rooms	Lot size	Appartment	Row house	Corner house	Detached
250000	71	4	92	0	1	0	0
209500	98	5	123	0	1	0	0
349500	128	6	114	0	1	0	0
250000	86	4	98	0	1	0	0
419000	173	6	99	0	1	0	0
225000	83	4	67	0	1	0	0
549500	165	6	110	0	1	0	0
240000	71	4	78	0	1	0	0
340000	116	6	115	0	1	0	0

Machine learning background survey 04.09.18

Please answer "Yes" to the following questions if:

This form is automatically collecting email addresses for VALEO users. Change settings

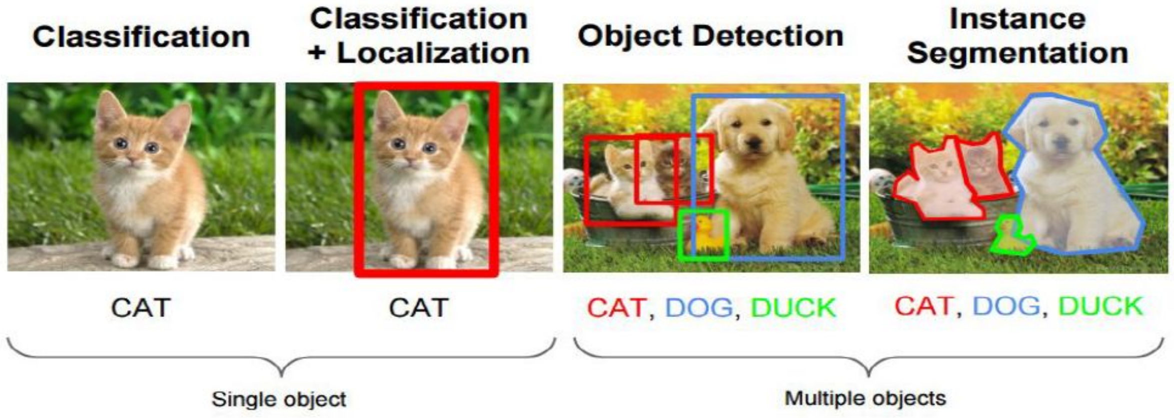
Know about basic linear algebra and matrices operations (multiplication, add, transpose)? *

- Yes
- No

Know how to apply differentiation and the chain rule? *

- Yes
- No

Unstructured data



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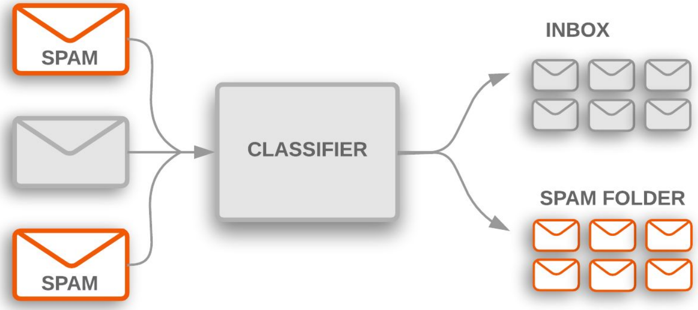
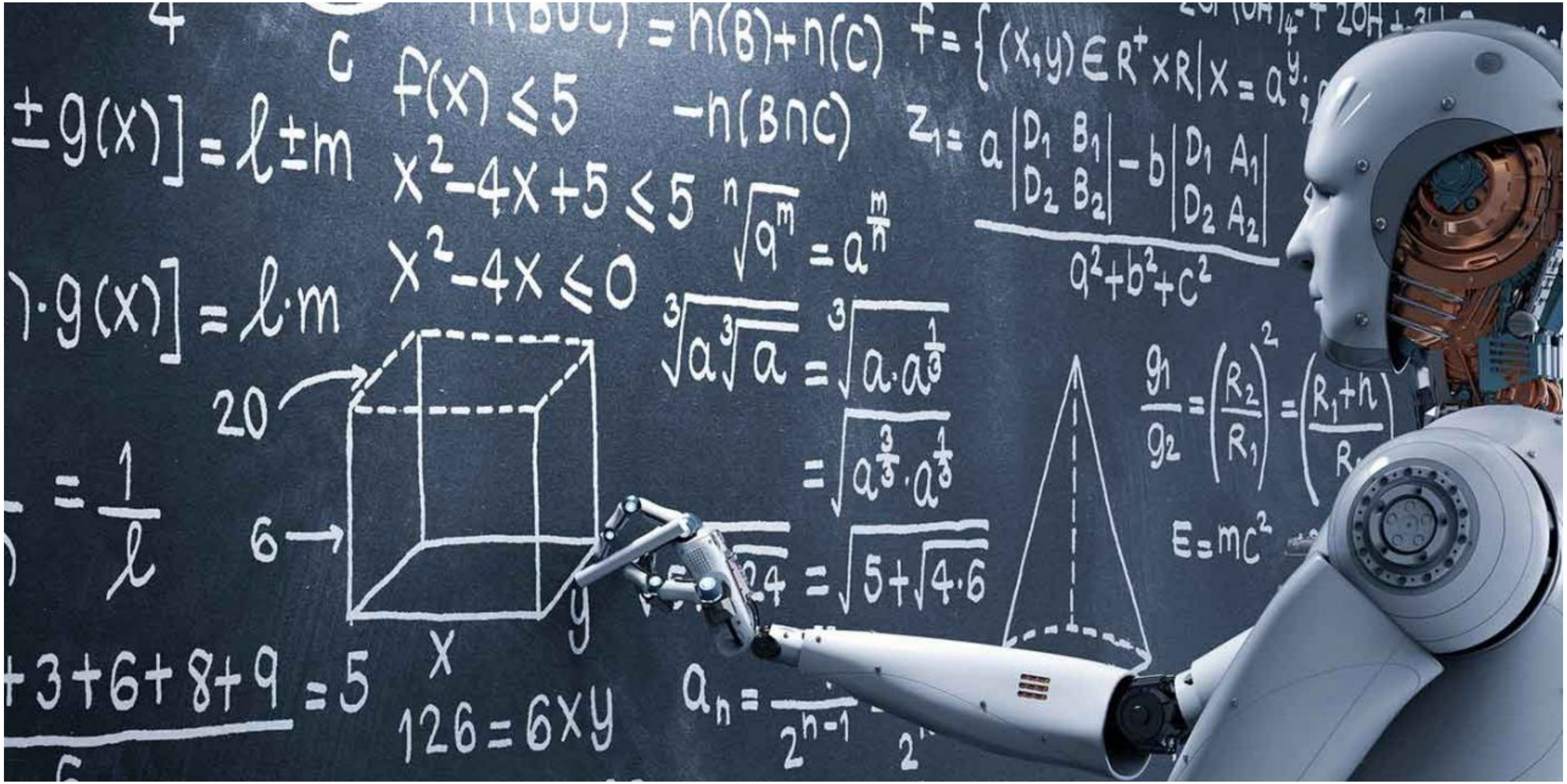


Artificial Narrow Intelligence: Structure or unstructured

What AI can NOT do?



Artificial General Intelligence is very far (10/100/1000 yrs)

What AI cannot do? Complex mappings

Gestures could be hard even sometimes for humans

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How to quickly spot the potential of AI to a project?

- Simple task for human → simple concept
    - < 1 sec
- And/or needs lots of data to perform
- Think Tasks not Jobs
    - Instead of replacing an operator, think of how AI can automate parts of his job

Examples:

- Simple perception: text, speech, image
- Automation: Look at many data and predict say house price

Agenda

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How to speak the language of AI team

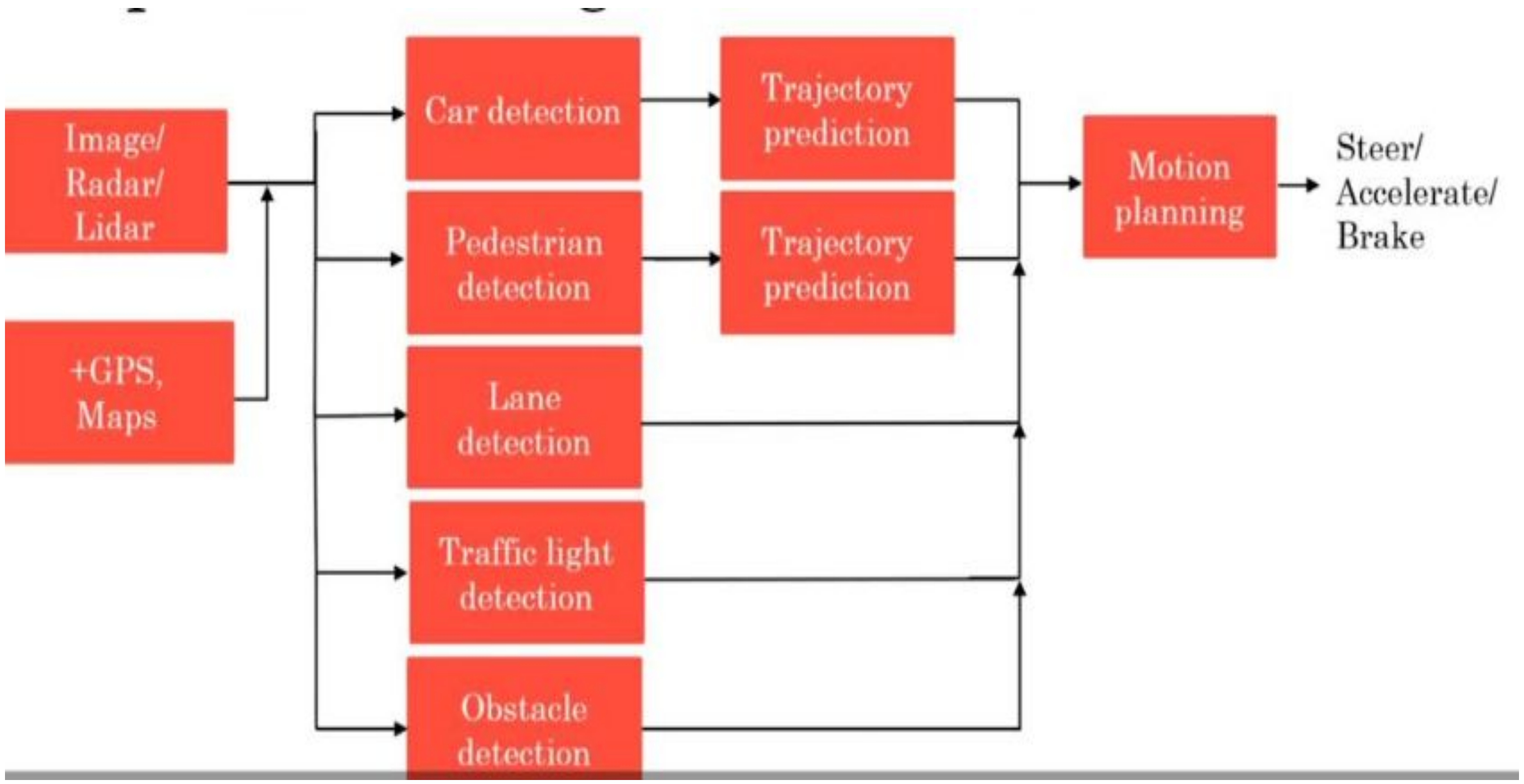
- What AI can and cannot do
- AI project lifecycle
- Define the performance requirements
- Data needs

Workflow of an AI project

AD pipeline

Each is an AI project: A --> B

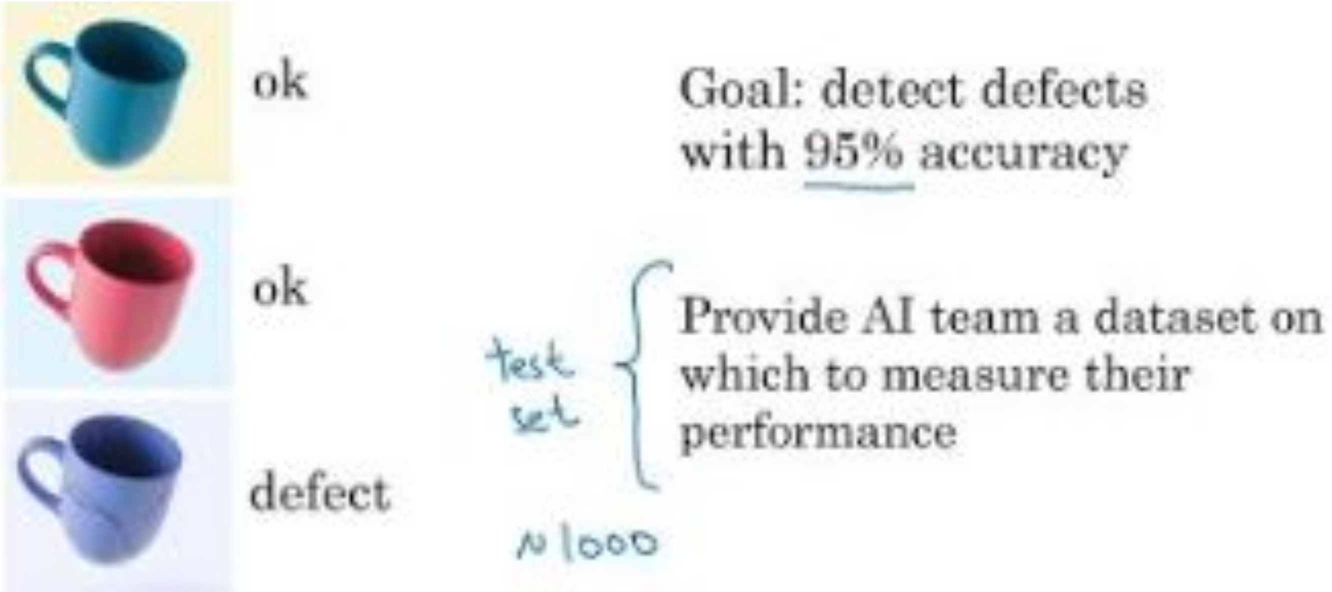
1. Data collection
2. Train
    a. Many iterations
3. Deploy



How to define performance requirements?

Always talk in a statistical metrics

- 100% is not possible due to reasons that will be described later



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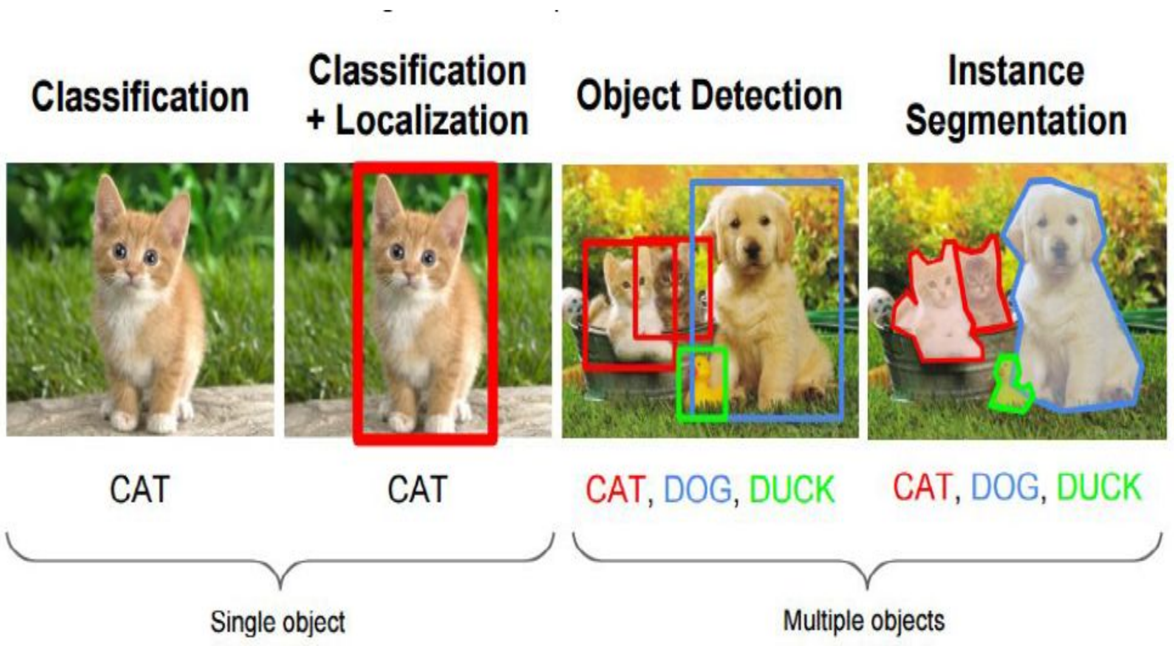
How to acquire data?

1. Raw data collection, where?
    a. Public
    b. Own
    c. From users experience (early deployment)
2. Annotation = Labeling
    a. Manual
    b. Automatic → Observe behaviors
    c. Semi-automatic



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Data acquisition tips

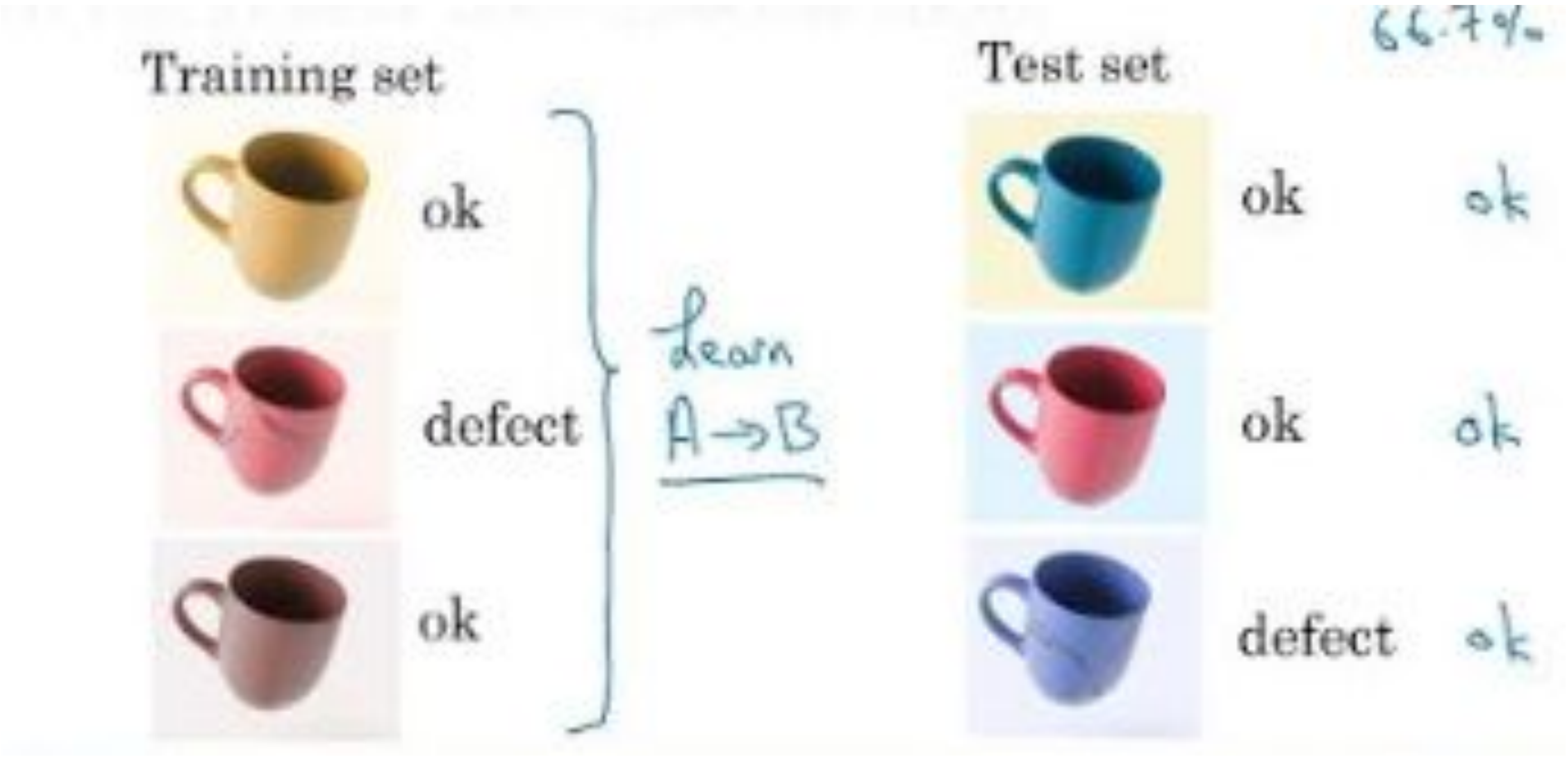
- Integrate AI teams
  - Quick feedback
  - Set data collection requirements and quality
- Deploy early (Tesla model)
  - Do not wait years to collect all the data
  - Quick feedback

How much data?

