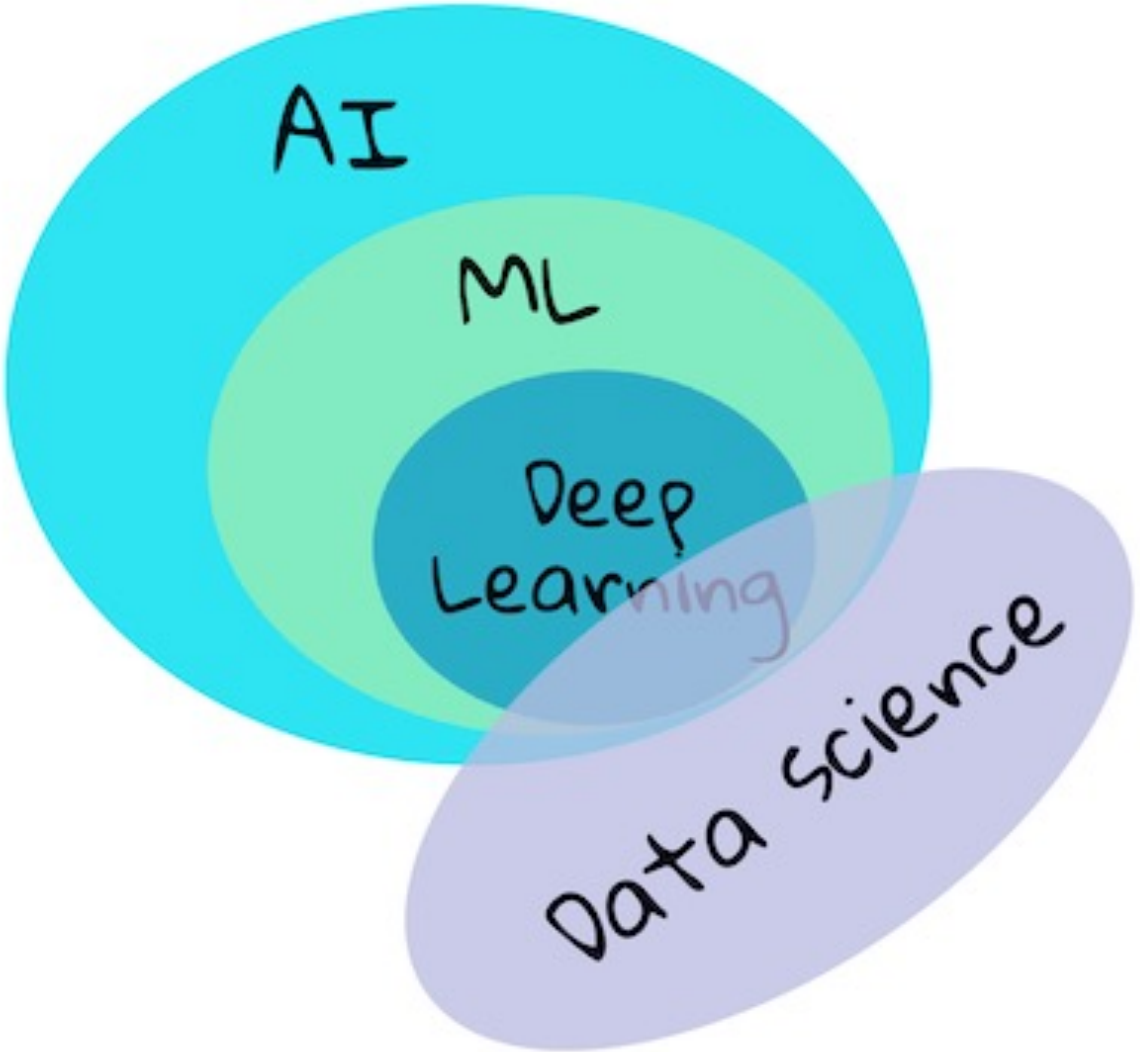
Machine Learning

06048203

แผนการสอน	
สัปดาห์ที่	หัวข้อ
1	Introduction to Machine Learning
2	Basic python programing for Machine Learning
3	Advance python programing for Machine Learning
4	Simple Linear Regression Multiple Linear Regression And Advance Regression
5	Logistic Regression
6	K-nearest neighbors (K-NN)
7	Support vector machine (SVM)
9	Naïve Bayes
10	Decision tree
11	Random forest; Clustering
12	machine learning with imbalanced data
13	Deep learning with pytorch I
14	Deep learning with pytorch II
15	Real-world Applications and Future Trends I
16	Real-world Applications and Future Trends II



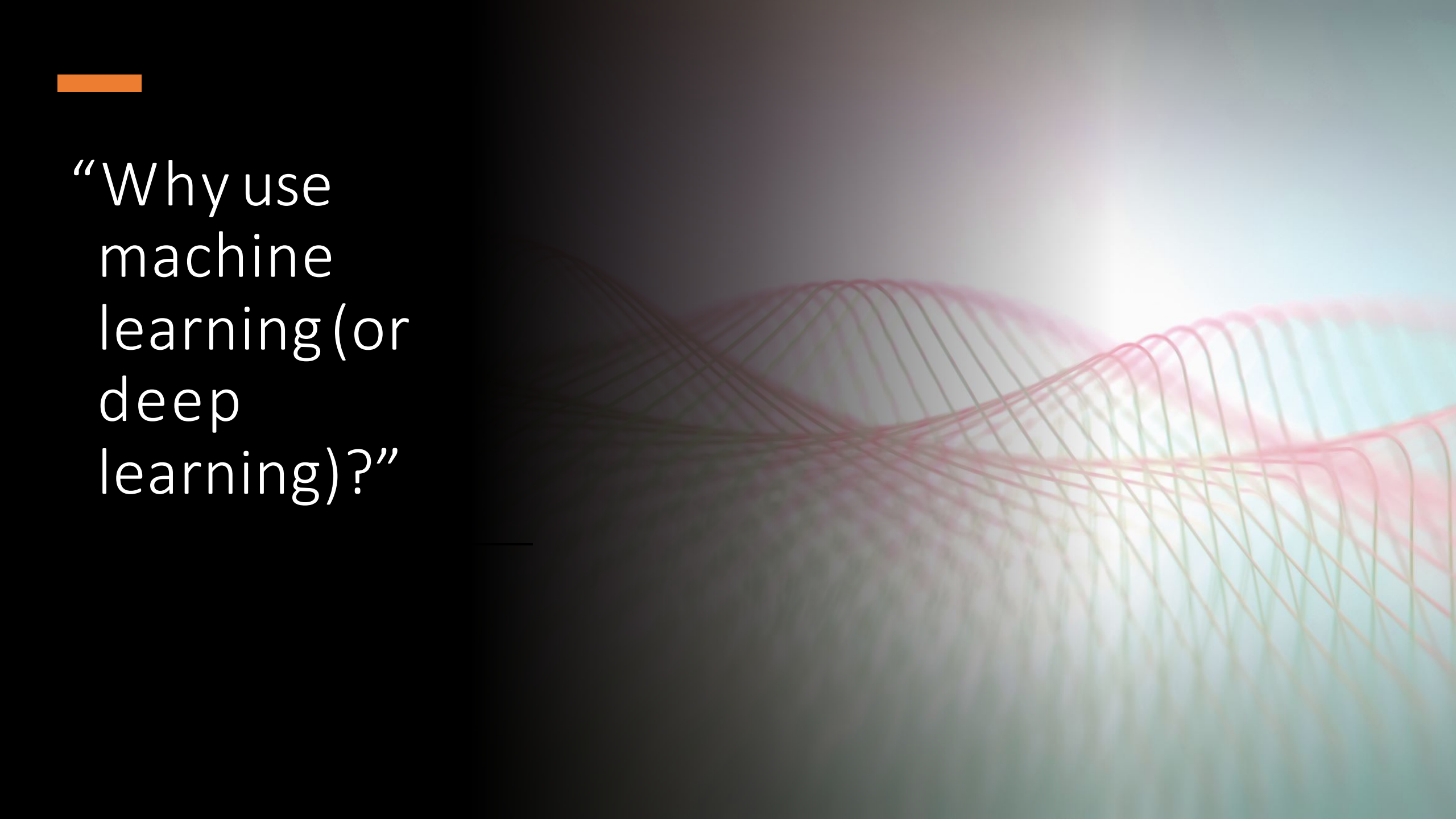
- Artificial Intelligence (AI) is a field focused on creating intelligent systems that can perform tasks requiring human-like intelligence. It encompasses both narrow AI, which is designed for specific tasks, and general AI, which aims to achieve human-level intelligence.

- Machine Learning (ML) is a subset of AI that involves developing algorithms and models that allow computers to learn from data and improve their performance without being explicitly programmed. ML focuses on pattern recognition, prediction, and decision-making based on learned patterns.

- Deep Learning is a specialized branch of ML that utilizes deep neural networks with multiple layers to automatically learn hierarchical representations of data. It excels at tasks involving complex patterns and feature extraction, and often requires substantial computational resources.

