A Beginner's Guide to Machine Learning and Deep Learning

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Online

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Postdoctoral researcher at Ontology Engineering Group (UPM)

- BSc Computer Engineer/Mathematician
- MSc Applied Mathematics and Scientific Calculus
- MSc Artificial Intelligence
- Doctoral Thesis: “Processing, Identification and Representation of Temporal Expressions and Events in Legal Documents”

https://short.upm.es/lw7gd

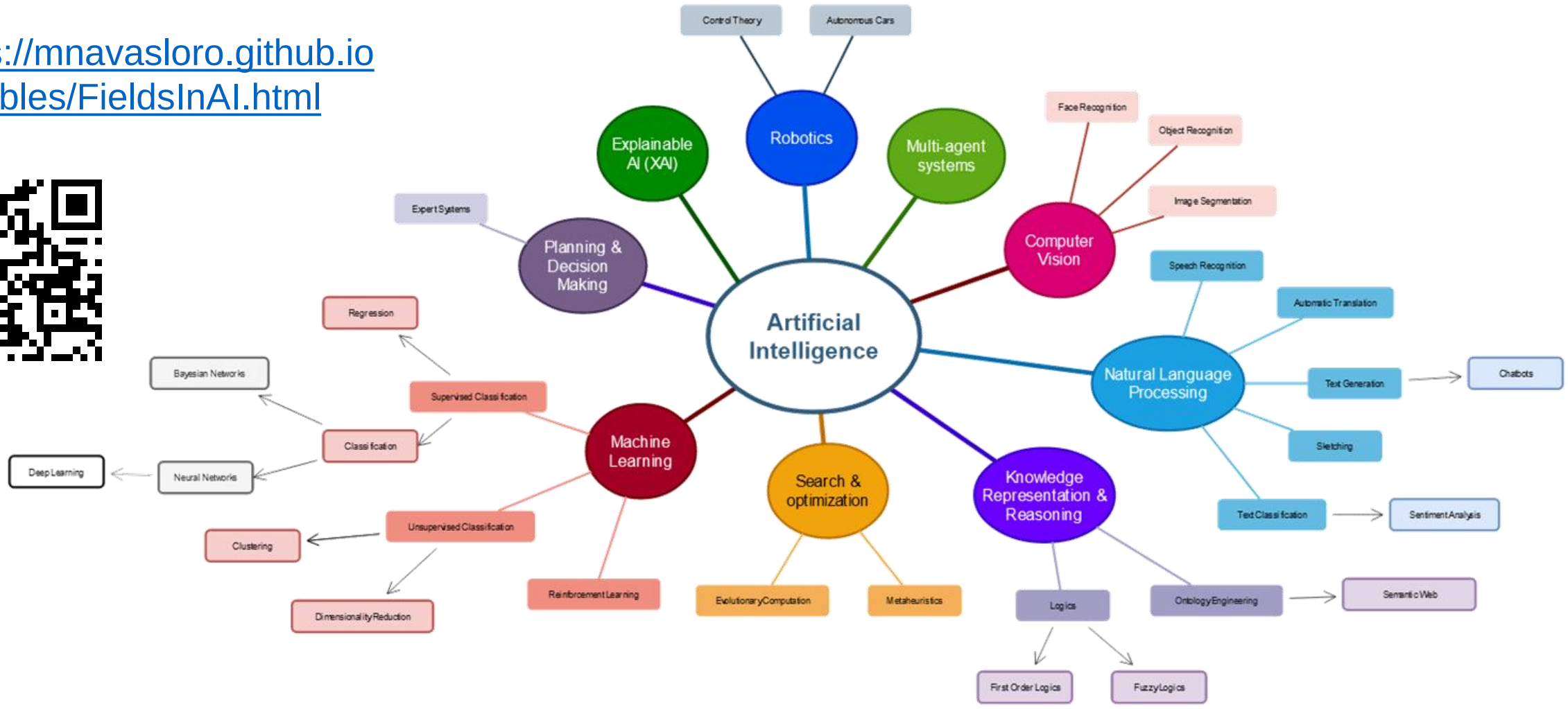
Experience

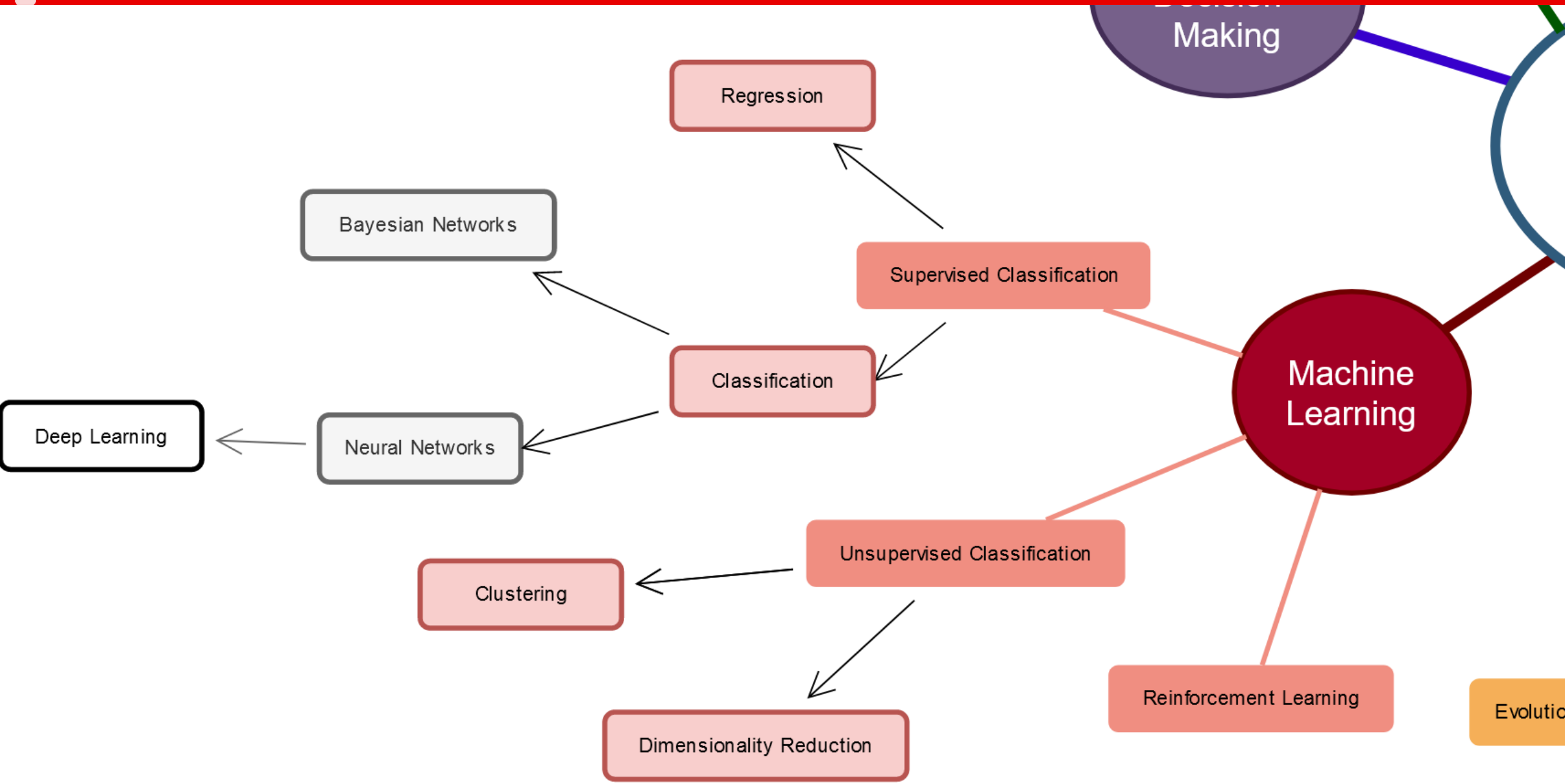
Natural Language Processing, Knowledge Representation, Machine Learning

- Brief introduction to different ways to process your data using Machine Learning and Deep Learning
- How last advancements can be applied to industry

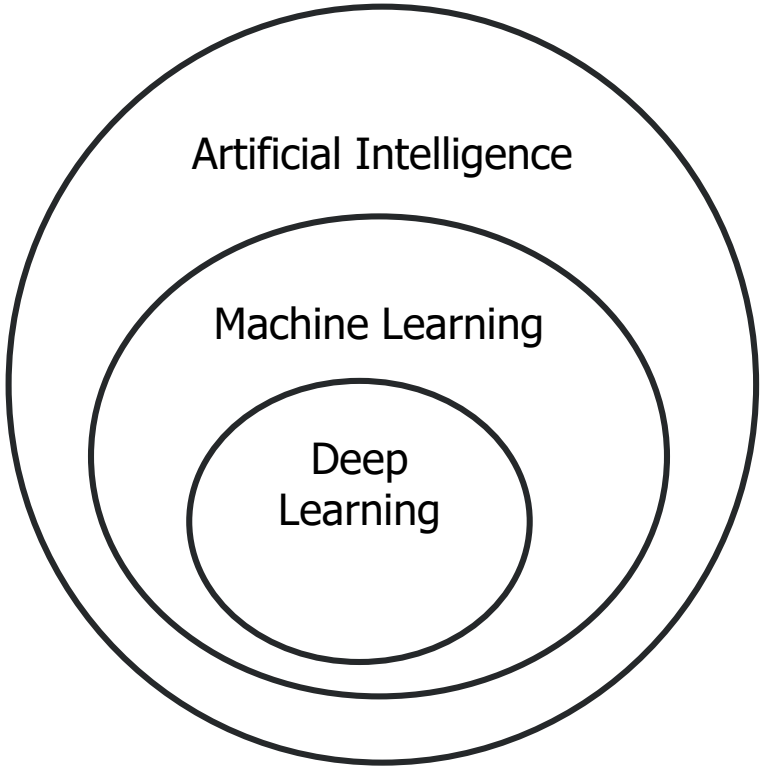
What is Artificial Intelligence?