- Usually BigData → How big?
    - The bigger the better → MB, GB, TB, PB
    - Problem dependent
    - Rule of thumb, 5k/class → if classification

What data sets an AI team needs?

- Train data
- Test data
- Validation data



100% is not possible

- Garbage in - Garbage out
  - Incorrect labels
  - Missing values
  - Ambiguous labels
- ML limitations
  - Statistical methods
  - Traditional ways fails due to many cases

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AI Technical tools

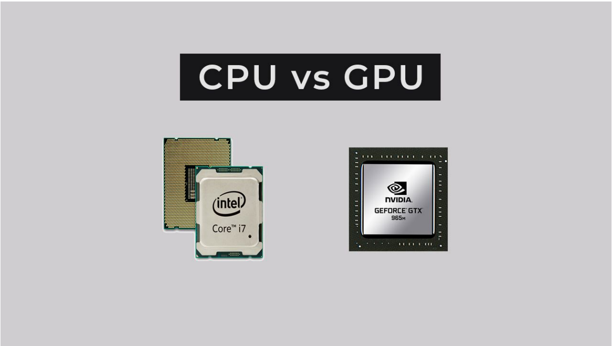
ML frameworks: TensorFlow, Pytorch, Keras, CNTK,...etc

Linux

Opensource: Github → critical for fast prototyping. Most of the ideas are from research papers.

GPU vs CPU

Cloud vs. On-prem



Make or buy?

- ML can be in-house or outsourced
  - Most probably it will soon be an industry standard
  -
- Data science (analytics) are better in-house → custom
- Embrace the industry standards → re-use when possible
  - Do not reinvent the wheel

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AI and Society

- Hype of AI
- Limitations of AI
  - Bias
  - Adversarial Attacks
- Effect on Jobs

The hype of AI

AGI is too far

- AI cannot do everything
- There’s no need to fear it! This creates limitations

AI winter is too far as well

- AI is creating lots of gains in economy already

Limitations of AI

Explainability

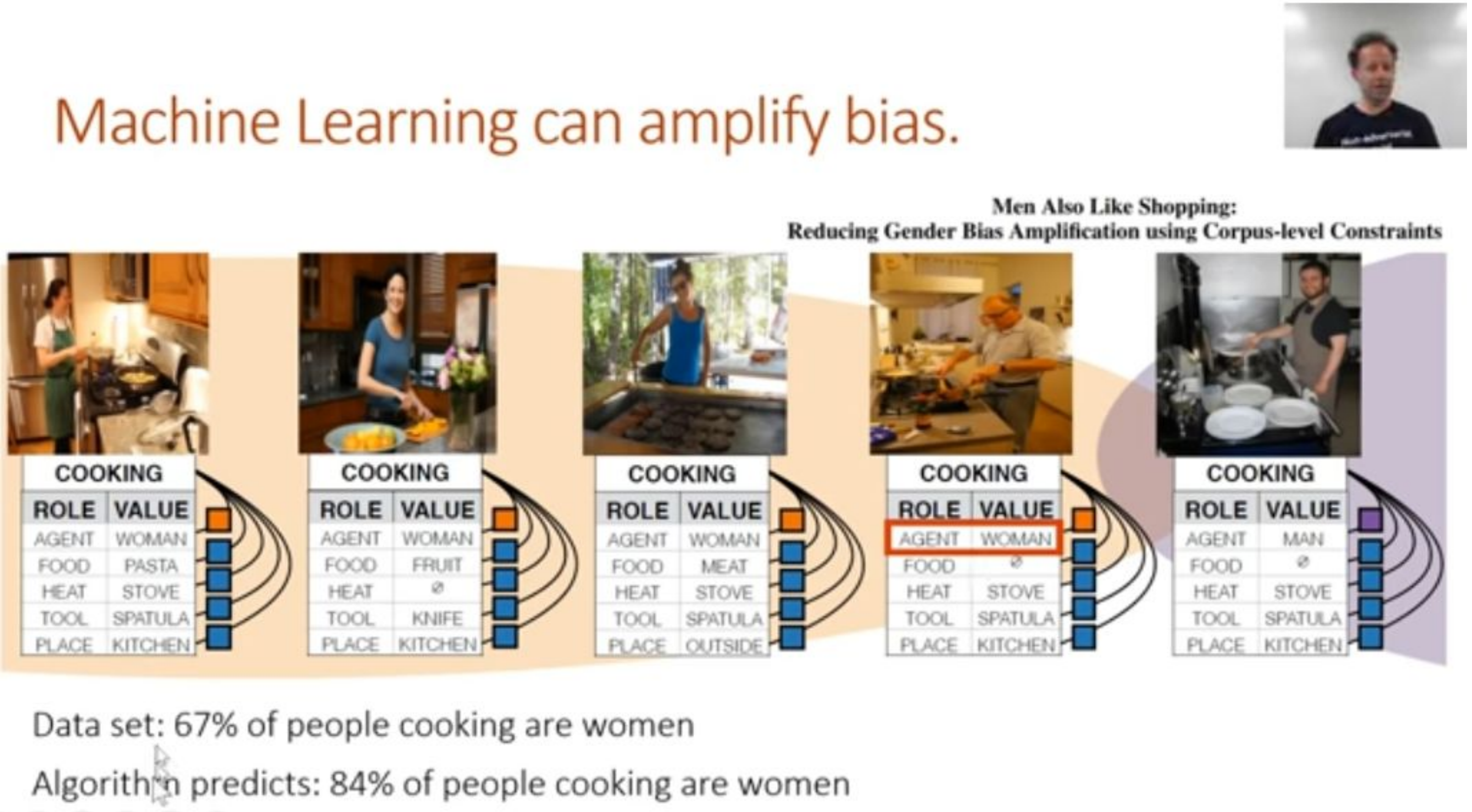
[Rajpurkar et al. (2018). CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning.]

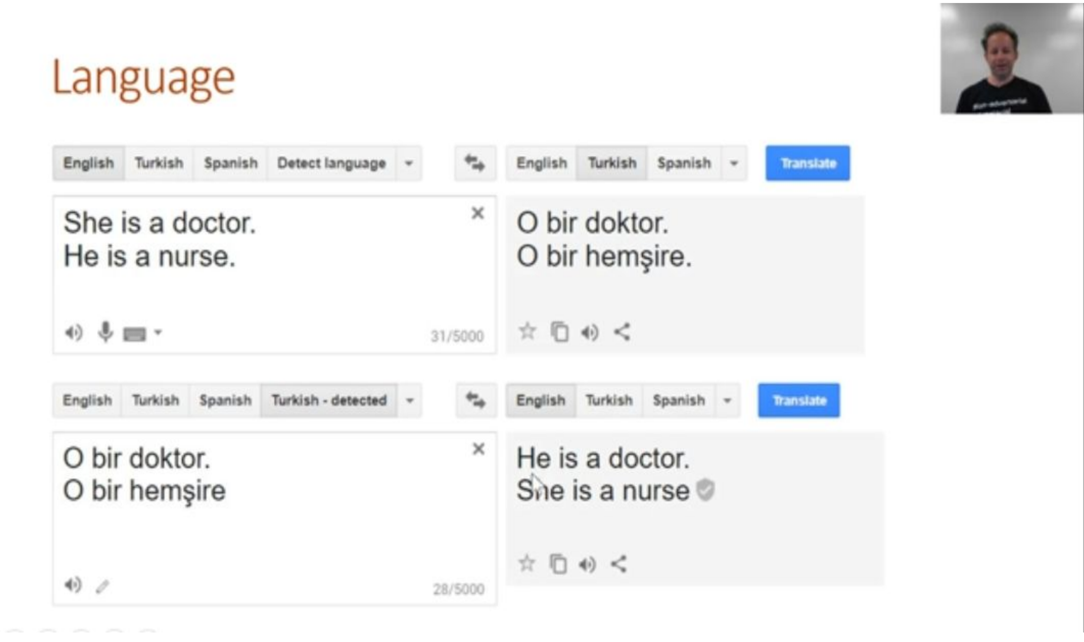
Humans also have hard time explain themselves, but are less susceptible to errors

Limitations of AI

Bias

Gender bias





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Limitations of AI

Bias

Ethnic bias

A War of Words Puts Facebook at the Center of Myanmar's Rohingya Crisis

By MEGAN SPECIA and PAUL MOZUR OCT. 27, 2017

Across Myanmar, Denial of Ethnic Cleansing and Loathing of Rohingya

查看简体中文版 | 查看繁體中文版

By HANNAH BEECH OCT. 24, 2017

137

"Kalar are not welcome here because they are violent and they multiply like crazy, with so many wives and children," he said.

Mr. Aye Swe admitted he had never met a Muslim before, adding, "I have to thank Facebook because it is giving me the true information in Myanmar."

PROPUBLICA

Machine Bias

There's software used across the country to predict future criminals. And it's biased against blacks.

by Julia Angwin, Jeff Larson, Surya Mattu and Lauren Kirchner, ProPublica

May 23, 2016

Prediction Fails Differently for Black Defendants

	WHITE	AFRICAN AMERICAN
Labeled Higher Risk, But Didn't Re-Offend	23.5%	44.9%
Labeled Lower Risk, Yet Did Re-Offend	47.7%	28.0%

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Limitations of AI

Why is it a problem?

- AI is involved in hiring, so hiring can be biased
- Facial recognition works better for light-skinned than dark-skinned, and is used in security departments
- Bank loan approvals
- Can lead to wars!

Limitations of AI

How to deal with bias?

- Technical solutions: collect balanced data
- Auditing: frequently test cases of bias from your algorithm
- Diverse workforce: creates less biased applications

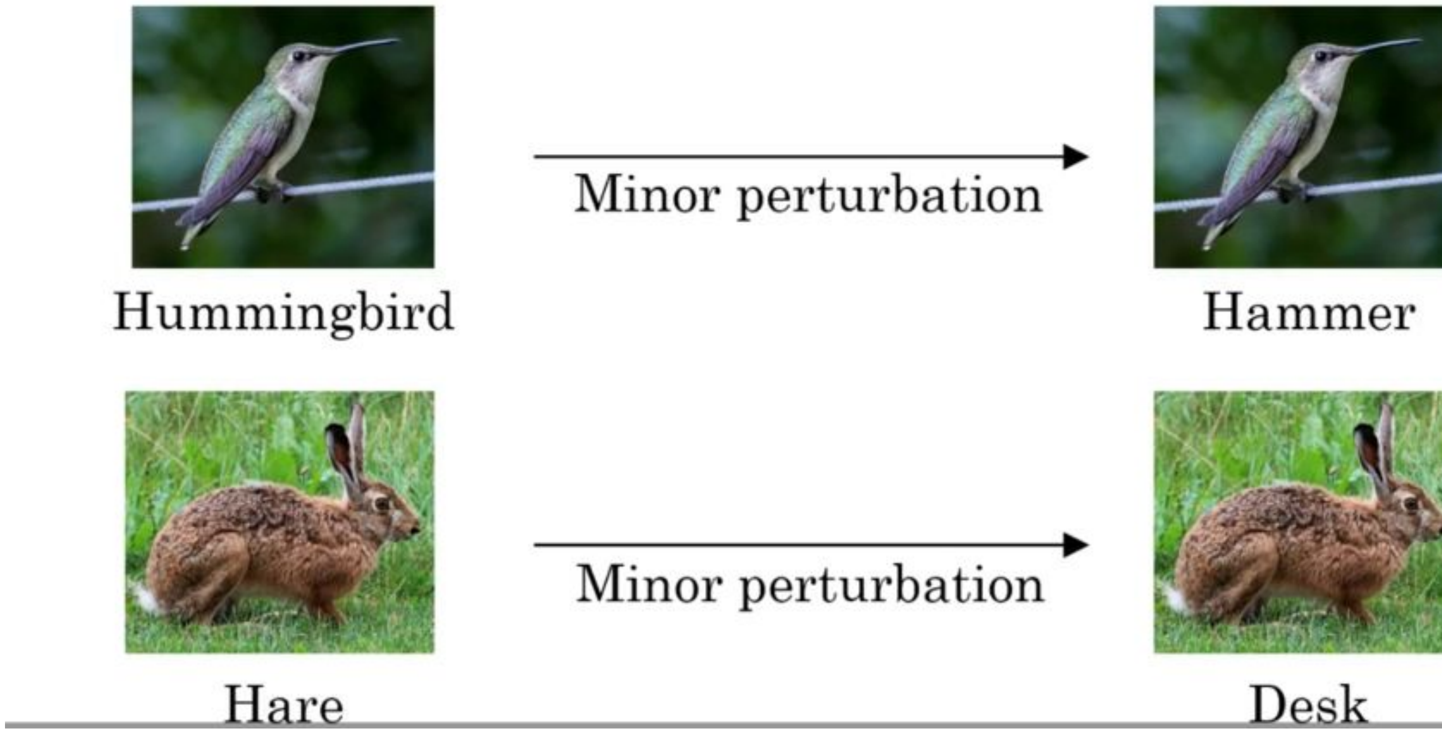
Limitations of AI

Adversarial attacks

- AI does not see as we see

Adversarial defense

- Technical solutions exists, but with cost of slow running time
- Still in research phases



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Limitations of AI

Mis-use of AI

- Deep Fakes https://www.youtube.com/watch?v=cQ54GDm1eL0
  - Fake videos of people
- Manipulate freedom
  - Oppressive surveillance
  - Elections manipulation through personalized content
- Fraud (anti-fraud) attacks

AI Effect on jobs

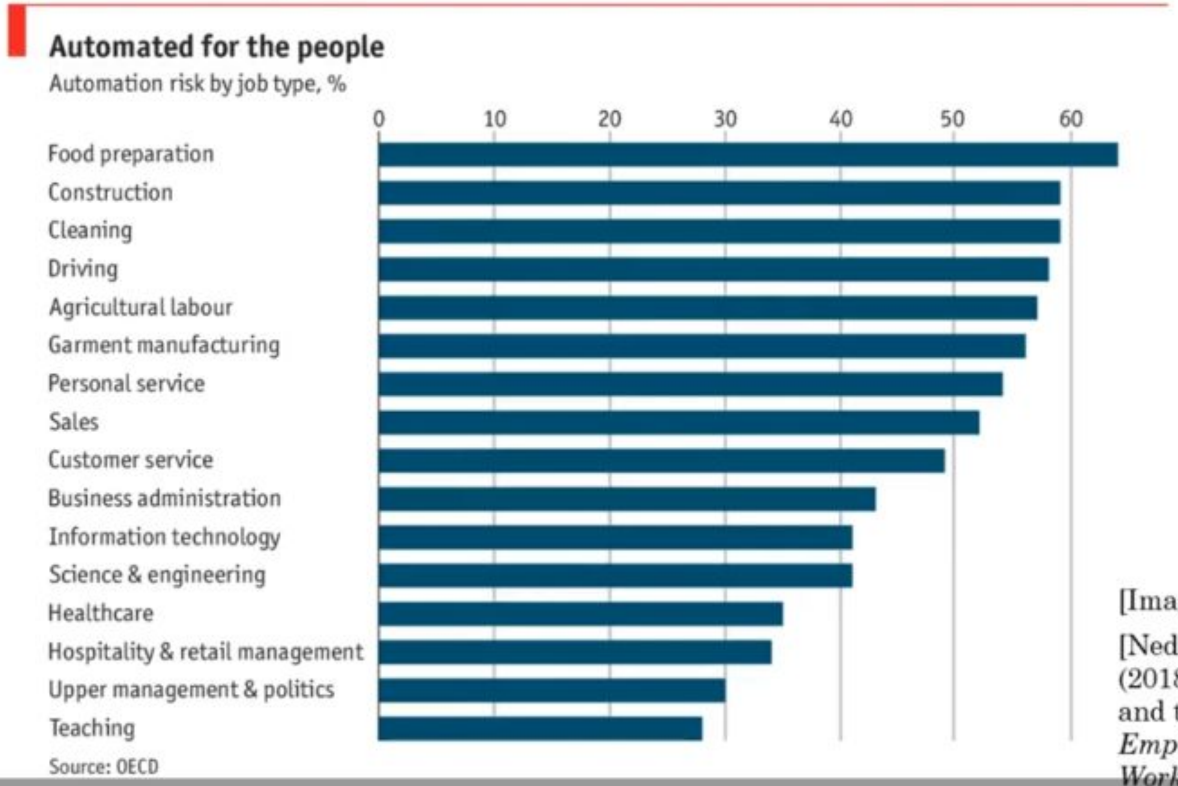
Jobs displaced by 2030

400-800 mil

Jobs created by 2030

555-890 mil

[Source: McKinsey Global Institute.]



[Image credit: Economist.com]

[Nedelkoska, L. and G. Quintini. (2018). Automation, skills use and training. *OECD Social, Employment and Migration Working Papers*, No. 202.]