- Data Science is an interdisciplinary field that involves extracting knowledge and insights from data using scientific methods, processes, algorithms, and tools. It encompasses various techniques, including AI, ML, and Deep Learning, to analyze and interpret large and complex datasets to solve problems and make informed decisions.

“Why use machine learning (or deep learning)?”



(maybe not very simple…)

"If you can build a simple rule-based system that doesn't require machine learning, do that."

Good reason:

Why not?

Better reason: For a complex problem, can you think of all the rules?

(probably not)

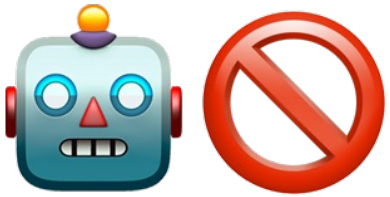
What deep learning is good for

Problems with long lists of rules—when the traditional approach fails, machine learning/deep learning may help.

Continually changing environments—deep learning can adapt (‘learn’) to new scenarios.

Discovering insights within large collections of data—can you imagine trying to hand-craft rules for what 101 diSerent kinds of food look like?

What deep learning is not good for



When you need explainability—the patterns learned by a deep learning model are typically uninterpretable by a human.

When the traditional approach is a better option — if you can accomplish what you need with a simple rule-based system.

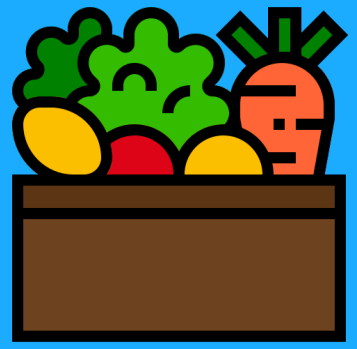
When errors are unacceptable — since the outputs of deep learning model aren't always predictable.

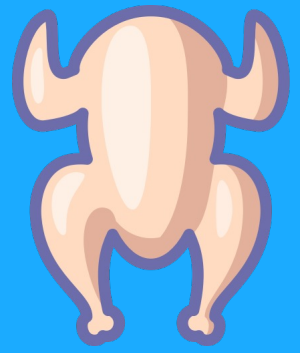
When you don't have much data — deep learning models usually require a fairly large amount of data to produce great results.

(though we'll see how to get great results without huge amounts of data)

Traditional programming

Inputs





Rules

1. Cut vegetables
2. Season chicken
3. Preheat oven
4. Cook chicken for 30-minutes
5. Add vegetables

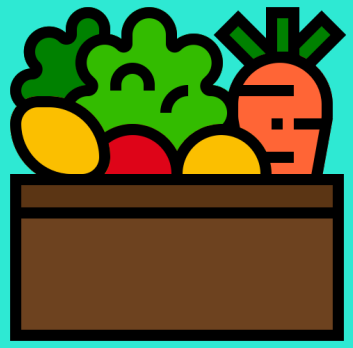
Output

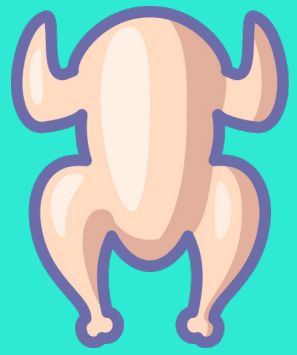
Starts with

Makes

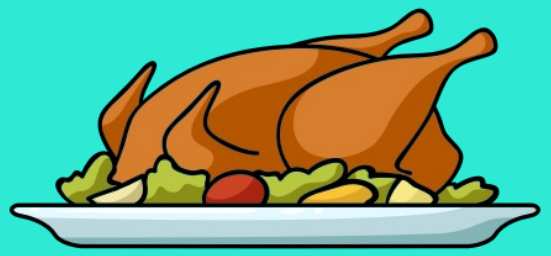
Machine learning algorithm

Inputs





Output



Rules

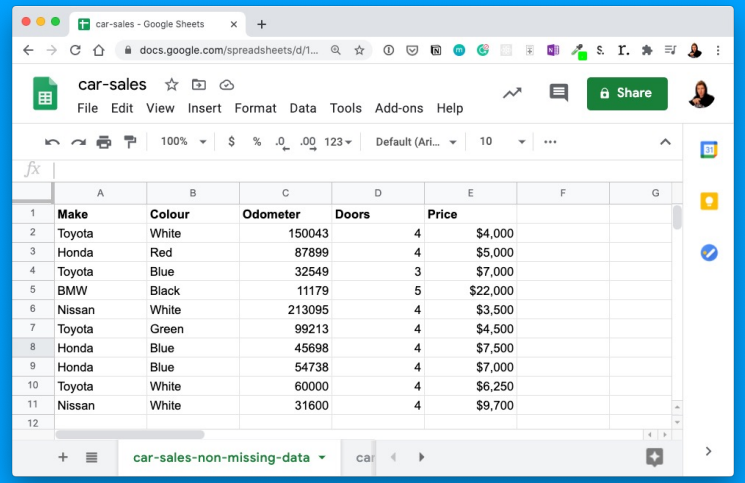
1. Cut vegetables
2. Season chicken
3. Preheat oven
4. Cook chicken for 30-minutes
5. Add vegetables

Starts with

Figures out

Machine Learning vs. Deep Learning

Machine Learning



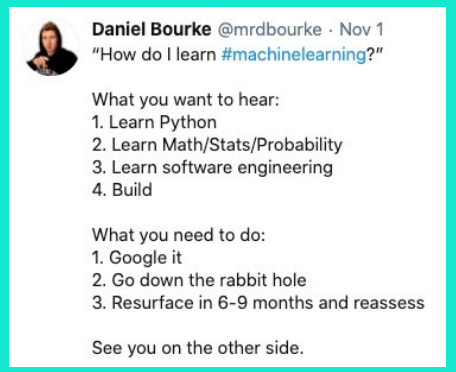
	Make	Colour	Odometer	Doors	Price
1	Toyota	White	150043	4	$4,000
2	Honda	Red	87899	4	$5,000
3	Toyota	Blue	32549	3	$7,000
4	BMW	Black	11179	5	$22,000
5	Nissan	White	213095	4	$3,500
6	Toyota	Green	99213	4	$4,500
7	Honda	Blue	45698	4	$7,500
8	Honda	Blue	54738	4	$7,000
9	Toyota	White	60000	4	$6,250
10	Nissan	White	31600	4	$9,700