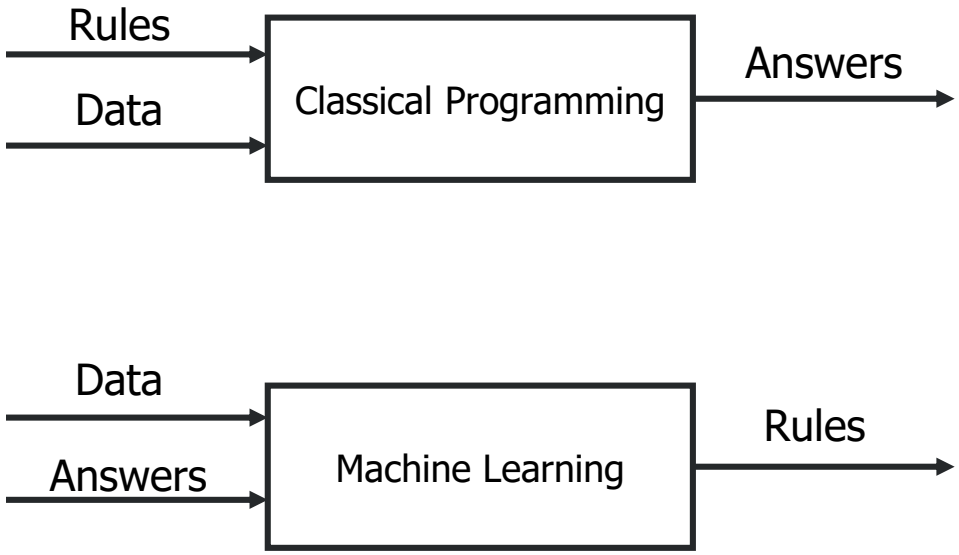
https://mnavasloro.github.io/escibles/FieldsInAI.html




Making
Regression
Bayesian Networks
Supervised Classification
Classification
Machine Learning
Deep Learning
Neural Networks
Unsupervised Classification
Clustering
Reinforcement Learning
Dimensionality Reduction
Evolutic

Understanding Machine Learning



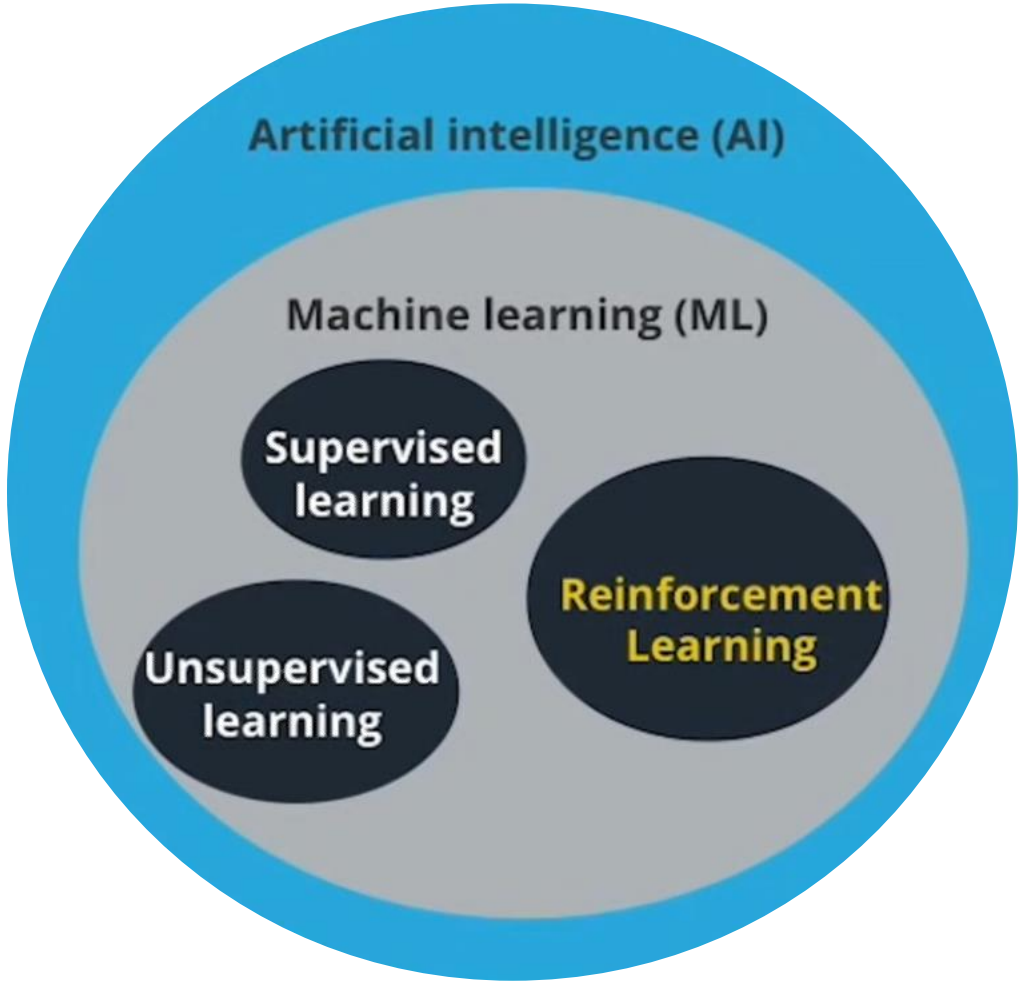


Deep Learning with Python. François Chollet. Manning

Machine Learning

- Self-learning algorithms that derive knowledge from data to create predictions

- Examples:
  - Spam filters
  - Chess playing programs
  - Self-driving cars
  - Medical prediction
  - Information extraction
  - Recommendation Systems



From AWS Machine Learning Foundations.
https://classroom.udacity.com/nanodegrees/nd065/dashboard/overview

Classical Machine Learning

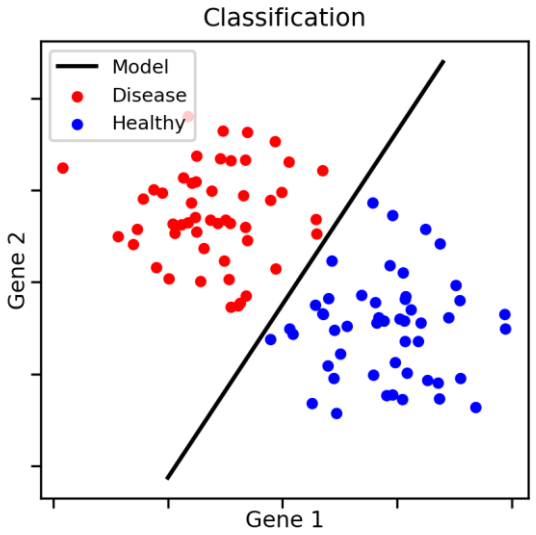
Supervised Learning

- Labeled data; we know if:
  - Someone is sick or not
  - An email is spam or not
  - Type of a document
- Prediction of result of new data based on previous data.
- Two types:

Classification

Discrete labels

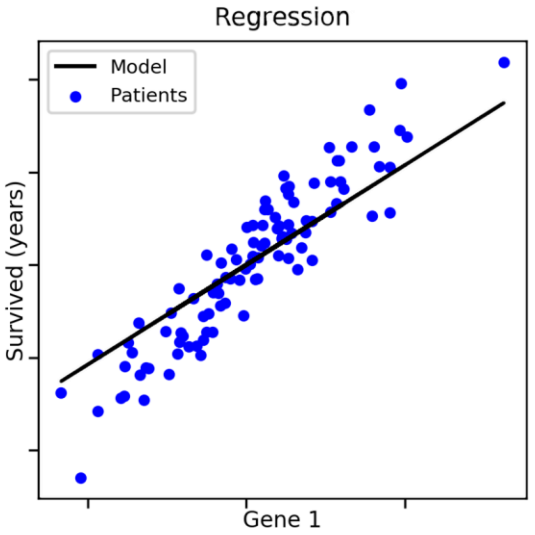
Examples (spam, emotion…)



Regression

Labels are a continuous value (We want to predict a numeric value)

Example: Price of a house based on some characteristics.

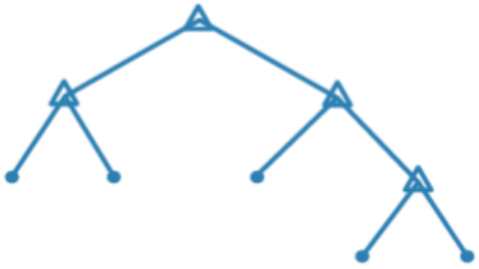


Classification

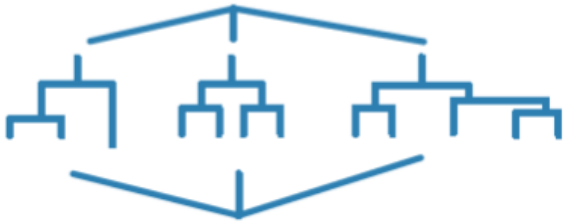
Naïve Bayes

Support Vector Machine (SVM)

