

A Beginner's Guide to Machine Learning and Deep Learning

María Navas-Loro
Ontology Engineering Group
Universidad Politécnica de Madrid, Spain

✉ mnavas@fi.upm.es

🌐 <https://marianavas.linkedata.es>

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📍 Online

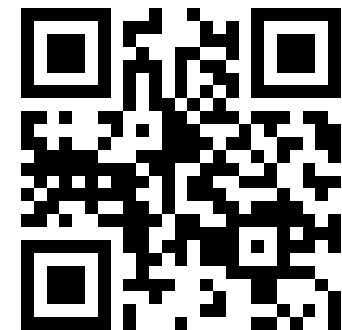


María NAVAS LORO

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>



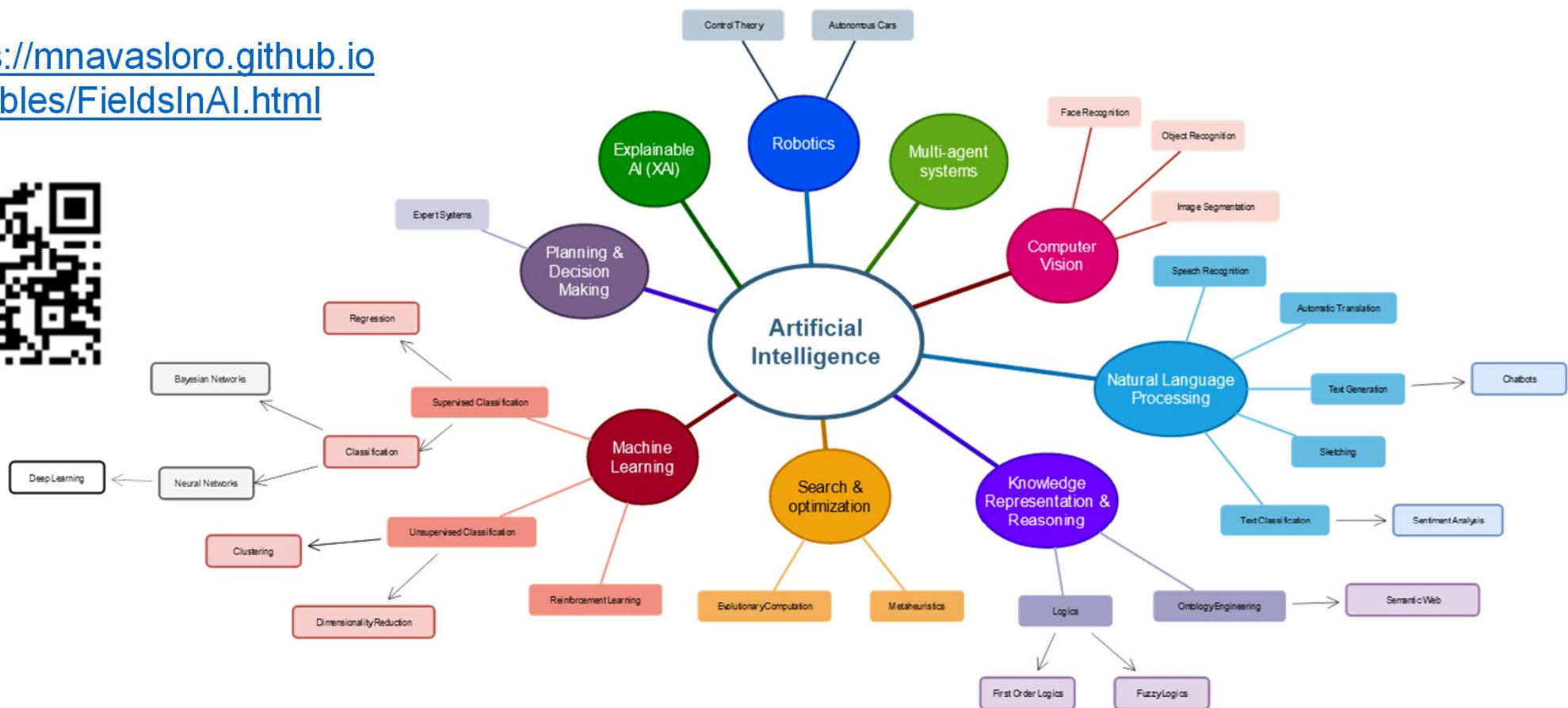
Experience

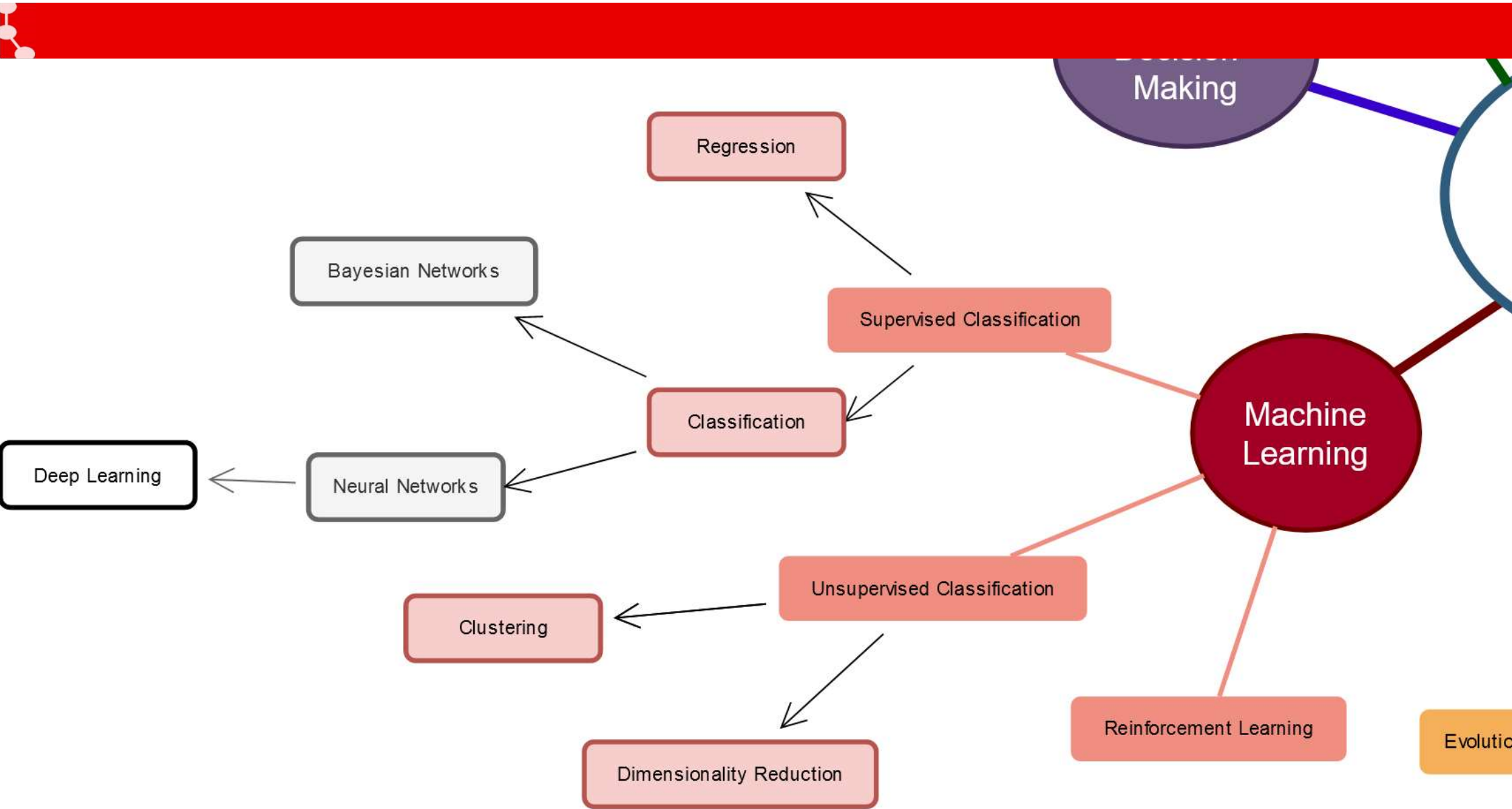
Natural Language Processing, Knowledge Representation, Machine Learning