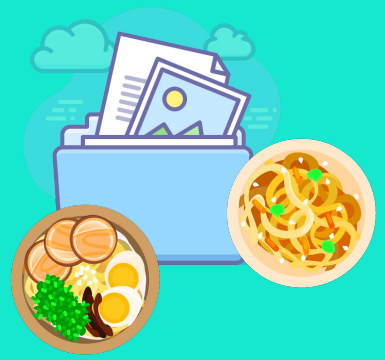
Algorithm: gradient boosted machine

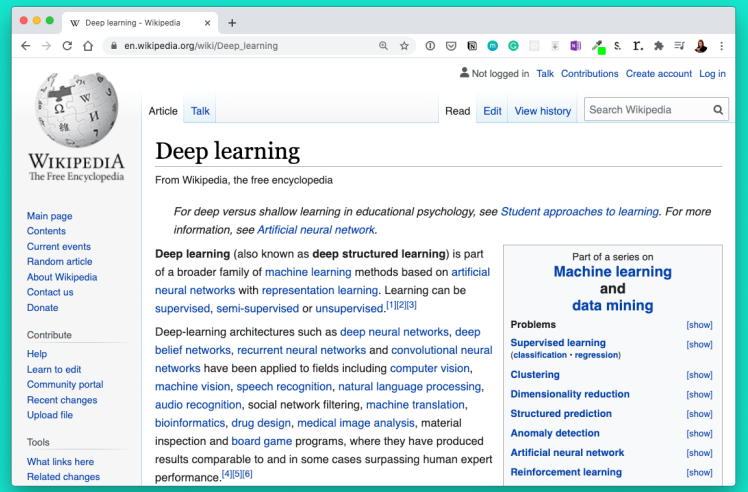
dmlc XGBoost

Structured data

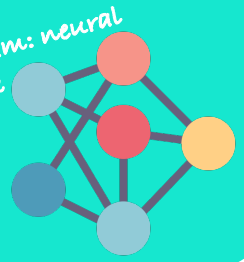
Deep Learning



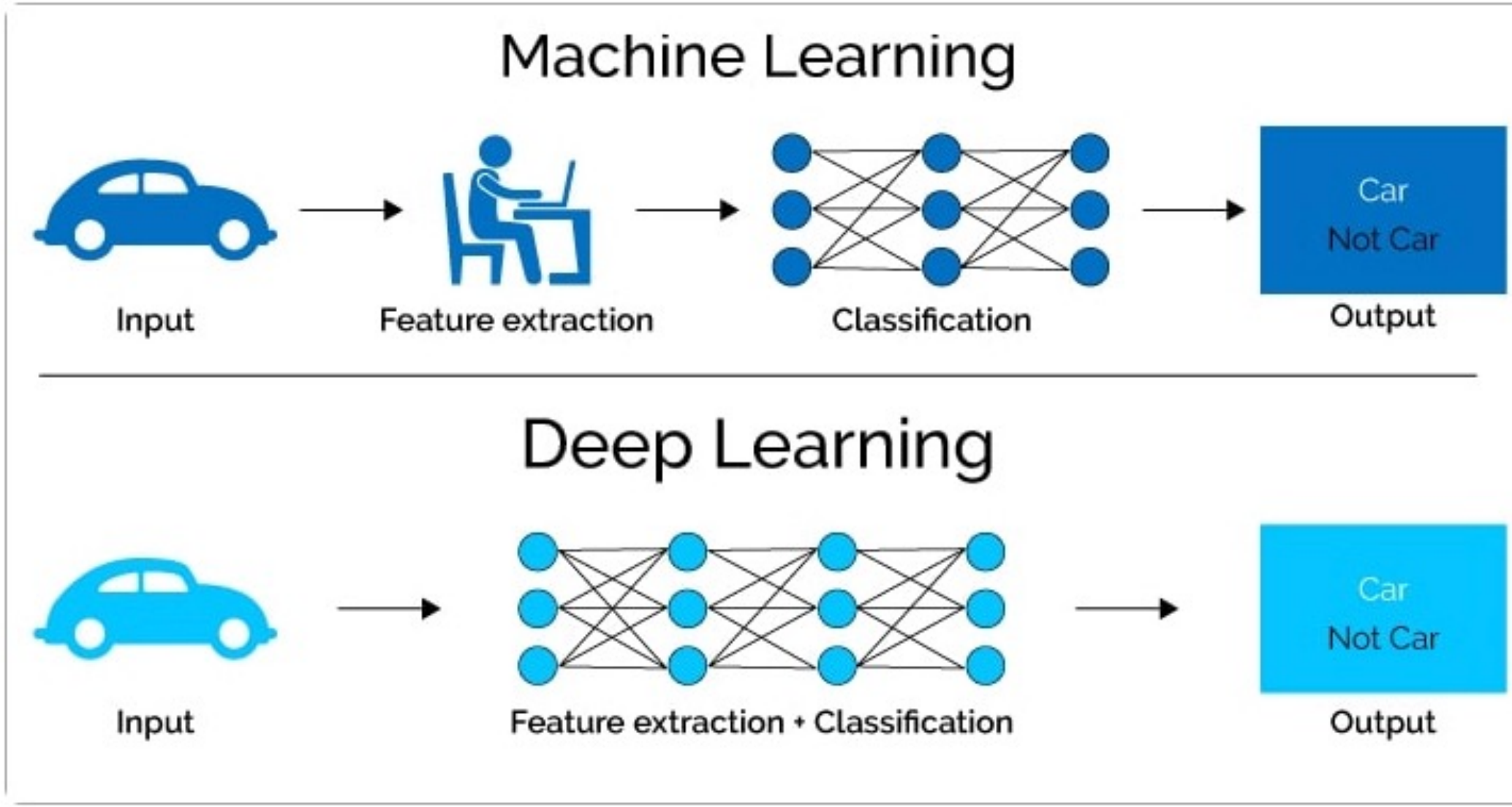




Algorithm: neural network



Unstructured data


Machine Learning
Input
Feature extraction
Classification
Car
Not Car
Output
Deep Learning
Input
Feature extraction + Classification
Car
Not Car
Output

Machine Learning vs. Deep Learning

(common algorithms)

- Random forest
- Gradient boosted models
- Naive Bayes
- Nearest neighbour
- Support vector machine
- …many more

(since the advent of deep learning these are often referred to as "shallow algorithms")

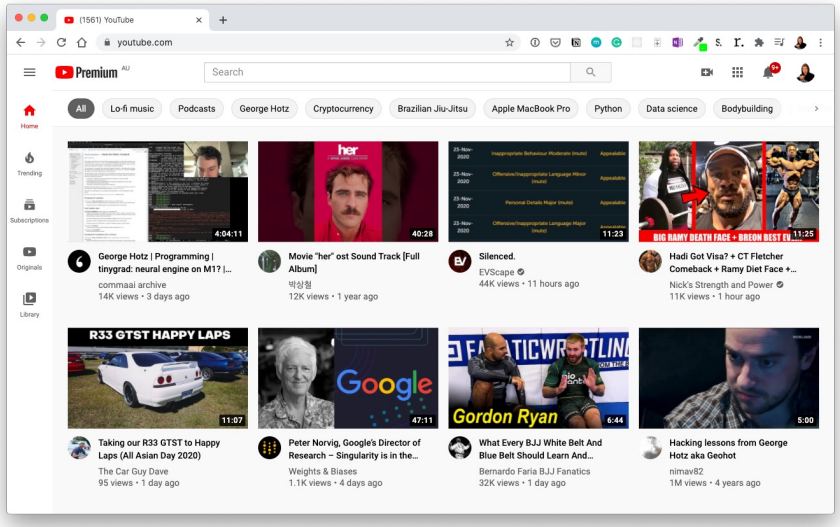
- Neural networks
- Fully connected neural network
- Convolutional neural network
- Recurrent neural network
- Transformer
- …many more

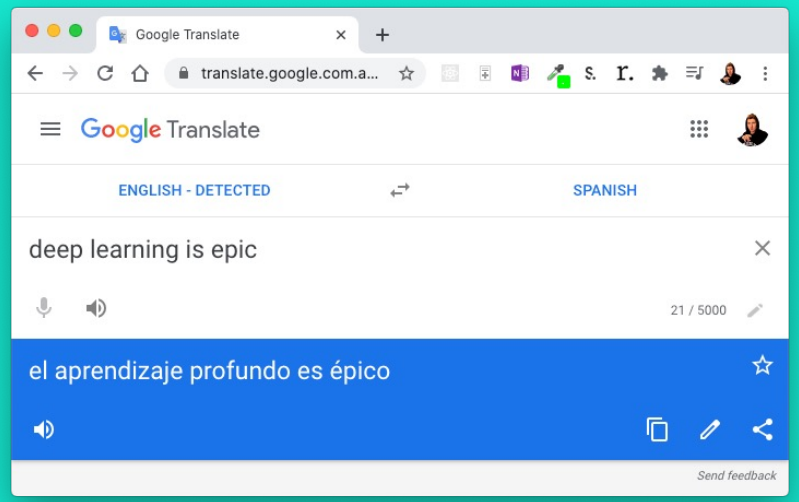
What we're focused on building (with PyTorch)

(depending how you represent your problem, many algorithms can be used for both)

Structured data ⟷ **Unstructured data**

Deep Learning Use Cases





Translation

"Hey Siri, who's the biggest big dog of them all?"

Speech recognition

Computer Vision

To: daniel@mrdbourke.com
Hey Daniel,

This deep learning course is incredible! I can't wait to use what I've learned!

Not spam

To: daniel@mrdbourke.com
Hay daniel…

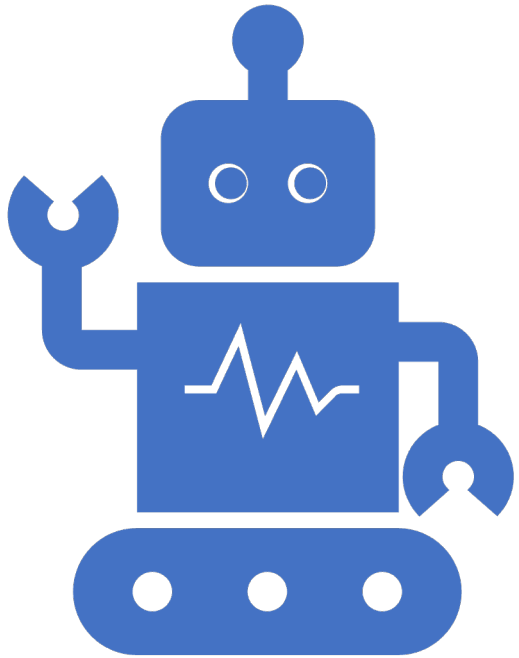
C0ongratu1ations! U win $1139239230

Spam

Natural Language Processing (NLP)