Decision Tree



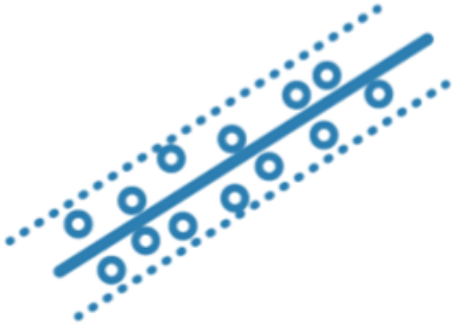
Bagged and Boosted Decision Trees



Regression

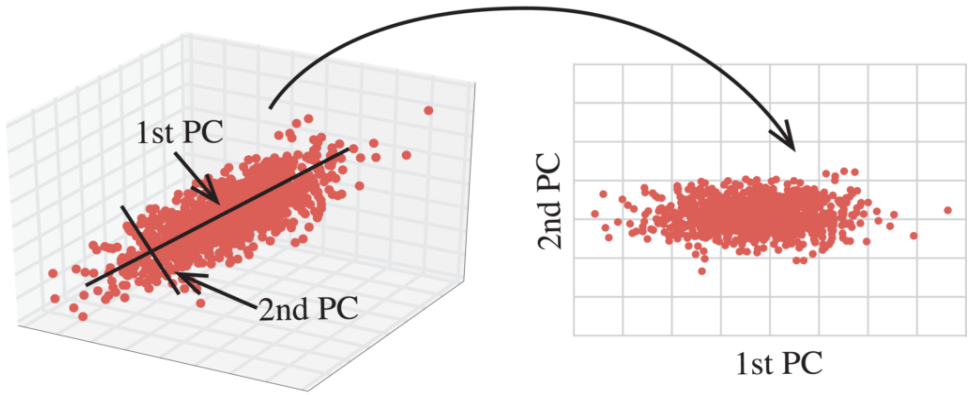
Regression Tree

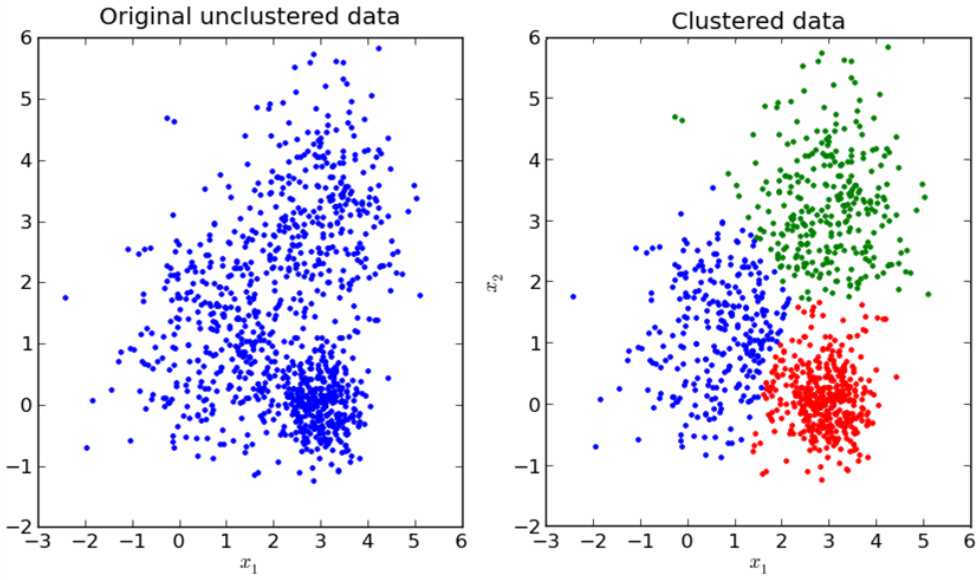
SVM Regression



Unsupervised Learning

- Unlabeled data, search of hidden structure in the data.
- Relevant information extraction without the help of a known result variable.
- Usage:
  - **Clustering**: search of patterns, similarity, groups (user recommendation).
  - **Dimensionality Reduction** for data sharing.





Unsupervised Learning

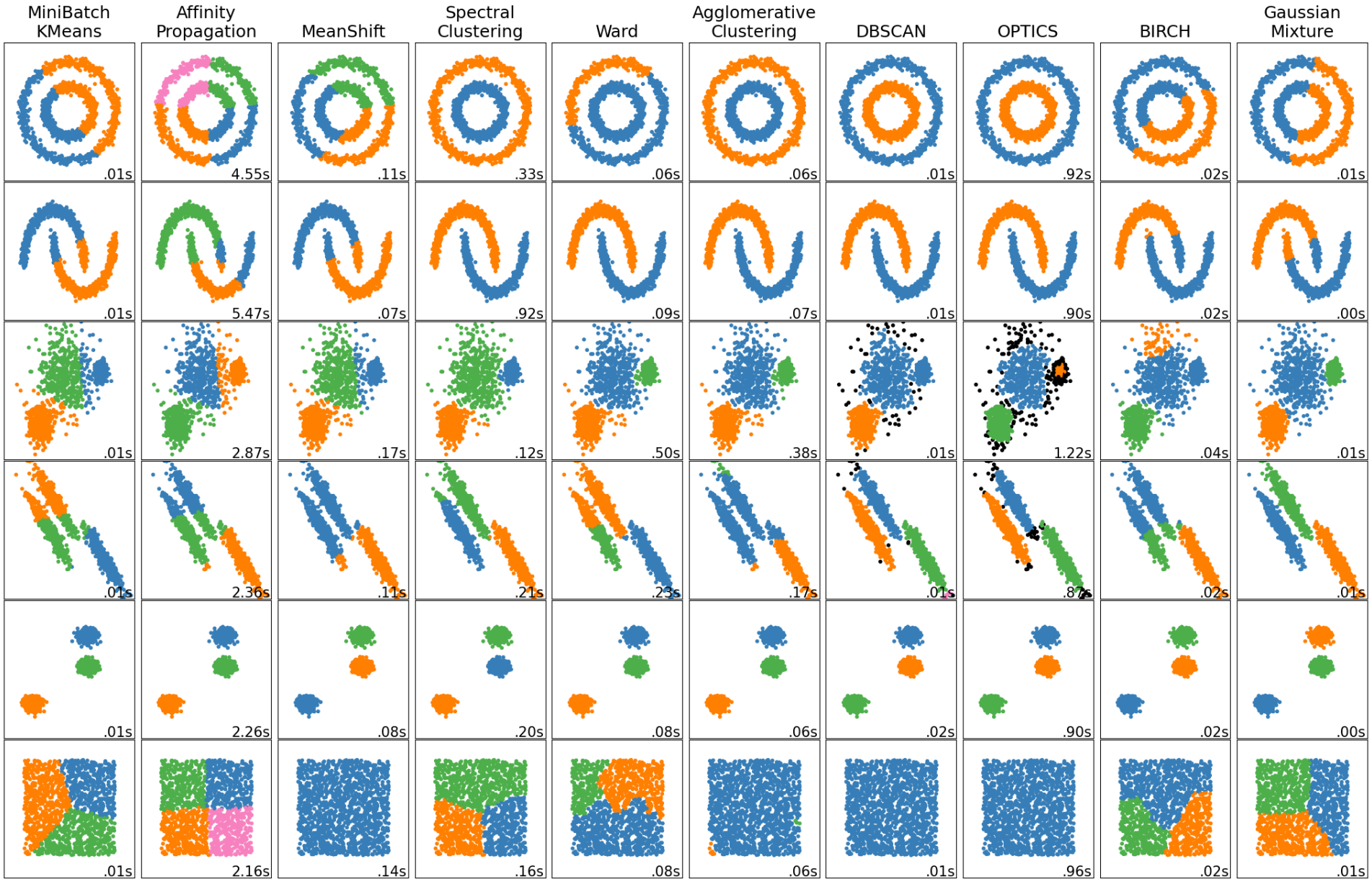
Some algorithms

Hierarchical Clustering

Fuzzy c-Means

Gaussian Mixture Model

k-Means

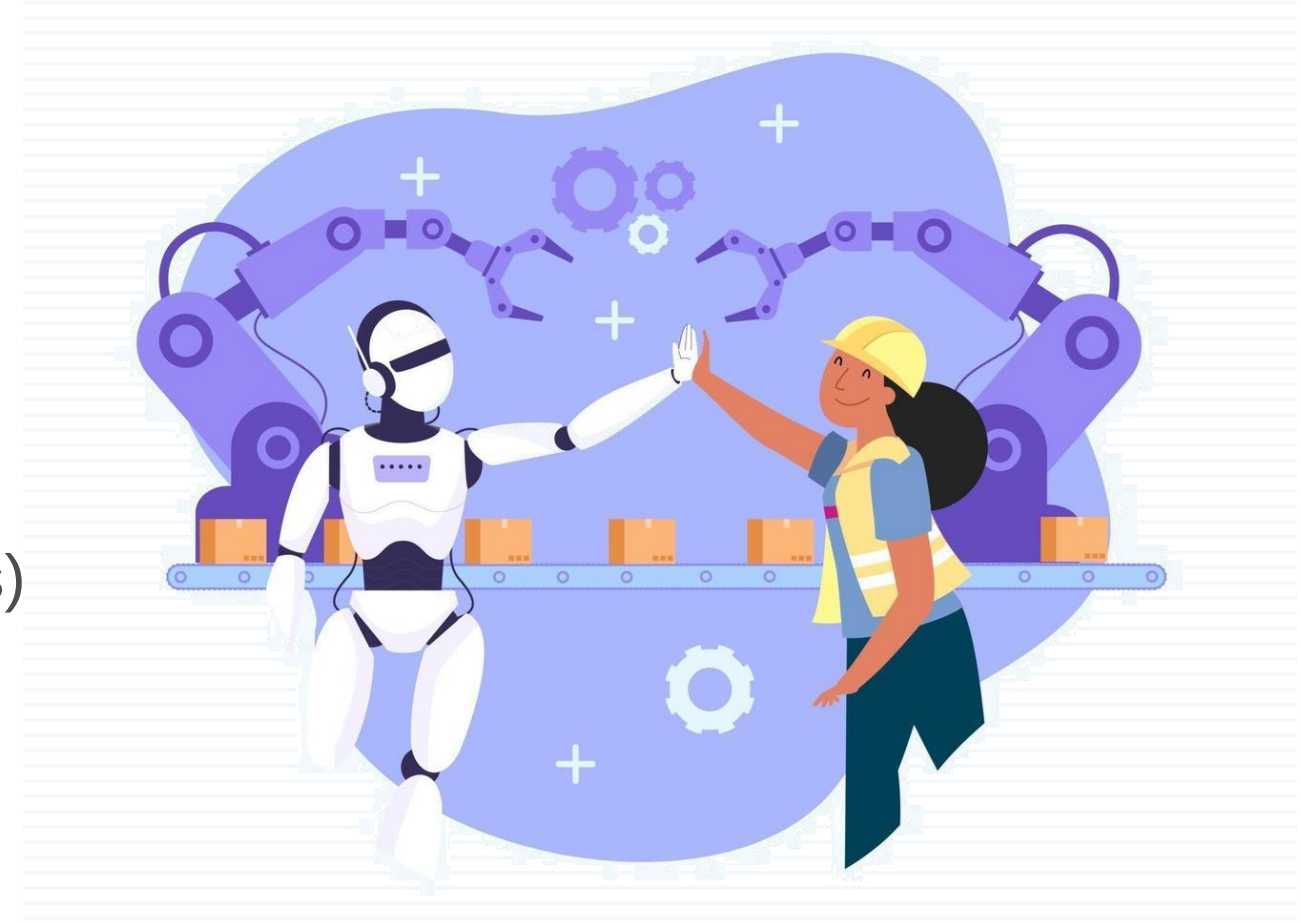


https://scikit-learn.org/stable/auto_examples/cluster/plot_cluster_comparison.html

Why is this interesting for industry?

Safe ground, has been used for many years.

- Document classification
- Sentiment Analysis (e.g. tweets)
- Predictive Maintenance in Manufacturing (e.g. plane engines)
- Quality Control: detect defects
- Fraud Detection in Banking
- …and much more!