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

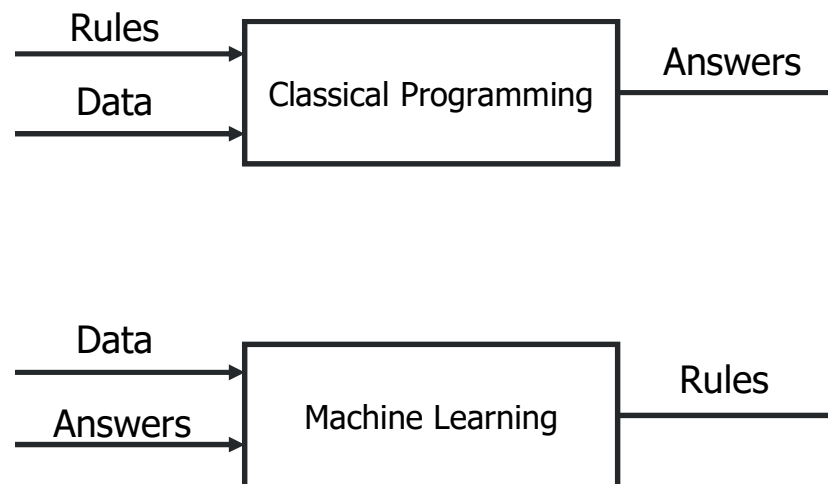
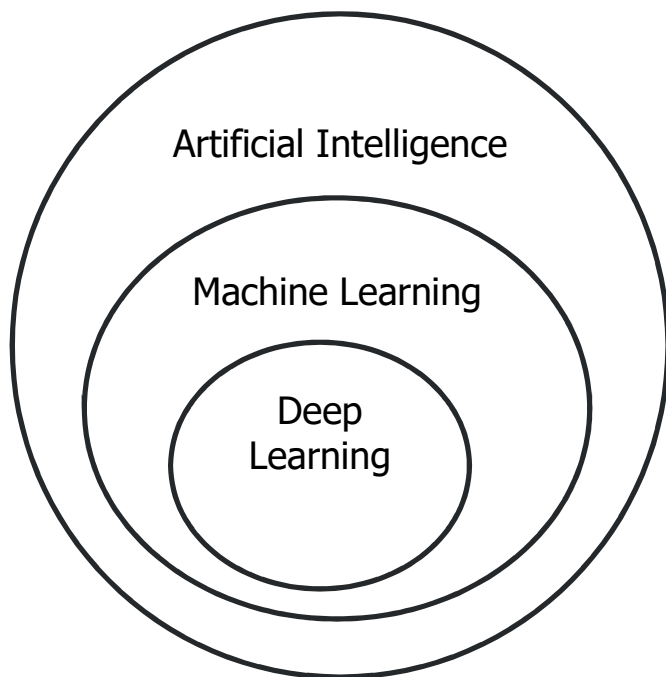
What is Artificial Intelligence?

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





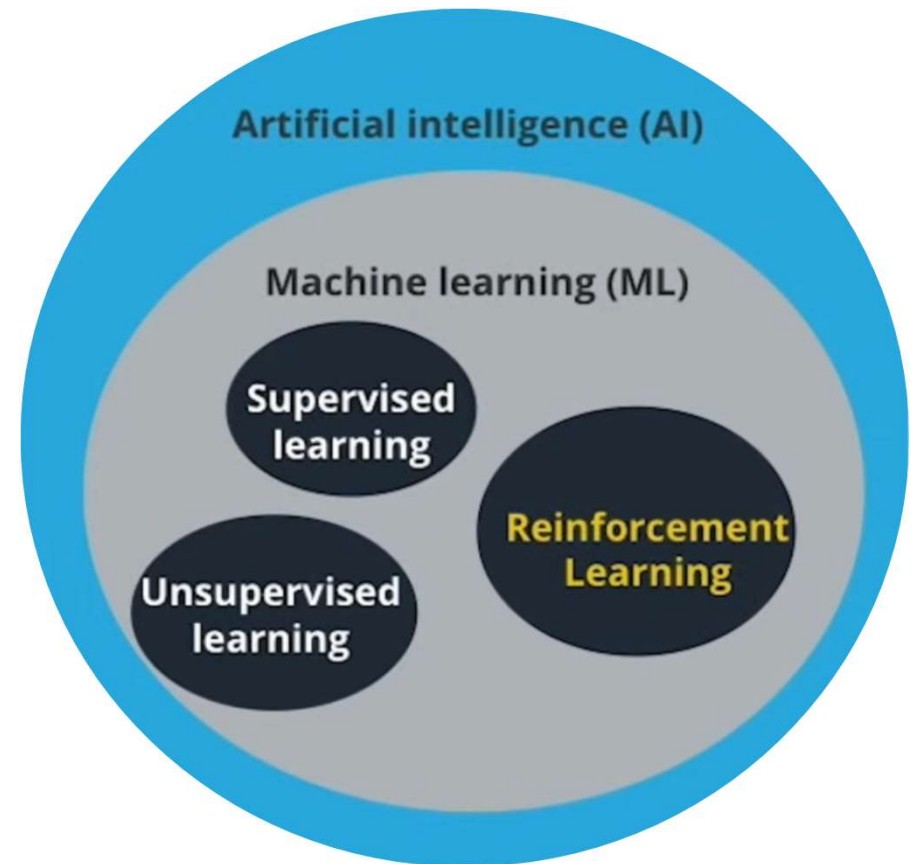
Understanding Machine Learning



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

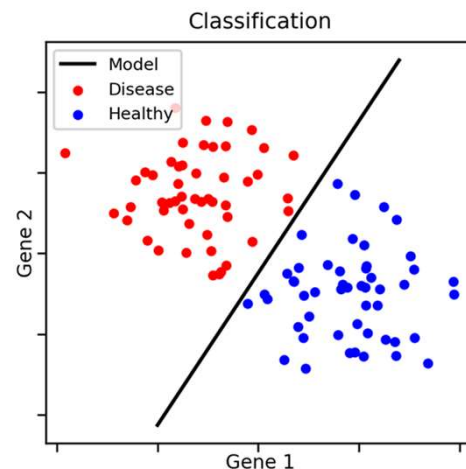
Supervised Learning

- 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

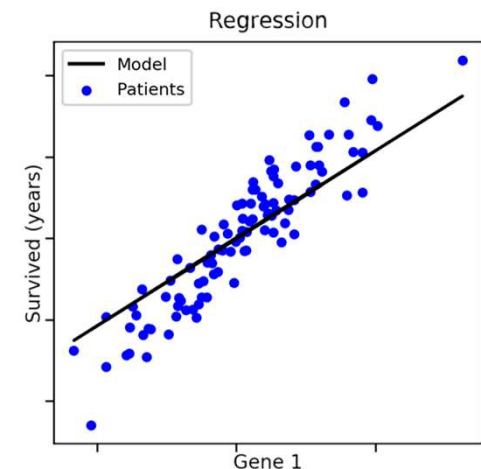
Discrete labels

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

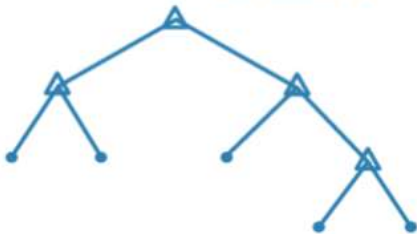
Naïve Bayes



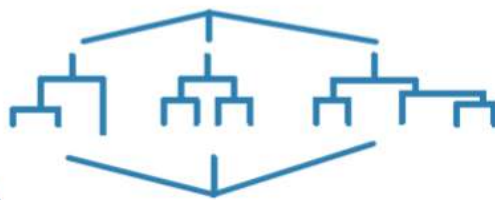
Support Vector Machine (SVM)



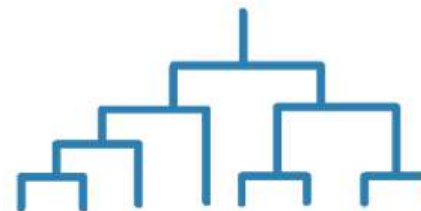
Decision Tree



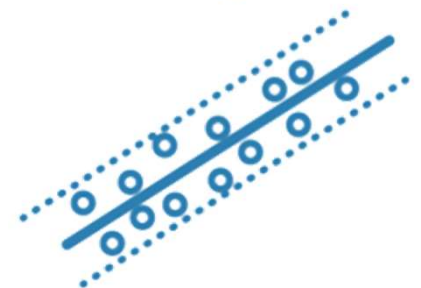
Bagged and Boosted Decision Trees



Regression Tree



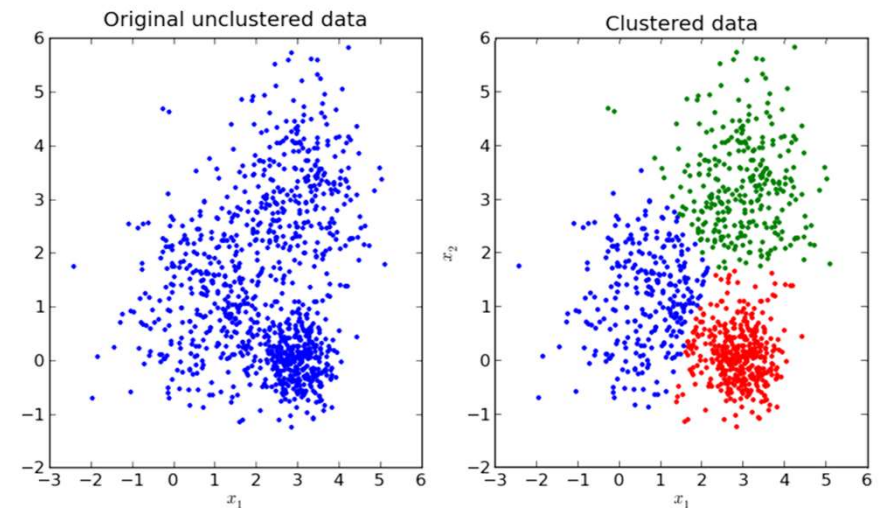
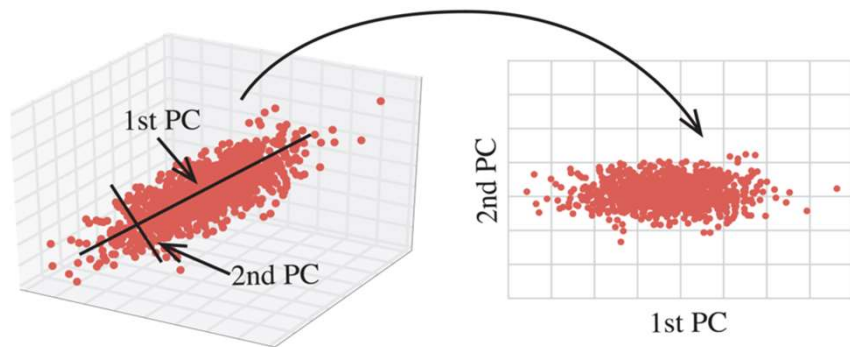
SVM Regression



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.