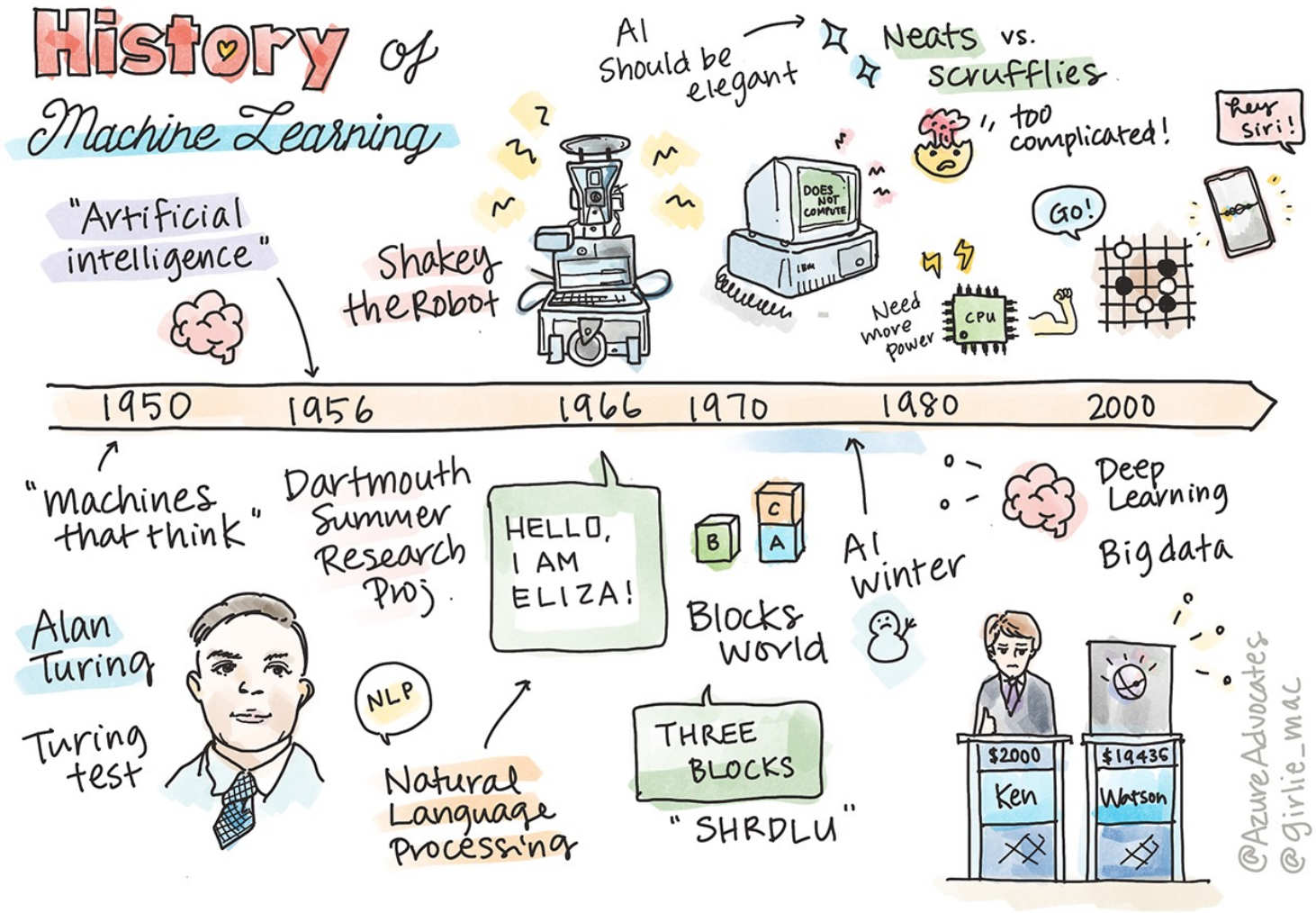
Example of Application of machine learning

- To predict the likelihood of disease from a patient's medical history or reports.
- To leverage weather data to predict weather events.
- To understand the sentiment of a text.
- To detect fake news to stop the spread of propaganda.



Finance, economics, earth science, space exploration, biomedical engineering, cognitive science, and even fields in the humanities have adapted machine learning to solve the arduous, data-processing heavy problems of their domain.