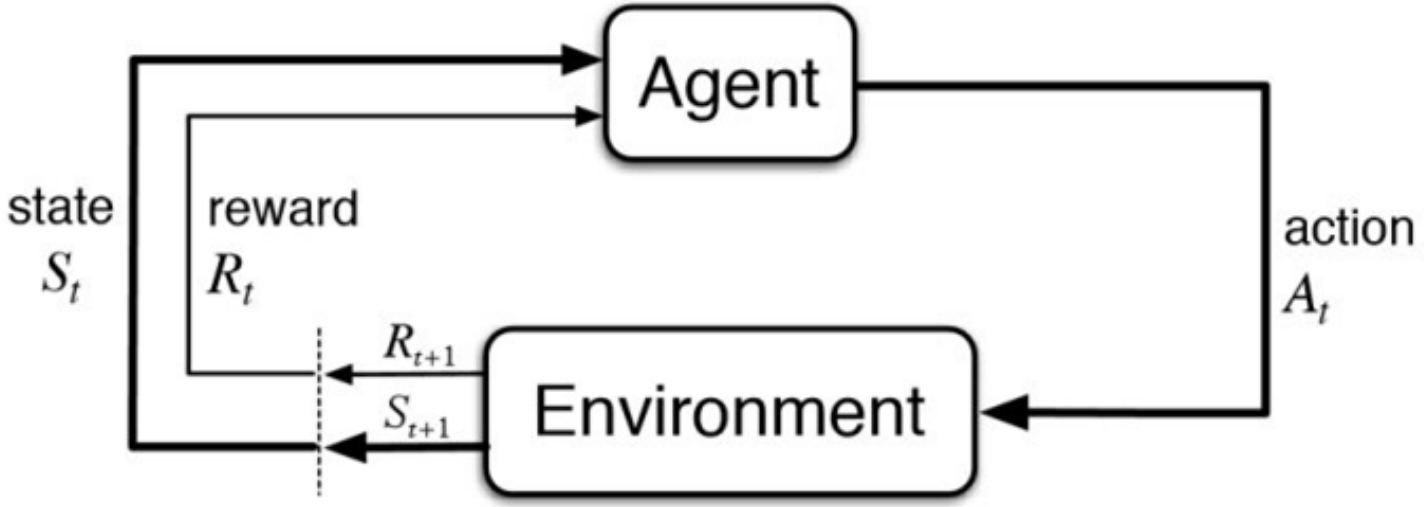


Reinforcement Learning

Reinforcement Learning (RL)

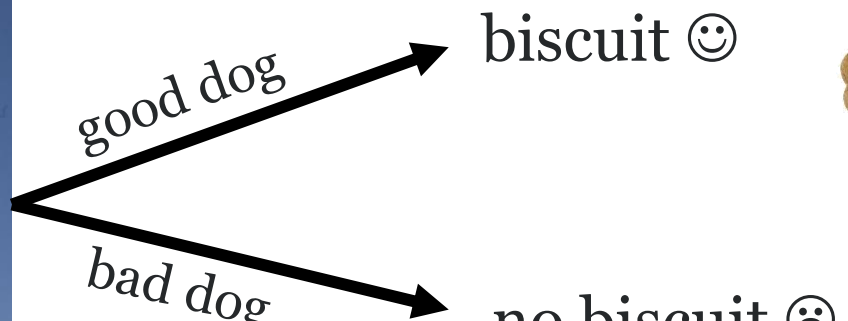
Reinforcement Learning is a type of learning where:

- An **agent**
- Is trained to get a **goal**
- Based on a **feedback**
- Got when interacting with an **environment**.



Reinforcement Learning (RL)

- Actions that favour the objective are positively **rewarded**.
- Those that don't, are negatively rewarded or not rewarded.



biscuit ☺

no biscuit ☹

Reinforcement Learning

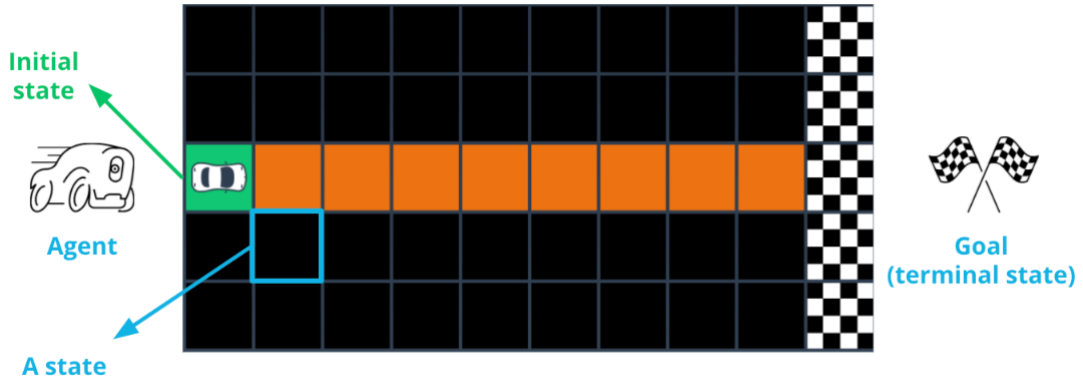
- Learning happens trough **episodes**.
- The agent passes from a state to another through **actions**.
- Reward is numeric.

Learn by experience

https://www.youtube.com/watch?v=VMp6pq6_QjI

Reinforcement Learning example (self-driving car)

- Environment: circuit
- State: what captured by cam/sensors/radar. Terminal states are the end line or going out of the road.
- Actions: accelerate, turn, etc.
- Episode: each attempt from start to a terminal state.



Imagine the **reward function** as a grid mapped over the track with each square representing a **state**.

These **rewards** incentivize center-line driving.

From AWS Machine Learning Foundations.
https://classroom.udacity.com/nanodegrees/nd065/dashboard/overview

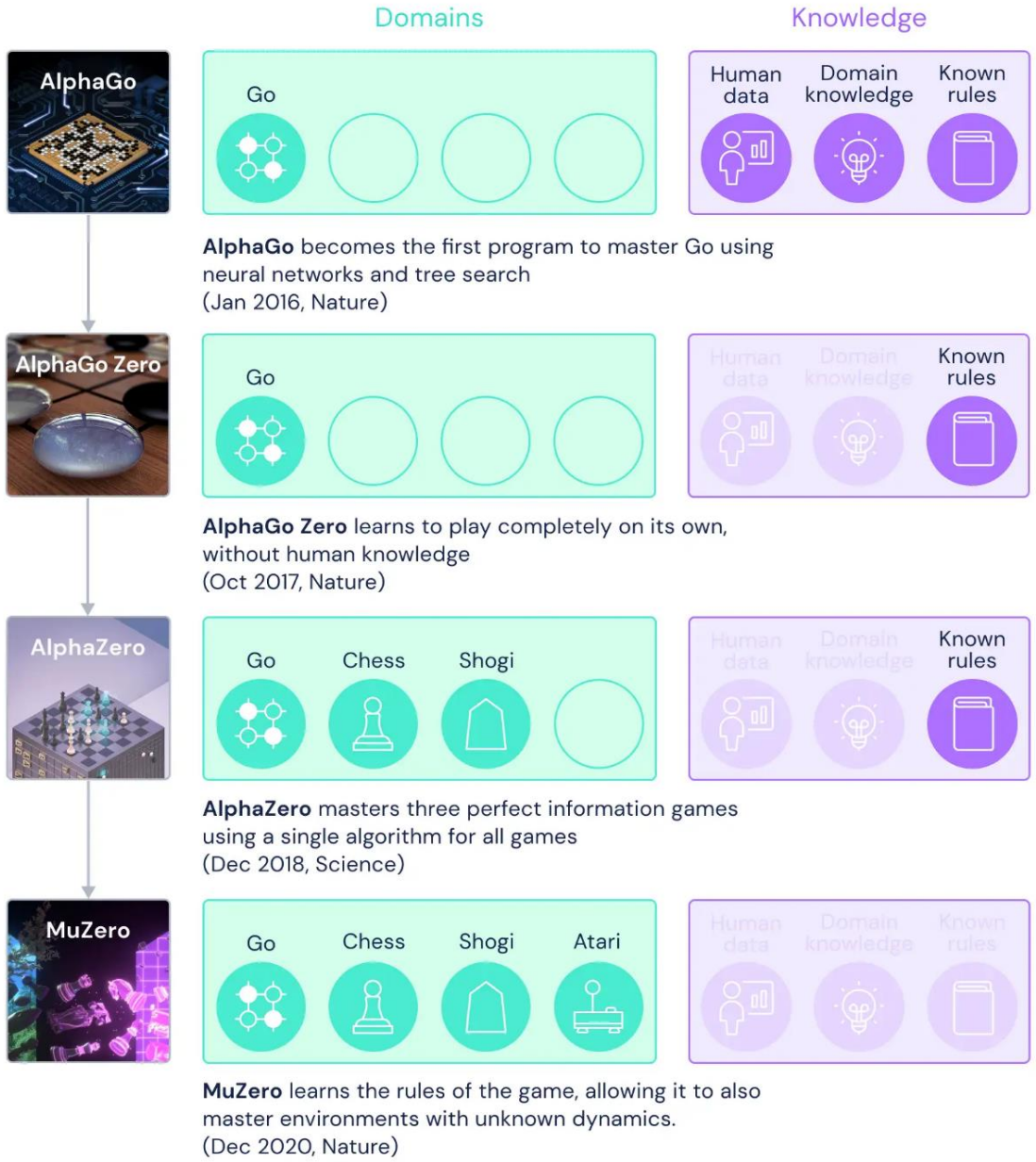
Reinforcement Learning

Aplications:

- Games: Go (AlphaGo Zero), Atari, StarCraft…
- Optimizaton of wind eolic stations.
- Robotics, fraud detection, self-driven cars…

Problems:

- Define rewards: as a human? (Example: AlphaGo)
- Exploration vs Exploitation.
- Real world presents new problems



https://deepmind.com/blog/article/muzero-mastering-go-chess-shogi-and-atari-without-rules

Why is this interesting for industry?

Have you heard about Digital Twins?

- Virtual replicas of physical objects or systems, created using data collected from sensors and other sources.
- Digital representation of the physical world, used to simulate, monitor, and analyze the behavior and performance of real-world objects and systems.

https://www.nvidia.com/en-us/omniverse/solutions/digital-twins/

Why is this interesting for industry?