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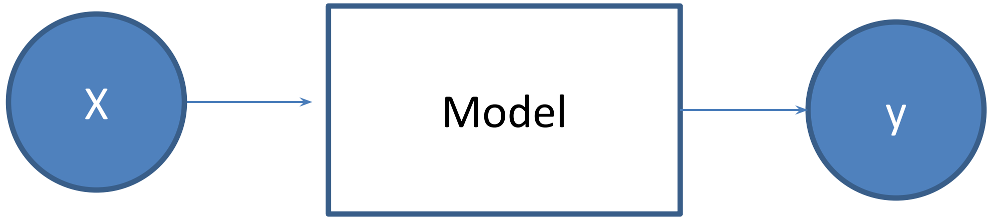
What AI can do?



Simple mappings

What is AI is best at today?

Supervised Learning:

-->Learning for examples

Price	Floor space	Rooms	Lot size	Appartment	Row house	Corner house	Detached
250000	71	4	92	0	1	0	0
209500	98	5	123	0	1	0	0
349500	128	6	114	0	1	0	0
250000	86	4	98	0	1	0	0
419000	173	6	99	0	1	0	0
225000	83	4	67	0	1	0	0
549500	165	6	110	0	1	0	0
240000	71	4	78	0	1	0	0
340000	116	6	115	0	1	0	0

Example: Machine Learning Background Survey

Machine learning background survey 04.09.18

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- Yes
- No

Know how to apply differentiation and the chain rule? *

- Yes
- No

Timestamp	Know about basic linear a	Know how to apply differe	Know how to apply differe	Know what is a probability	Know what is a probability	Know the difference betw	Know the difference betw	Know the difference betw	Know what is a trai
9/4/2018 8:50:55	Yes	No	No	No	No	No	Yes	Yes	No
9/4/2018 8:54:23	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No
9/4/2018 10:38:22	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9/4/2018 10:39:26	Yes	No	No	No	No	No	Yes	Yes	No

https://docs.google.com/forms/d/1nt0wSweEP_qYmV77Bim53-RtJK1e1T64jcAfAc-eMrI/edit?usp=drive_web

Example: Machine Learning Background Survey

$q^i = [q1, q2, \ldots qN]$, N is the number of questions in the survey

q^i_j is the answer of question j for user i

$q^i_j \in [0, 1]$ for (Y/N) questions $q^i_j \in [0, L]$ for range questions, where $L \in R$

A	B	C	D	E	F	G	H
	Know the differe	Know the differer	Know what is an	Know what is a b	Know what is reg	Know what is overfitting and underfitting?	Knows ML

$0 <= i <= M, M =$number of users

For each q^i we want to predict Y/N result indicating whether the user knows or not ML: $y^i \in [0, 1]$

The set $\{q^i, y^i\}, 0 <= i <= M$ is called the data set or the design matrix.

A	B	C	D	E	F	G	H
Timestamp	Know about basic linear a	Know how to apply differe	Know how to apply differe	Know what is a probability	Know what is a probability	Know the difference betw	Know the difference betw
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9/4/2018 8:54:23	Yes	Yes	Yes	Yes	Yes	No	Yes
9/4/2018 10:38:22	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9/4/2018 10:39:26	Yes	No	No	No	No	No	Yes

Example: Machine Learning Background Survey

The question now, how to find a mapping from q^i to y^i ?

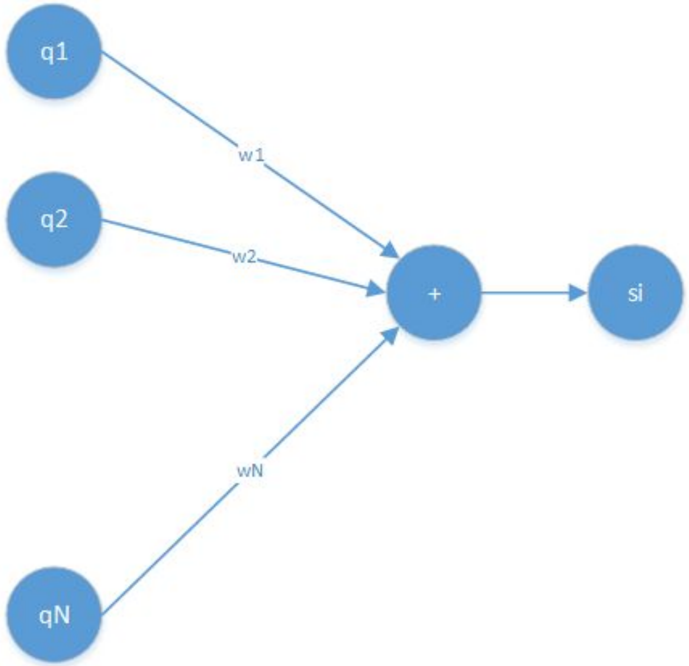
$y^i = f(q^i)$

Specifically, how to find f?

Let's assume we will give every question j in the survey a certain *importance* $w_j \in R$

Now, we can have a score for each question as follows:

$s^i_j = w_j * q^i_j$



Now to get a score for the whole user s^i, all we need is to sum the individual scores:

$s^i = \sum_{j=1}^{N} s^i_j$

The above score is unnormalized, meaning, it can take any value.

We better have a nomalized weight $0 <= w_j <= 1$:

$s^i_j = w_j / \sum_{j=1}^{N}(w_j) * q^i_j$

Now we can have normalized scores $0 <= s^i_j <= L$, where L is 1 for binary questions or max for range ones.

if we want $0 <= s^i_j <= 1$then we formulate s^i_j as follows: $s^i_j = w_j / \sum_{j=1}^{N}(w_j) * q^i_j / L_j$, where L_j is the range of the question q^i_j

Example: Machine Learning Background Survey

Normalization

The above score is unnormalized, meaning, it can take any value.

We better have a nomalized weight $0 <= w_j <= 1$:

$s_j^i = w_j / \sum_{j=1}^{N}(w_j) * q_j^i$

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But this will give us a score that cannot be > 1, since we normalize the weights. Check if all weights are 1 , $w_j = 1$:

$s^i = 1/N * \sum_{j=1}^{N} q_j^i / L_j$

So it's like the average score, which is either [0,1] for the normalized case above (when each question answer we divide by L_j) or [0, L_j] if we don't divide. Say if all answers $q_j = L_j$, then the final answer is either 1 for the normalized case or L_j for the unnormalized case.

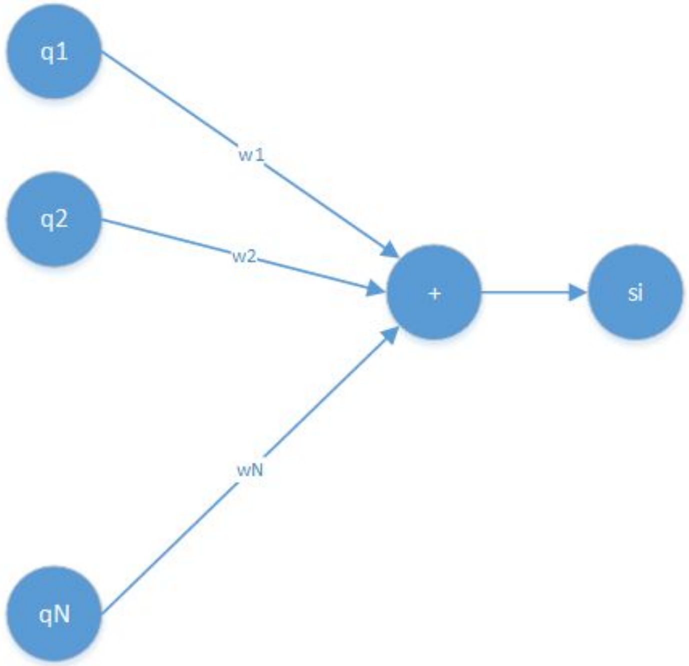
A special case of the above if all questions have the same range $L_j = L$, and if we want the final score to be in the same range (say [0,10] not [0,1]), all what we need to do is multiply by L: $s^i = L * \sum_{j=1}^{N} s_j^i$

In this case, we just have a weighted average of the questions: $s^i = \sum_{j=1}^{N}(w_j / \sum_{j=1}^{N}(w_j)) * q_j^i$

Check, if all questions have $w_j = 1$ and $q_j^i = L_j$, then have have normalized $s^i = 1$ and unnormalize $s^i = L_j$

$s^i = 1/N * \sum_{j=1}^{N} q_j^i$

Which is again the average.



Now to get a score for the whole user s^i, all we need is to sum the individual scores:

$$s^i = \sum_{j=1}^{N} s_j^i$$

Example: Machine Learning Background Survey

Now, back to the normal case, if we plug the whole equation we get:

$$s^i = \sum_{j=1}^{N}(w_j / \sum_{j=1}^{N}(w_j)) * q_j^i / L_j$$

The is just a parameterized function mapping from q_j^i to a score s^i

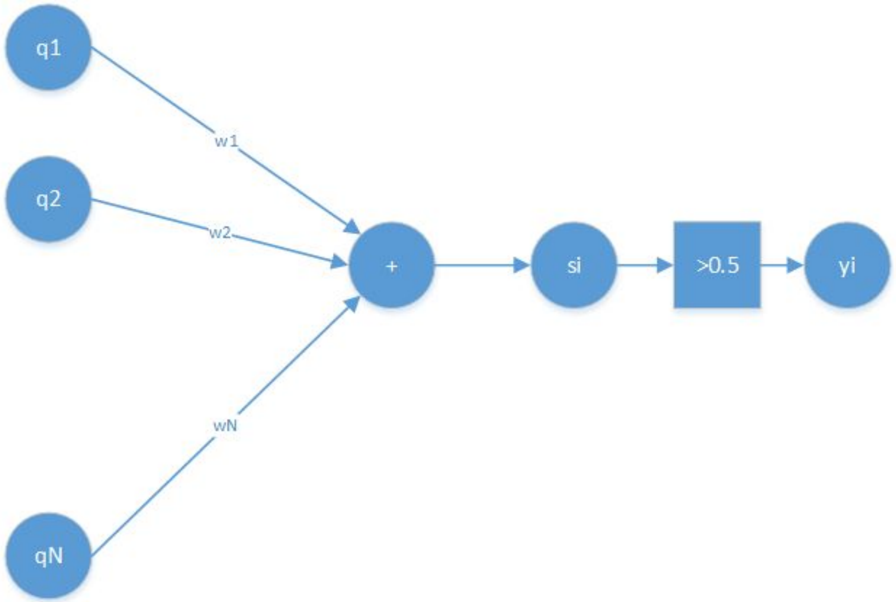
$$s^i = s(q_j^i; w_j)$$

To get a final result y^i whether a person knows ML or not, we need to apply a threshold, say 0.5:

$$y^i = 1\{s^i > 0.5\}$$

1- How to find w's and threshold?

2- How to decide on the questions q's?



How to set w’s?

If the answer to this question is: "by experience or applying pre-defined rule", then you are doing rule-based AI or traditional AI.

If the answer is "we learn them" then you are doing ML.

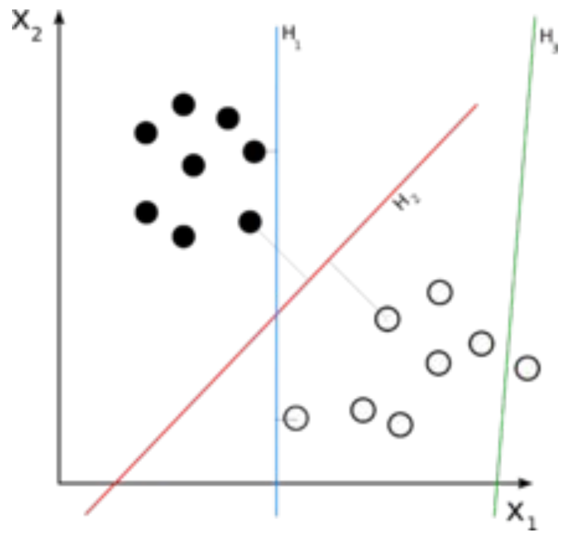
ML: How to learn w's?

Assume only 2 q's:

Basically → Search: ax1+bx2+c (**Model**)→ w1=a, w2=b, w0=c (bias, to be clear later)

Try many lines, and get the one that separates the **Data** better → How good? **Loss**

Practically→ Smarter methods (**Optimizer**) are used better than brute force or random search!



How to decide on questions?

We call the questions vector $q^i=[q1, q2,...qN]$ ***features vector***

In case of structured data like above, normally we choose them based on experience.

A	B	C	D	E	F	G	H
Timestamp	Know about basic linear a	Know how to apply differe	Know how to apply differe	Know what is a probability	Know what is a probability	Know the difference betw	Know the difference betw
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9/4/2018 10:39:26	Yes	No	No	No	No	No	Yes

In case of unstructured data like images, the input vector is just the pixel values. So the question, what are the features?

The answer to this question defines if we do ML or DL

In general, if we feed raw pixels, we do DL, if we define specific features, we do ML. This will get more clear

Semantic gap - What the computer can see?

https://colab.research.google.com/drive/1IwhBkAvgBG0QiBwGPJb2FbOXtz_sQyBW?authuser=1#scrollTo=kJbwGQ5QhYXa

Semantic gap - What is the best representation of sensory signals for computers?

Old problem → ADC

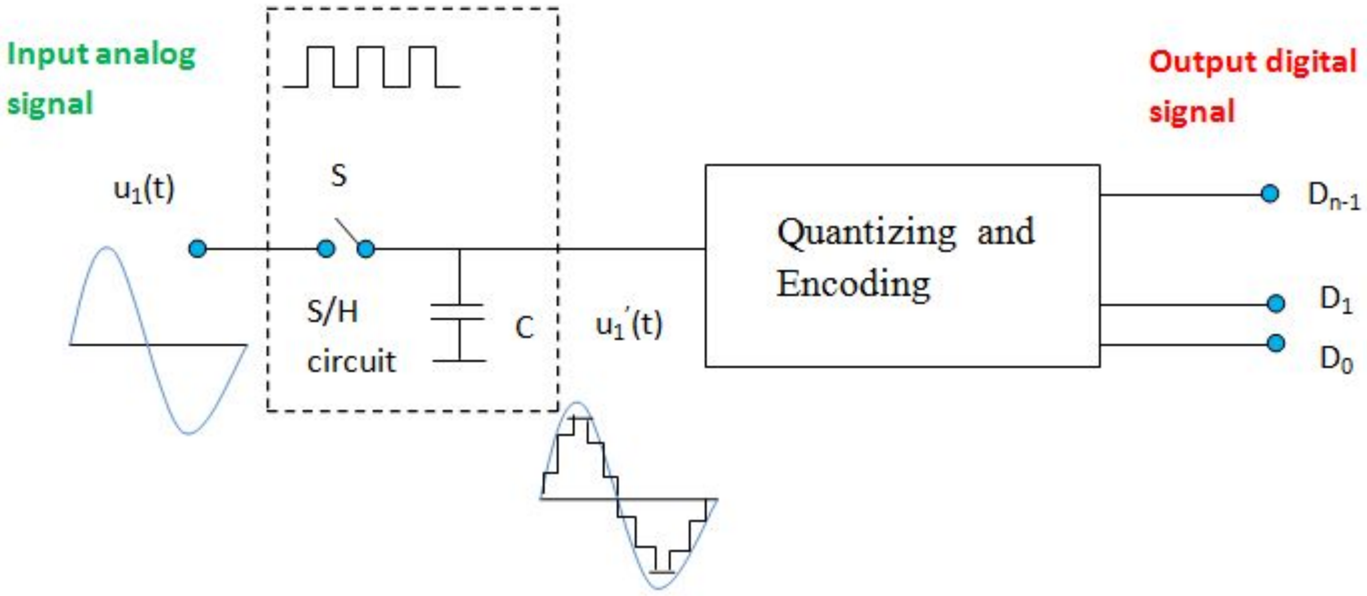
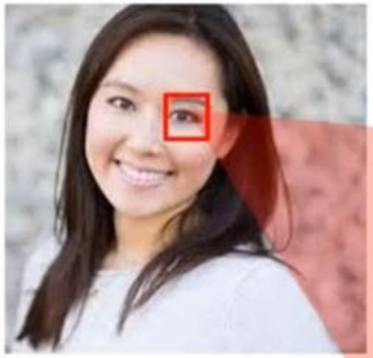


Figure 2

Semantic gap - What the computer can see?