History of machine learning



```
Welcome to
                  EEEEEE  LL      IIII   ZZZZZZ   AAAAA
                  EE      LL       II       ZZ   AA   AA
                  EEEEE   LL       II     ZZZ    AAAAAAA
                  EE      LL       II    ZZ      AA   AA
                  EEEEEE  LLLLLL  IIII ZZZZZZ    AA   AA

  Eliza is a mock Rogerian psychotherapist.
  The original program was described by Joseph Weizenbaum in 1966.
  This implementation by Norbert Landsteiner 2005.


ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```

Eliza, an early 'chatterbot', could converse with people and act as a primitive 'therapist'. You'll learn more about Eliza in the NLP lessons.

Notable discoveries

1950s:

- 1950: Alan Turing proposes the "Turing Test" as a measure of machine intelligence.
- 1956: John McCarthy organizes the Dartmouth Workshop, marking the birth of artificial intelligence (AI) as a field of study.

1960s:

- 1967: The concept of nearest neighbor algorithms is introduced by Evelyn Fix and Joseph Hodges.
- 1969: The "Perceptron" algorithm, a type of artificial neural network, is developed by Frank Rosenblatt.

1970s:

- 1970: The "ID3" algorithm is introduced by J.R. Quinlan, becoming one of the first decision tree learning algorithms.
- 1974: Paul Werbos introduces the concept of backpropagation, a crucial technique for training artificial neural networks.

1980s:

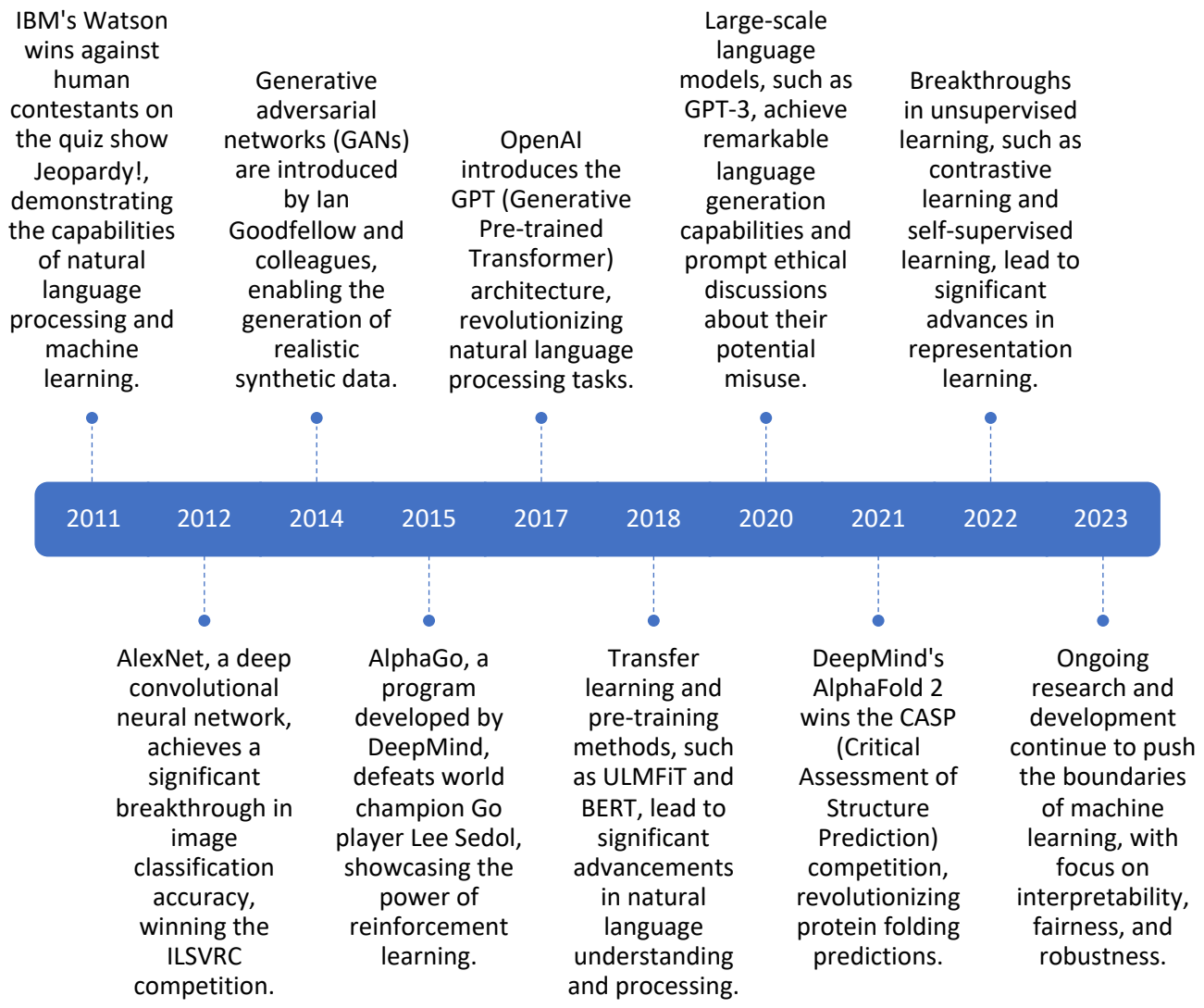
- 1981: Gerald DeJong develops the "Explanation-Based Learning" approach, enabling systems to learn from explicit explanations.
- 1986: Geoffrey Hinton, David Rumelhart, and Ronald Williams demonstrate the practical effectiveness of backpropagation, leading to a resurgence of interest in neural networks.

1990s:

- 1995: Vladimir Vapnik and Alexey Chervonenkis propose the Support Vector Machines (SVM) algorithm for classification tasks.
- 1997: IBM's Deep Blue defeats world chess champion Garry Kasparov, showcasing the power of machine learning in complex games.