Aplications: learn in a virtual environment

https://twitter.com/DeepMind/status/1651897358894919680

"Our agents were trained in simulation and transferred to real robots zero-shot"

"The soccer teacher was trained for 158 hours, equivalent to approximately 580 days of simulated matches."

To know more:

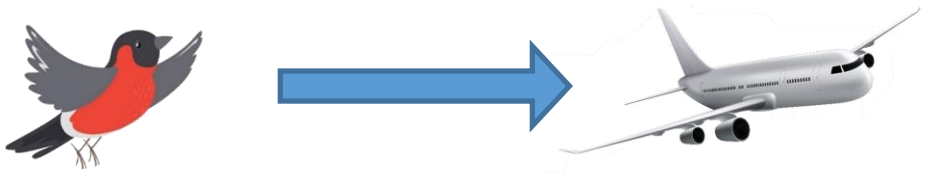
- Official: https://sites.google.com/view/op3-soccer
- Dissemination: https://youtu.be/efw8xuex4uI

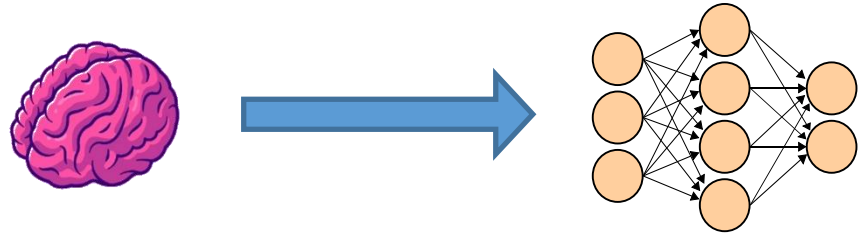
https://www.youtube.com/watch?v=tZjQwZNw2po

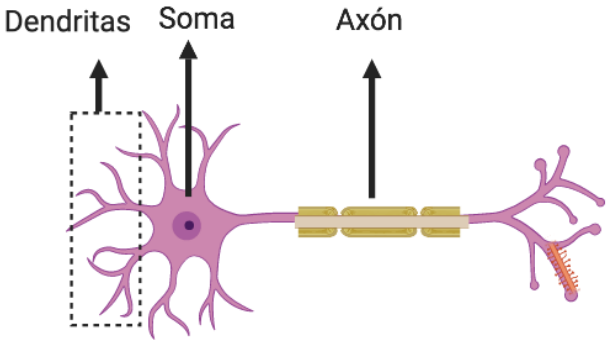
Neural Networks and Deep Learning

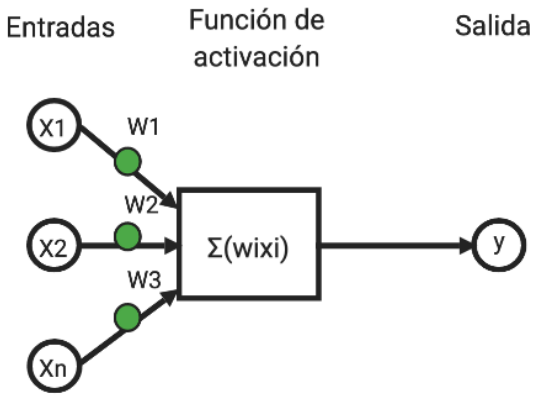
Neural Networks and Deep Learning

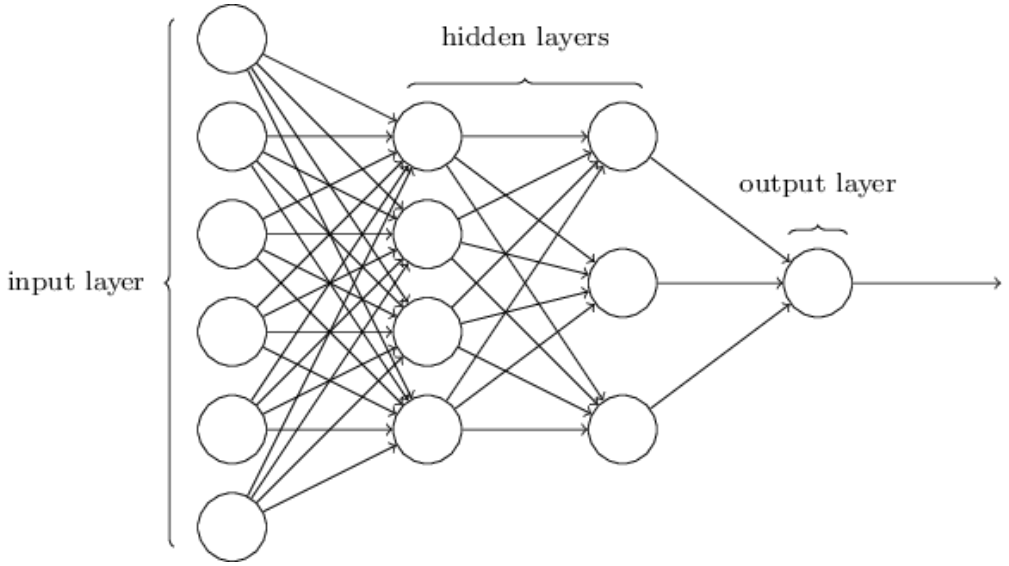
What if we could write a program that imitates the structure of the brain?



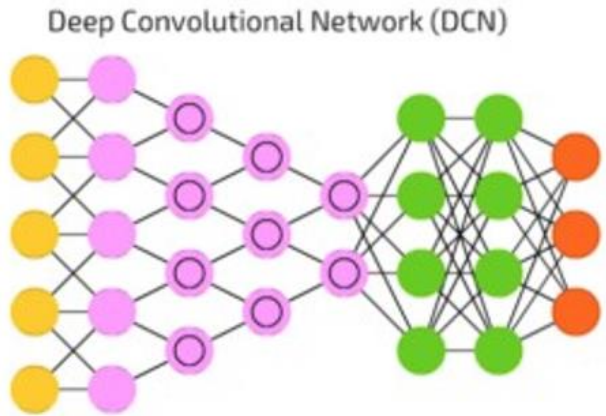


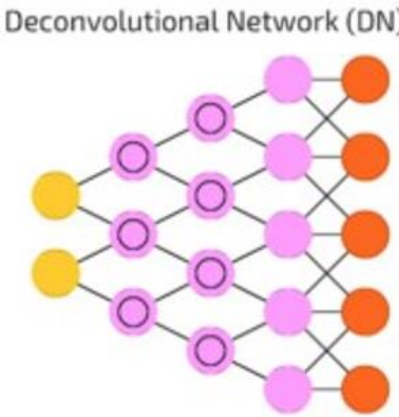


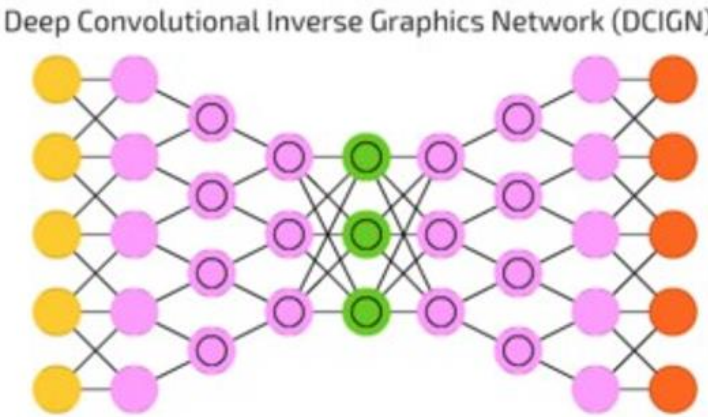


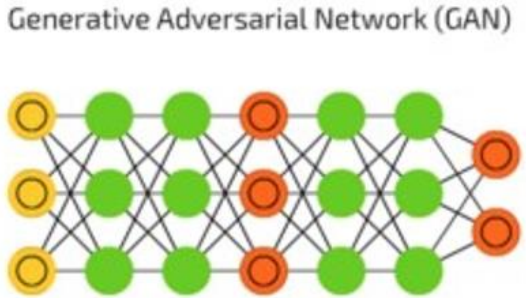


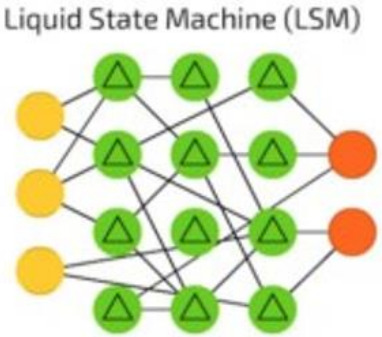
Images from https://www.freepik.com/vectors/ and https://commons.wikimedia.org/wiki/File:Artificial_neural_network.svg