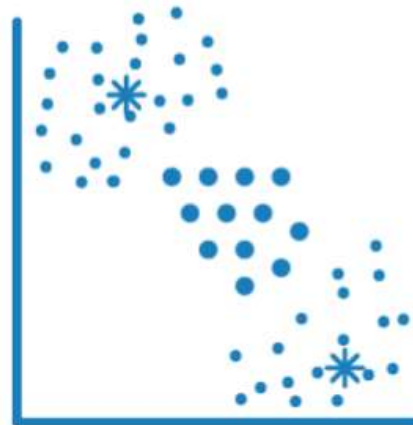
Unsupervised Learning

Some algorithms

Hierarchical Clustering



Fuzzy c-Means

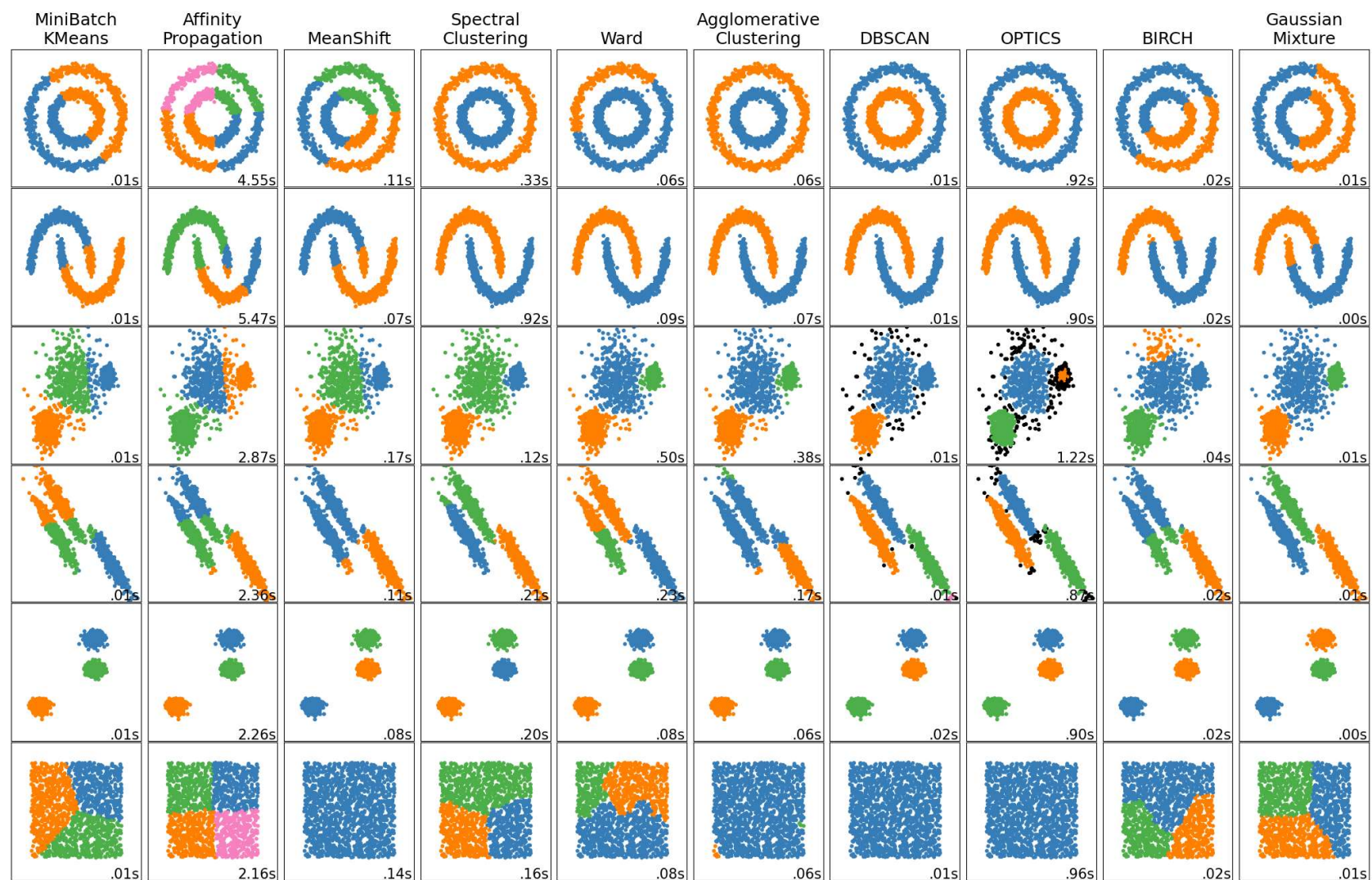


Gaussian Mixture Model



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!



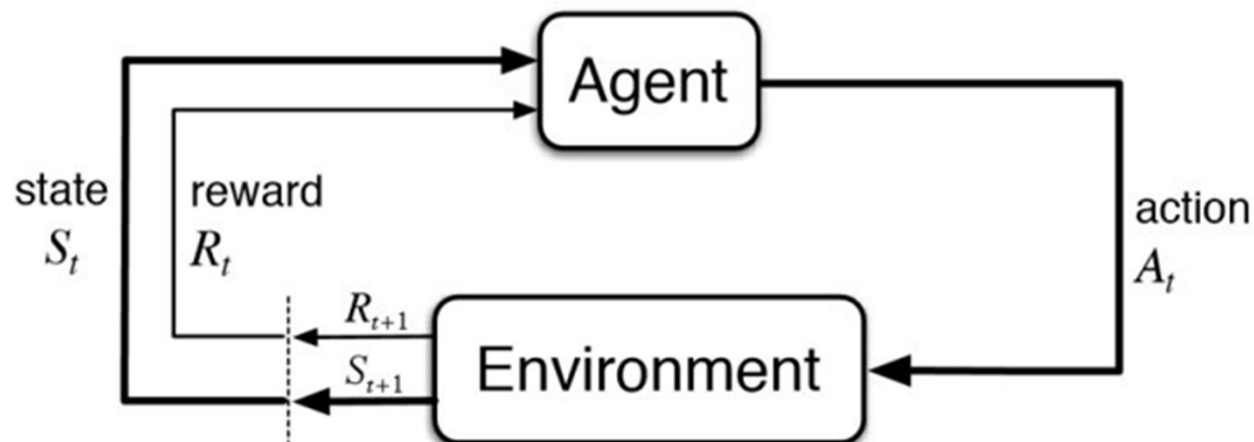
Reinforcement Learning



Reinforcement Learning (RL)

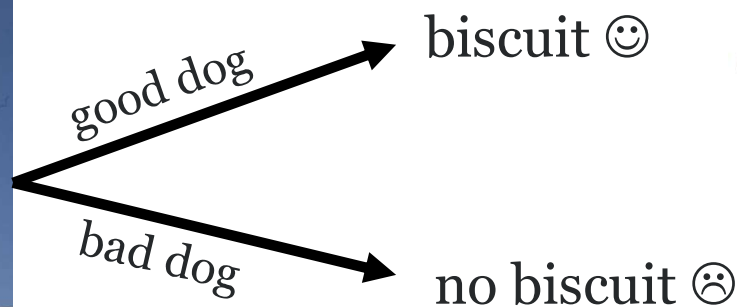
Reinforcement Learning is a type of learning where:

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



Reinforcement Learning (RL)