2000s:

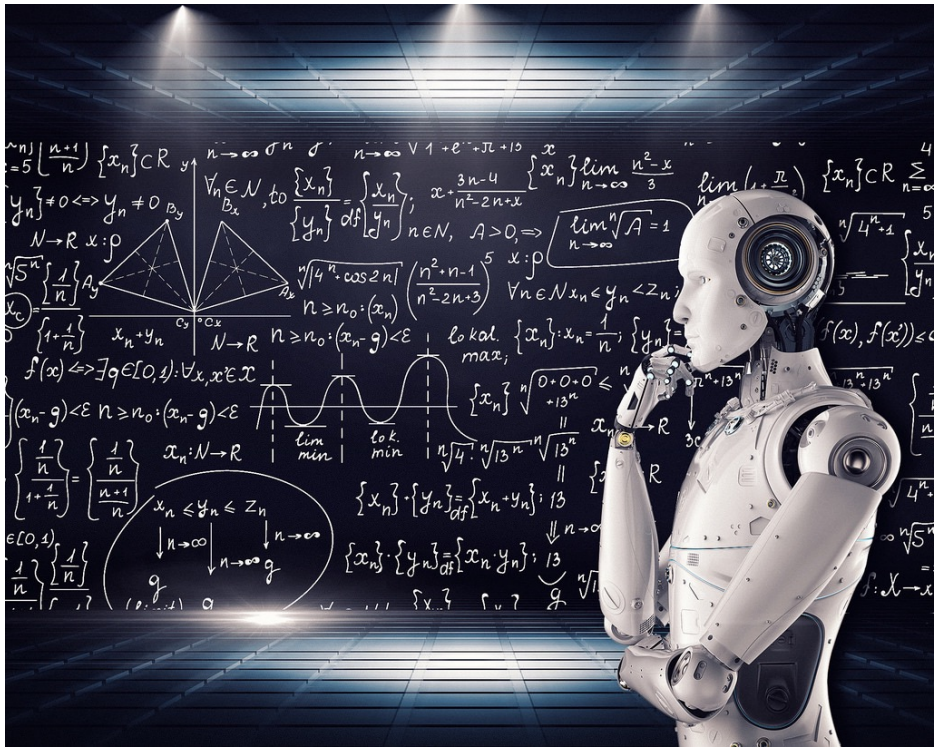
- 2001: The "AdaBoost" algorithm, which combines multiple weak classifiers to form a strong classifier, is introduced by Yoav Freund and Robert Schapire.
- 2006: Geoffrey Hinton and colleagues publish a seminal paper on deep belief networks, paving the way for modern deep learning architectures.
- 2009: The "ImageNet" dataset and the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) are introduced, spurring advancements in computer vision.

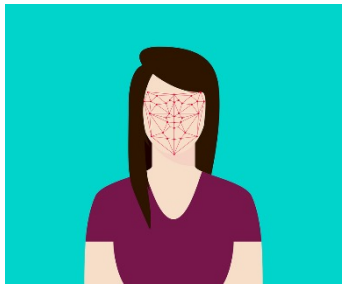

IBM's Watson wins against human contestants on the quiz show Jeopardy!, demonstrating the capabilities of natural language processing and machine learning.
Generative adversarial networks (GANs) are introduced by Ian Goodfellow and colleagues, enabling the generation of realistic synthetic data.
OpenAI introduces the GPT (Generative Pre-trained Transformer) architecture, revolutionizing natural language processing tasks.
Large-scale language models, such as GPT-3, achieve remarkable language generation capabilities and prompt ethical discussions about their potential misuse.
Breakthroughs in unsupervised learning, such as contrastive learning and self-supervised learning, lead to significant advances in representation learning.
2011
2012
2014
2015
2017
2018
2020
2021
2022
2023
AlexNet, a deep convolutional neural network, achieves a significant breakthrough in image classification accuracy, winning the ILSVRC competition.
AlphaGo, a program developed by DeepMind, defeats world champion Go player Lee Sedol, showcasing the power of reinforcement learning.
Transfer learning and pre-training methods, such as ULMFiT and BERT, lead to significant advancements in natural language understanding and processing.
DeepMind's AlphaFold 2 wins the CASP (Critical Assessment of Structure Prediction) competition, revolutionizing protein folding predictions.
Ongoing research and development continue to push the boundaries of machine learning, with focus on interpretability, fairness, and robustness.