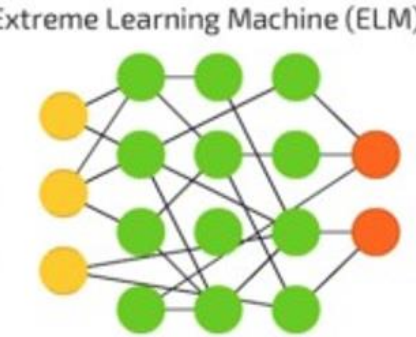


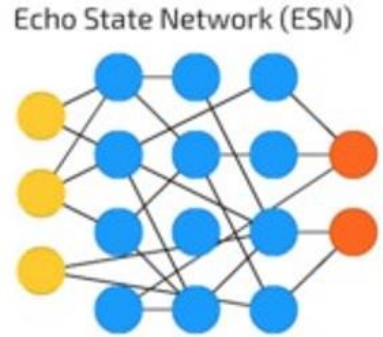


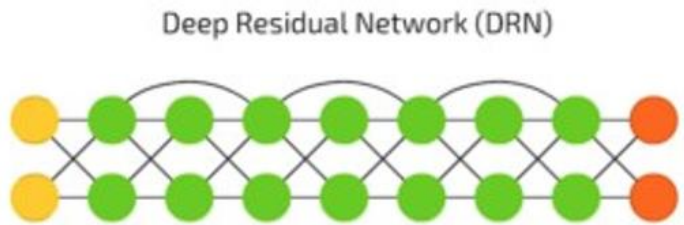


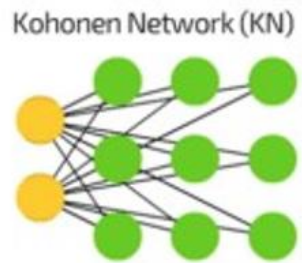


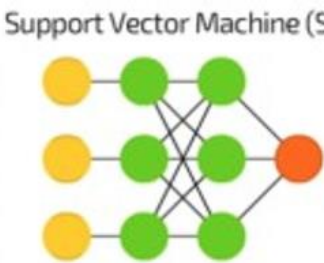


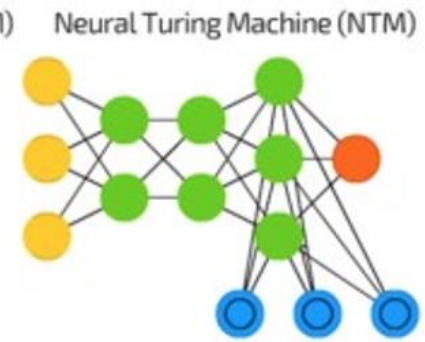










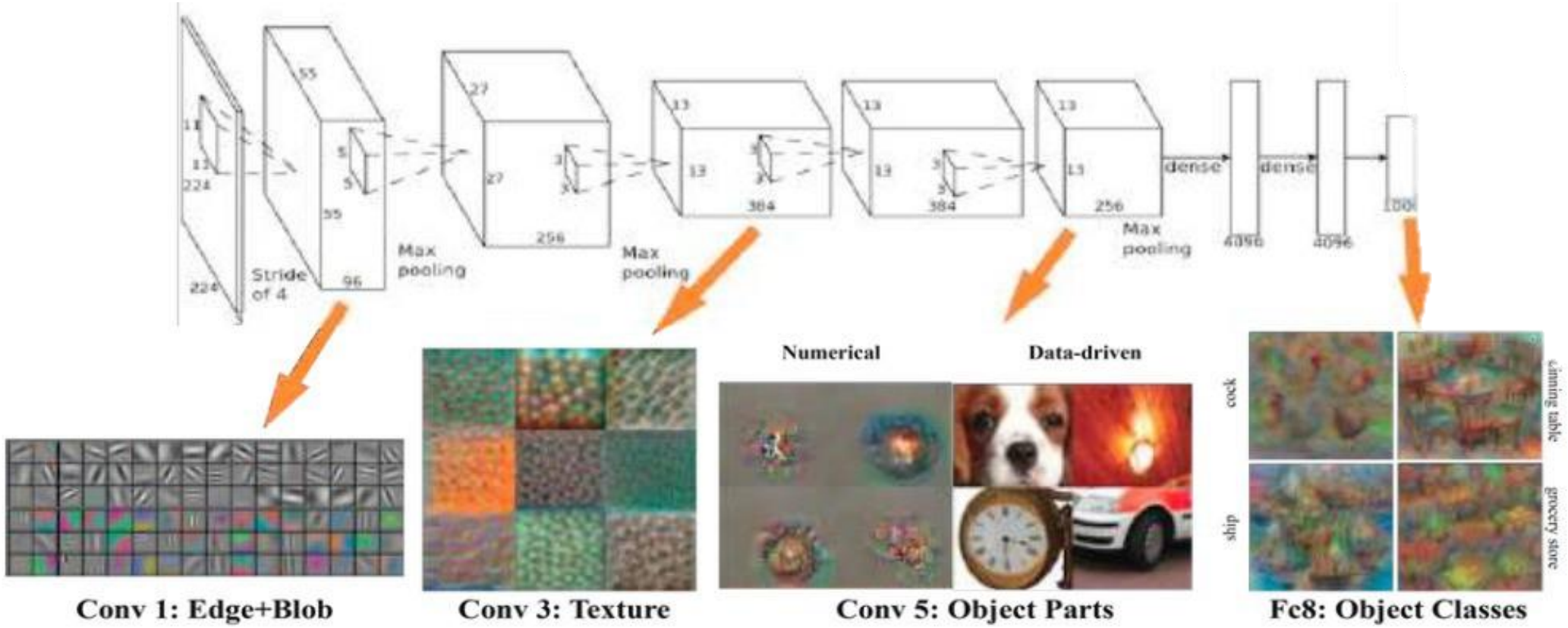


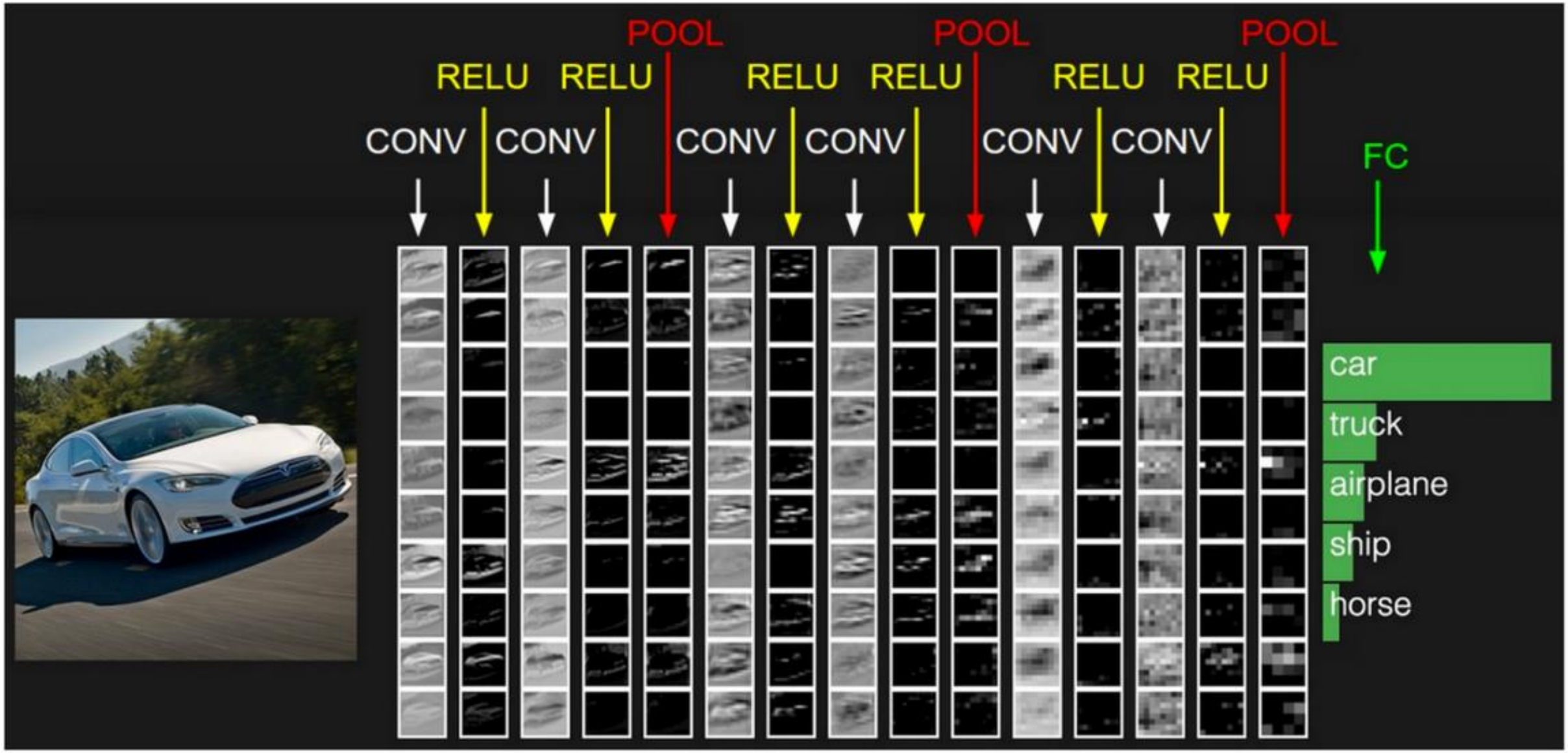
asimovinstitute.org/neural-network-zoo

Computer Vision

Convolutional Networks (CNN)

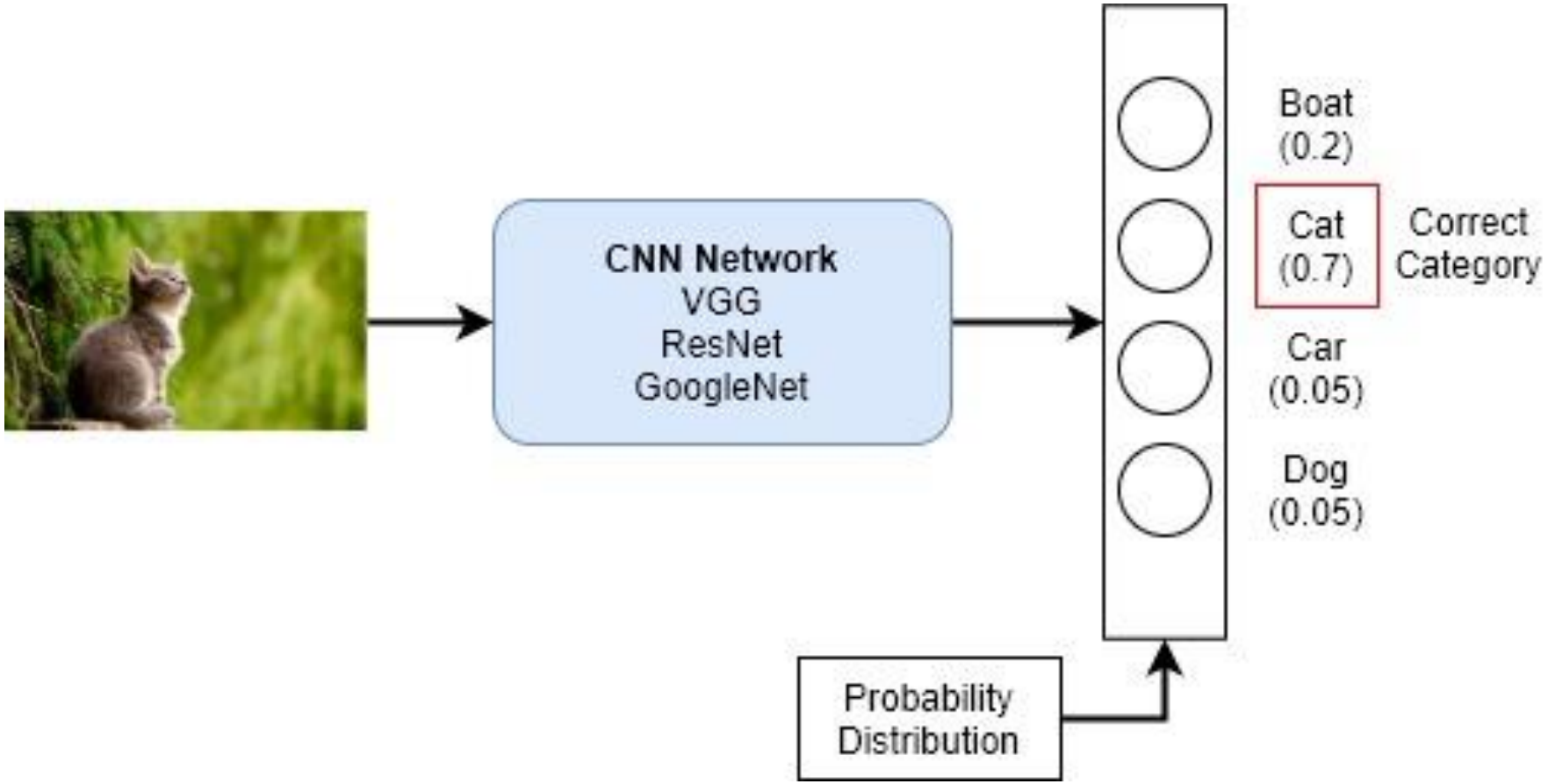
Used for Computer Vision, we can see how the image is being "cut up".