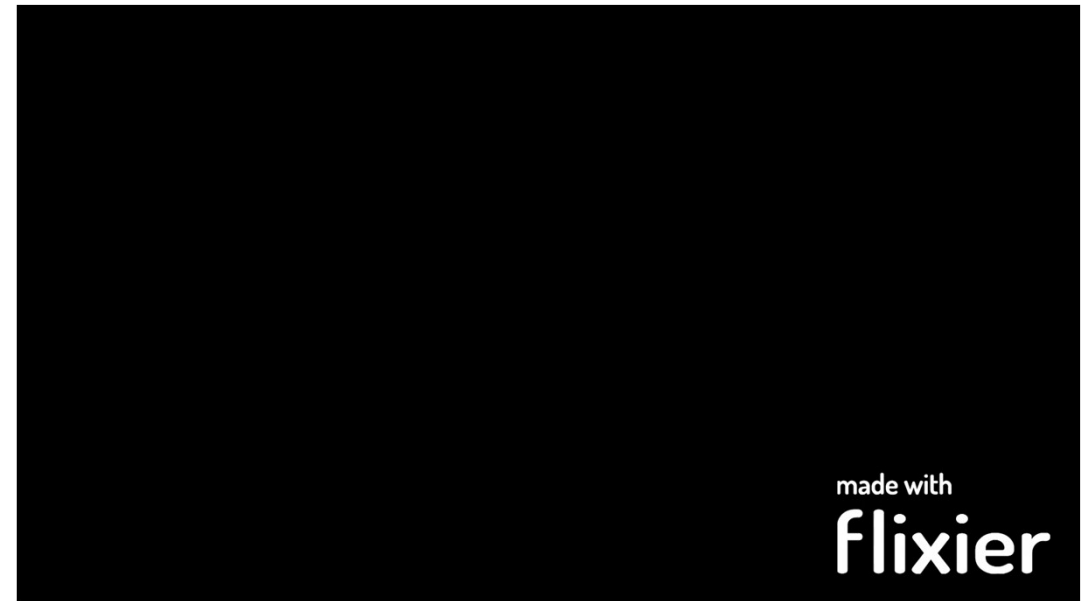
- Actions that favour the objective are positively **rewarded**.
- Those that don't, are negatively rewarded or not rewarded.



Reinforcement Learning

- Learning happens through **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

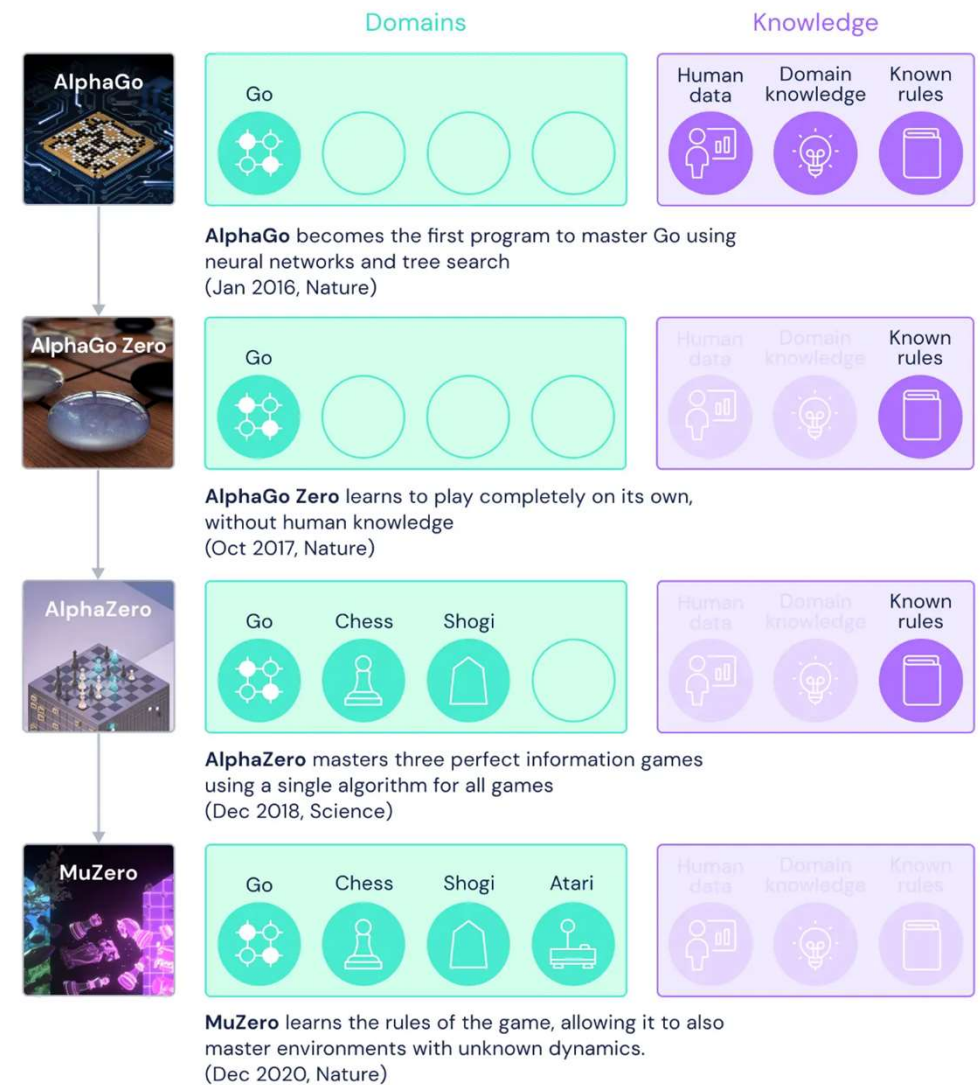
Reinforcement Learning

Applications:

- 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?

Applications: learn in a virtual environment

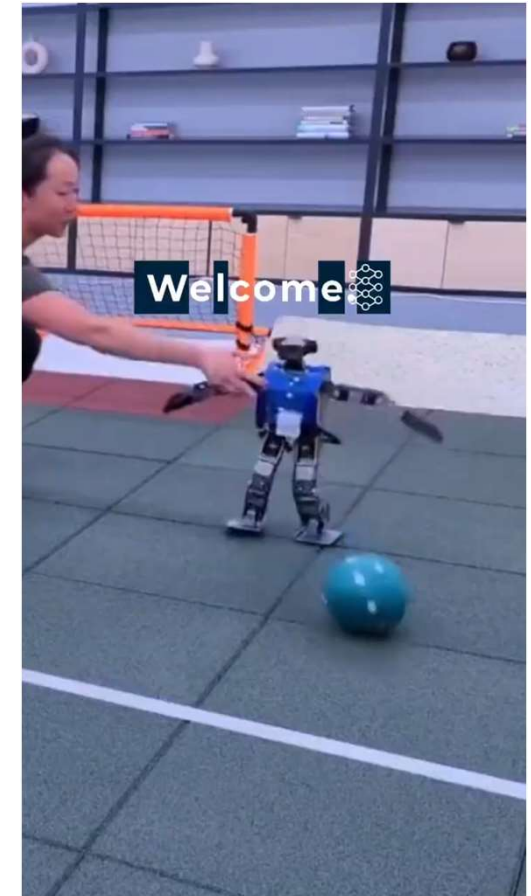
<https://twitter.com/DeepMind/status/1651897358894919680>

