

What is Artificial intelligence, Machine Learning and Deep Learning?

Marcus Rüb

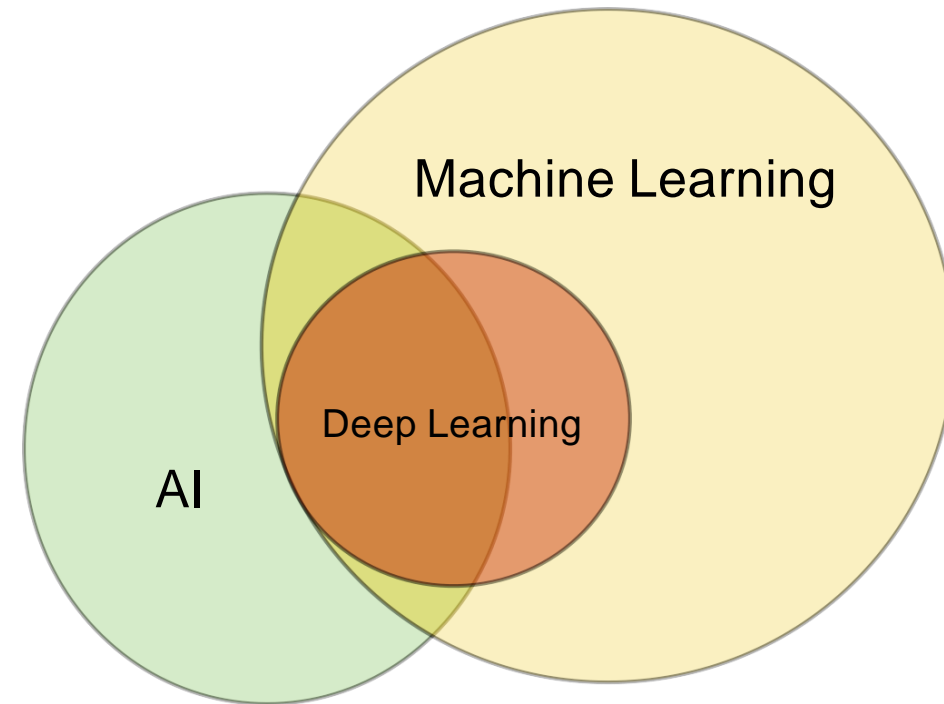
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This Session:

- Introduction
- What is Machine Learning?
- Examples
- How Machine Learning works?
- Machine Learning concepts



The Connection Between Fields



The Connection Between Fields

Artificial Intelligence (AI):

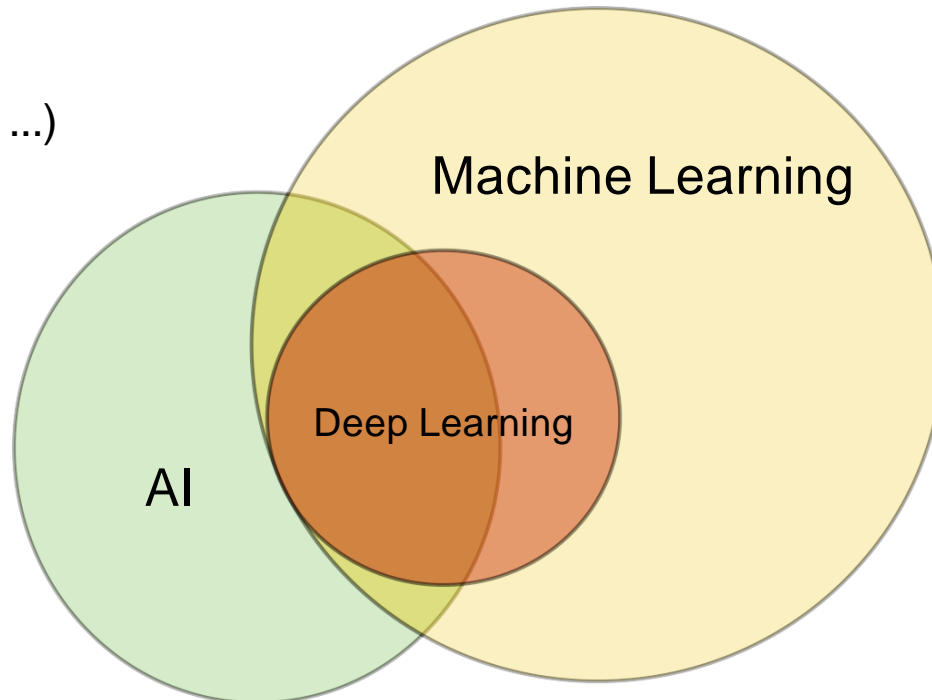
orig. subfield of computer science, solving tasks humans are good at (natural language, speech, image recognition, ...)

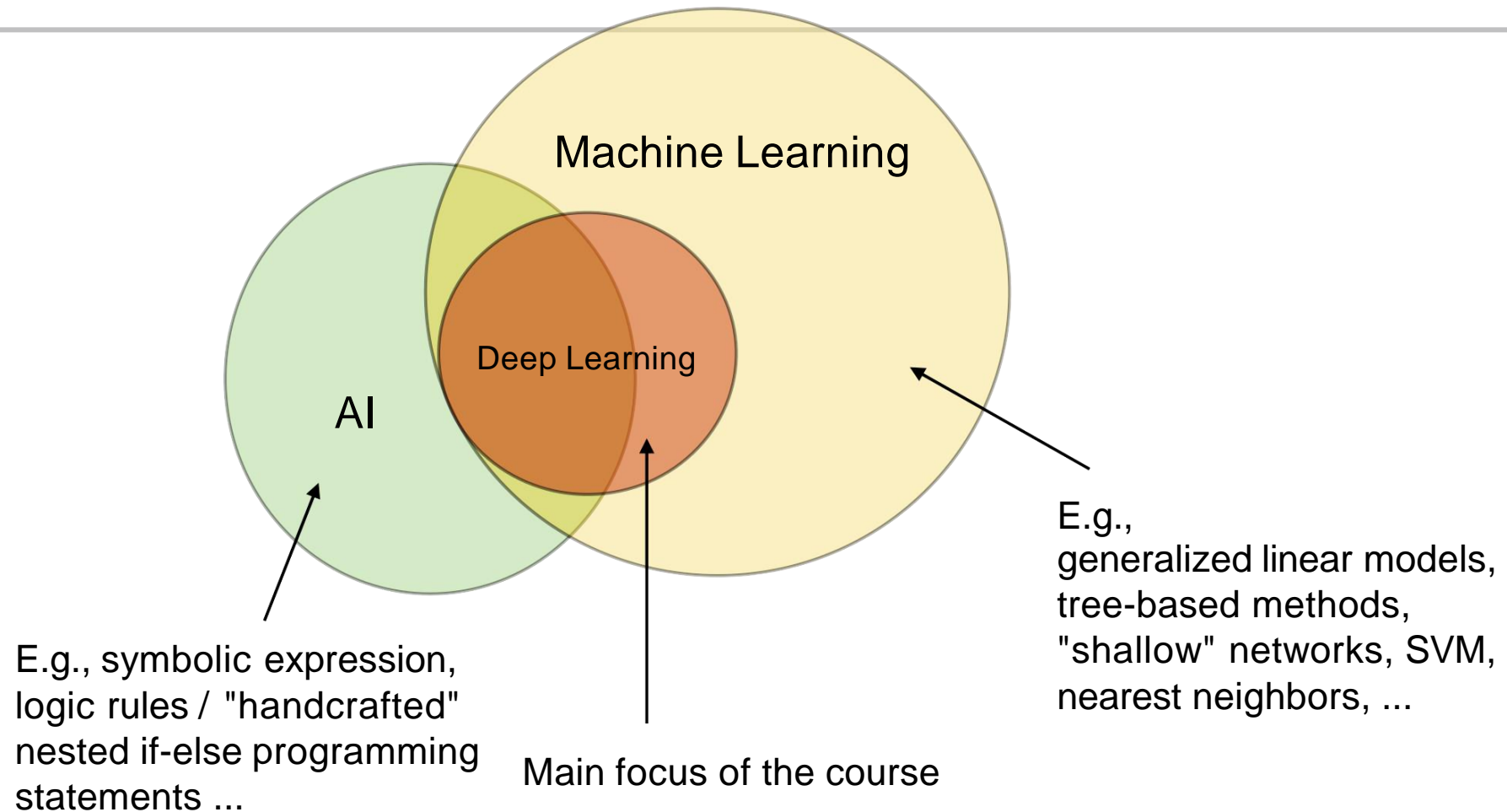
Artificial General Intelligence (AGI):