https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

Image Classification



Object Detection

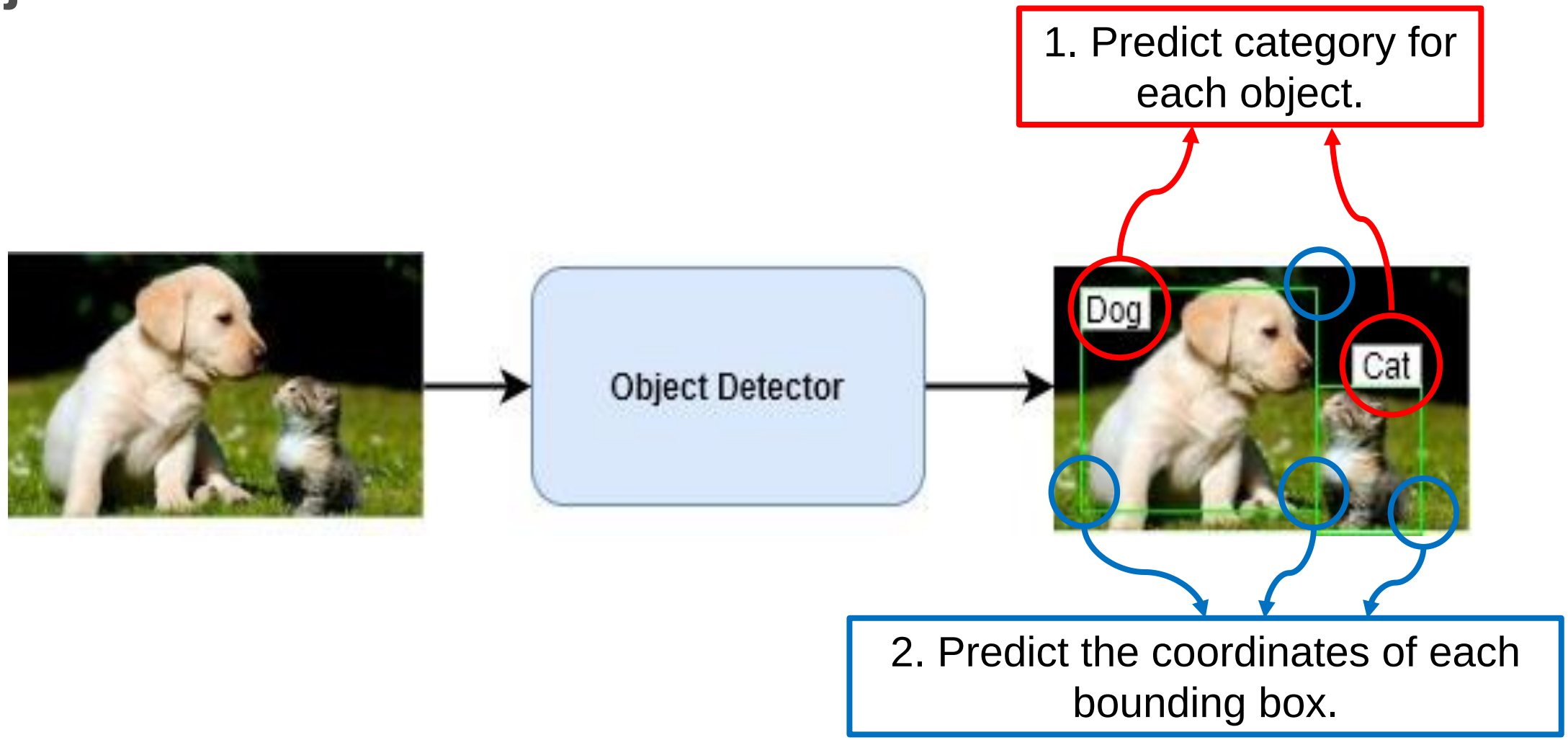
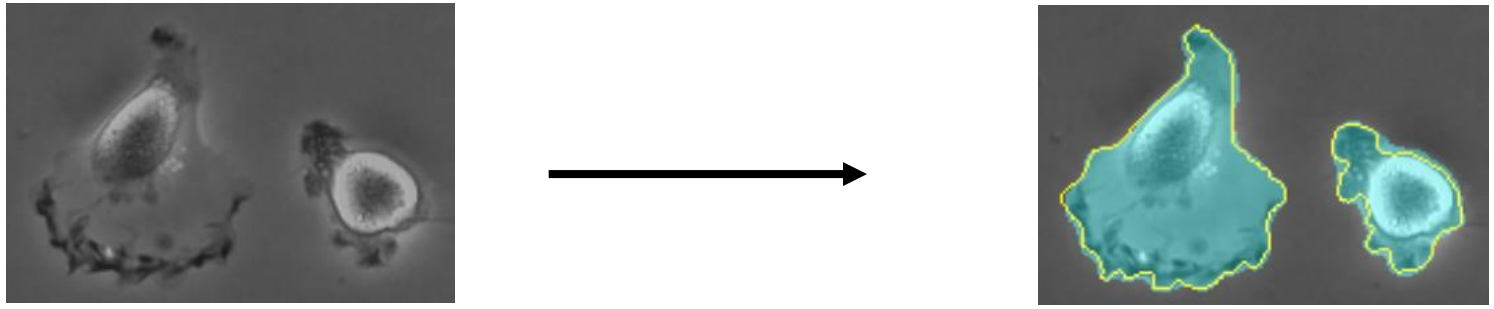


Image Segmentation



Why is this interesting for industry?

Aplications: real time object identification/linking

Medicine, security, marketing (click on part of video, see the clothes someone is wearing)…

https://segment-anything.com/ Meta AI

https://segment-anything.com/ Meta AI

Natural Language Processing

Transformer-based models

- Seq2Seq: Text in, text returned
- They use a mechanism called “attention”