“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>

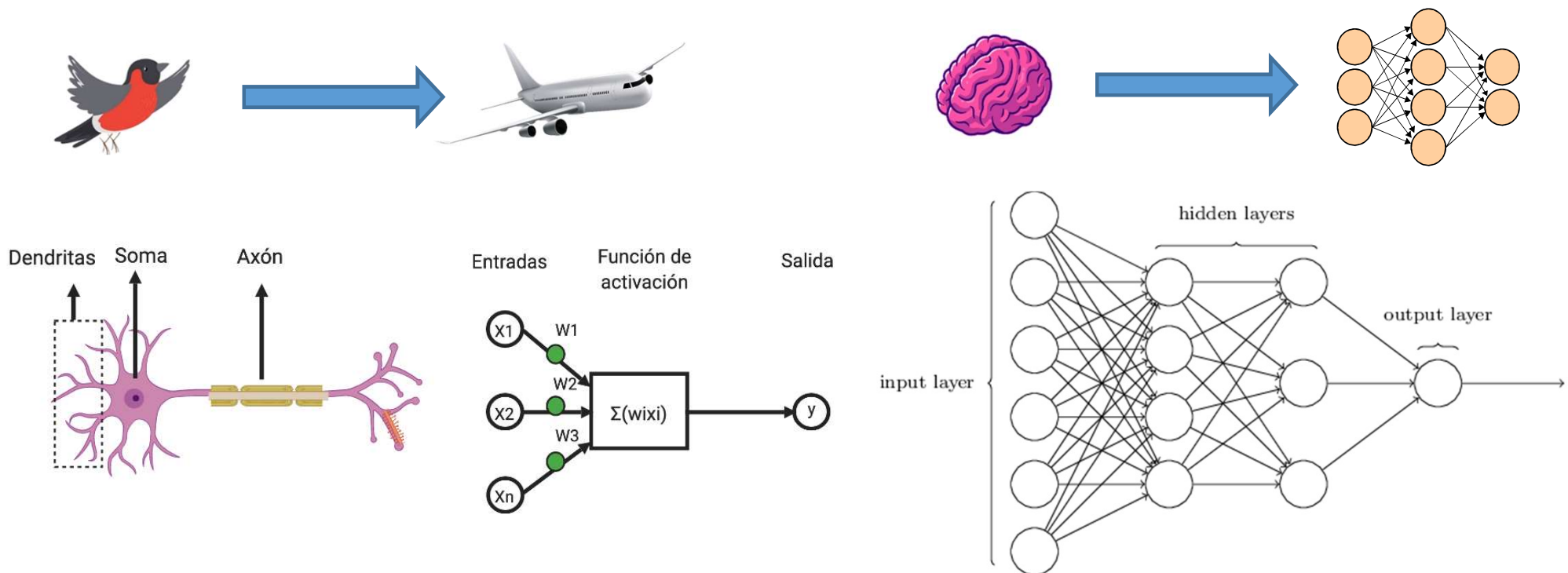


<https://www.youtube.com/watch?v=tZjQwZNw2po>

Neural Networks and Deep Learning

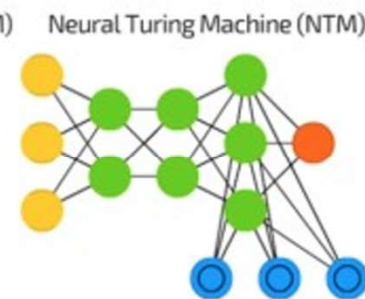
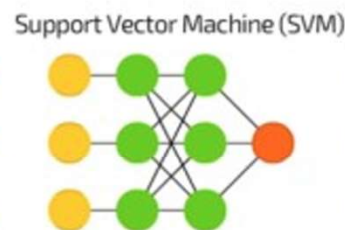
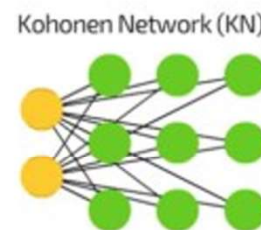
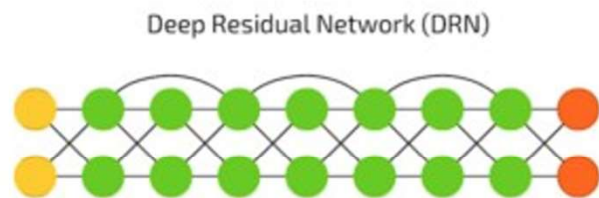
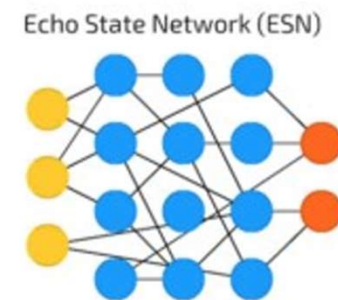
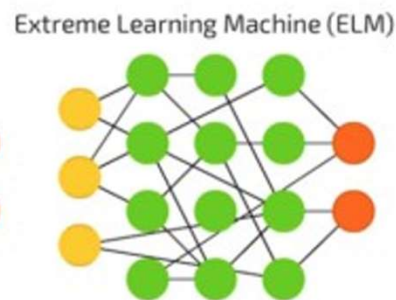
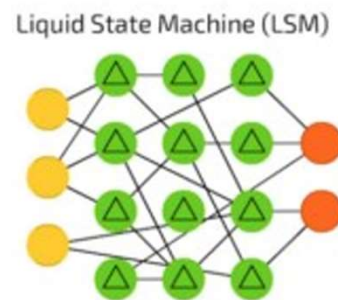
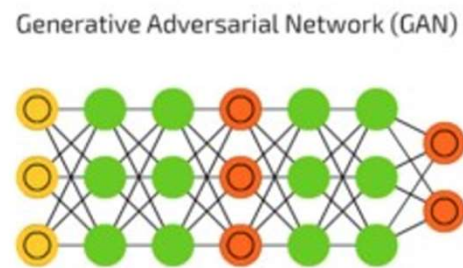
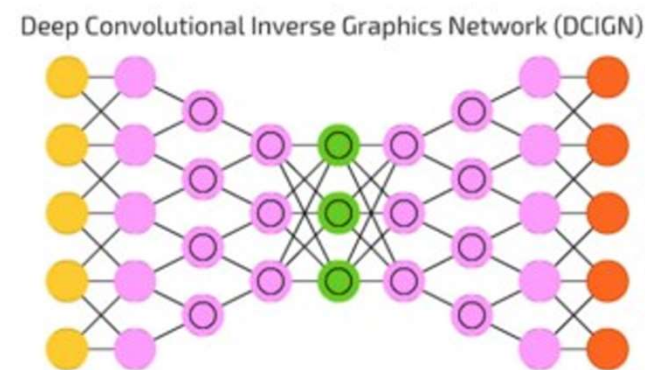
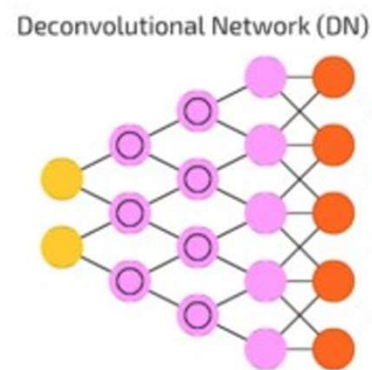
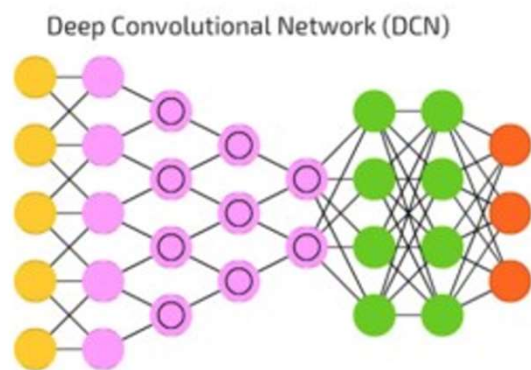
Neural Networks and Deep Learning

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

-  Backfed Input Cell
-  Input Cell
-  Noisy Input Cell
-  Hidden Cell
-  Probabilistic Hidden Cell
-  Spiking Hidden Cell
-  Output Cell
-  Match Input Output Cell
-  Recurrent Cell
-  Memory Cell
-  Different Memory Cell
-  Kernel
-  Convolution or Pool