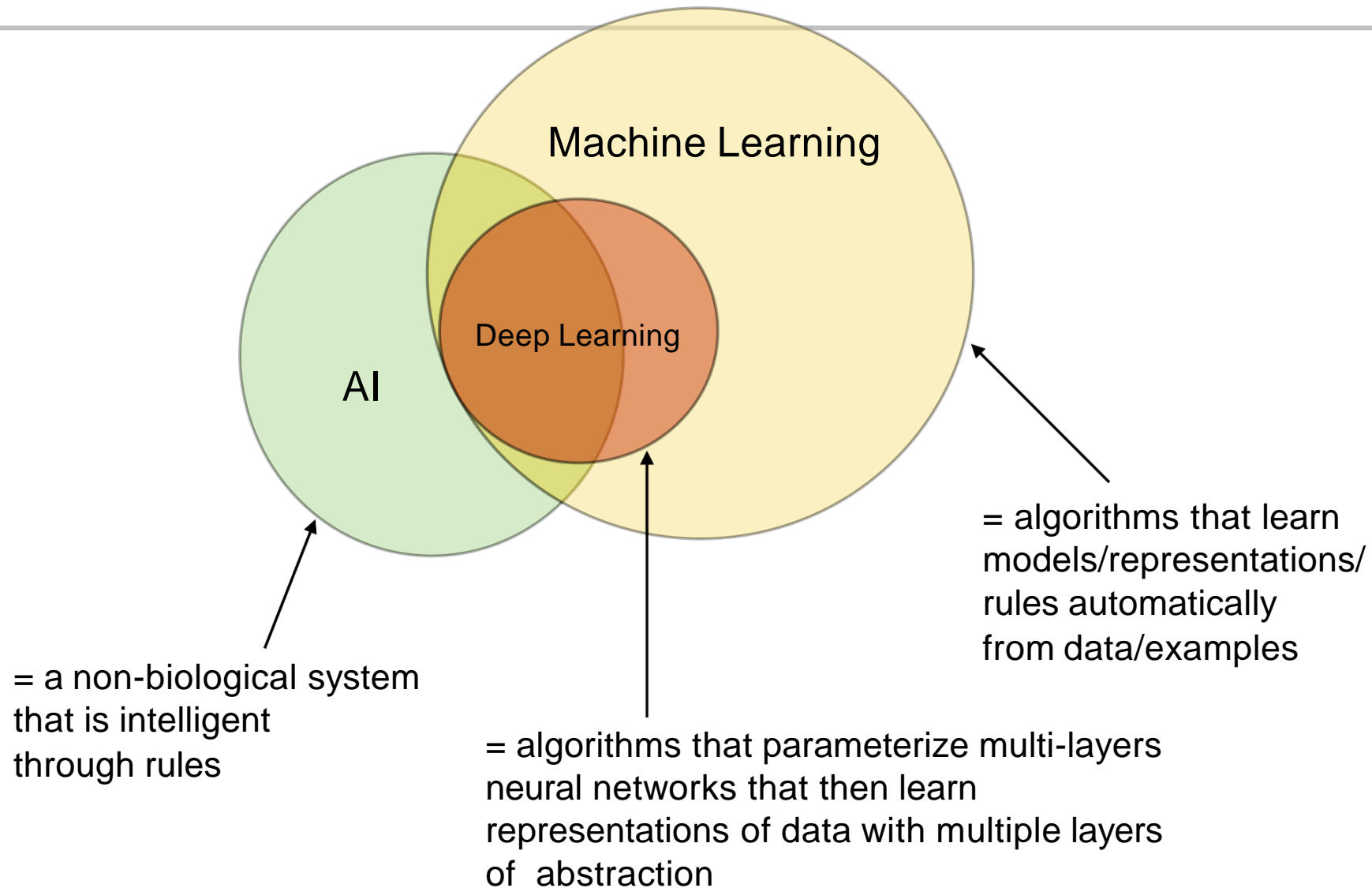
multi-purpose AI mimicking human intelligence across tasks

Narrow AI:

solving "a" task (playing a game, driving a car, ...)

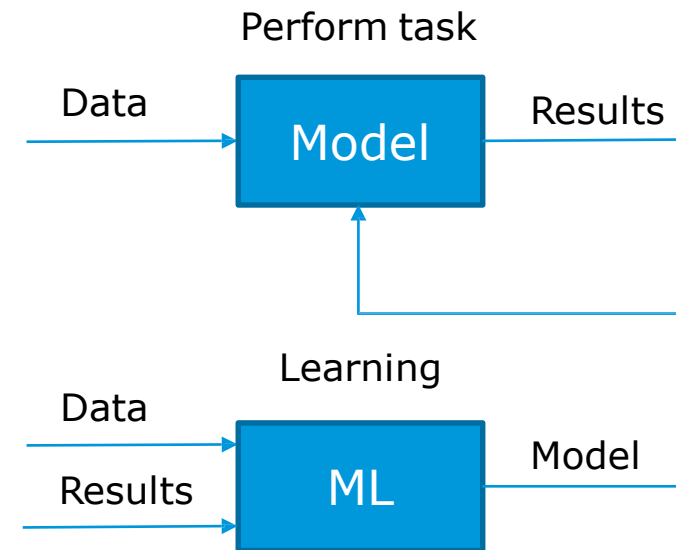
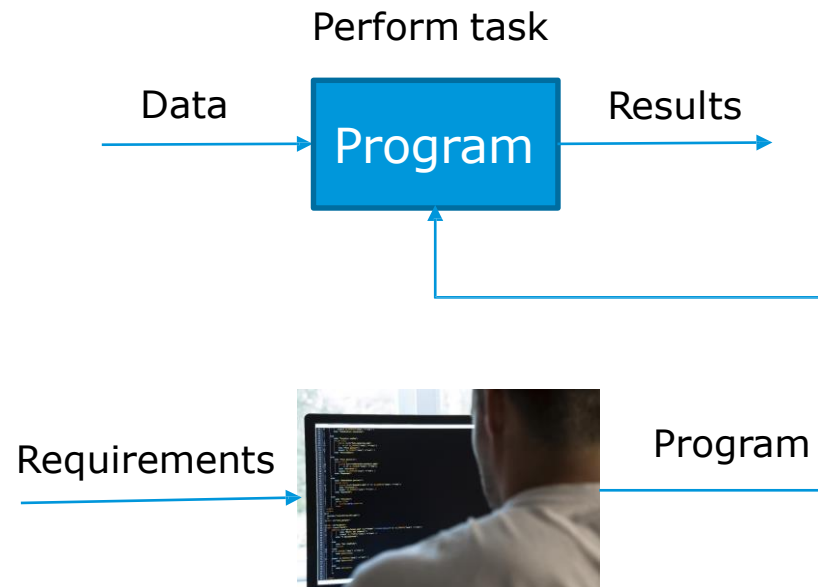






- **The science (and art) of programming computers so that they can learn from data [Aurélien Géron, 2017]**
- “The field of study that gives computers the ability to learn without being explicitly programmed” [Artur Samuel, 1959]
- “A computer program is said to learn from experience E with respect to some task T and some performance measure P , if its performance on T , as measured by P , improves with experience E ” [Tom Mitchell, 1997]

How is Machine Learning different from programming



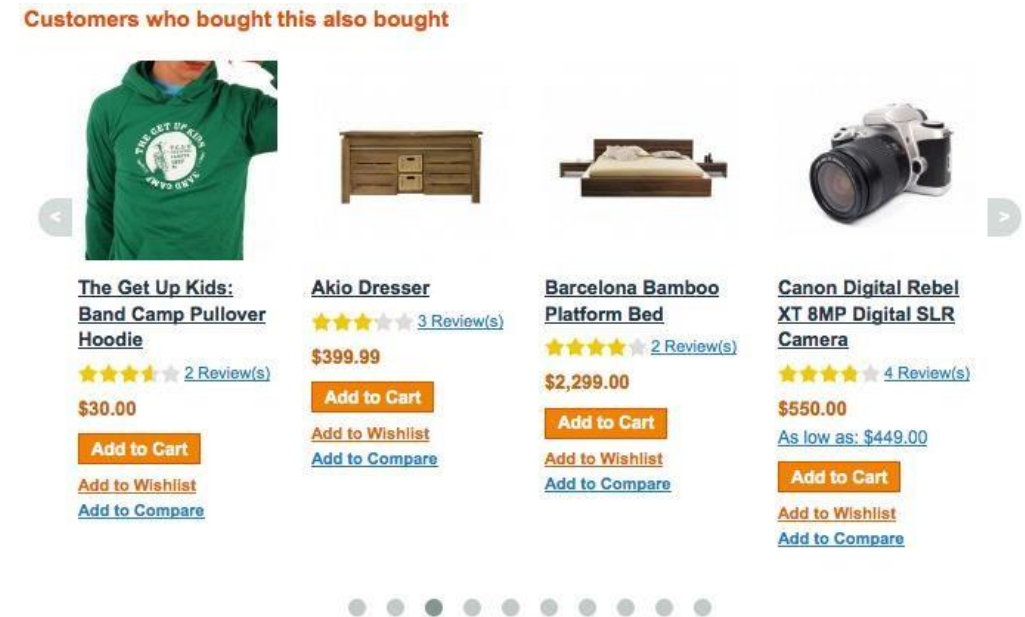
Only for some tasks

Which tasks can Machine Learning perform?

- Let's see some examples




Spam Filter



Recommendation Engine


Which tasks can Machine Learning perform?






**111 Archer Ave,
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4 beds • 3 baths • 3,410 sqft

Built in 2009, perfectly blending elegance with functional living space. Excellent floor plan with 3 beds up and 1 on main. Open living, kitchen & dining w/ huge fireplace & Sound views. Spacious kitchen w/ slab granite surfaces & center island. Huge master suite with Jacuzzi tub & separate shower. Features; hdwd floors, all

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Real Estate

Predict at which price
a property will be sold

Which tasks can Machine Learning perform?