30	32	22	12	10	10	12	33	35	30
12	11	12	234	170	176	13	15	12	12
234	222	220	230	200	222	230	234	56	78
190	220	186	112	110	110	112	180	30	32
49	250	250	250	4	2	254	200	44	6
55	250	250	250	3	1	250	245	25	3
189	195	199	150	110	110	182	190	199	55
200	202	218	222	203	200	200	208	215	222
219	215	220	220	222	214	215	210	220	220
220	220	220	220	221	220	221	220	220	222

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Image Classification: A core task in Computer Vision

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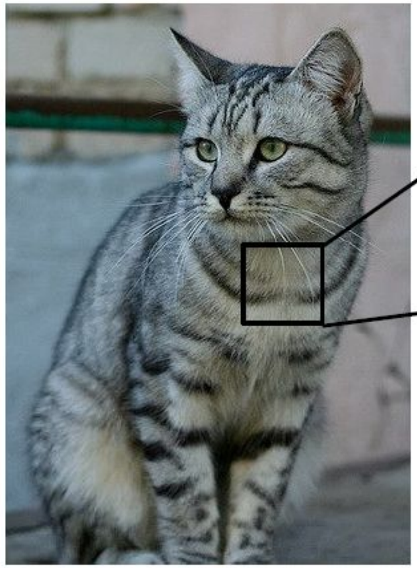
(assume given set of discrete labels)
{dog, cat, truck, plane, ...}