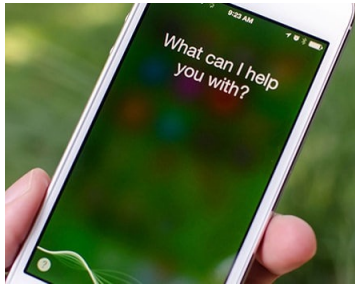
MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE: INTRODUCTION

STEMPLICITY
SCIENCE TECHNOLOGY ENGINEERING & MATH MADE SIMPLE

- Artificial Intelligence/Machine learning does not only mean robots or Sci-Fi movies!
- Machine learning applications are everywhere!
- Google search engine, amazon recommender systems, Facebook facial recognition (tagging), Siri

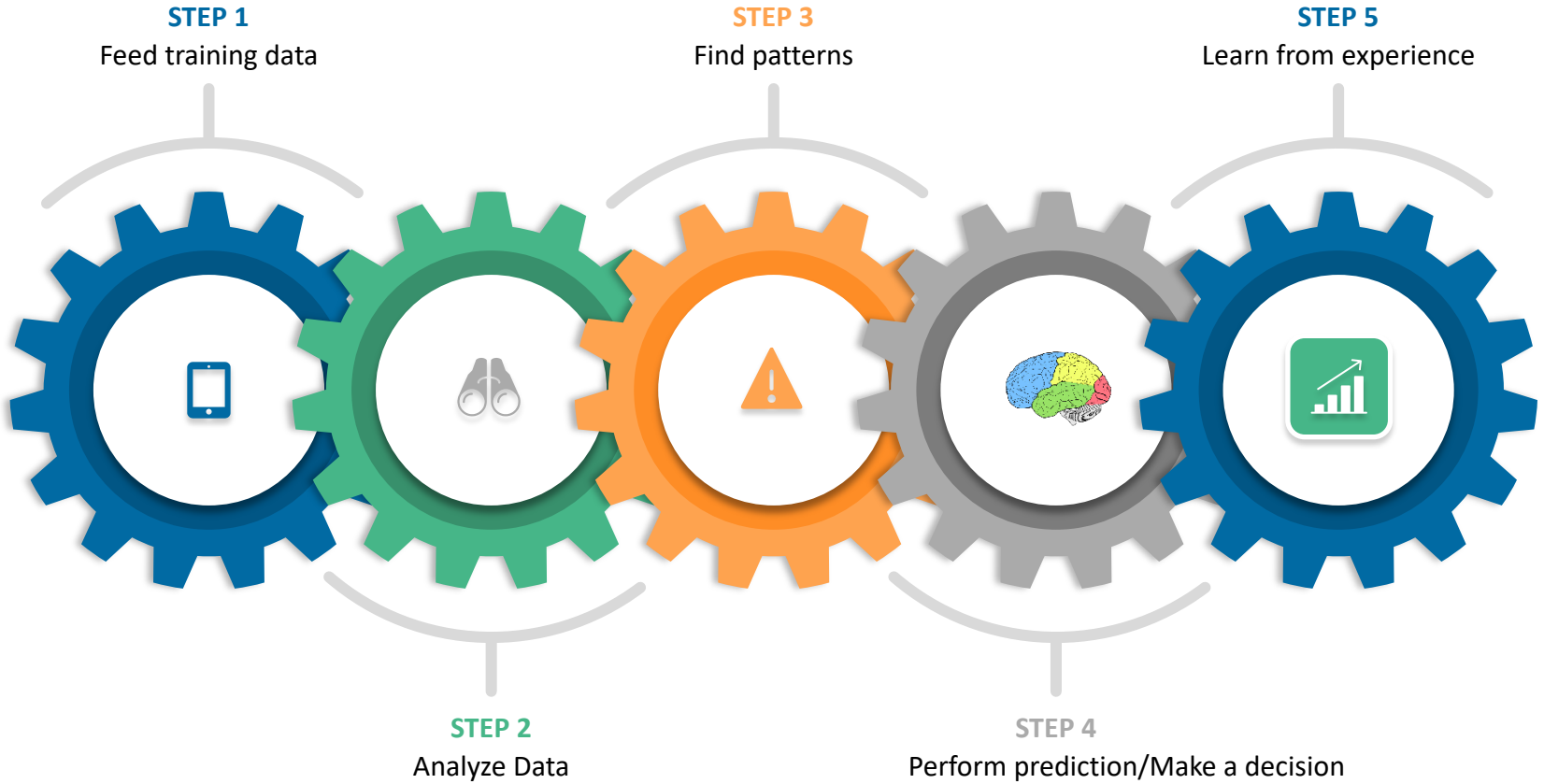






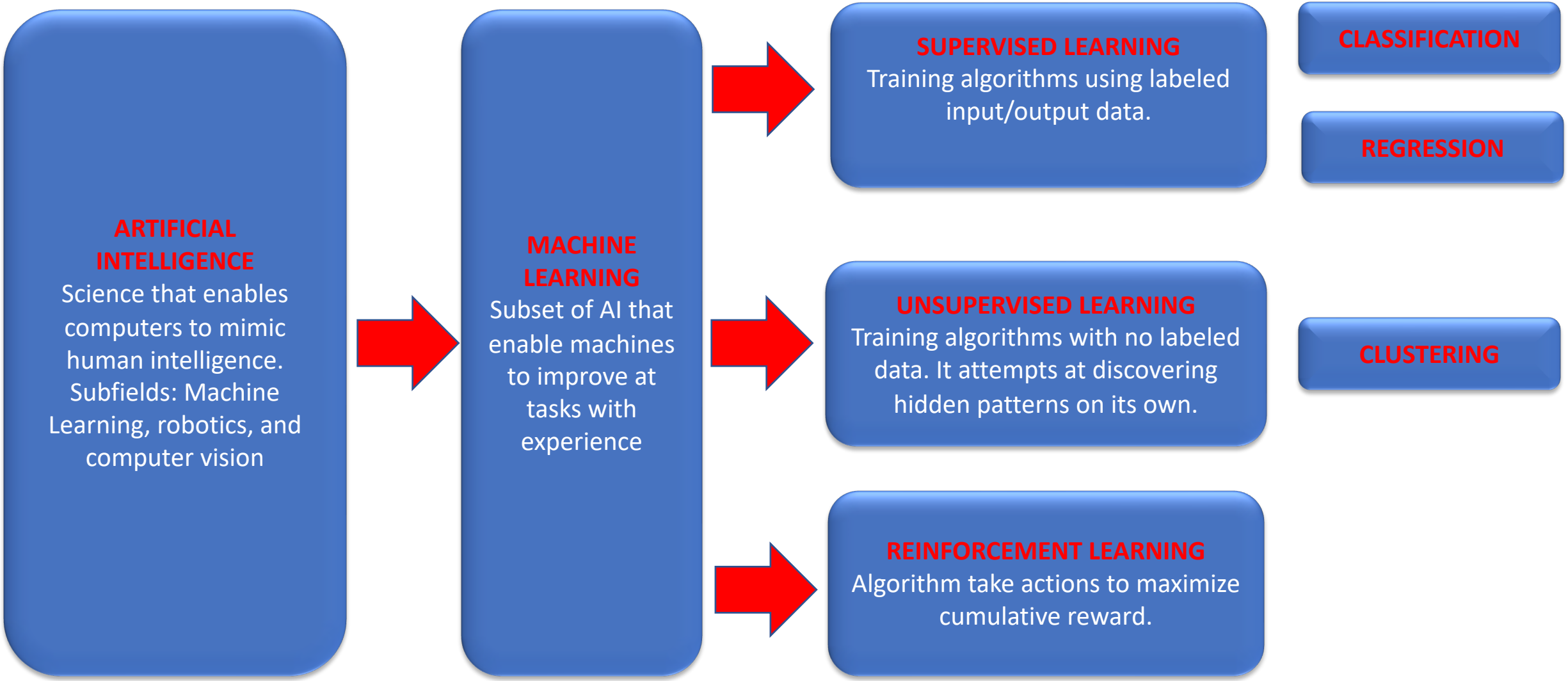
MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE: PROCESS

- Machine learning is the study of algorithms that teach computers to learn from experience.
- Through experience (more training data), computers can continuously improve their performance.

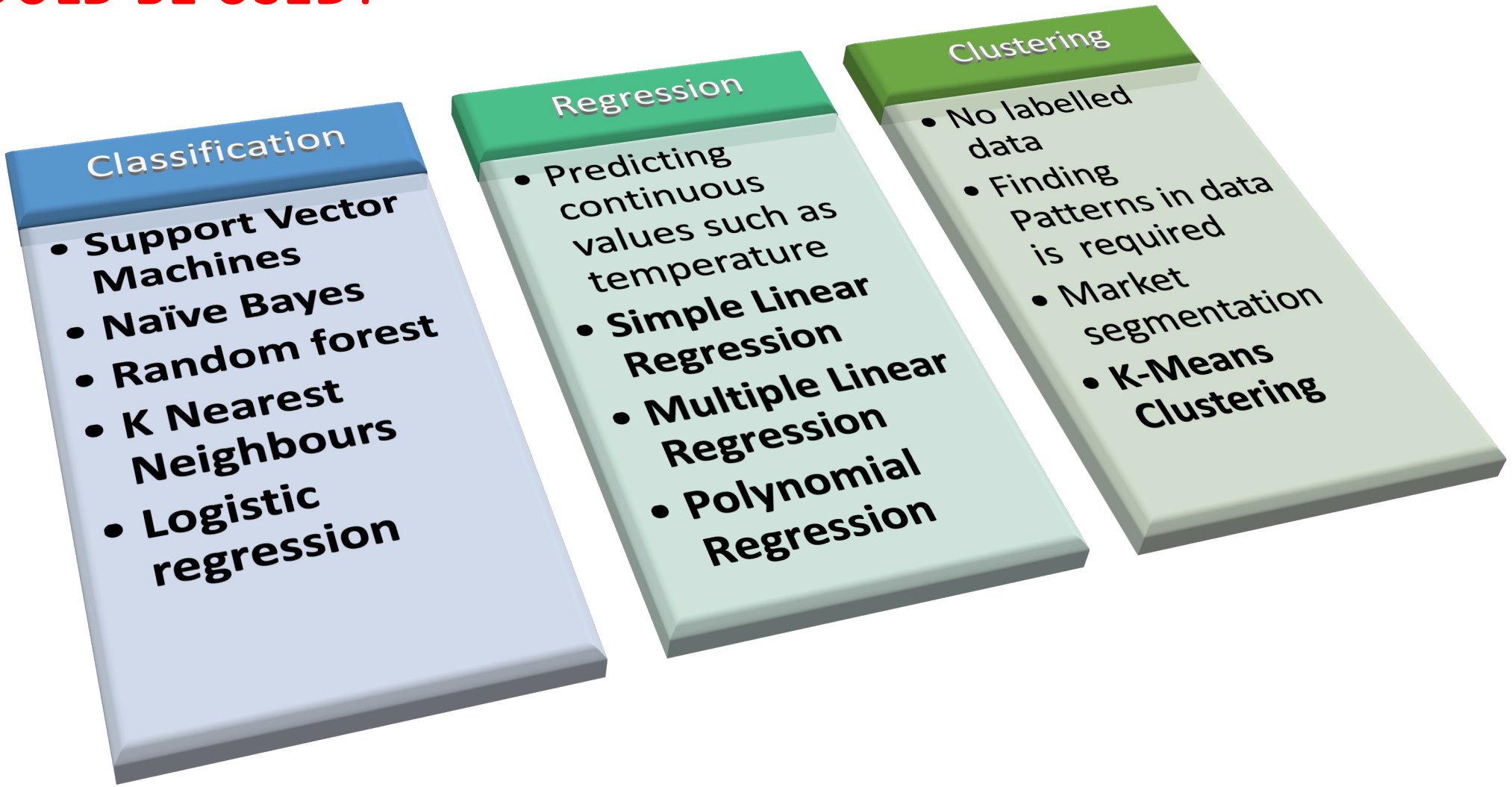


MACHINE LEARNING: BIG PICTURE

STEMPLICITY
SCIENCE TECHNOLOGY ENGINEERING & MATH MADE SIMPLE

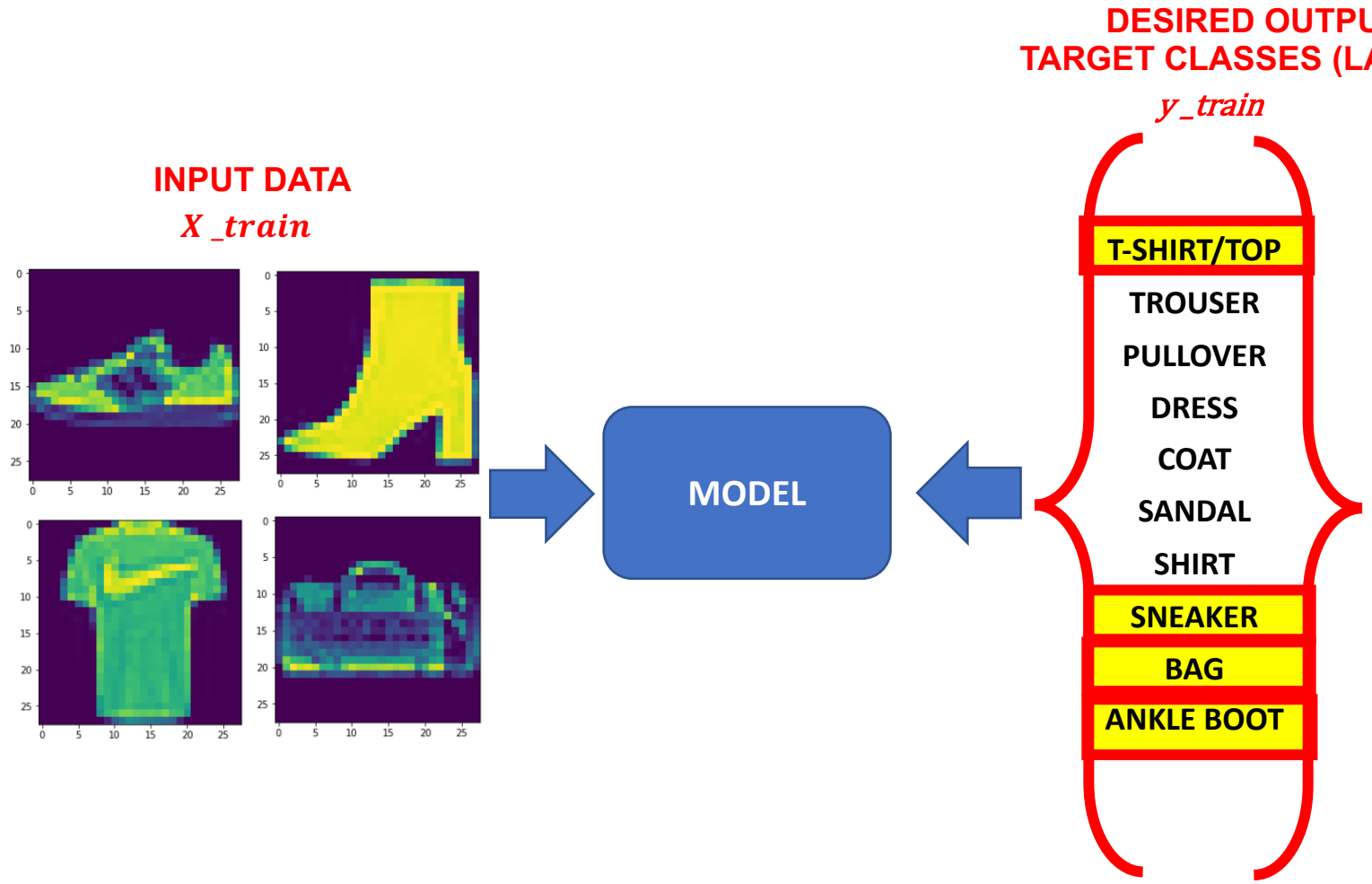


MACHINE LEARNING: WHICH TECHNIQUE SHOULD BE USED?



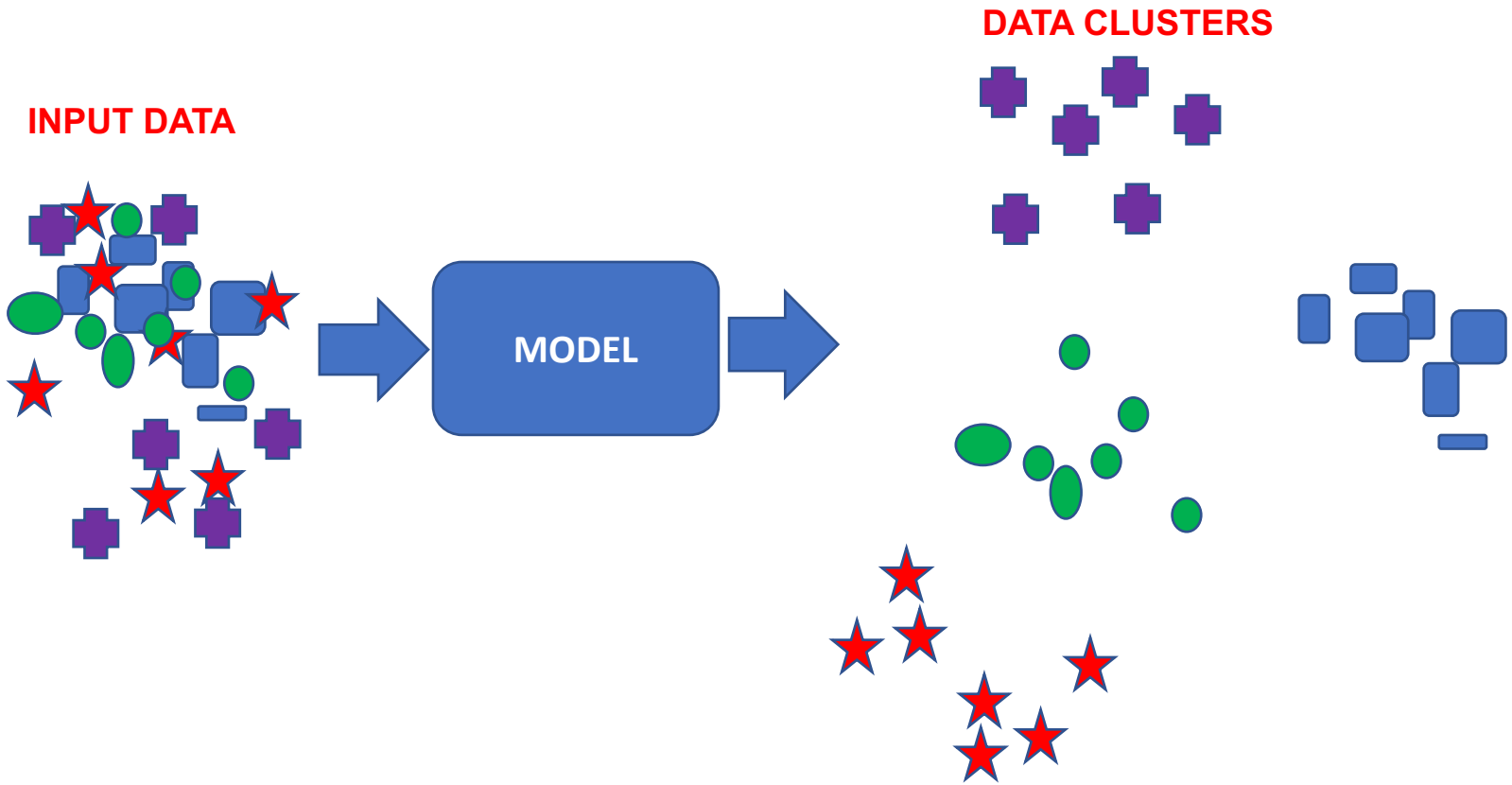
MACHINE LEARNING: SUPERVISED LEARNING

- **Supervised:** used to train algorithms using labeled input and output data.
- Performance is assessed by comparing trained model prediction vs. real output.



MACHINE LEARNING: UNSUPERVISED LEARNING

- **Unsupervised learning:** provides the algorithm with no labeled data.
- The algorithm attempts at discovering hidden patterns within the training data.
- Unsupervised learning methods can analyze complex data that humans might find difficult to interpret.
- No feedback!

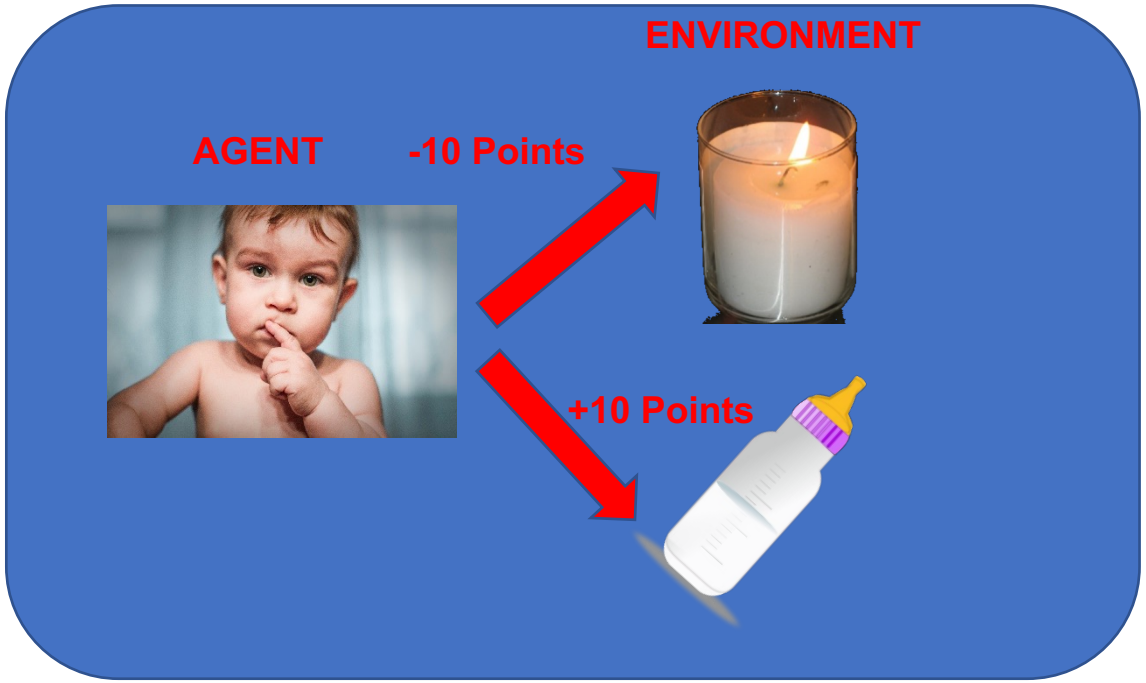


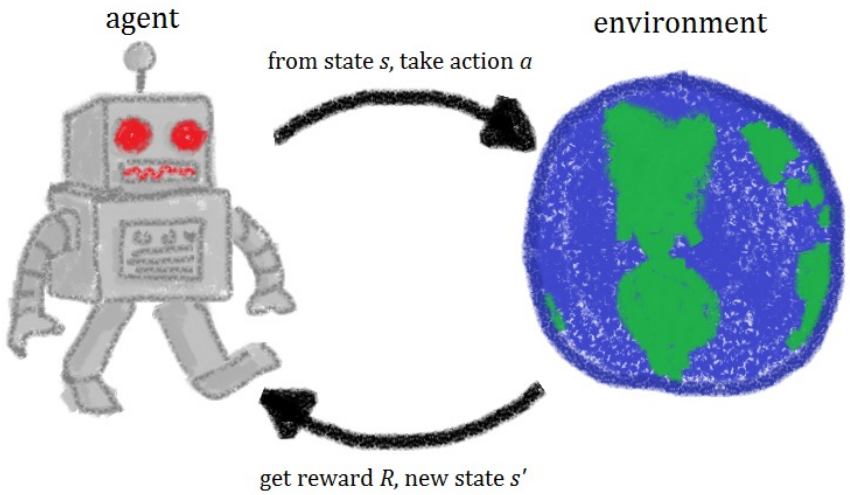
Machine learning

- Linear Regression: A linear regression algorithm fits a linear equation to the data by minimizing the difference between the predicted and actual values. It is used for regression tasks where the target variable is continuous.
- Logistic Regression: Logistic regression is used for binary classification problems. It estimates the probability of an instance belonging to a particular class by fitting a logistic function to the data.