The screenshot shows a Google search for "android mobile phones". The search bar is at the top with the Google logo on the left and a search icon on the right. Below the search bar are tabs for "All", "Shopping", "Images", "News", "Videos", and "More". The "All" tab is selected. Below the tabs, it says "About 9.340.000 results (0,68 seconds)".

The main content area is titled "Shop for android mobile phones". It displays five product cards, each with a phone image, name, price, and retailer. A "Sponsored" label is above the last card.

Product	Price	Retailer
Sony Xperia X Compact Zwart	€342,69	KPN.com
Samsung Galaxy J7 2017 Goud in	€250,25	Tele2.nl
Nieuwe Samsung Galaxy	€918,69	KPN.com
Samsung Galaxy A3 2017 Zwart	€270,69	KPN.com
LG K10 (2017) - 16 GB - Dual ...	€159,00	Paradigit.nl

Below the product cards are two sponsored advertisements:

- Mobile Phones bij KPN | Abonnement geldig in de EU | KPN.com**
[Ad] mobielsite.kpn.com/Mobile/Phones
Bestel nú jouw **mobile phone** bij KPN. Voor 23:59 besteld = Morgen in huis!
Razendsnel 4G internet · Gratis Thuisbezorgd · Korting voor KPN-klanten · Gratis Nummerbehoud
- Samsung Android telefoons | Voor iedereen een smartphone**
[Ad] www.samsung.com/Smartphones/Android
Bekijk alle Smartphones en ontdek welke Samsung Galaxy bij jou past!
2 jaar garantie · Water- en Stofbestendig · Topcamera · Gratis verzending

Advertising

Predict which ads you are more likely to click on

Which tasks can Machine Learning perform?

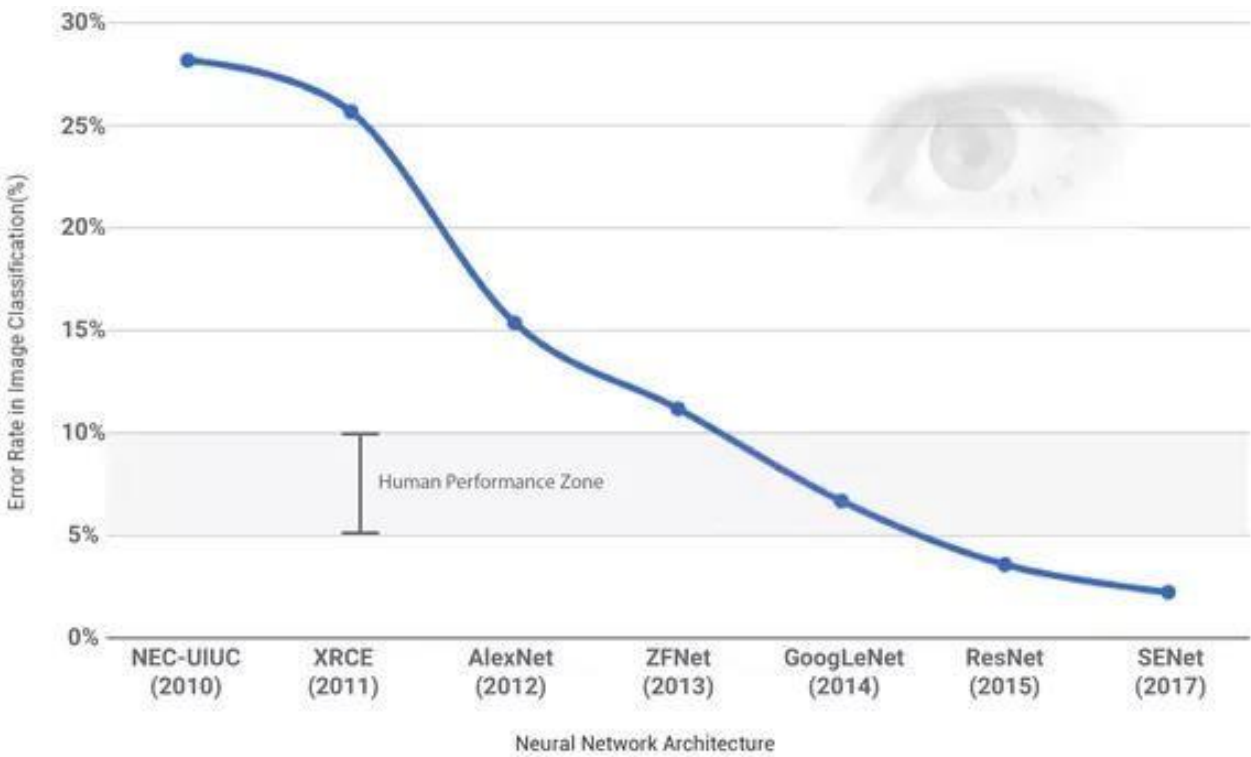
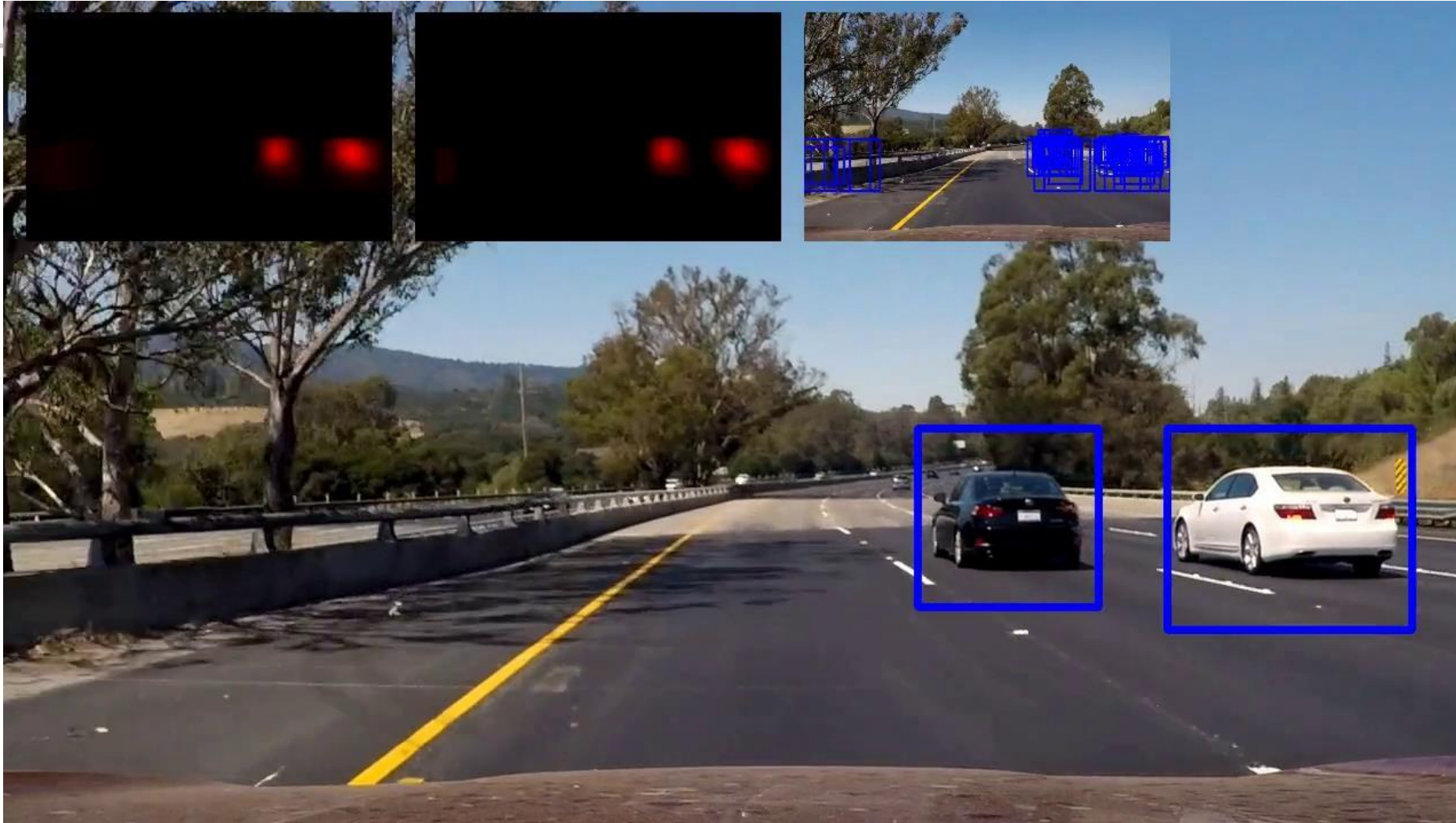


Image Classification

Which tasks can Machine Learning perform?



Self-driving cars

Which tasks can Machine Learning perform?



Speech Recognition
& Synthesis

Which tasks can Machine Learning perform?