→ cat

The Problem: Semantic Gap



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```
[[105 112 108 111 104  99 106  99  96 103 112 119 104  97  93  87]
 [ 91  98 102 106 104  79  98 103  99 105 123 136 110 105  94  85]
 [ 76  85  90 105 128 105  87  96  95  99 115 112 106 103  99  85]
 [ 99  81  81  93 120 131 127 100  95  98 102  99  96  93 101  94]
 [106  91  61  64  69  91  88  85 101 107 109  98  75  84  96  95]
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 [133 137 147 103  65  81  80  65  52  54  74  84 102  93  85  82]
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 [ 63  77  86  81  77  79 102 123 117 115 117 125 125 130 115  87]
 [ 62  65  82  89  78  71  80 101 124 126 119 101 107 114 131 119]
 [ 63  65  75  88  89  71  62  81 120 138 135 105  81  98 110 118]
 [ 87  65  71  87 106  95  69  45  76 130 126 107  92  94 105 112]
 [118  97  82  86 117 123 116  66  41  51  95  93  89  95 102 107]
 [164 146 112  80  82 120 124 104  76  48  45  66  88 101 102 109]
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 [123 107  96  86  83 112 153 149 122 109 104  75  80 107 112  99]
 [122 121 102  80  82  86  94 117 145 148 153 102  58  78  92 107]
 [122 164 148 103  71  56  78  83  93 103 119 139 102  61  69  84]]
```

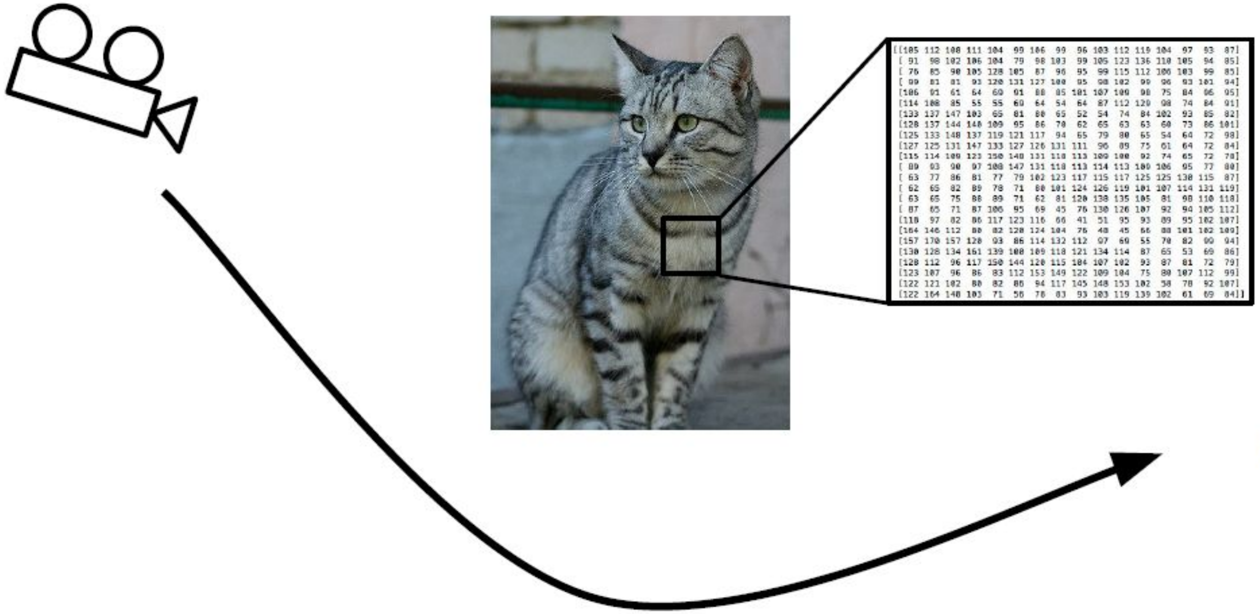
What the computer sees

An image is just a big grid of numbers between [0, 255]:

e.g. 800 x 600 x 3
(3 channels RGB)

https://github.com/ahmadelsallab/practical_dl/blob/master/AI_Basix/CV_Semantic_Gap_lec1.ipynb
https://github.com/ahmadelsallab/practical_dl/blob/master/AI_Basix/CV_Semantic_Gap_lec1_test.ipynb

Challenges: Viewpoint variation



All pixels change when the camera moves!

Challenges: Illumination

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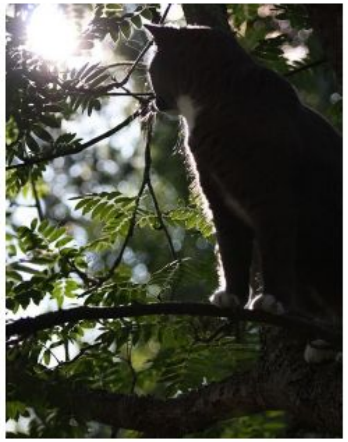

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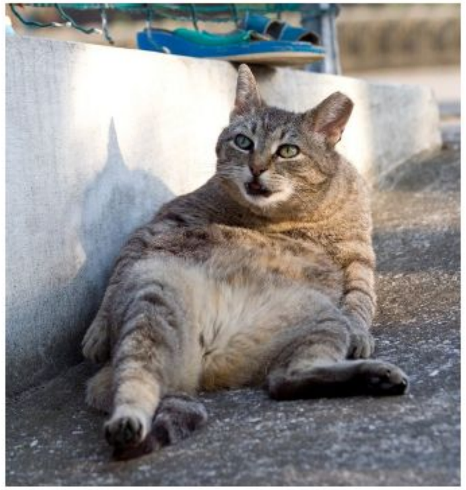
Challenges: Deformation



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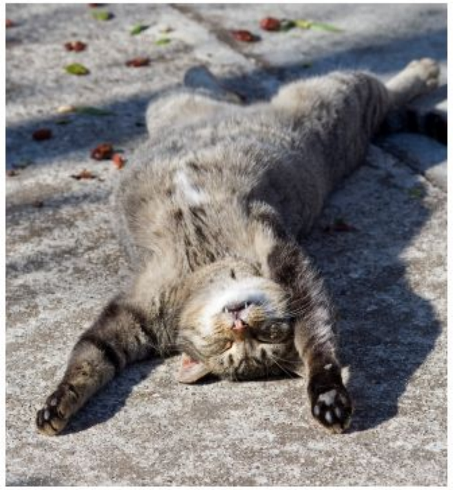

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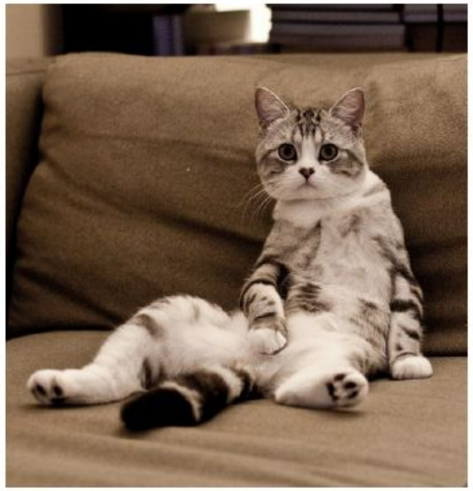

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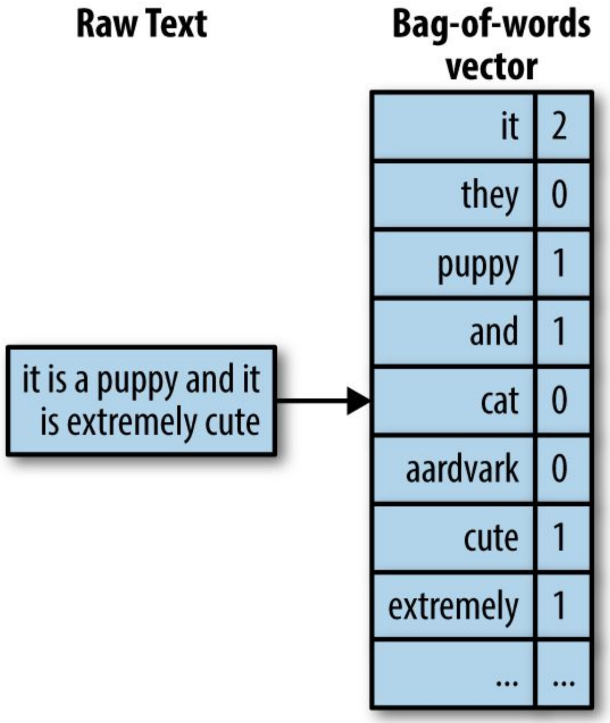