- Decision Trees: Decision trees create a flowchart-like structure where each internal node represents a decision based on a feature, and each leaf node represents a class label or a numerical value. They are versatile and can be used for both classification and regression tasks.
- Random Forests: Random forests are an ensemble learning method that combines multiple decision trees. Each tree is built on a random subset of features, and the final prediction is made based on the majority vote or average of the predictions from individual trees.
- Support Vector Machines (SVM): SVM is a powerful algorithm used for classification tasks. It finds a hyperplane that maximally separates the data into different classes. SVM can handle linear and non-linear separable data by using different kernel functions.
- Naive Bayes: Naive Bayes is a probabilistic algorithm based on Bayes' theorem. It assumes that features are conditionally independent given the class label and uses this assumption to calculate the probability of an instance belonging to a particular class.

MACHINE LEARNING: REINFORCEMENT LEARNING

- Reinforcement learning allows machines take actions to maximize cumulative reward.
- Reinforcement algorithms learn by trial and error through reward and penalty.
- Two elements: **environment** and **learning agent**.
- The environment rewards the agent for correct actions.
- Based on the reward or penalty, agent improves its environment knowledge to make better decision.

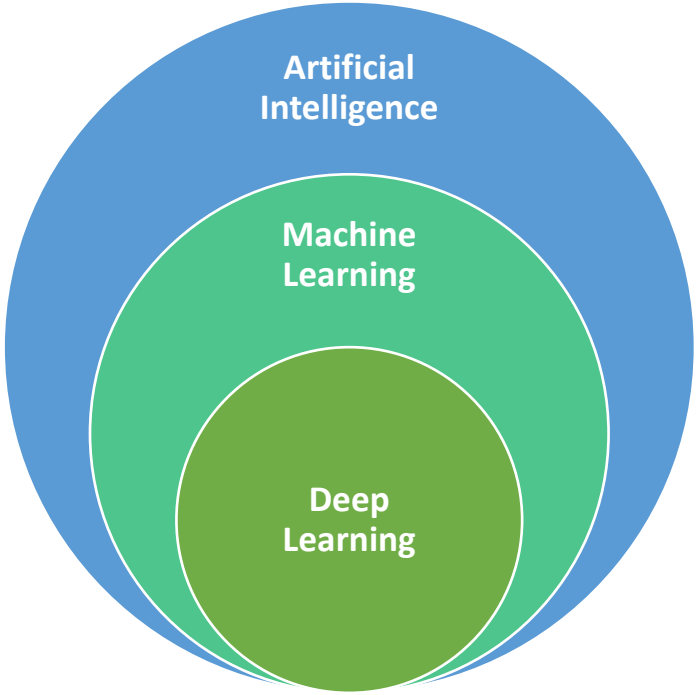




https://commons.wikimedia.org/wiki/File:Rl_agent.png

MACHINE LEARNING: DEEP LEARNING

- Deep learning is a subset of machine learning that utilizes multi-layer Artificial Neural Networks.
- Deep Neural Networks are inspired by the human brain and mimics the operation of biological neurons.



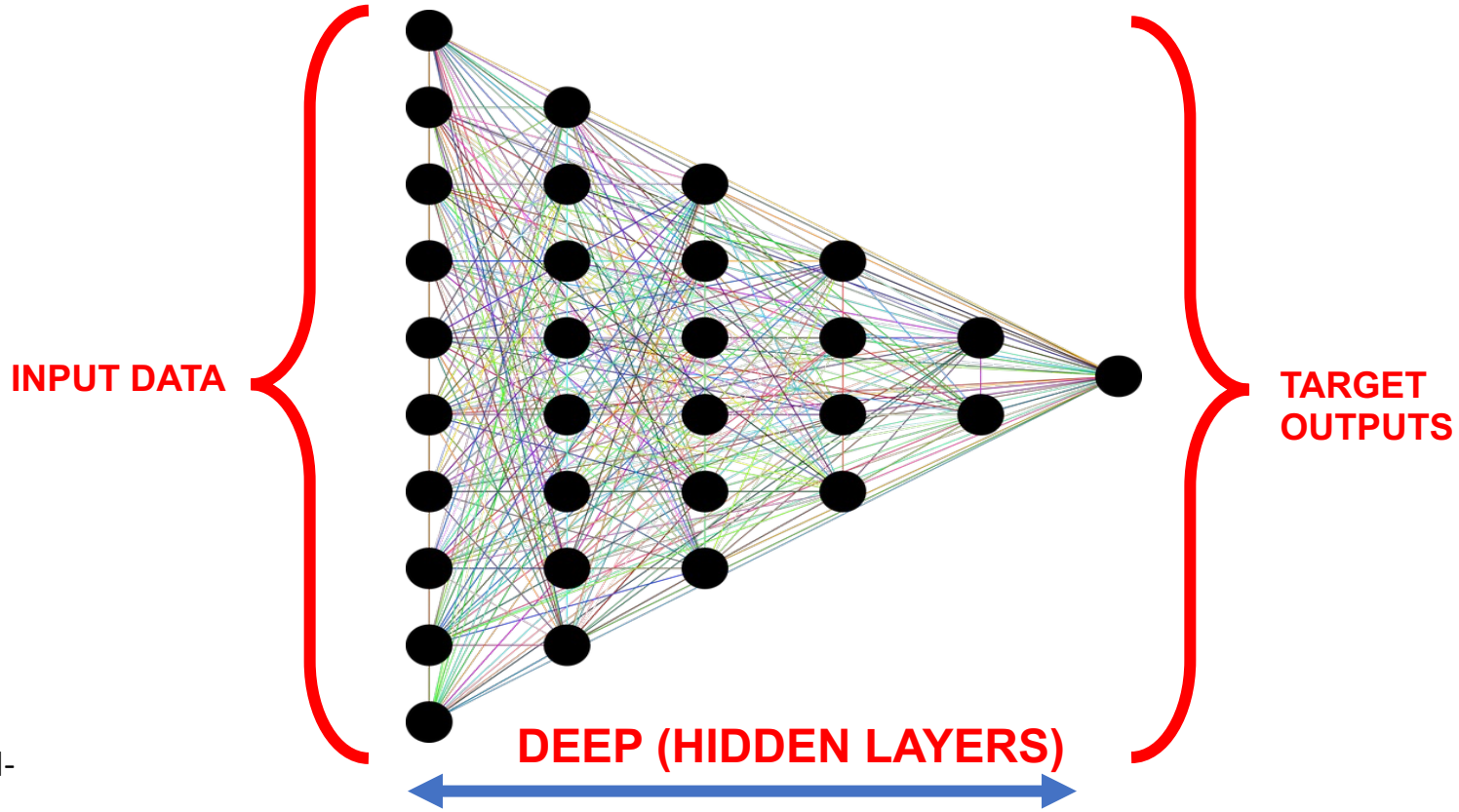


Photo Credit: https://pixabay.com/en/neural-network-thought-mind-mental-3816319/