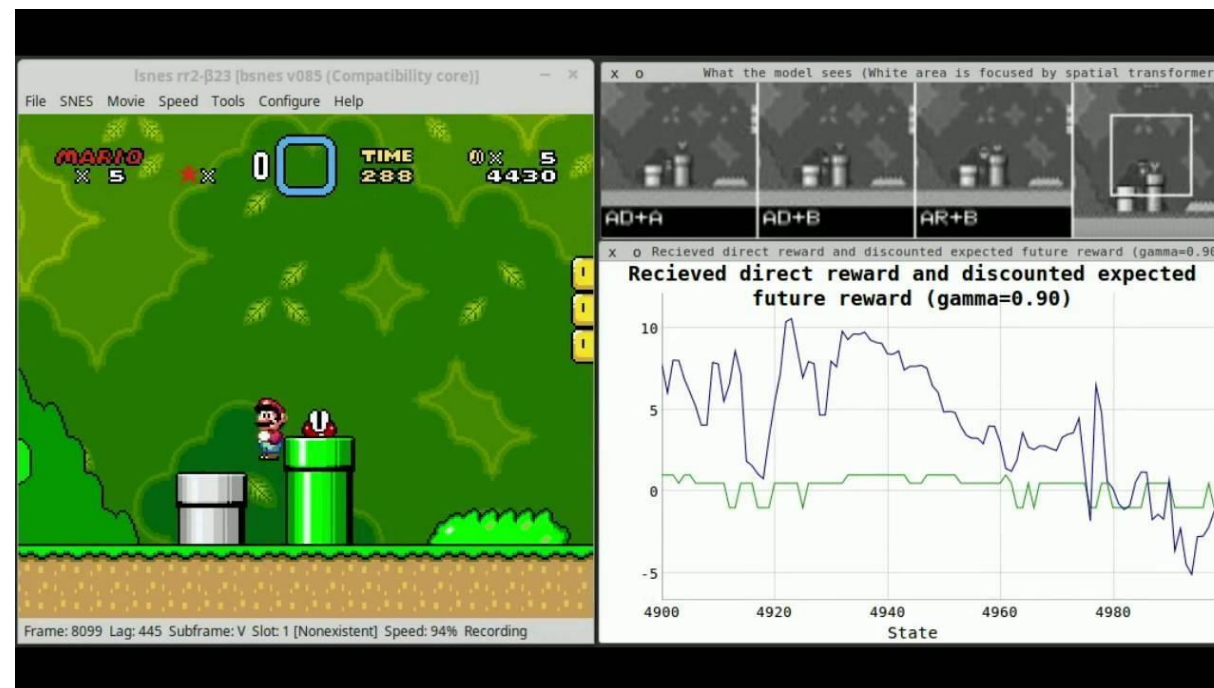
Language Translation

The screenshot displays the Google Translate web interface. At the top left is the Google logo. Below it, the word "Translate" is shown in red. On the right side, there is a link "Turn off instant translation" and a star icon. The main area features two language selection bars. The left bar has "English", "Spanish", "French", and "Detect language" with a dropdown arrow. The right bar has "Spanish", "German", and "Georgian" with a dropdown arrow, followed by a blue "Translate" button. Below the language bars, the input text "This translation has been performed by a machine" is shown in a text box with a close button (X) and a character count "48/5000". Below the input box are icons for speaker, microphone, and keyboard. The output text "Diese Übersetzung wurde von einer Maschine ausgeführt" is displayed in a light gray box. Below the output text are icons for star, copy, and speaker, and a "Suggest an edit" link.

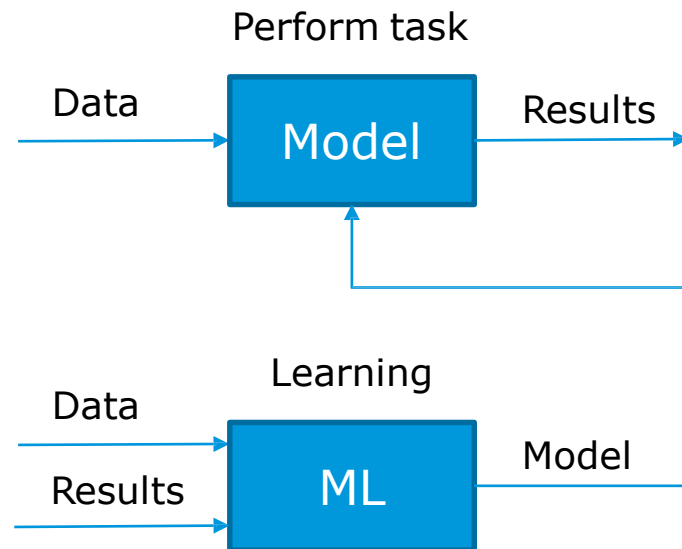
Which tasks can Machine Learning perform?



Playing Games

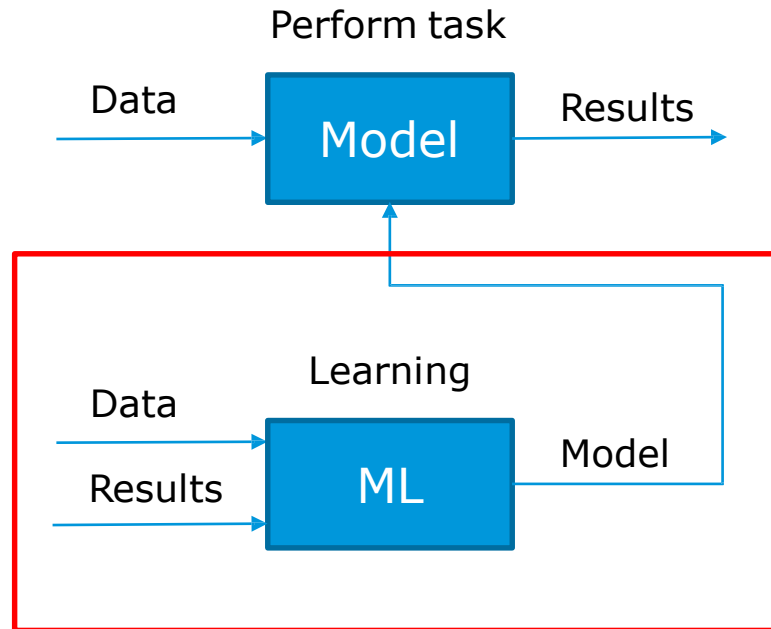


Considerations on using Machine Learning



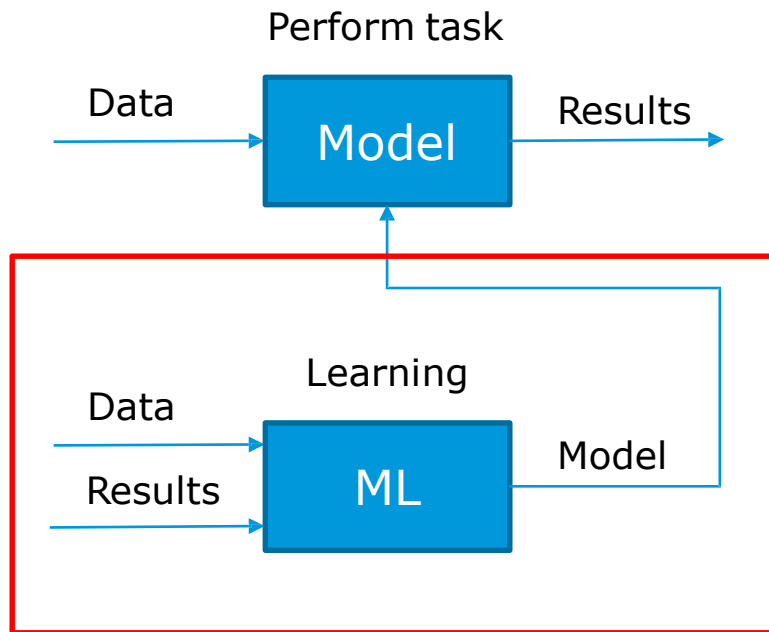
- There must be a pattern in the input – output relationship (lottery winning numbers cannot be predicted with ML)
- There must be enough data to discover this pattern
- It's difficult to formulate a mathematical expression (otherwise we will just use this formula instead)

How Machine Learning Learns?



- Different Machine Learning techniques for different kinds of tasks
- Learning is finding which model's parameters represent best the input – output mapping

How Machine Learning Learns?



- **Linear Regression example:**
 - Model: $f(x) = mx + b$
 - Model's parameters: m, b
 - Parameter values: $m=1, b=0$
- Learning is finding which values of ' m ' and ' b ' fit the data best (e.g. minimizes the prediction error)

Depending on the level of supervision ...