Challenges: Occlusion

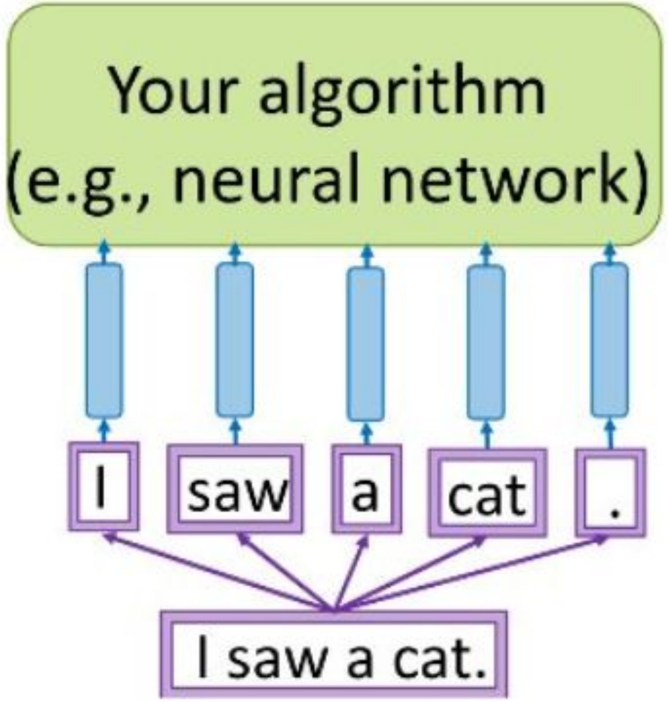
Semantic gap in text - What computers can read?

In images, we have matrix representation

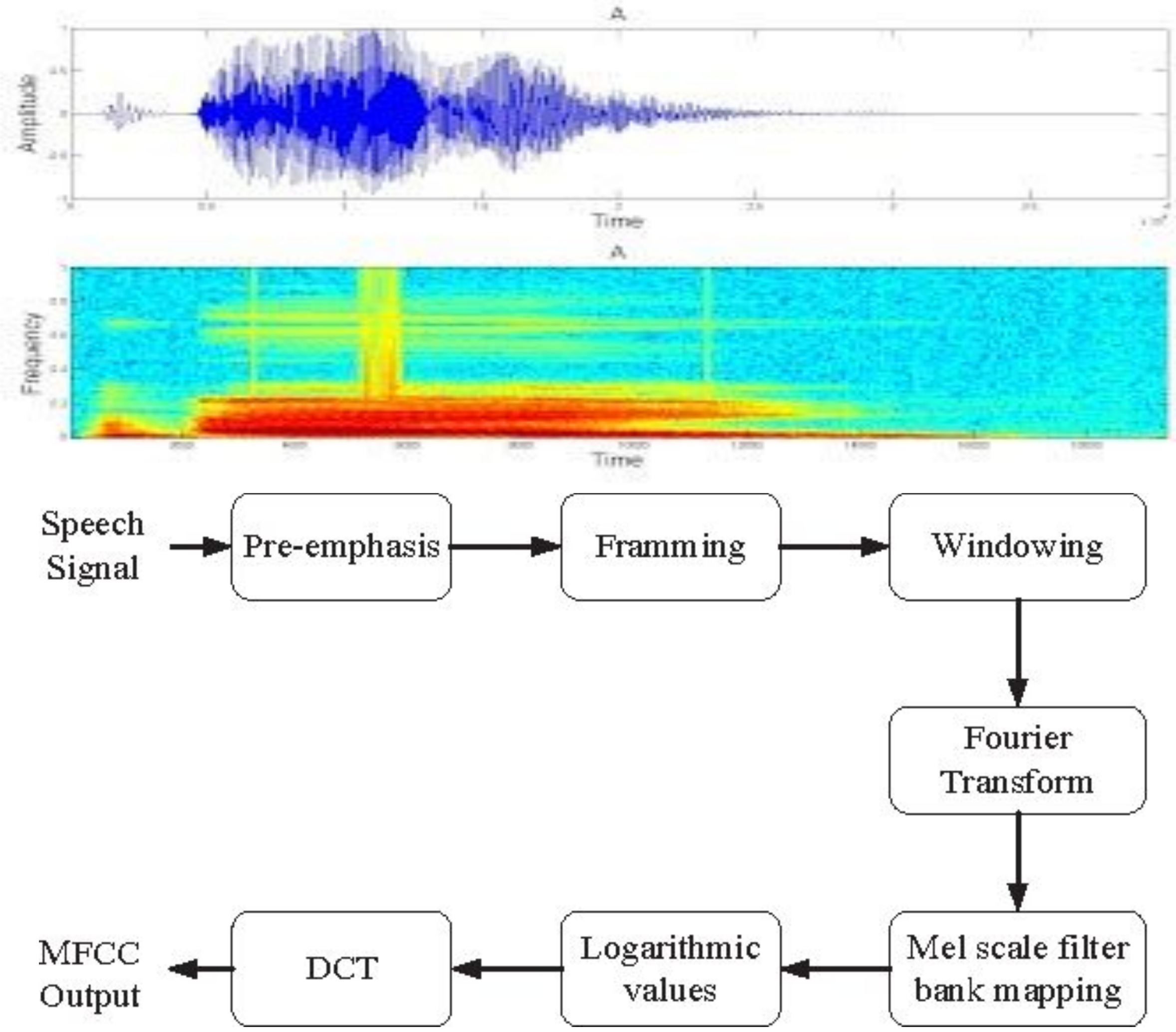
In text→ ??

→ Naive = BoW against vocab

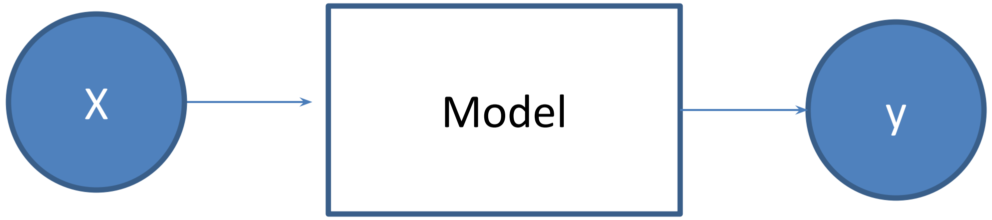




Semantic gap in speech - What computers can hear?

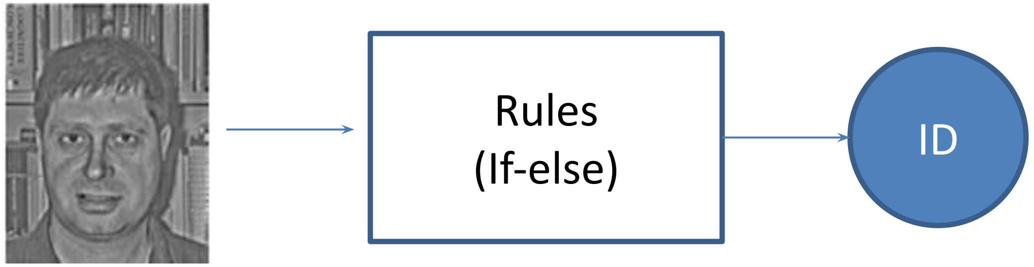


How to close the Gap?



How to obtain the model?

Face recognition with traditional AI



Rule based AI

Face recognition with traditional AI

Rules
(If-else)

ID

Did you handle Clutter?

Did you handle scale?

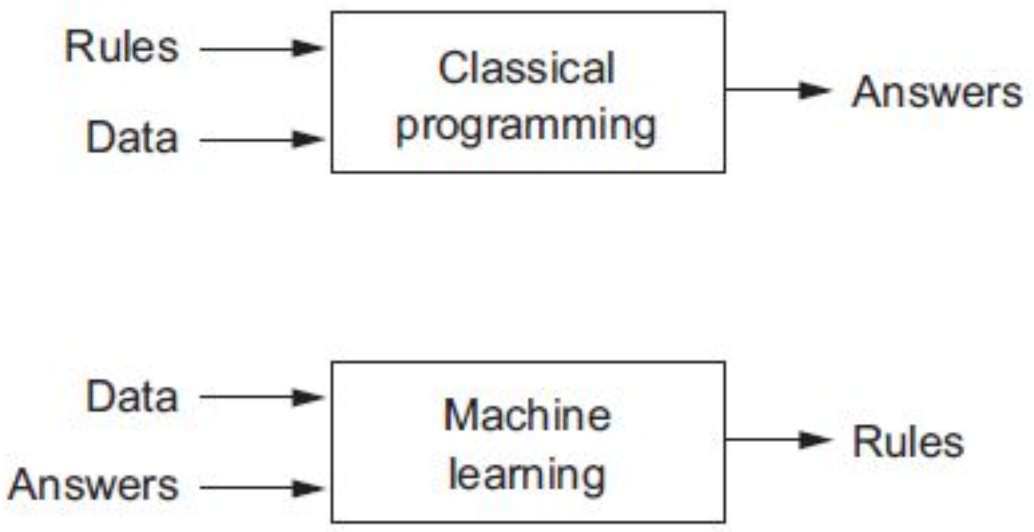
Did you handle pose?

Did you handle colors?

Too many cases!!

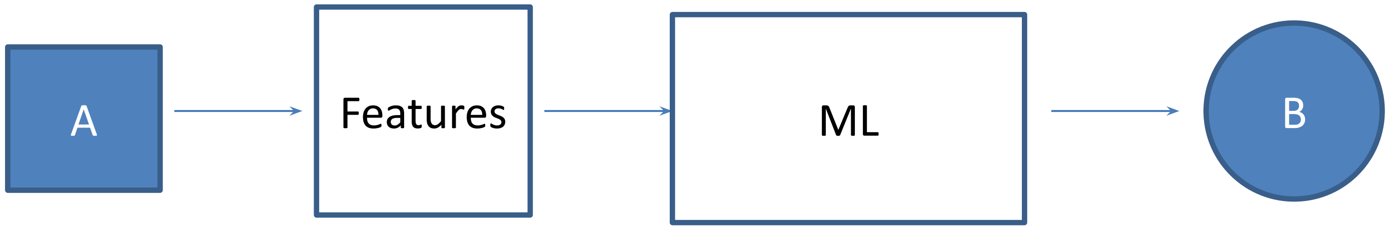
Let’s Learn the rule!

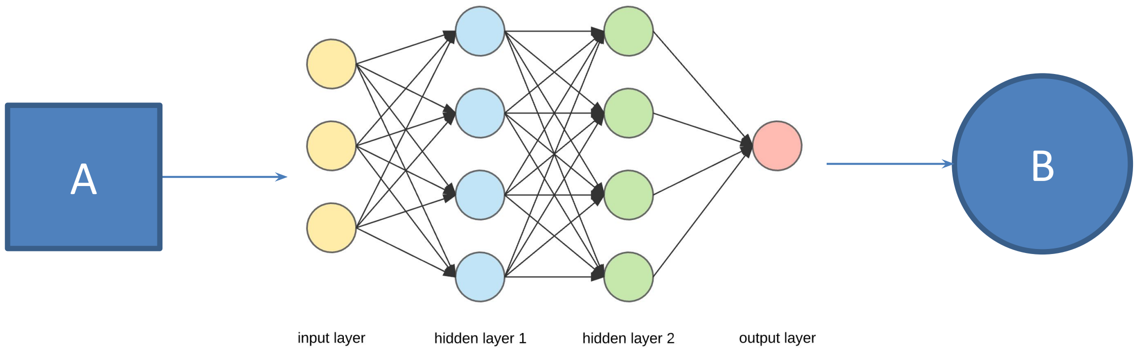
Rule based AI vs. ML



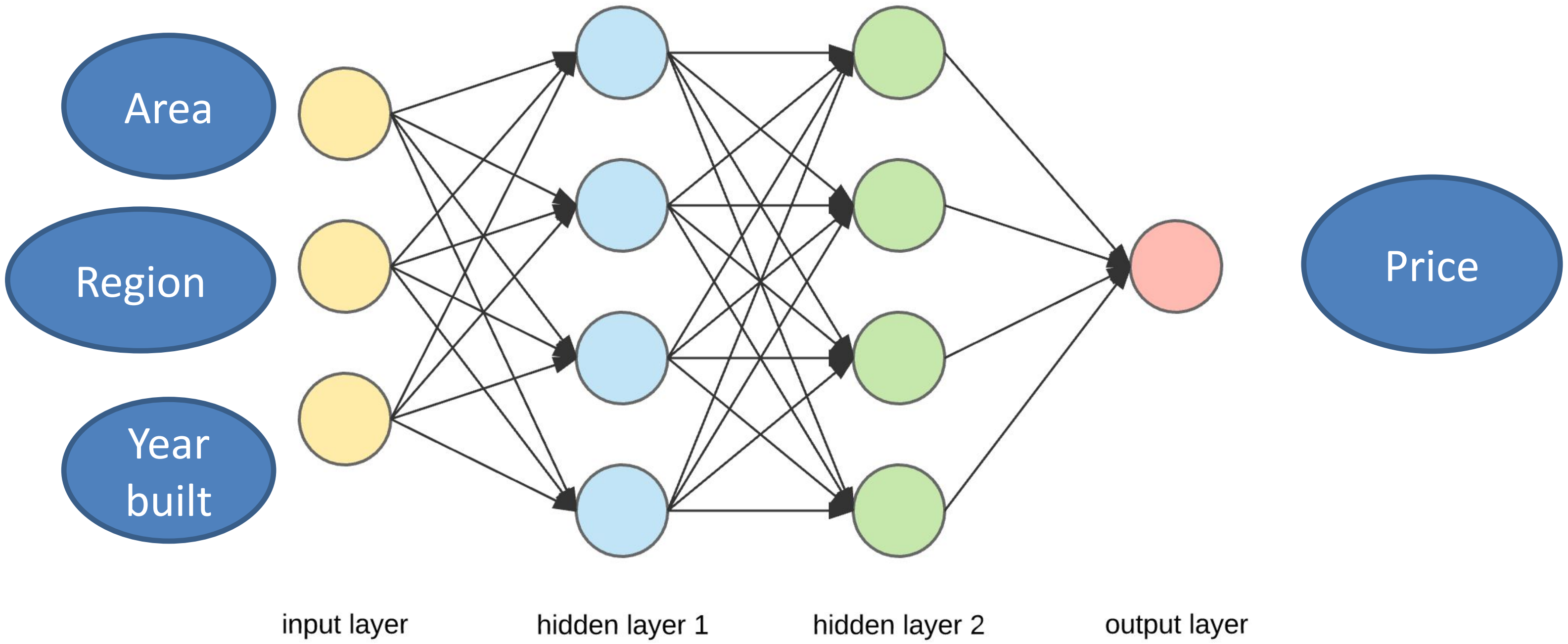
“Machine learning is the science of getting computers to act without being explicitly programmed”, Arthur Samuel 1959

Deep Learning vs. Machine Learning



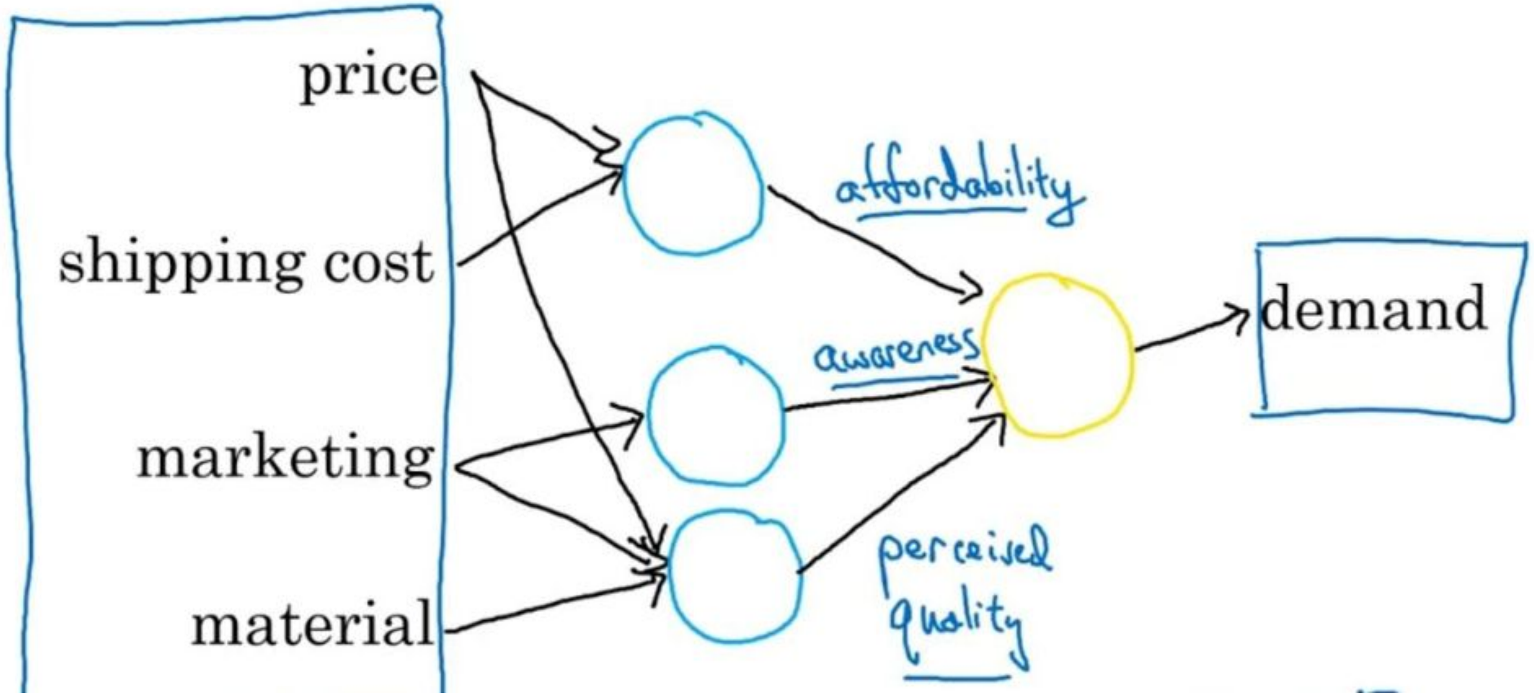


Deep Learning vs. Machine Learning

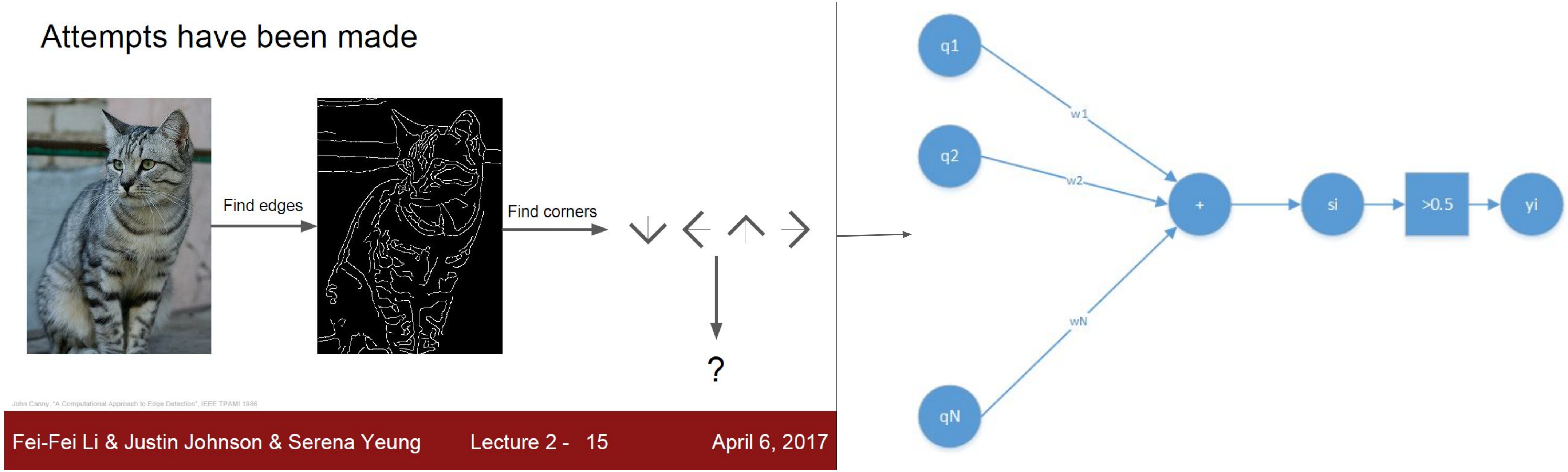


Price	Floor space	Rooms	Lot size	Appartment	Row house	Corner house	Detached
250000	71	4	92	0	1	0	0
209500	98	5	123	0	1	0	0
349500	128	6	114	0	1	0	0
250000	86	4	98	0	1	0	0
419000	173	6	99	0	1	0	0
225000	83	4	67	0	1	0	0
549500	165	6	110	0	1	0	0
240000	71	4	78	0	1	0	0
340000	116	6	115	0	1	0	0

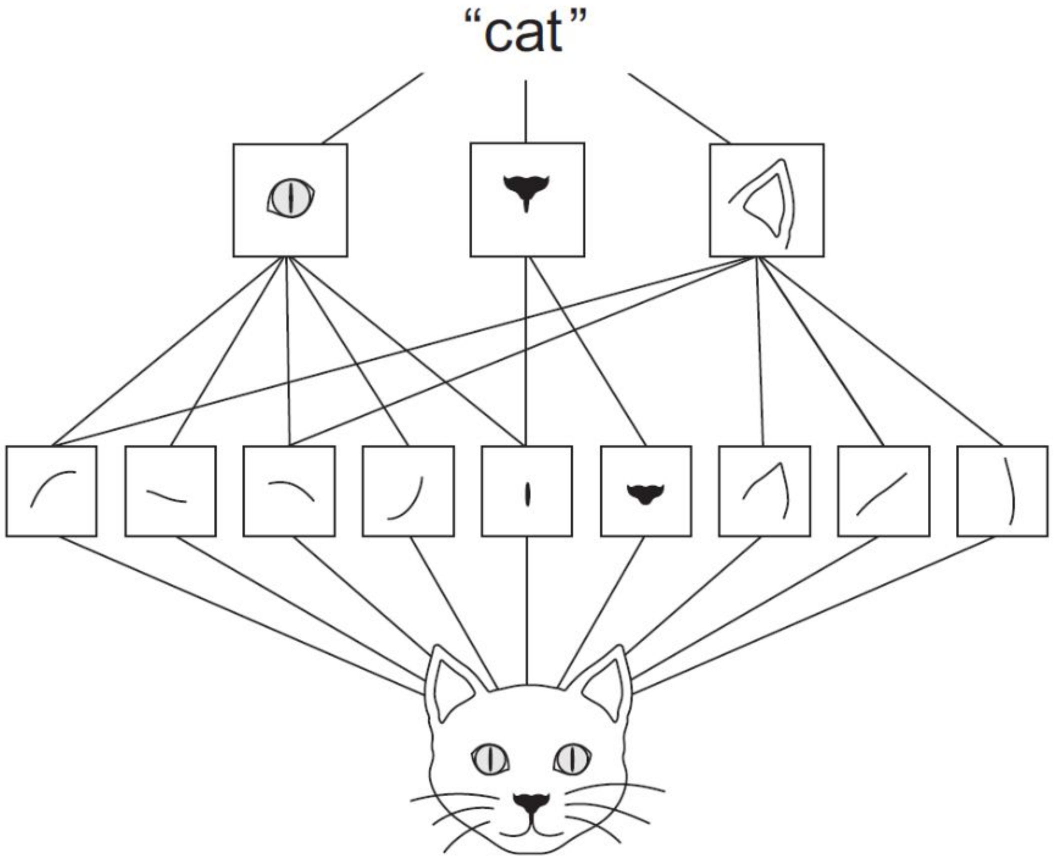
What neurons represent?



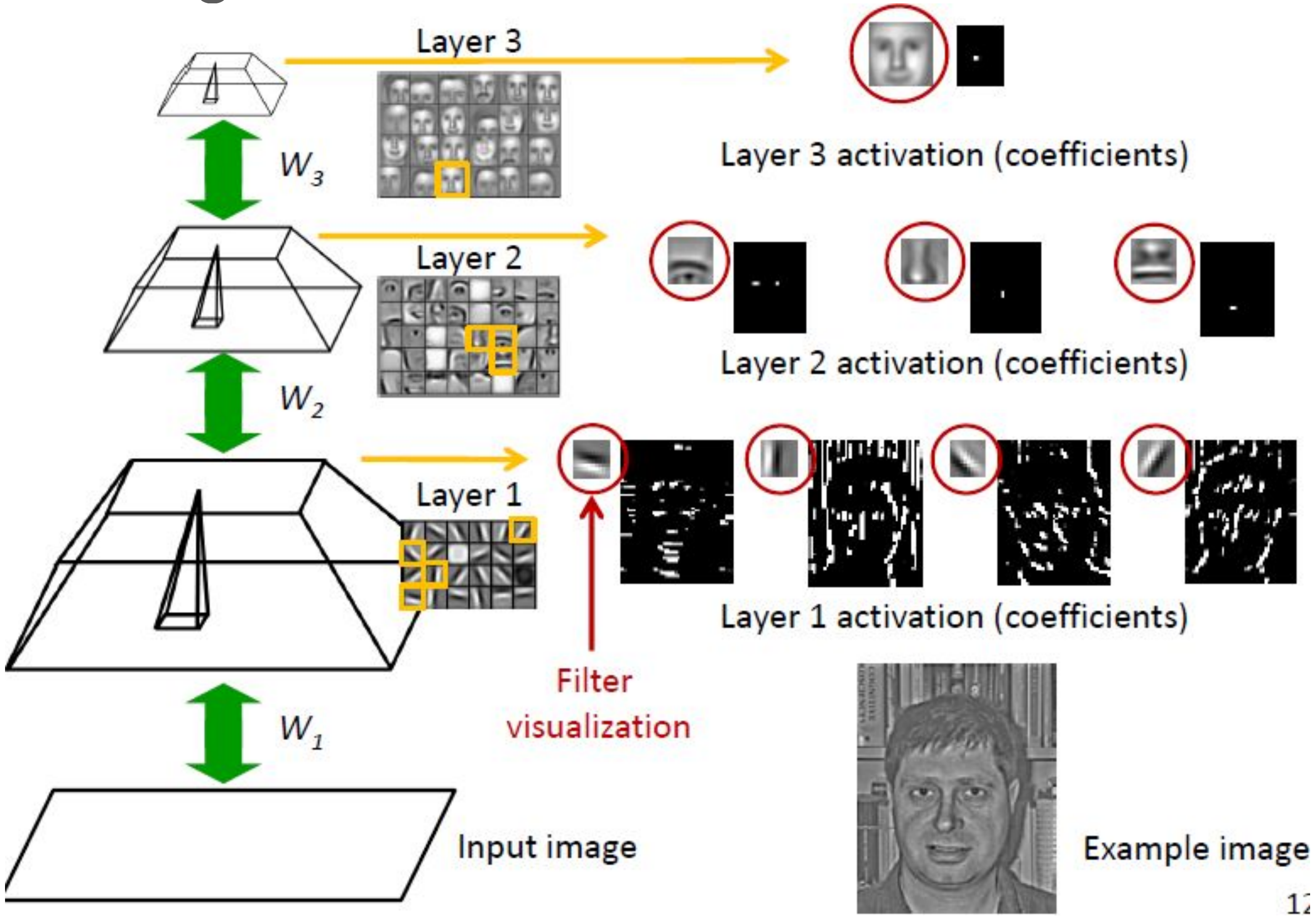
ML = manually engineered features vector
But learn the weights



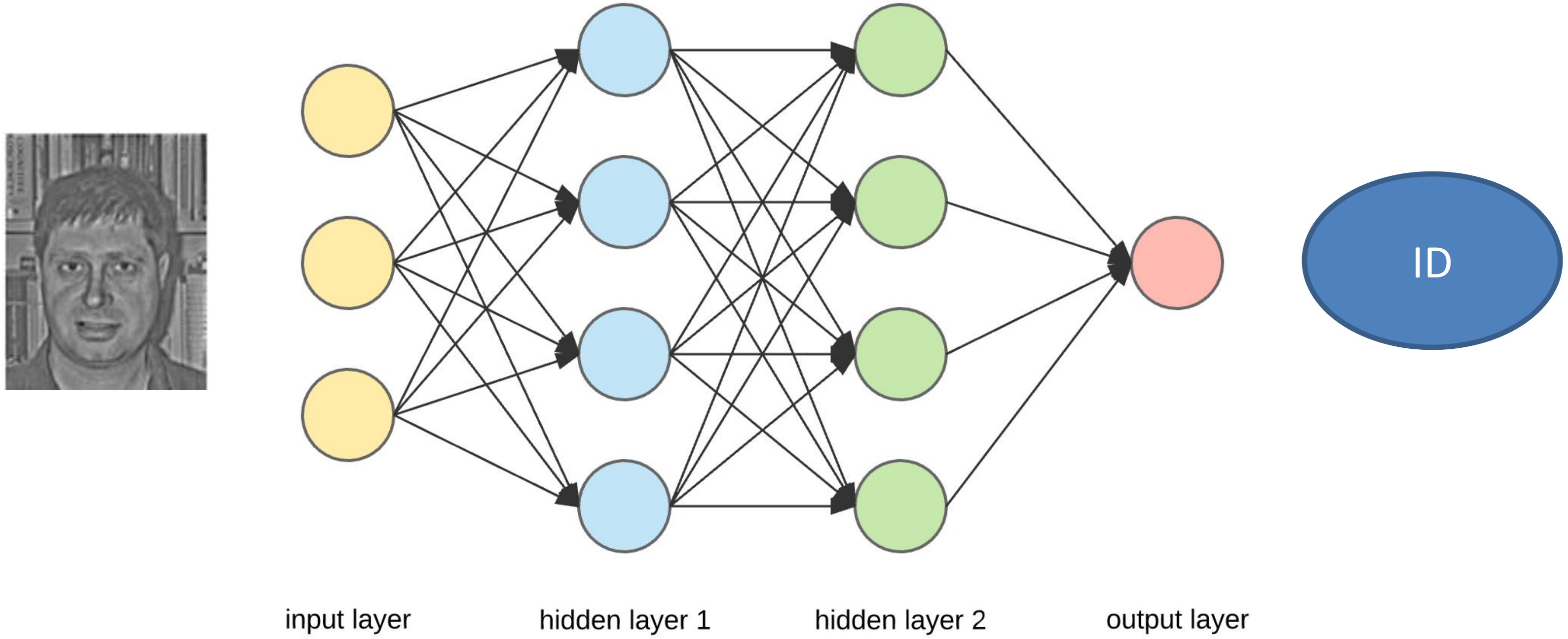
What could be good cat features?



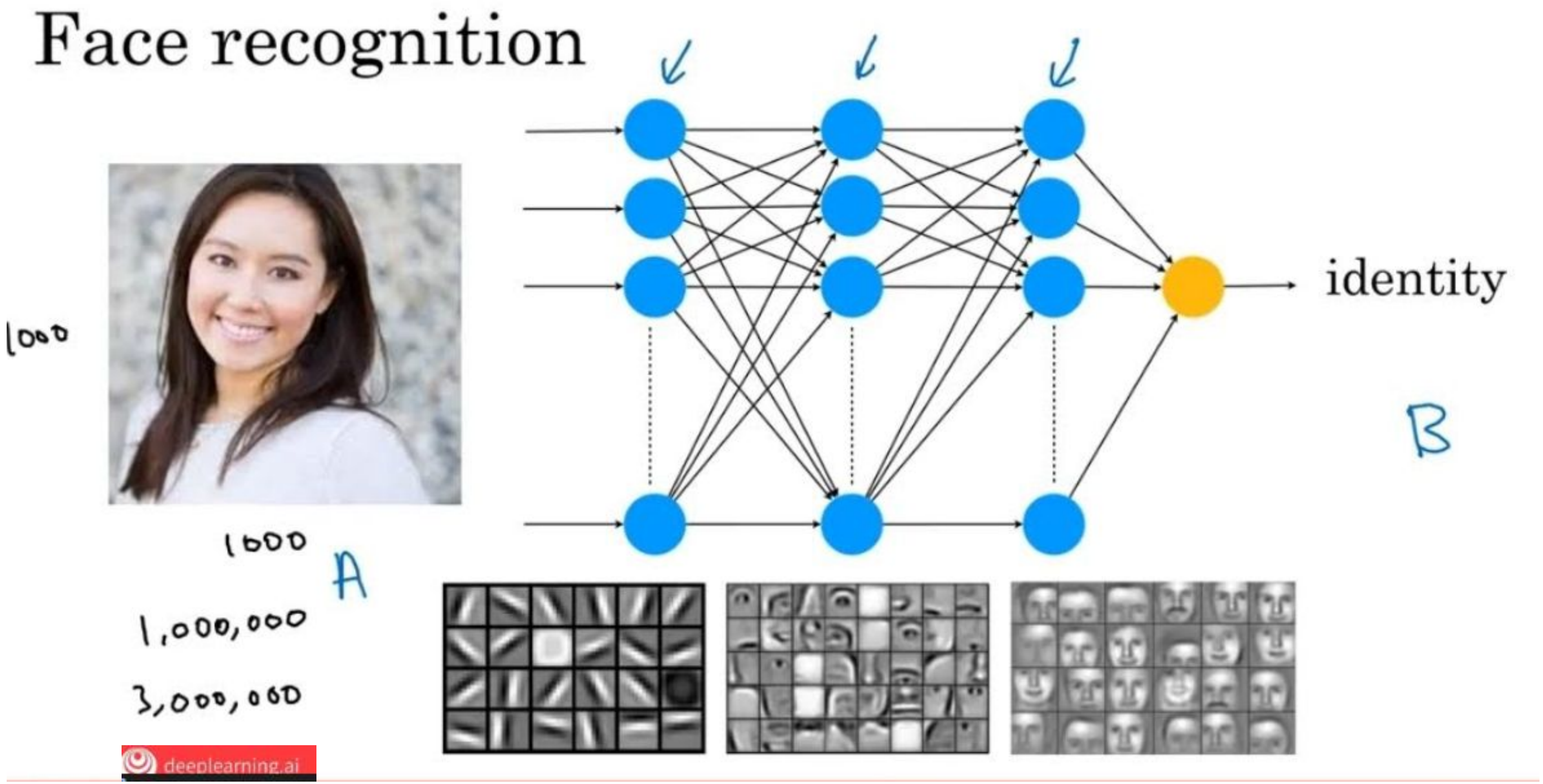
What could be good face features?



Deep Learning vs. Machine Learning



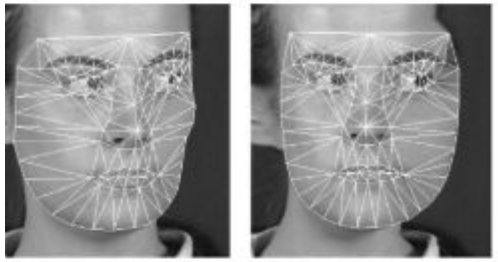
What neurons can see?



Features

Features = f(Raw data)

Raw data = pixels



Features = face points

Feature is a representation / **transformation** of raw data

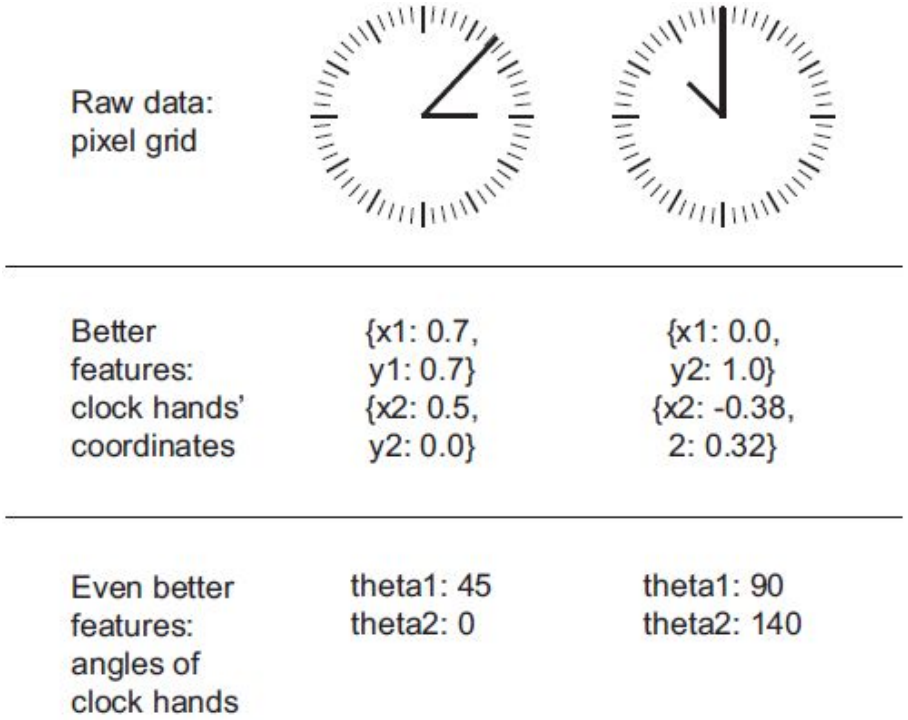
Why representation matters so much?

Which is easier to read the time?