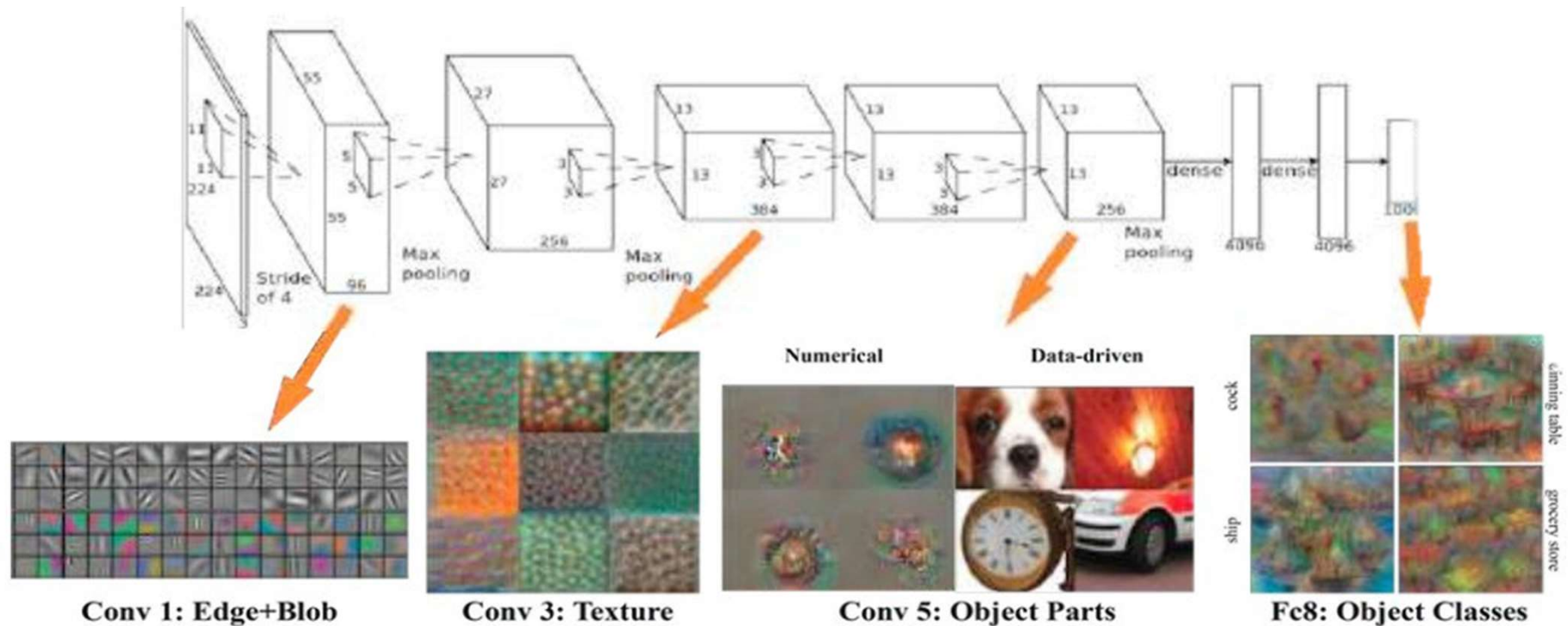


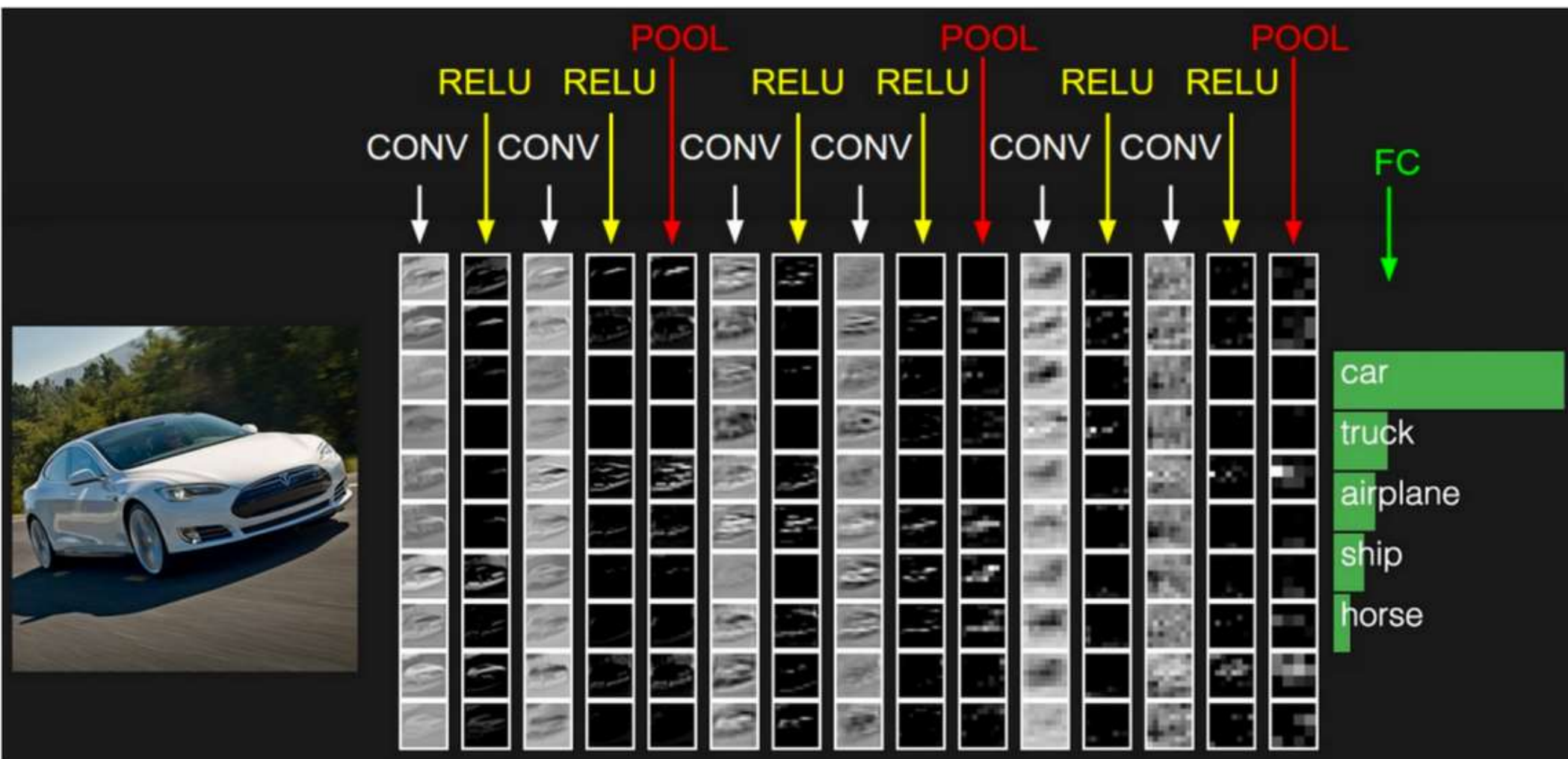
asimovinstitute.org/neural-network-zoo

Computer Vision

Convolutional Networks (CNN)

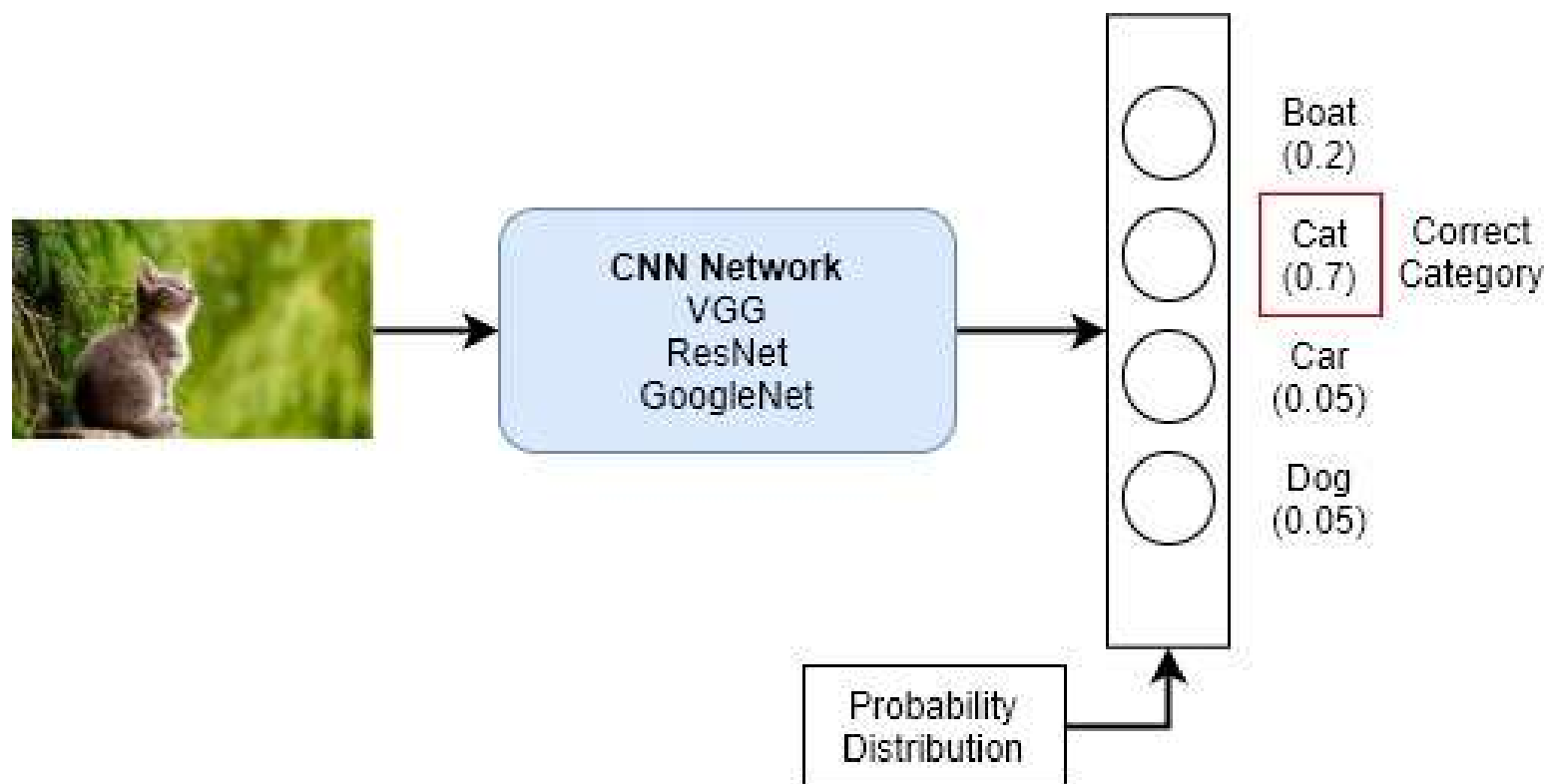
Used for Computer Vision, we can see how the image is being "cut up".