- Supervised
- Unsupervised
- Semi-supervised
- Reinforcement Learning

Supervised Learning

- > Labeled data
- > Direct feedback
- > Predict outcome/future

Unsupervised Learning

- > No labels/targets
- > No feedback
- > Find hidden structure in data

Reinforcement Learning

- > Decision process
- > Reward system
- > Learn series of actions

- Supervised
 - Supervision: we can tell for every case what the correct answer was
 - Example: predict the thermal power consumption



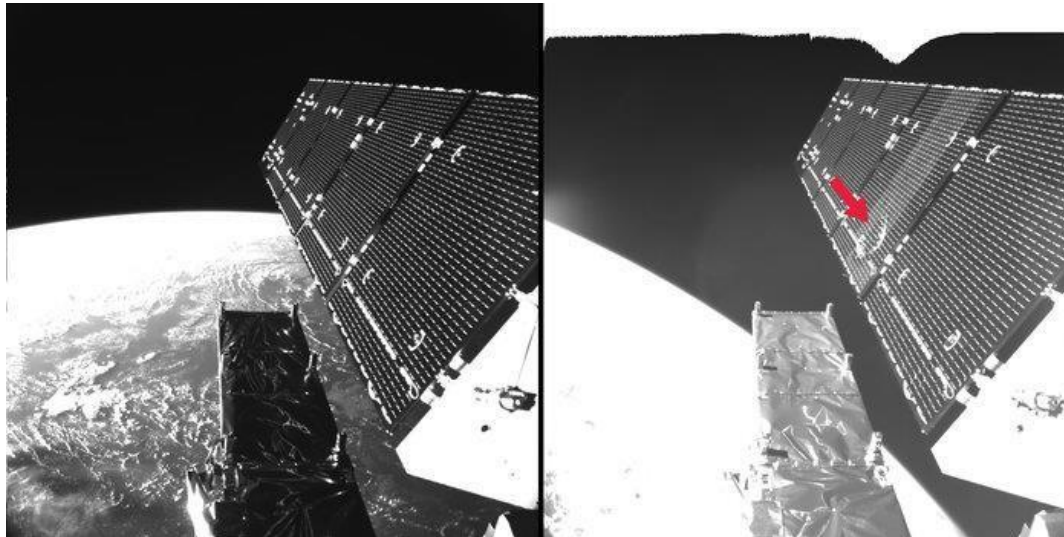
Focus
Predict the future

- Unsupervised
 - Supervision: there is no right answer, we are looking for insights
 - Example: market basket analysis for supermarkets



Focus
Understand the past

- Semi-supervised
 - Supervision: we can tell the correct output for a limited number of cases
 - Example: characterize what a particle impact looks like in TM



Focus

Understand the past

Sentinel-1A: particle impact
on August 23th 2016

- Reinforcement Learning
 - Supervision: we only know the final outcome, but not intermediate steps
 - Example: playing Go



Focus

Find which is the next action most likely to lead to the desired outcome

- The type of learning with most industrial applications is

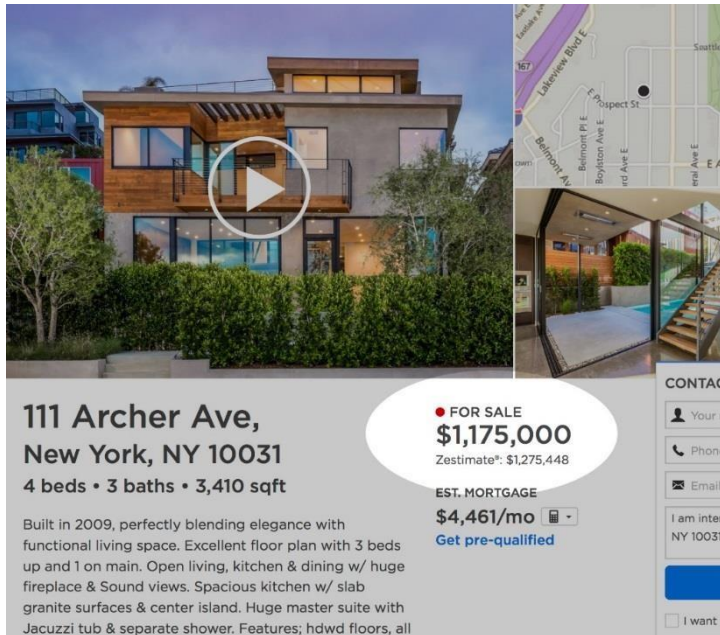
Supervised Learning

(Predictive Analytics)

- Depending of what kind of data is predicted we can talk about:
 - Regression
 - Classification

Regression

- Predict real numbers



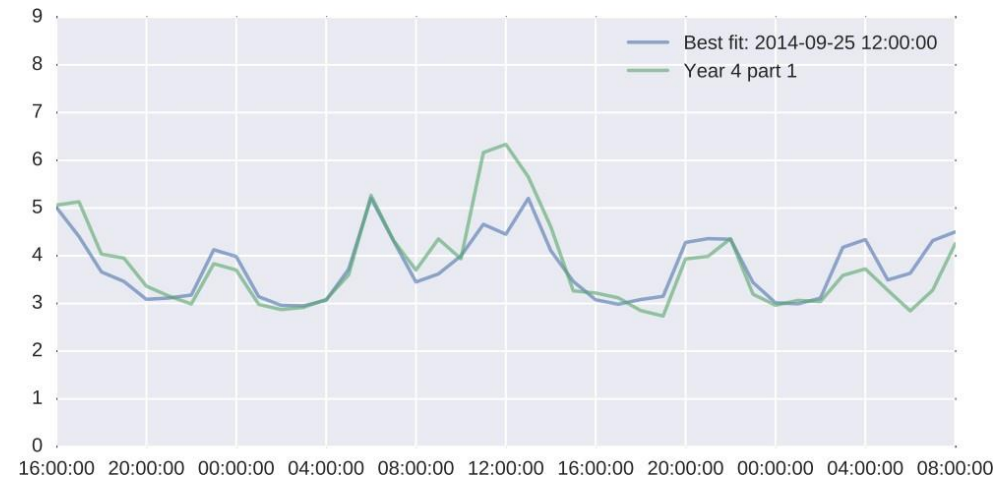
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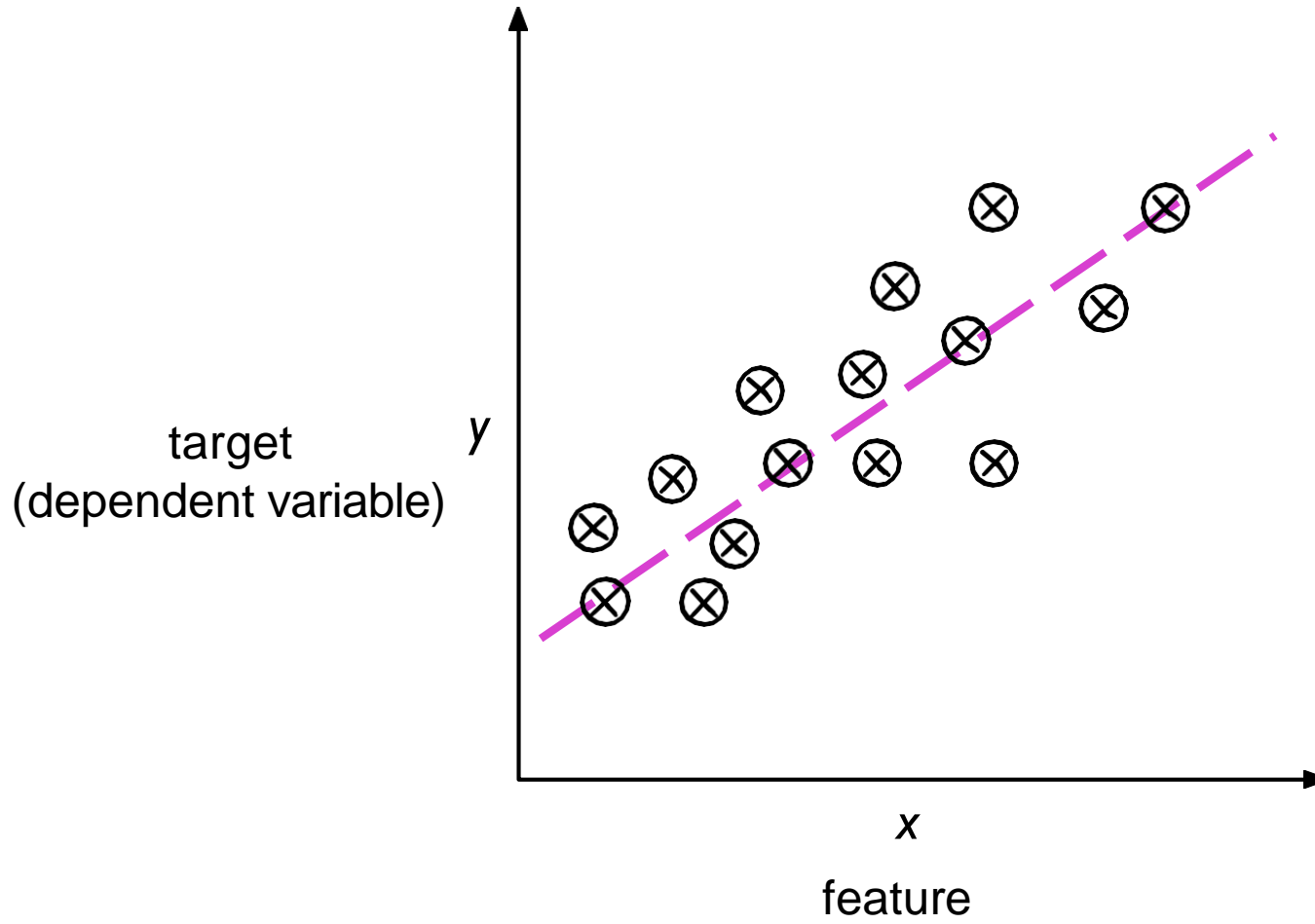
FOR SALE
\$1,175,000
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Regression