- to make computer vision program to see the analog form

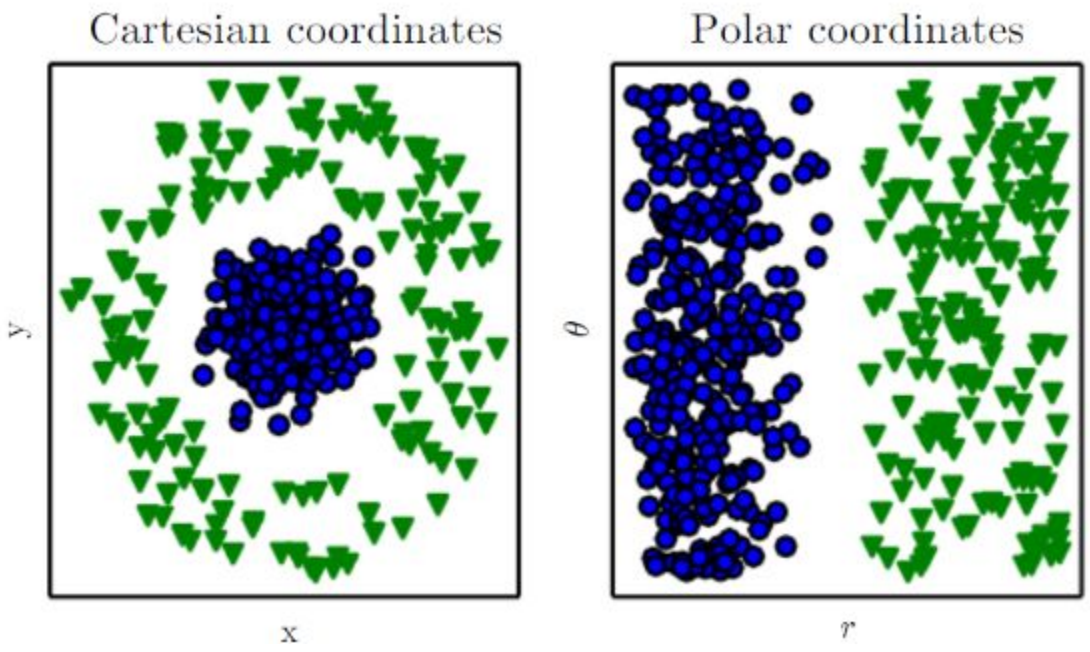
- just read x1,y1 and x2,y2 of the 2 pointers?

- just read theta 1 and theta 2 of the 2 pointers?



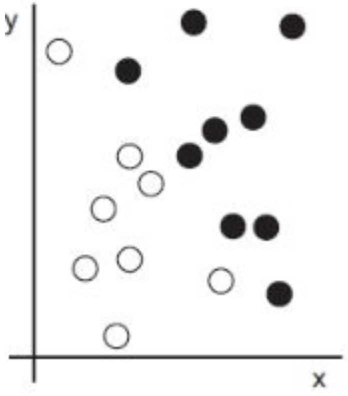
Why representation matters so much?

We have two categories (blue/green) which we want to cluster/separate/classify



So separating the two classes in this case is much easier just by using polar representation

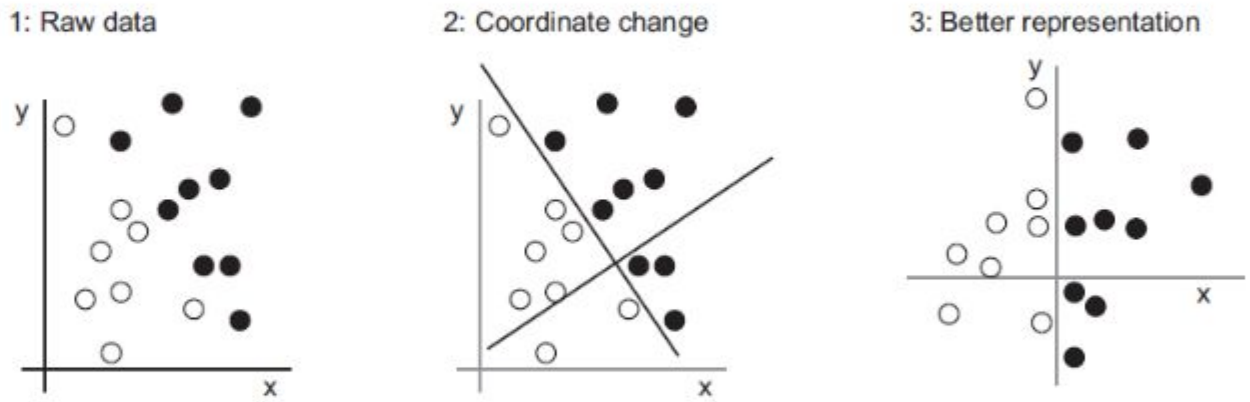
Why representation matters so much?



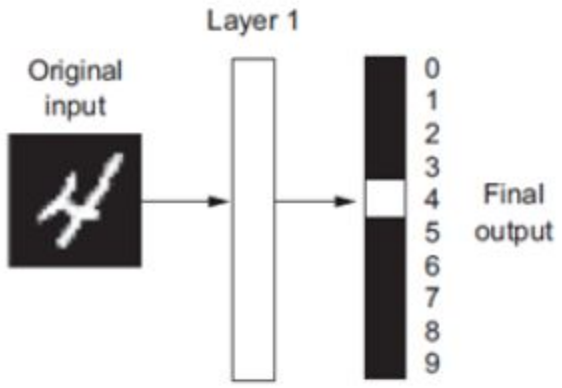
We want to develop an algorithm that can take the coordinates (x, y) of a point and output whether that point is likely to be black or to be white:

-Inputs: the coordinates of our points.

-Outputs: the colors of our points.



How to decide on which representation?

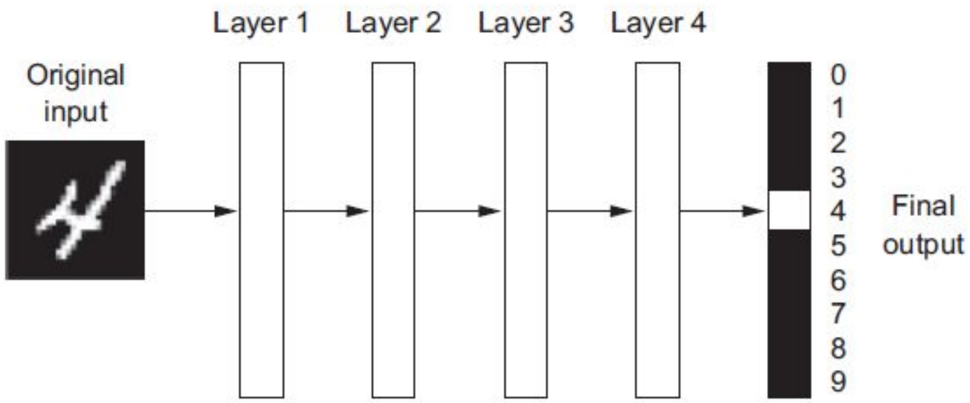


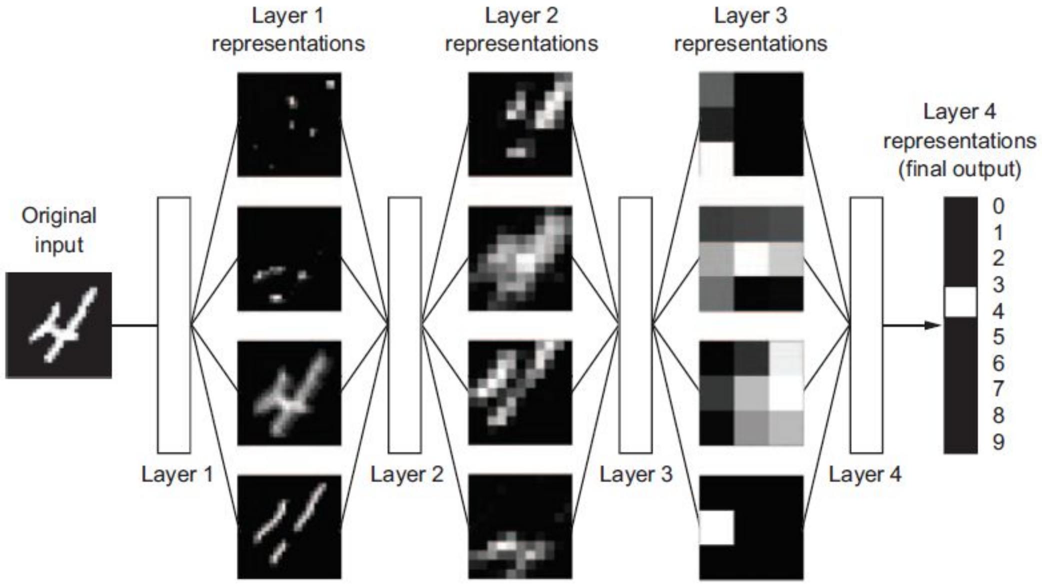
- Manual: ML
- Learning: DL

(Representation Learning)

- How ?
    - ***Hypothesis space*:** We have many possible transforms: f1, f2,…
    - ***Learning***: Search in the *hypothesis space*

The “Deep” in Deep Learning
Hierarichal Representation



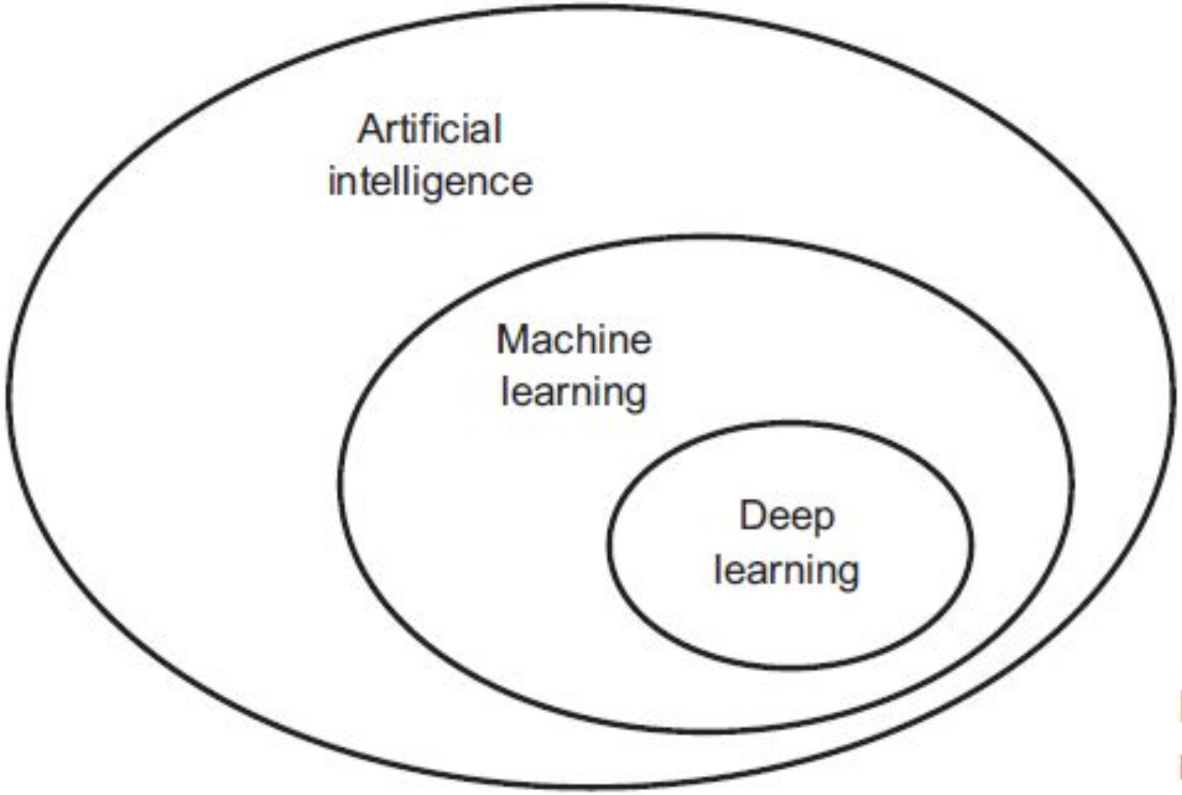


Now we converge to a definition of Deep Learning

Deep Learning = Deep Representation Learning

- *“Deep learning is a particular kind of machine learning that achieves great power and flexibility by learning to represent the world as a nested hierarchy of concepts, with each concept defined in relation to simpler concepts, and more abstract representations computed in terms of less abstract ones.”*
    - *Deep Learning Book, Ian Goodfellow, Yoshua Bengio, Aaron Courville*

Now we can draw a line between AI, ML, Representation Learning a



https://www.deeplearningbook.org/

Why now?

Computer

- Machine for logical and mathematical computations
- 1781 (Charles Babbage)

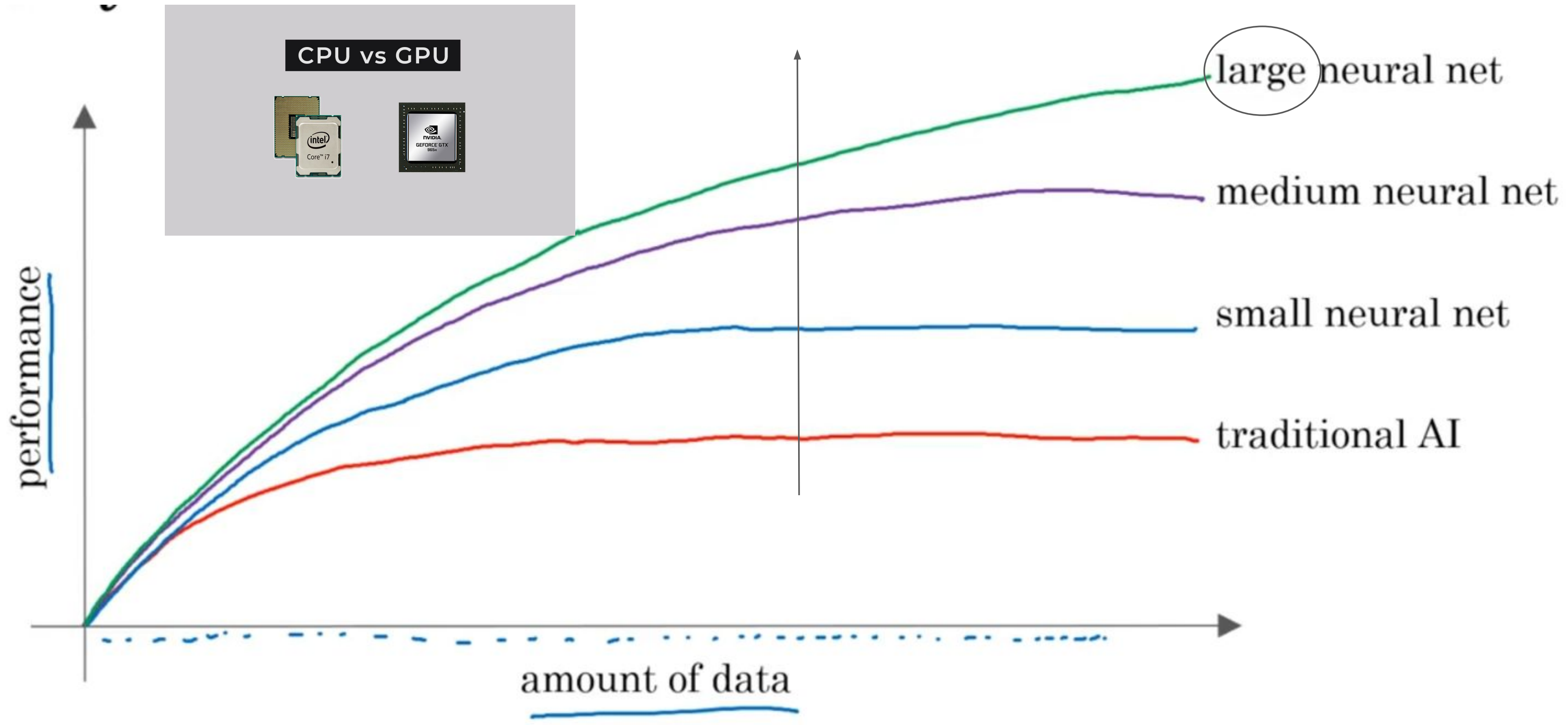
Programming

- If-else
- 1936 (Turing Machine)
- 1945 (ENIAC)

Machine learning

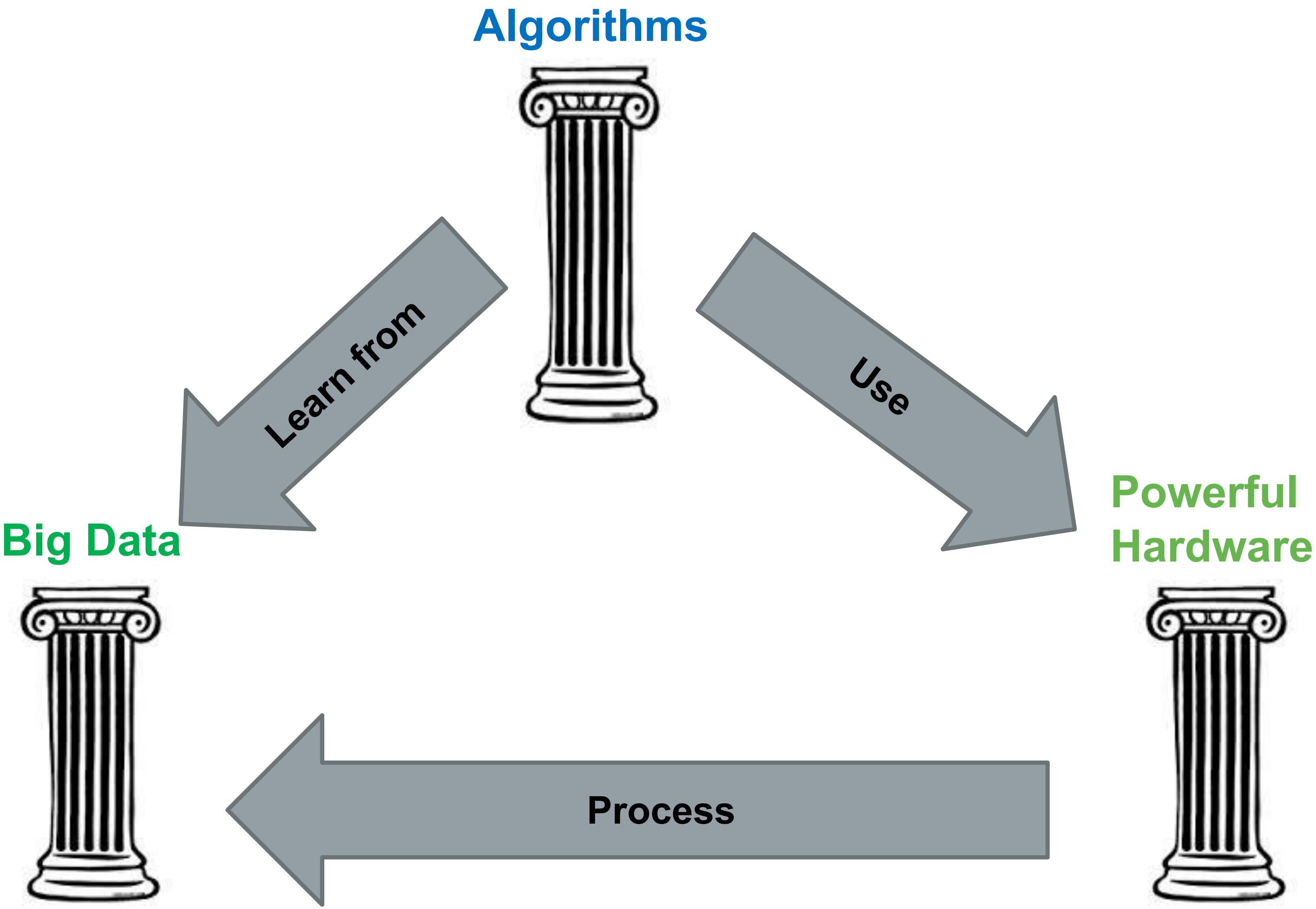
- 1959 (Arthur Samule)
- Problem: clutter, pose, conditions,…etc all affect the designed features vector

Why now?