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

Image Classification



Object Detection

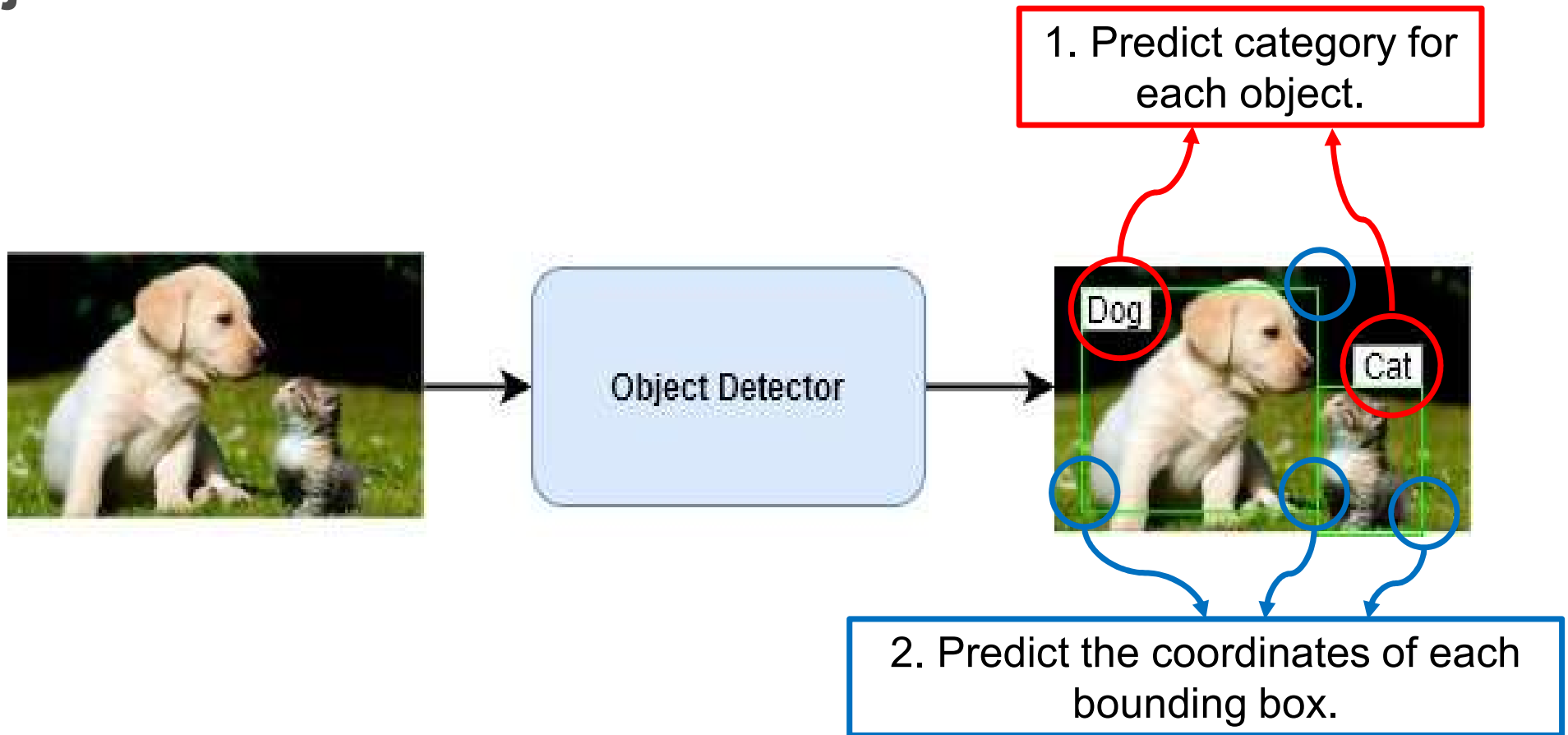
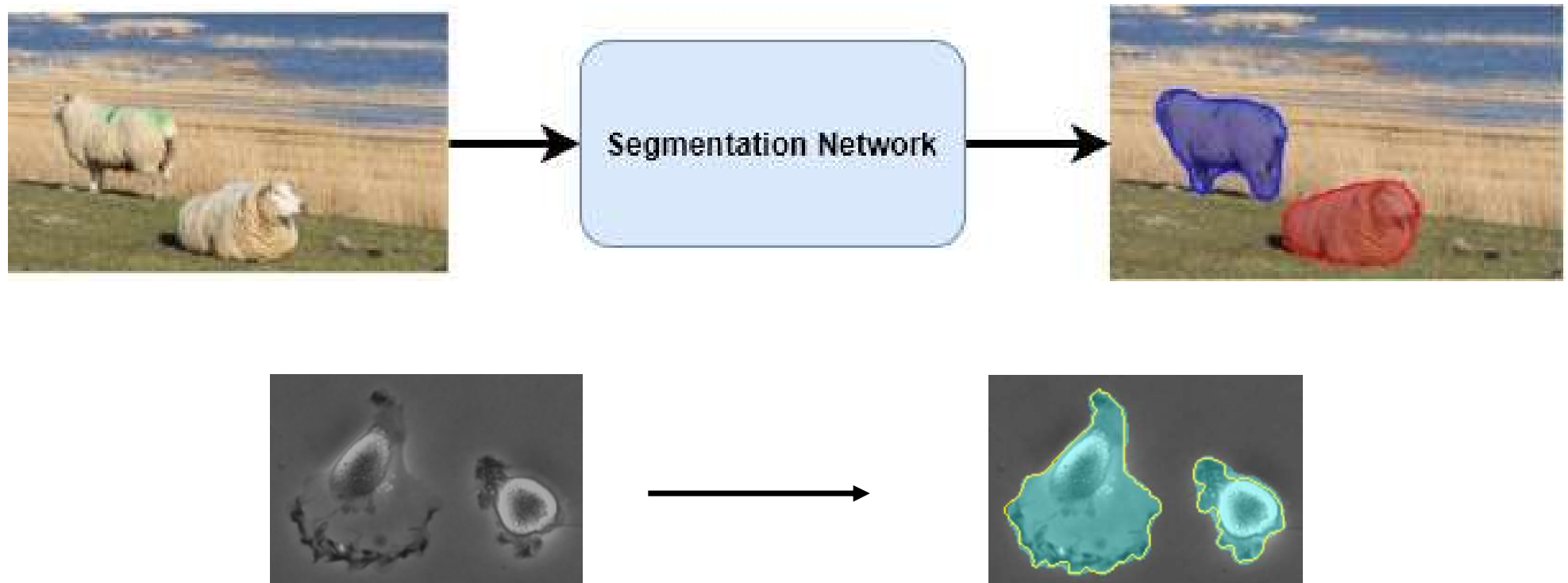


Image Segmentation



Why is this interesting for industry?

Applications: 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”