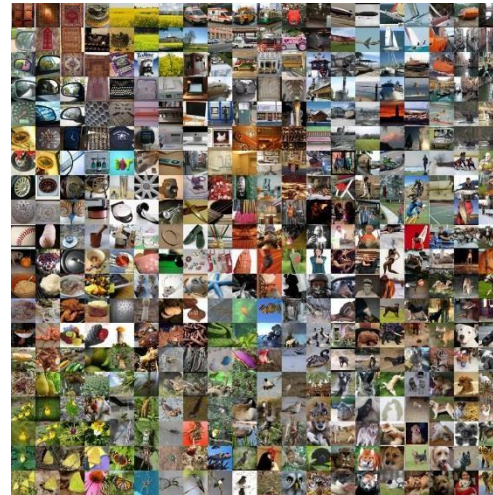
**Artificial
Intelligence**

$$\hat{y} = \mathbf{w}^\top \mathbf{x} + b$$

- Predict which option out of a limited set of possibilities



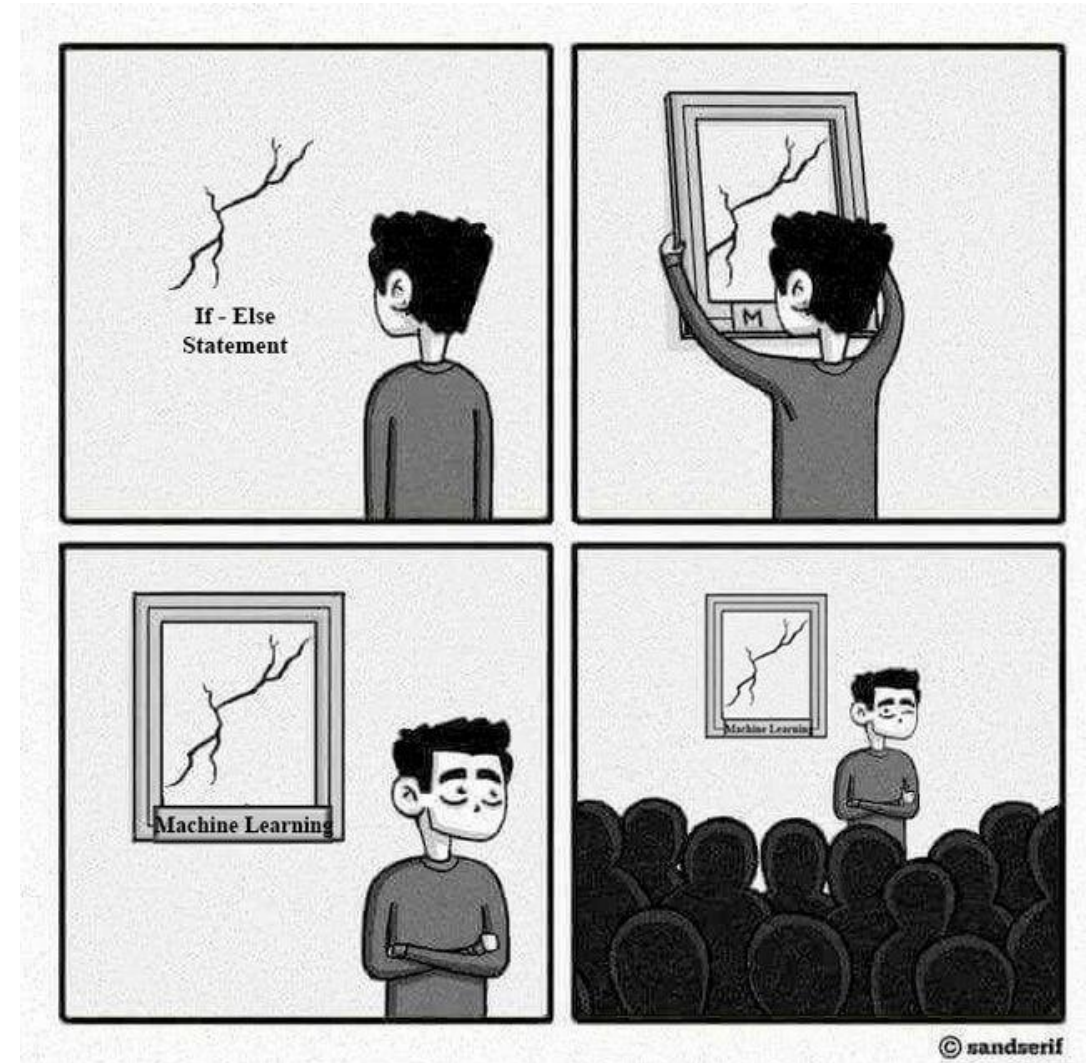
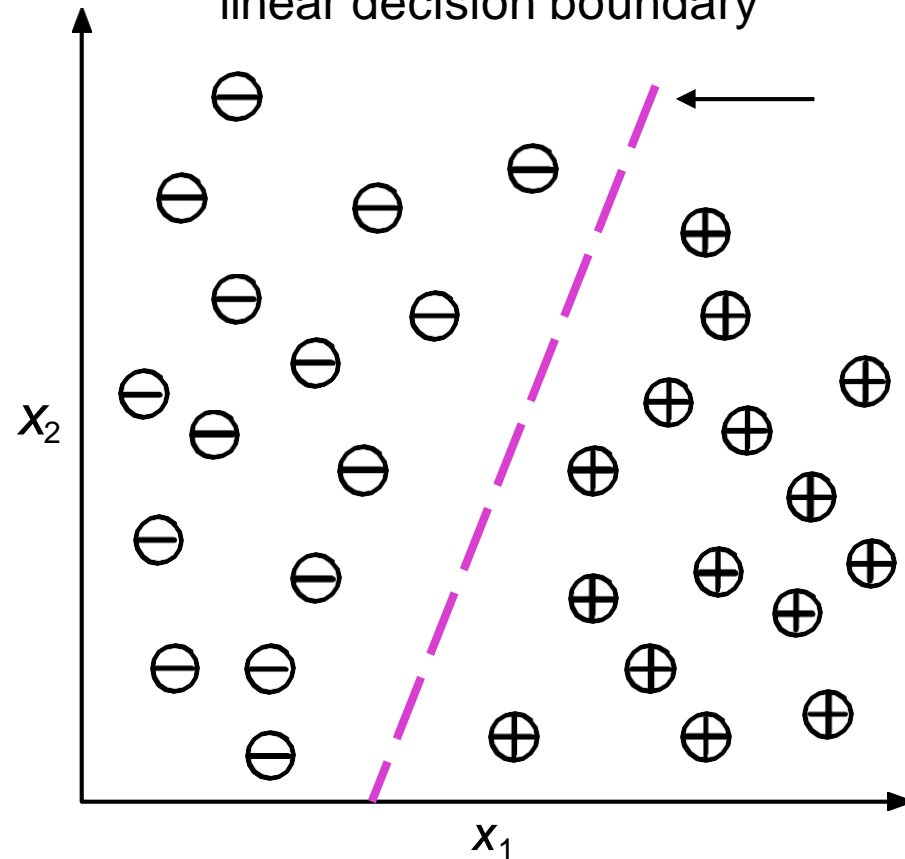
Spam Filter



What's in the picture

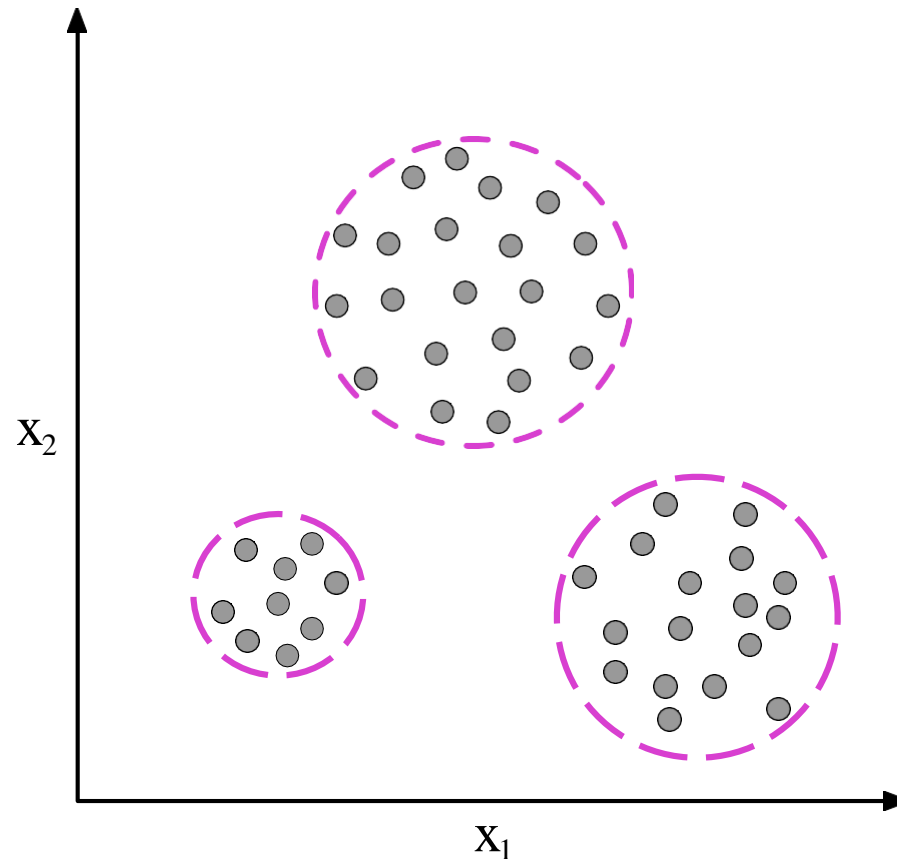
Classification

Binary classification example with
two *features* ("independent" variables, predictors)
linear decision boundary