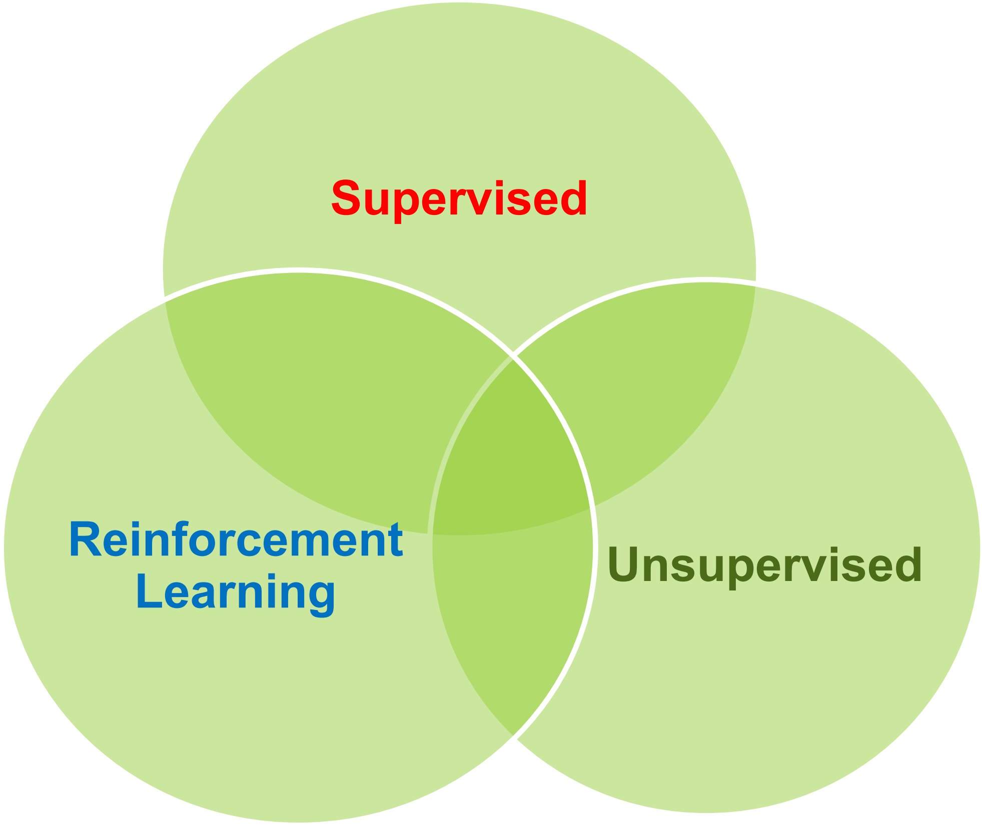


CPU vs GPU
intel
Core™ i7
NVIDIA
GEFORCE GTX
large neural net
medium neural net
small neural net
traditional AI
performance
amount of data

Why now?

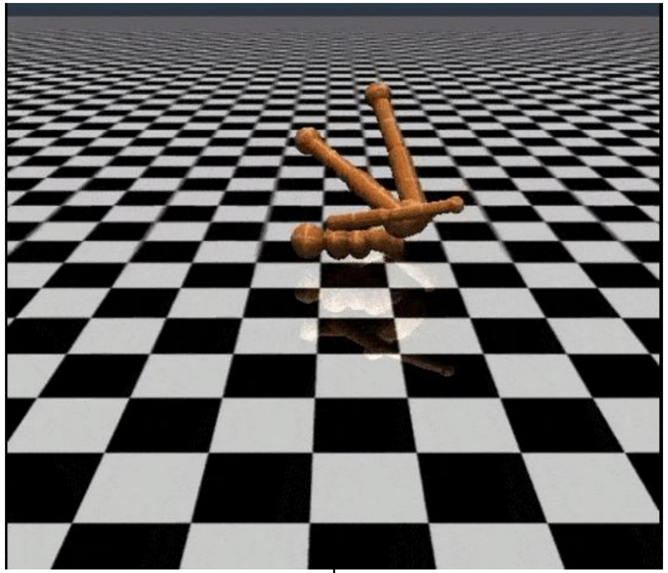

Algorithms
Learn from
Use
Big Data
Powerful Hardware
Process

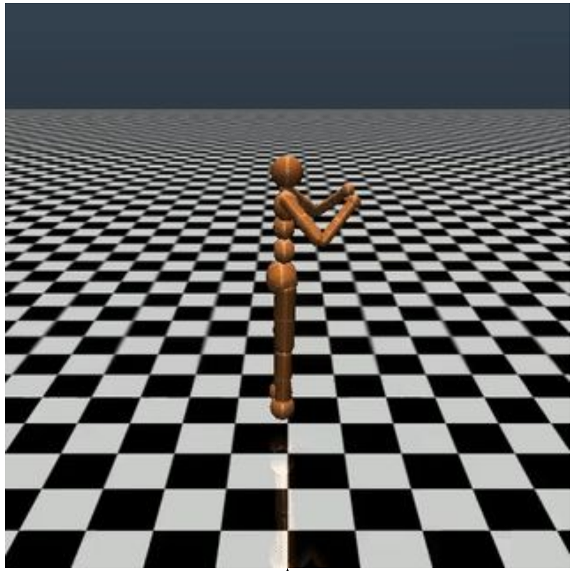
What other types of ML?



How it works? By interaction (Reinforcement)

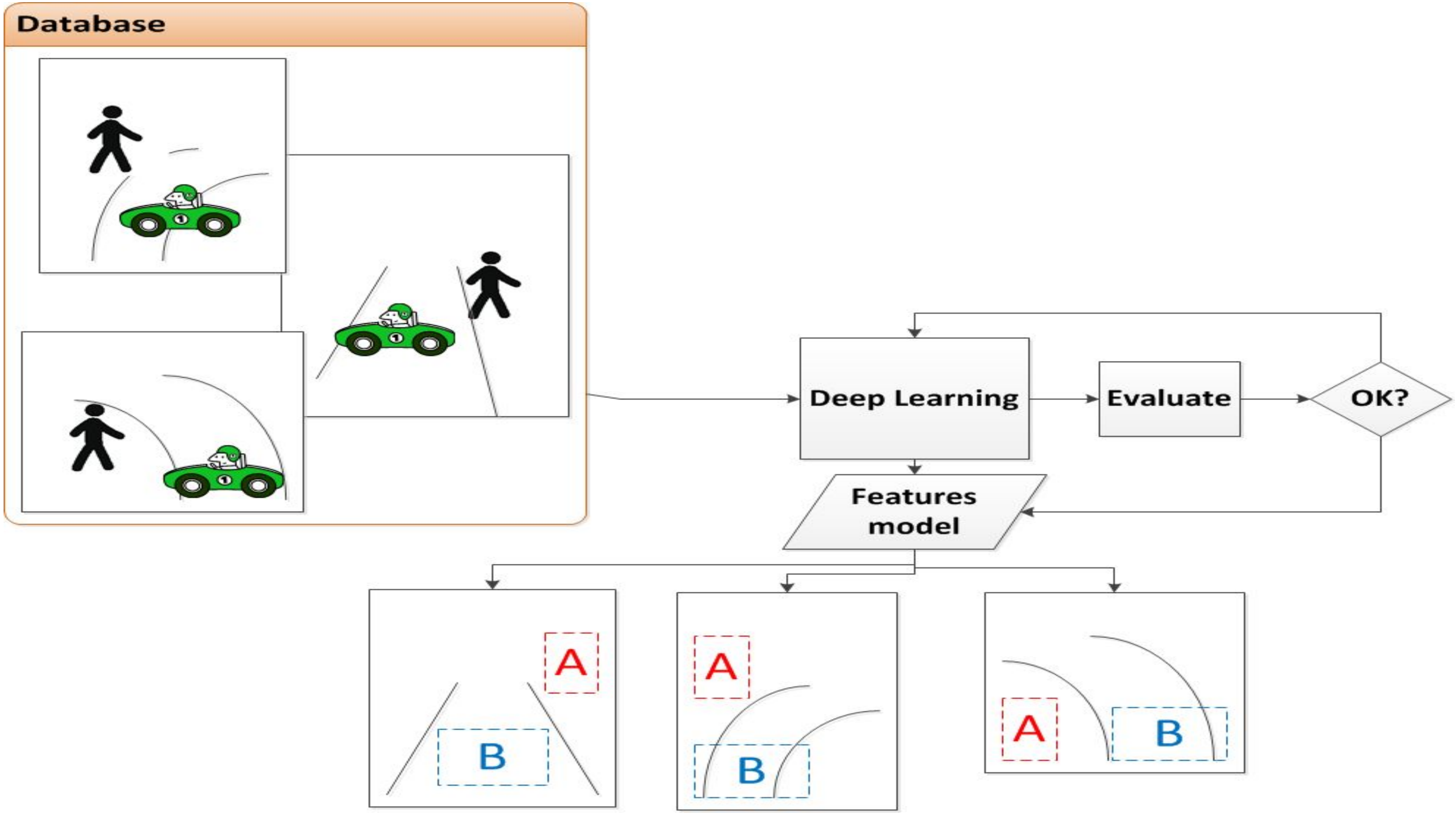
Learning in mammals



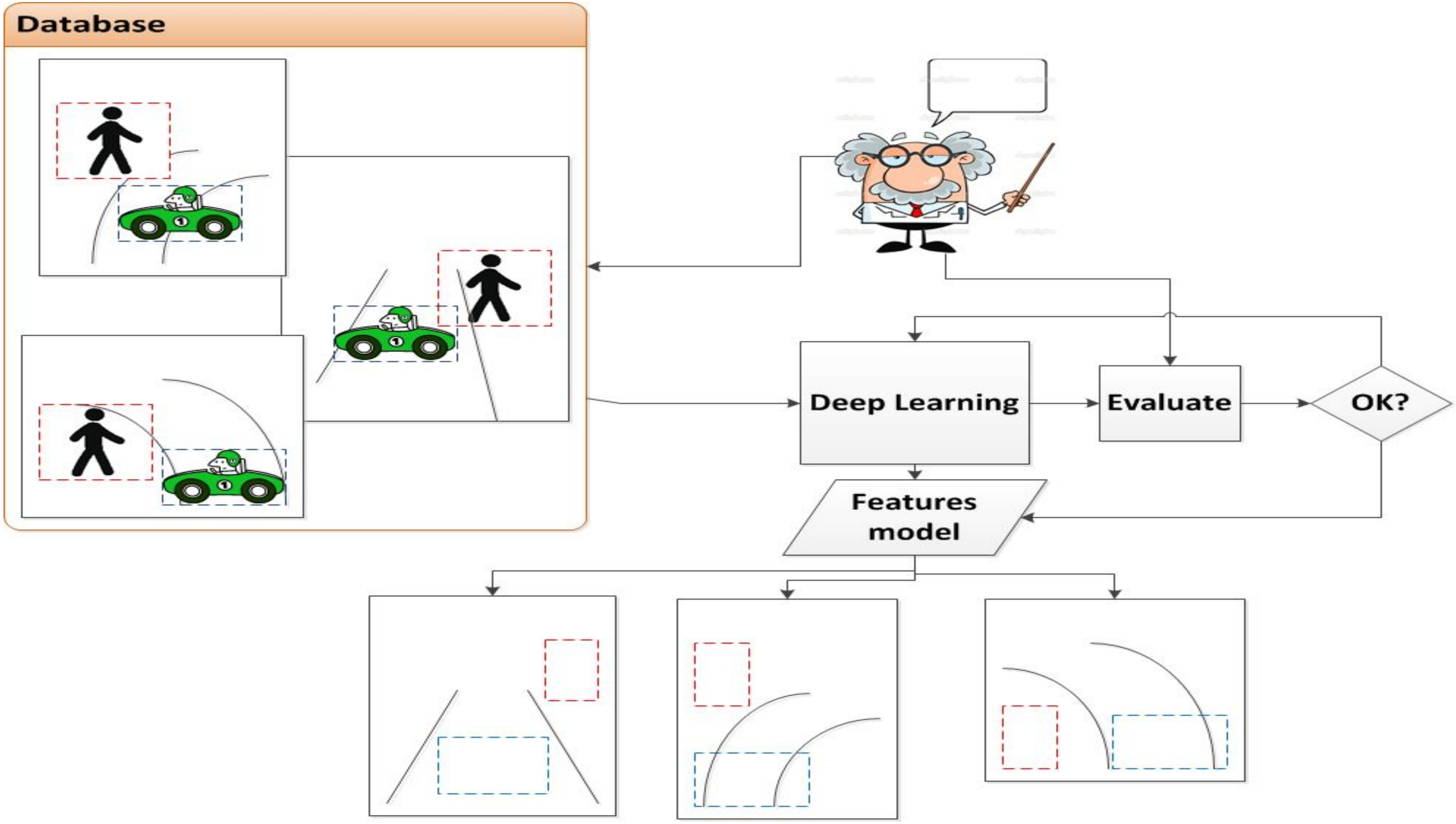


After many attempts

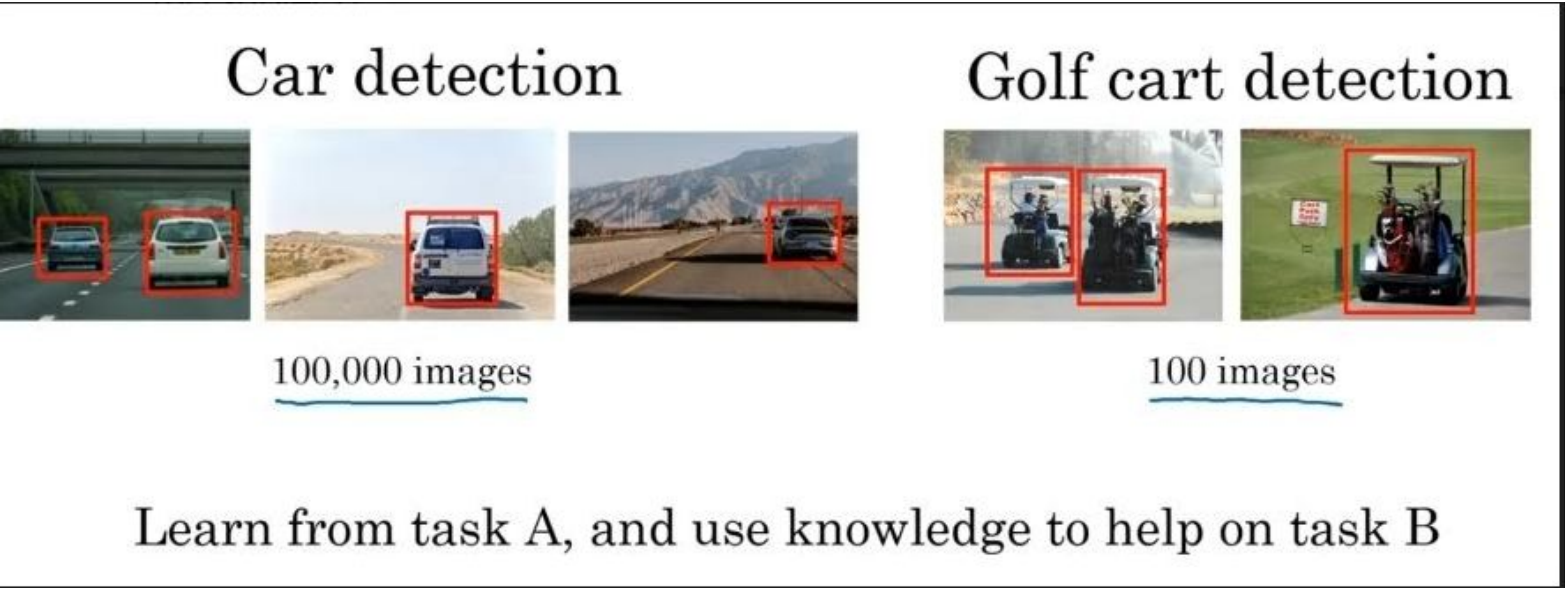
How it works? Unsupervised from big data



How it works? Supervised with a teacher



Transfer Learning



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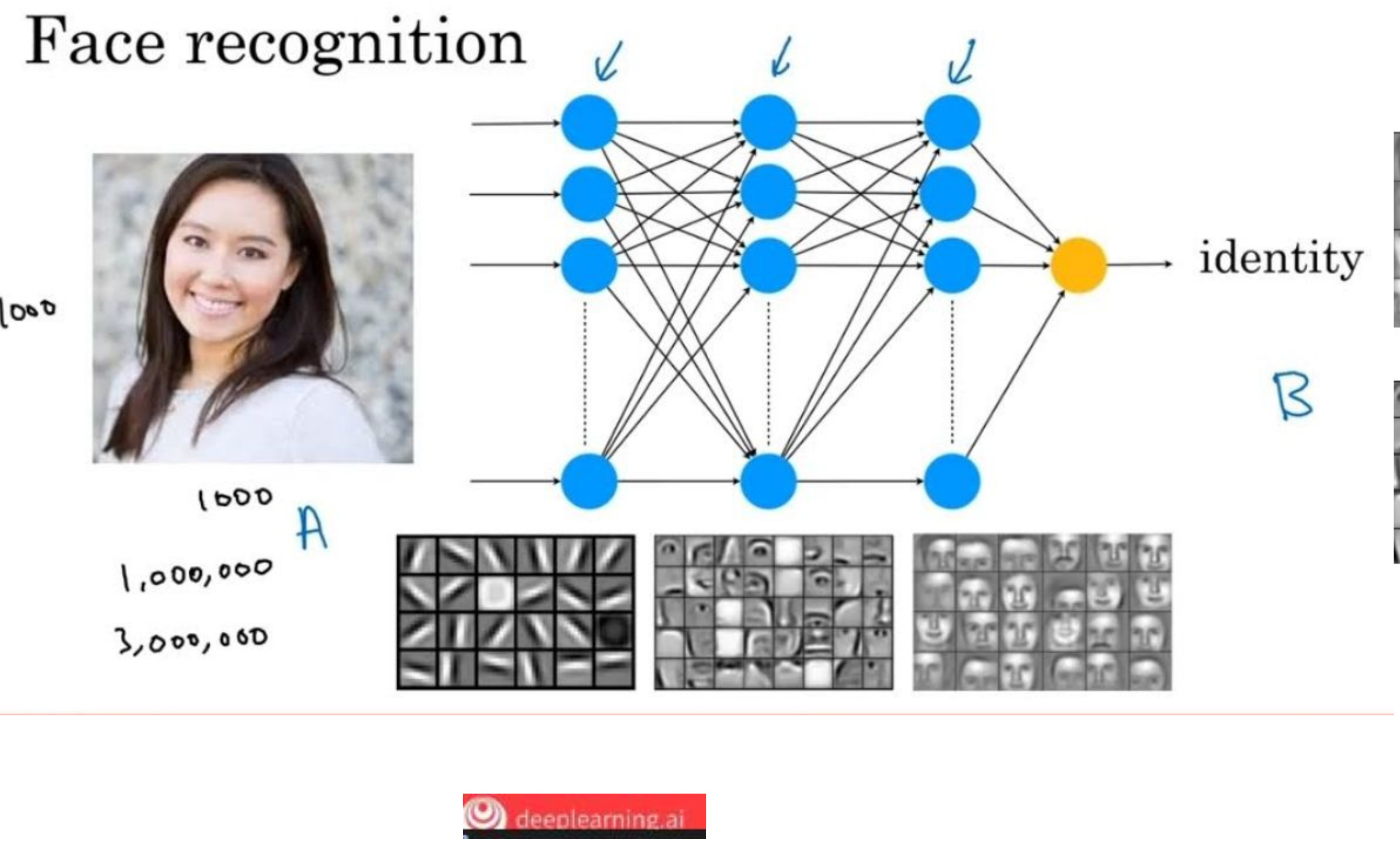
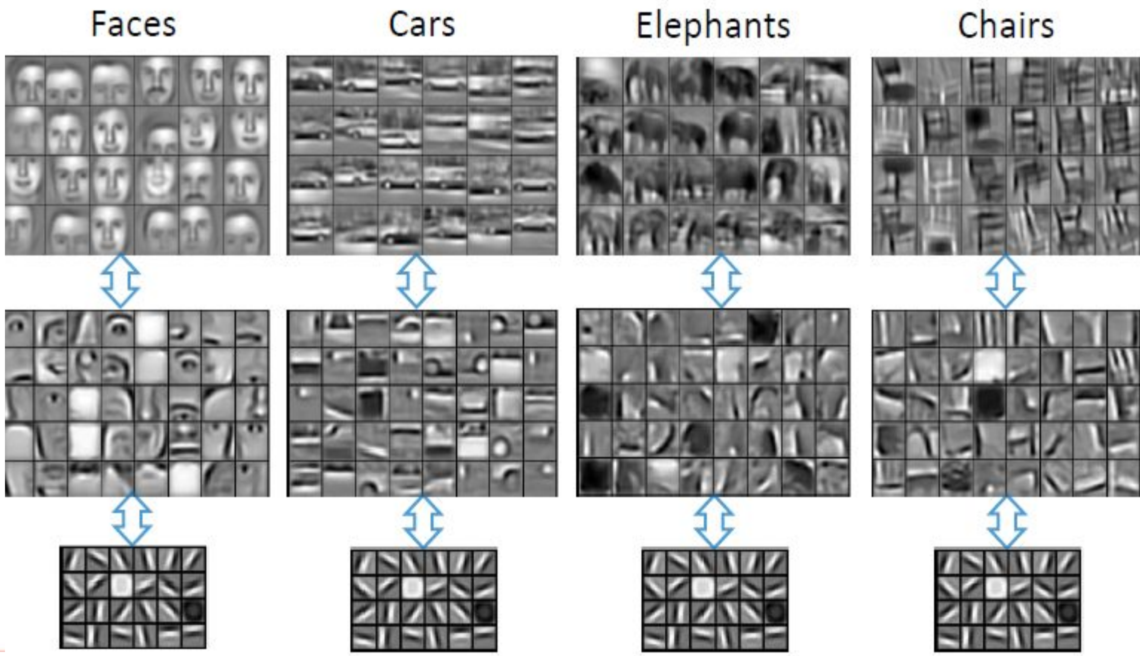
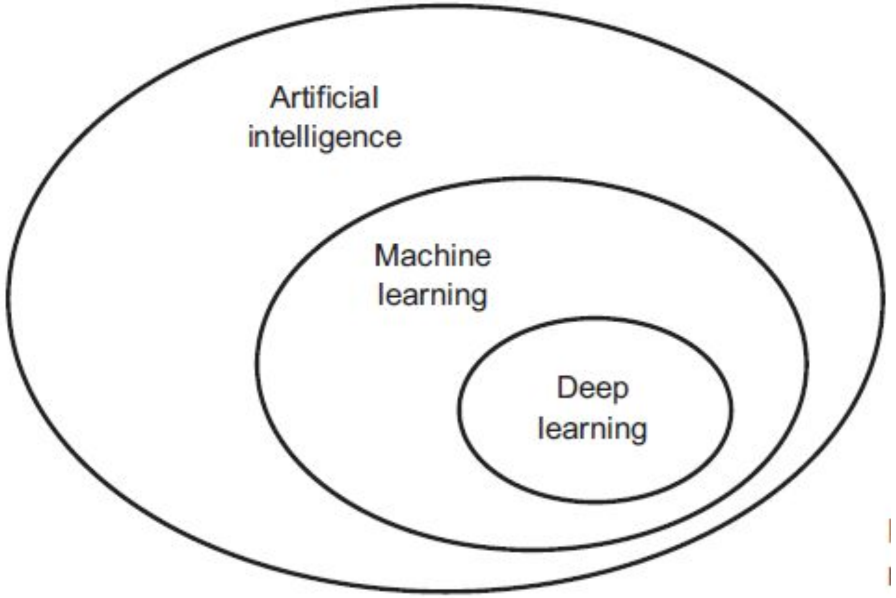
Transfer Learning - How is it possible?





Data science vs. Machine Learning

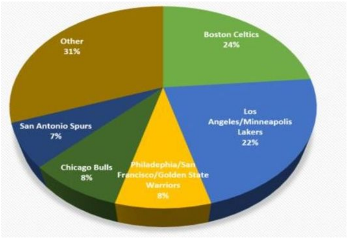
ML: “Make computers learn rather than explicitly programmed”, Arthur Samuel 1959



Output is software

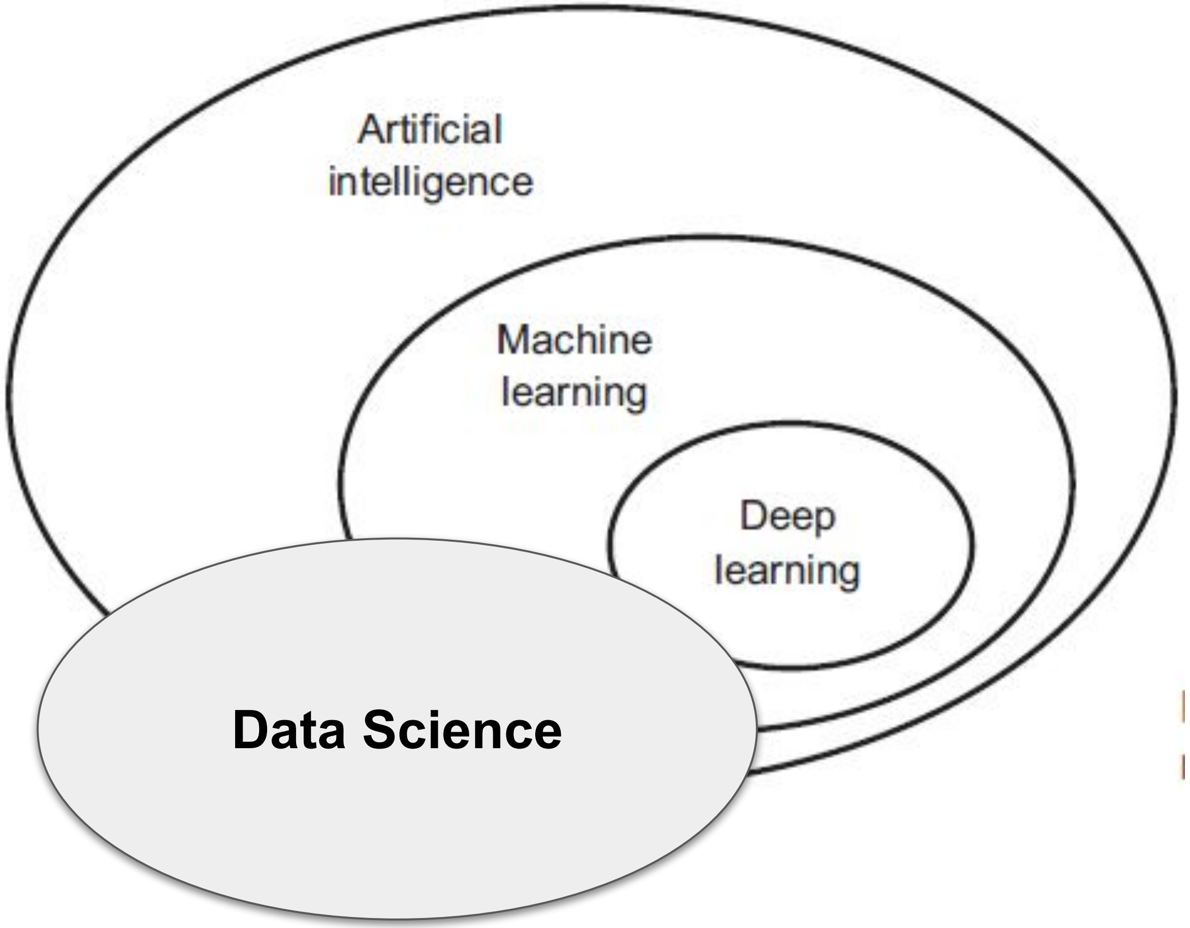
DS: “Science of extracting Knowledge and insights from data”

Price	Floor space	Rooms	Lot size	Appartment	Row house	Corner house	Detached
250000	71	4	92	0	1	0	0
209500	98	5	123	0	1	0	0
349500	128	6	114	0	1	0	0
250000	86	4	98	0	1	0	0
419000	173	6	99	0	1	0	0
225000	83	4	67	0	1	0	0
549500	165	6	110	0	1	0	0
240000	71	4	78	0	1	0	0
340000	116	6	115	0	1	0	0



Looking at market data, what is the best sales strategy?
Output = slide deck supporting decision making
“Speak with Data”

Data science vs. Machine Learning



Take away messages

ML is data driven

Global ML workflow

DL is more data driven + HW driven → Why now? GPU

AI is good at simple perception tasks and automation using analysis of tons of data

AI is not good at complex tasks. AGI is far.

Think statistical metrics. 100% is not possible.

AI Hype and Limitations: Bias, Attacks

References

https://www.coursera.org/learn/ai-for-everyone

https://www.coursera.org/learn/machine-learning-projects

https://course.fast.ai/

https://www.deeplearningbook.org/

QUESTIONS


THANK
YOU