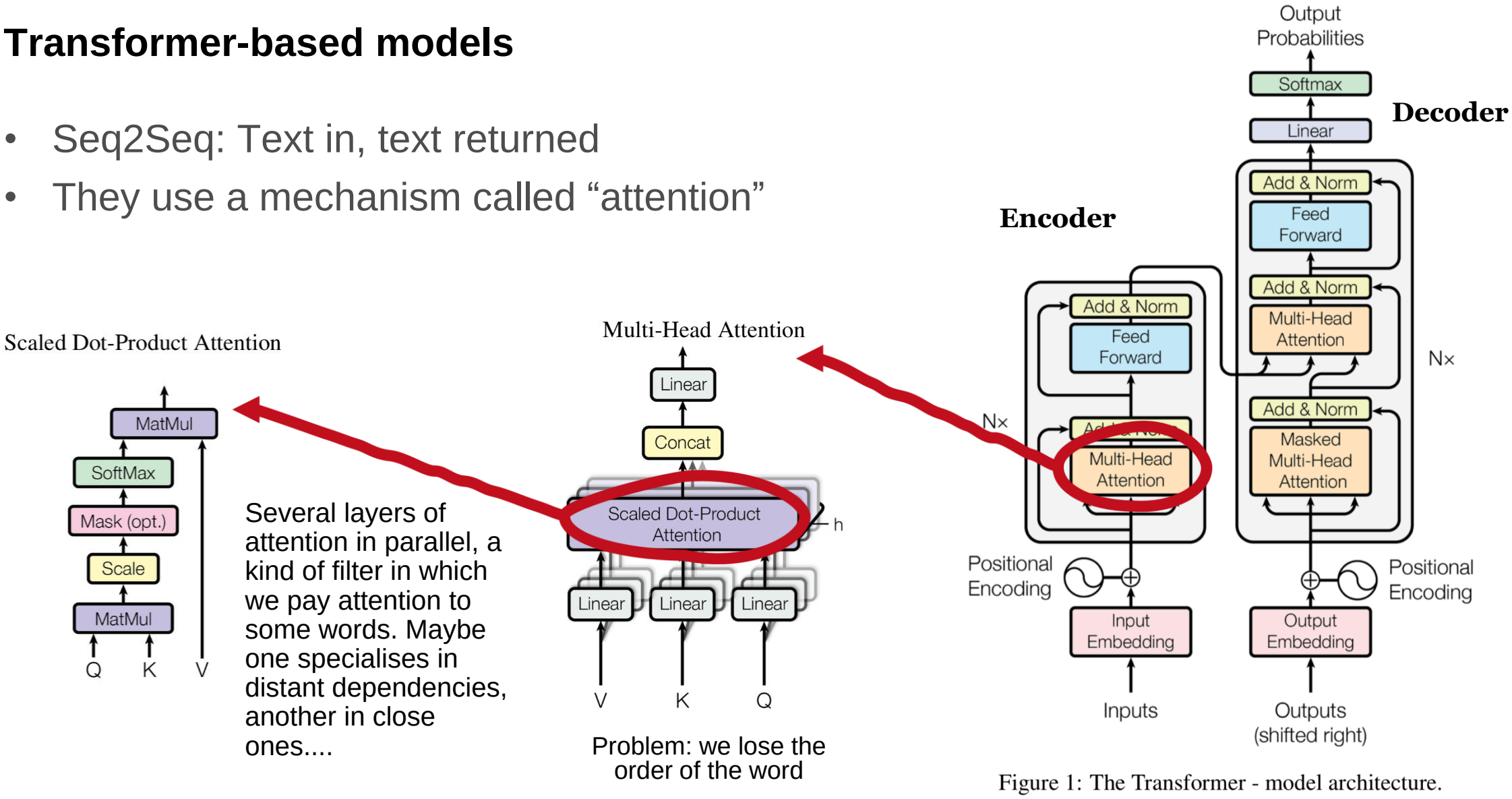
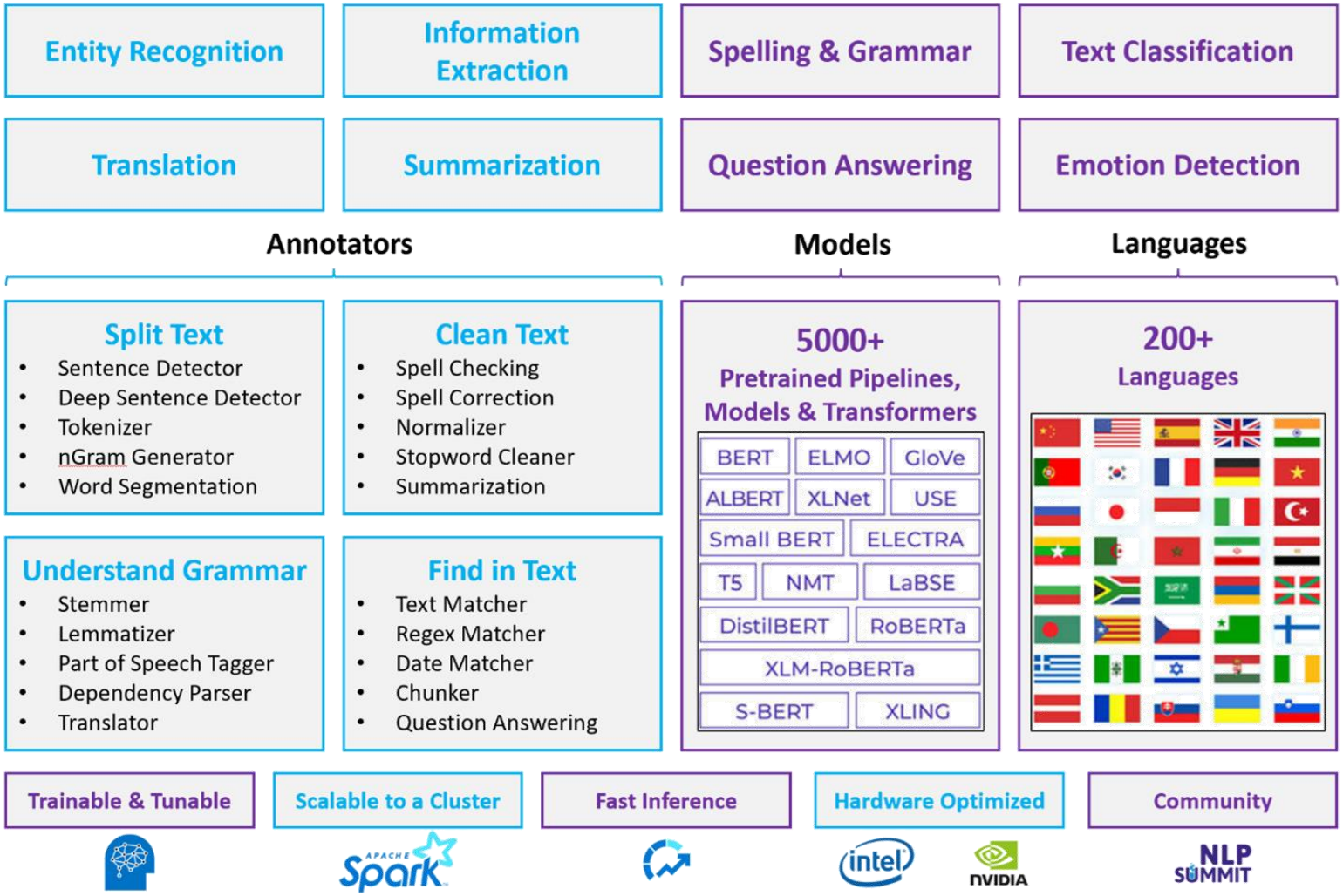


Figure 1: The Transformer - model architecture.

A lot of applications!

- Machine Translation
- Speech Recognition
- Question and Answer Systems
- Sentiment/Emotion Analysis
- Chatbots
- Summarizers
- Paraphrase/Clear Text
- Language Identification
- Text classification
- Social network profiling
- Fake news/spam detection

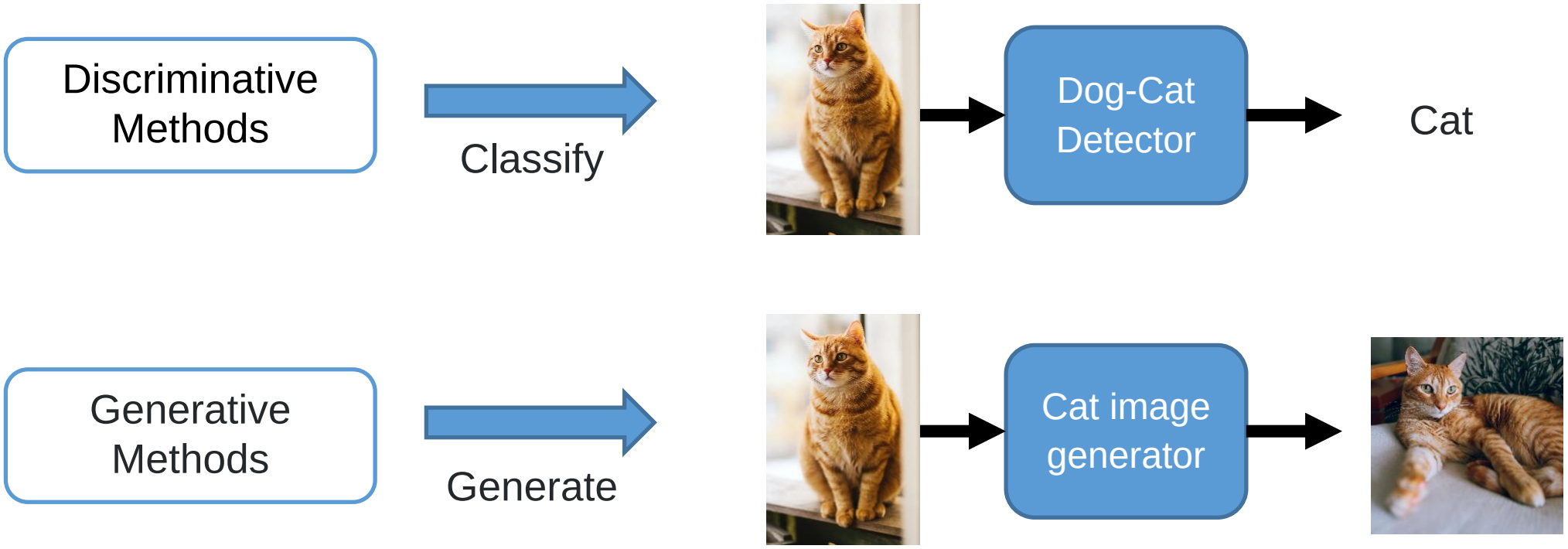
NLP services offered byAzure (Microsoft)



Generative Artificial Intelligence

Generative AI

New data is created from training data



Text Generation

ChatGPT, Bing, Lambda, Claude…

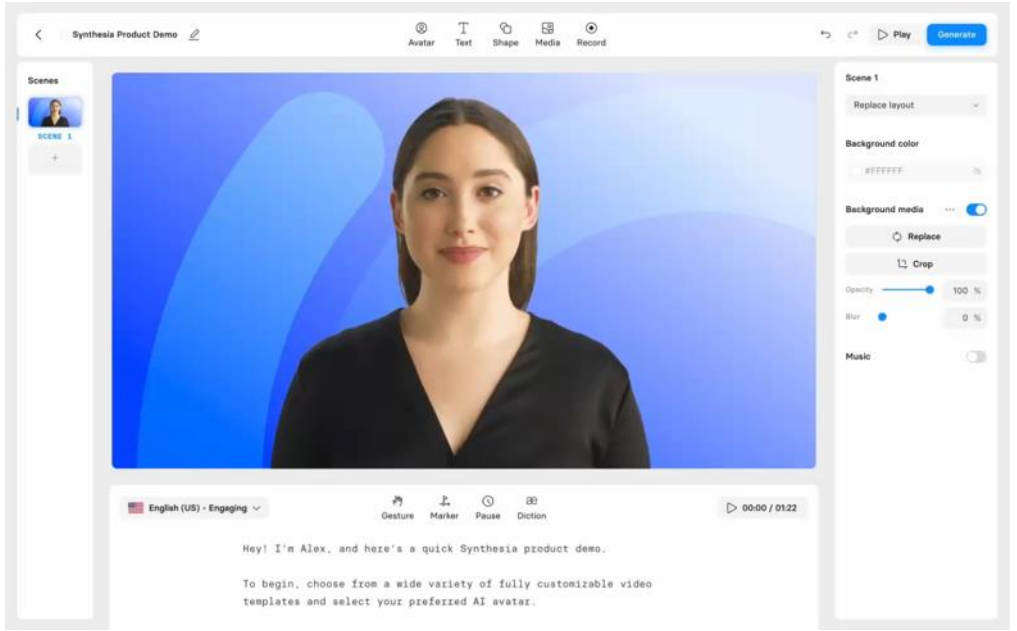
Image Generation

DALL-E 2, Stable Diffusion, Midjourney…

Video/Audio/Music Generation

Synthesia, DeepBrain, JukeBox, VALL-E…

Slide building, email drafter… any application you can dream of!



Conclusion

- Classical Machine Learning
  - Supervised Learning: we have correct labels to train with, you need to **classify**
  - Unsupervised Learning: we have no correct labels, but hidden patterns
- Reinforcement Learning
  - We have specific environment, actions and a goal
- Deep Learning
  - Many different architectures and models available
  - In many fields: Computer Vision, Natural Language Processing… **classify, RL, generative**…
- Approach depending on (1) problem and (2) resources available
- They can be combined: e.g., ChatGPT is DL+ Human Based RL
- AI will accelerate your work, so get familiar to it, incorporate it to your workflow

Thank you for your attention!

Questions, comments…

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