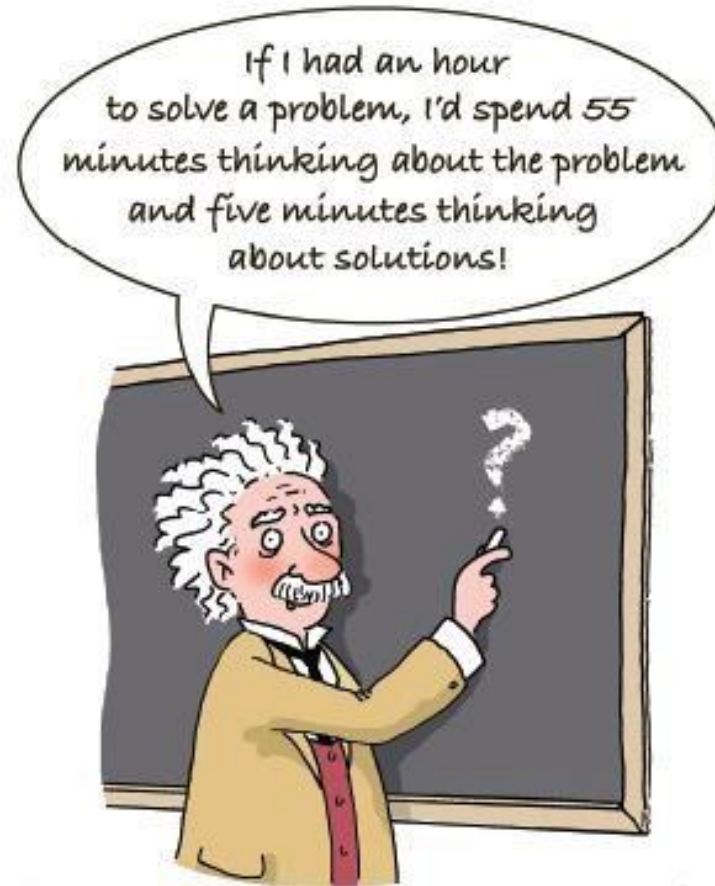


Unsupervised Learning: Clustering

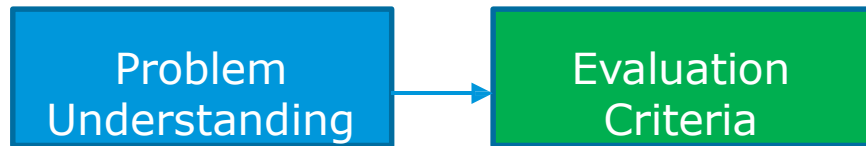
Assigning group memberships to unlabelled examples (instances, data points)



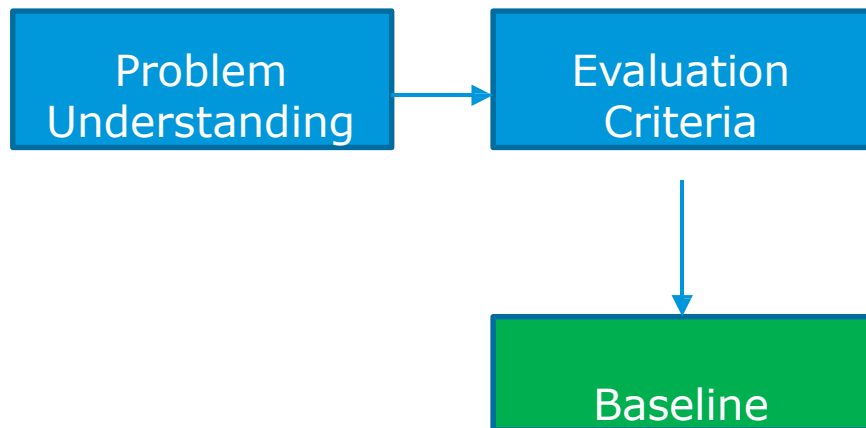
Problem
Understanding



- How will we measure how good the model is performing?
- Do we know already at what point it would be enough?

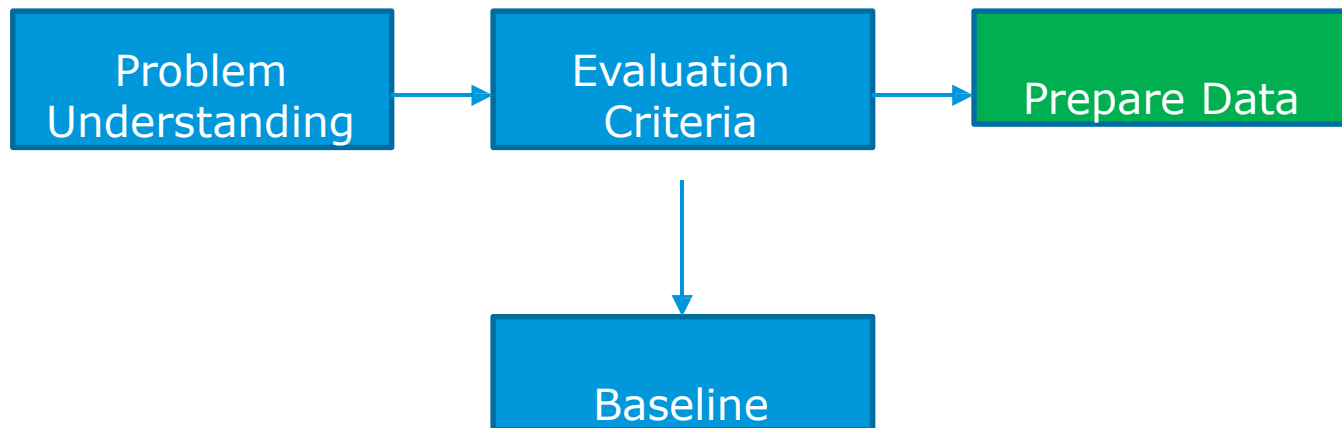


- How the current approach is performing against the evaluation criteria? Define a simple baseline if there is none (e.g. mean value)
- This will allow us to quantify how much Machine Learning helps and if it is worthwhile compared to simpler solutions



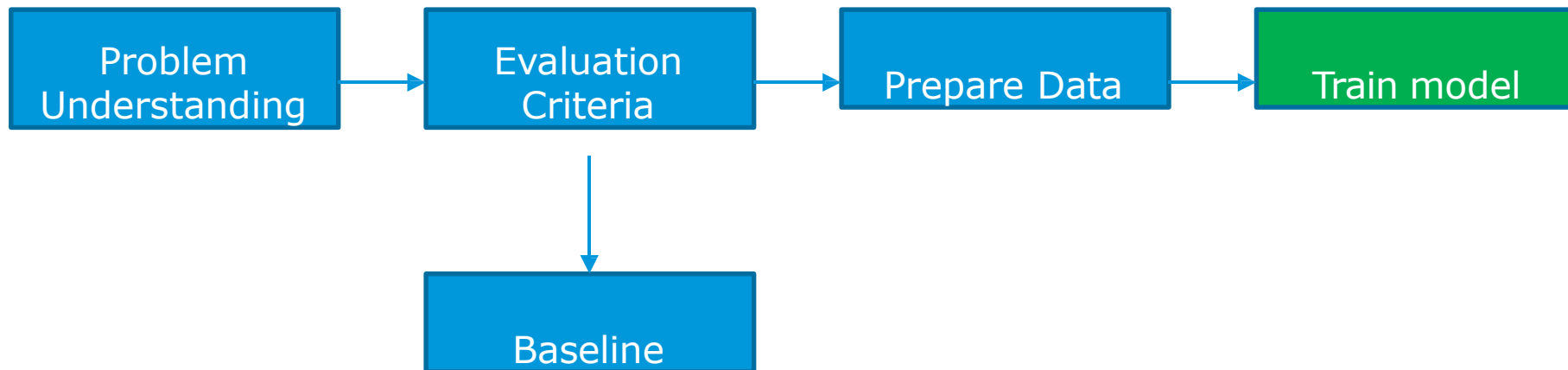
Machine Learning Workflow

- “Enough” data in the sense that it’s representative of the behaviour the model needs to learn
- Features: data transformations that encode your knowledge