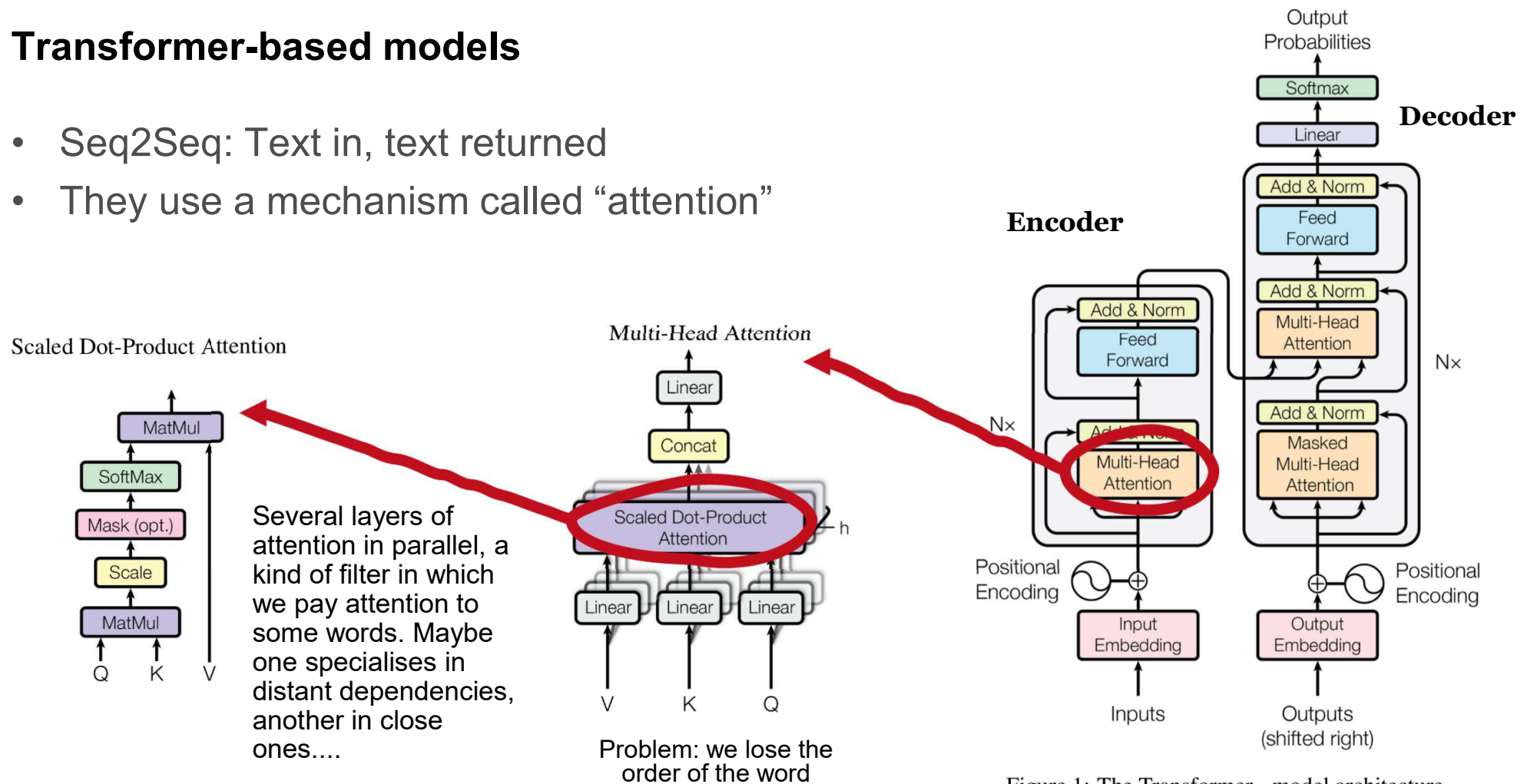
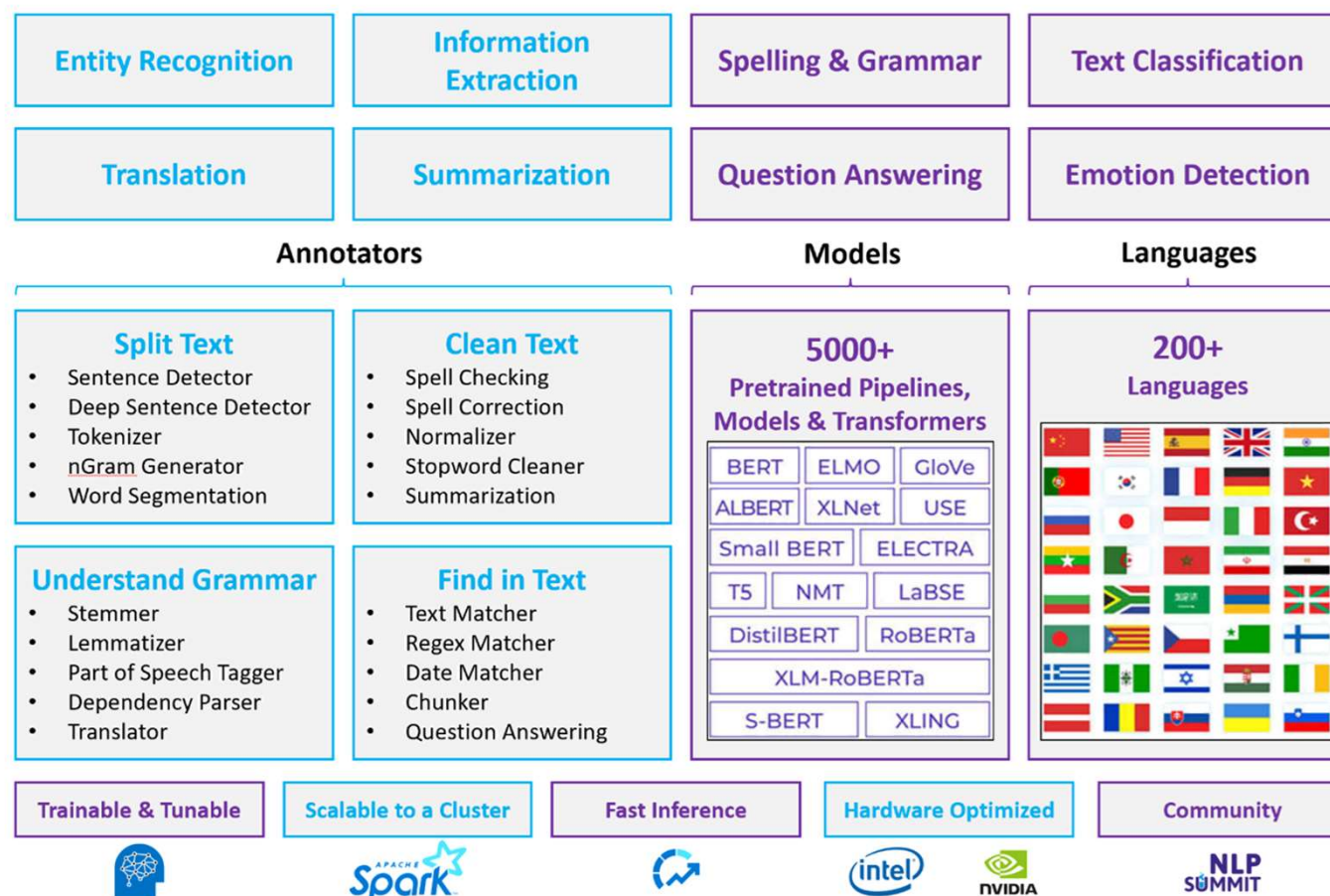


Figure 1: The Transformer - model architecture.

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 by Azure (Microsoft)

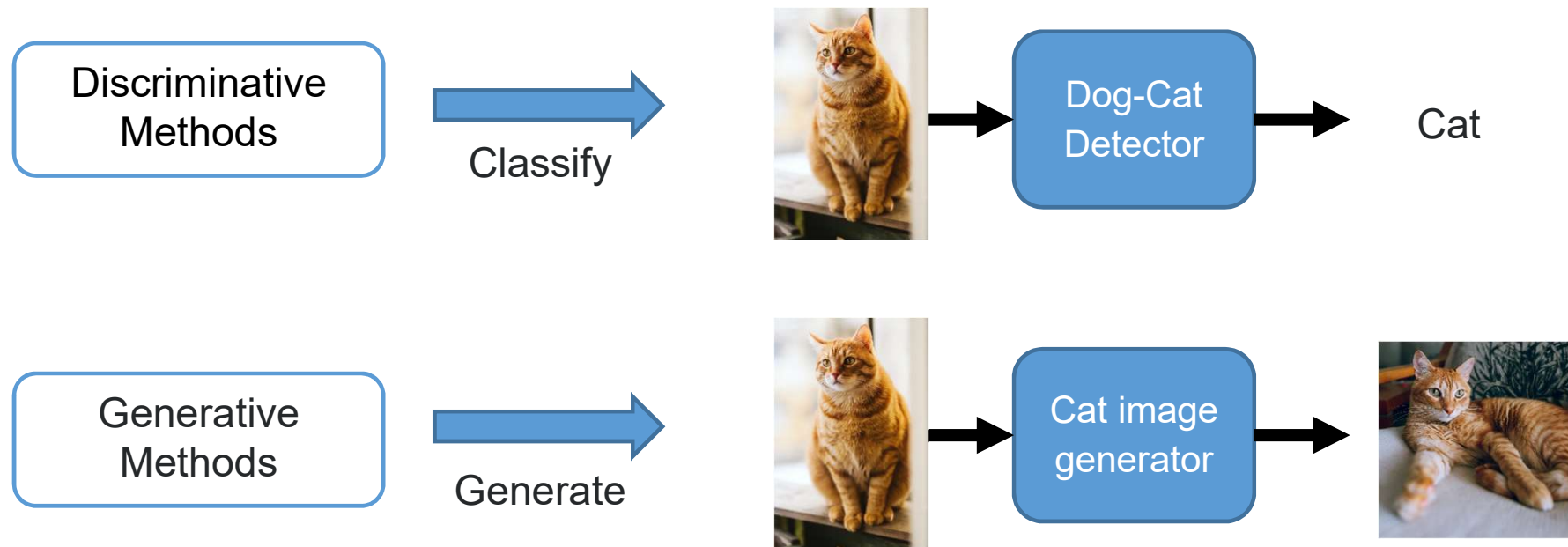


Generative Artificial Intelligence



Generative AI

New data is created from training data



Text Generation

ChatGPT, Bing, Lambda, [Claude](#)...

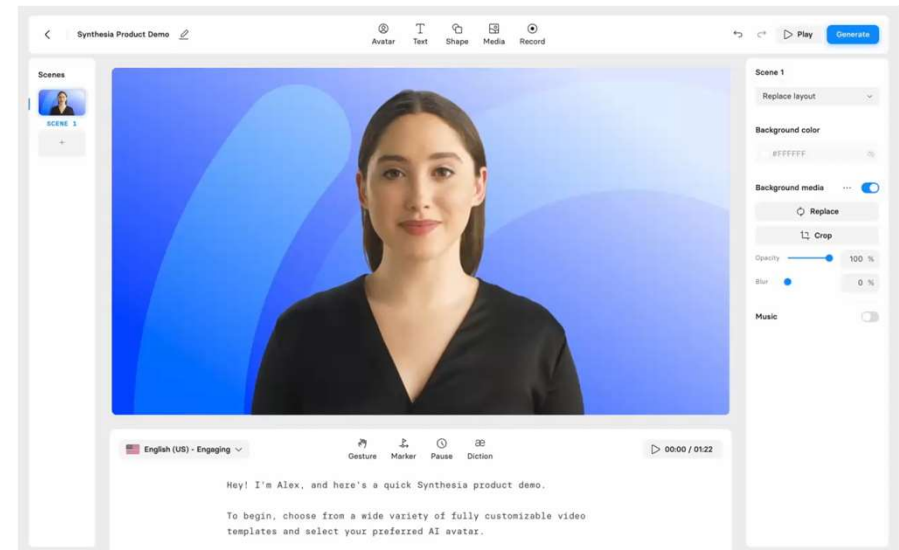
Image Generation

[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!

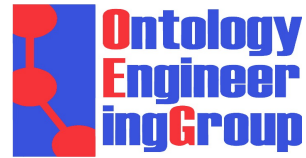


Conclusion

- 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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