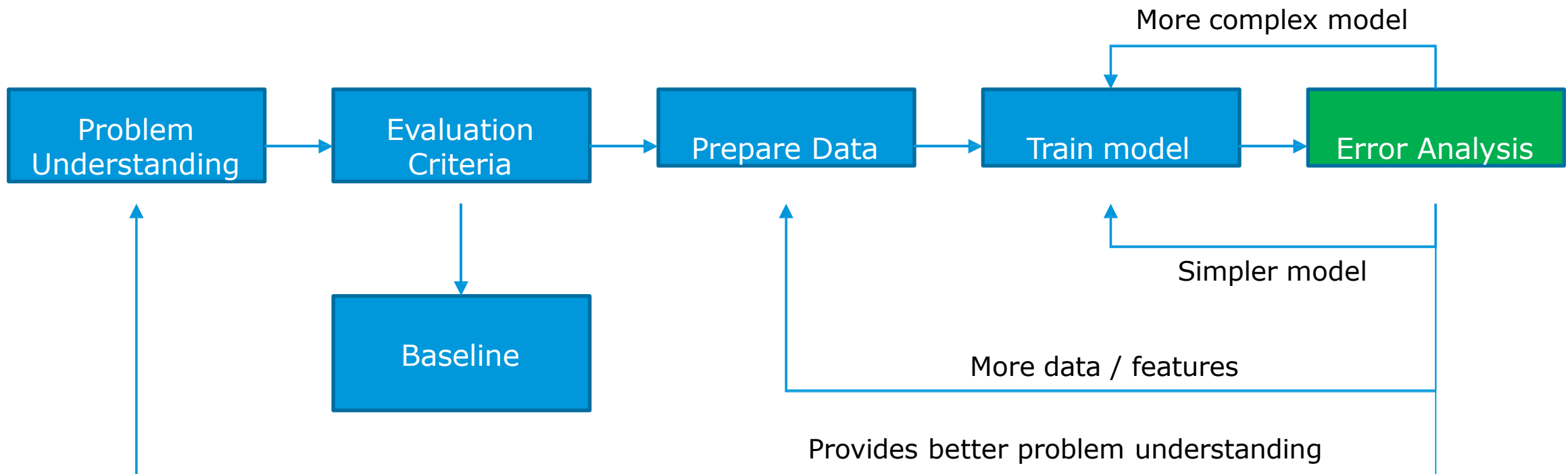
Machine Learning Workflow

- Use data / features to tune the parameters that optimize the evaluation criteria (e.g. minimise error)



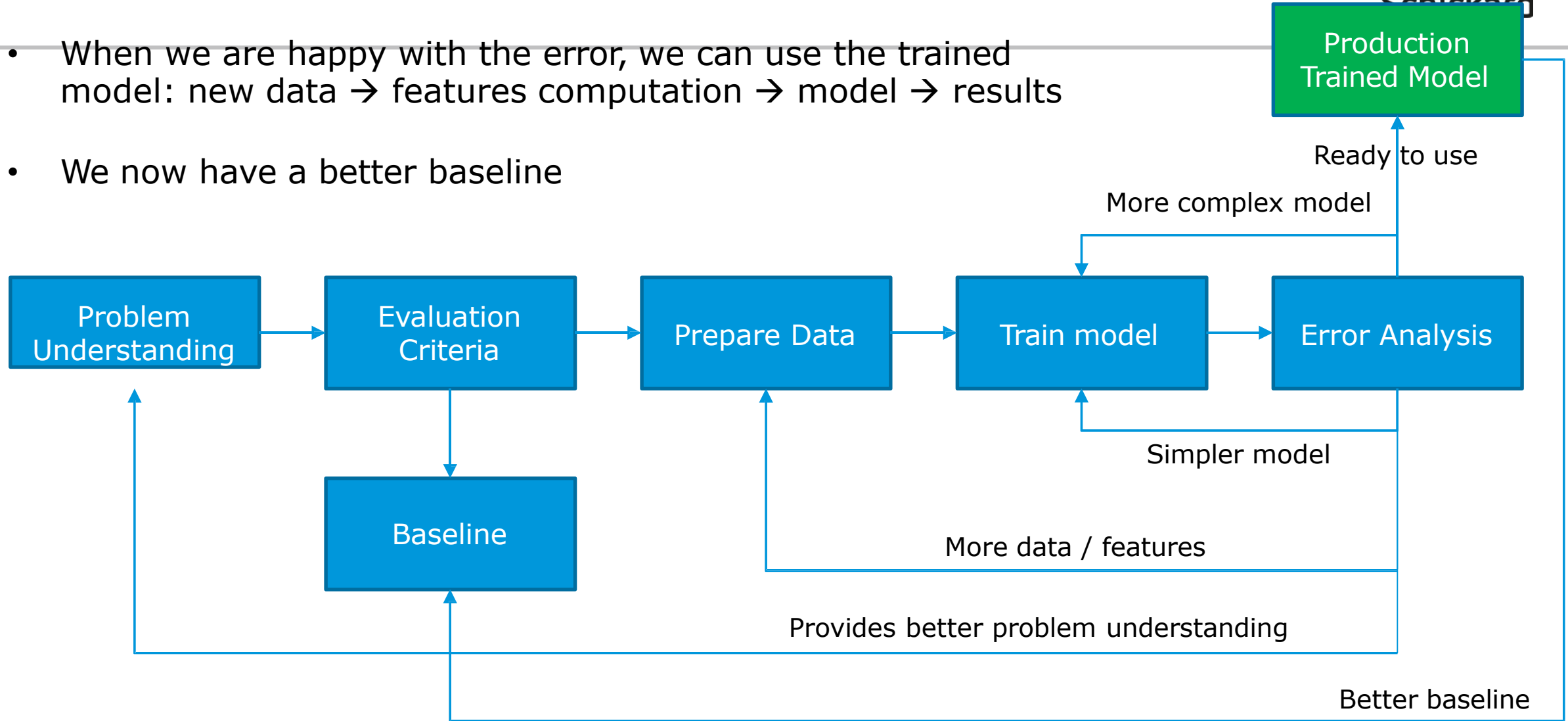
Machine Learning Workflow

- Understand what the model is doing: where is it right / wrong

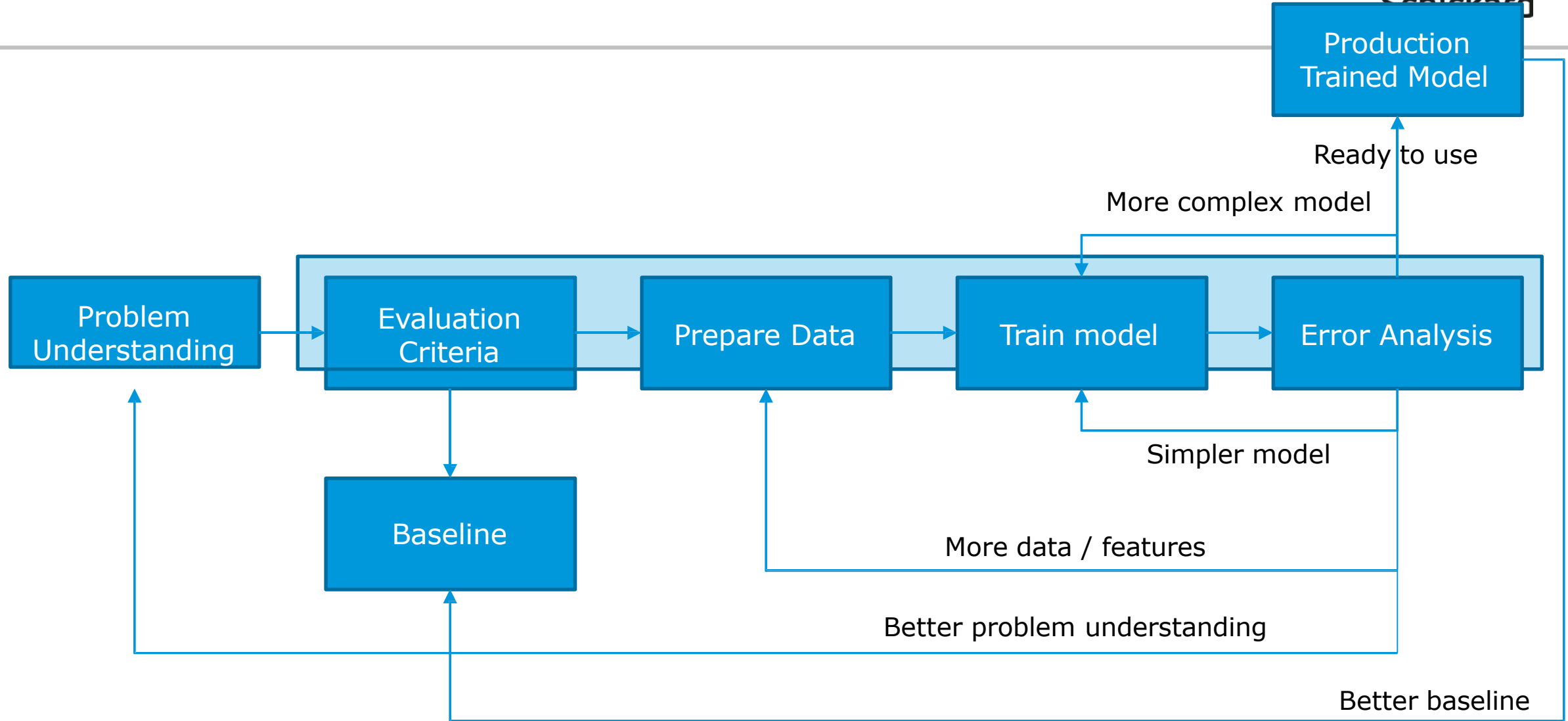


Machine Learning Workflow

- When we are happy with the error, we can use the trained model: new data → features computation → model → results
- We now have a better baseline



Machine Learning Workflow



Questions:

What is Artificial intelligence, Machine learning and deep learning.

Where do we use AI already?

Explain: Supervised, Unsupervised, Semi-supervised, Reinforcement Learning

Explain: Regression, Classification

