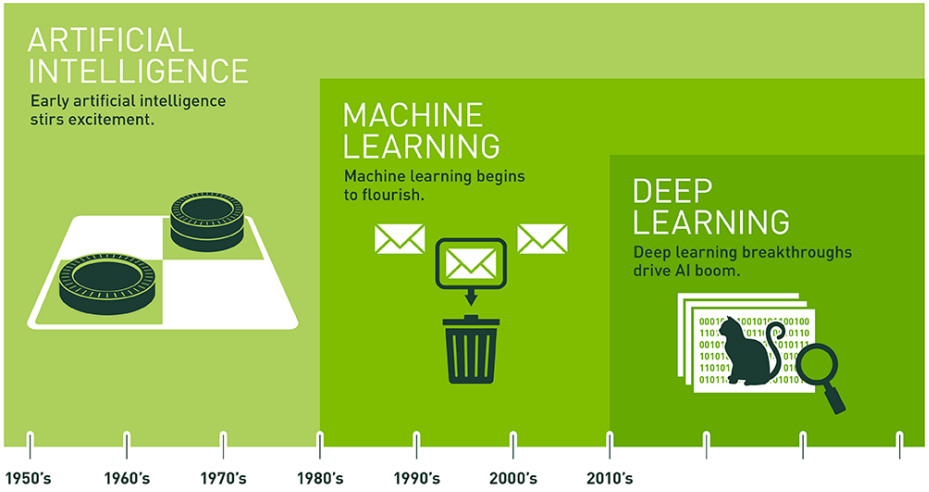
DEEP LEARNING

Introduction

What is AI, ML and DL

- Artificial Intelligence – AI
- Machine Learning – ML
- Deep Learning-DL



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

•**Artificial intelligence** is a science like mathematics or biology. It studies ways to build intelligent programs and machines that can creatively solve problems, which has always been considered a human prerogative.

•**Machine learning** is a subset of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. In ML, there are different algorithms (e.g. neural networks) that help to solve problems.

•**Deep learning**, is a subset of machine learning, which uses the neural networks to analyze different factors with a structure that is similar to the human neural system.

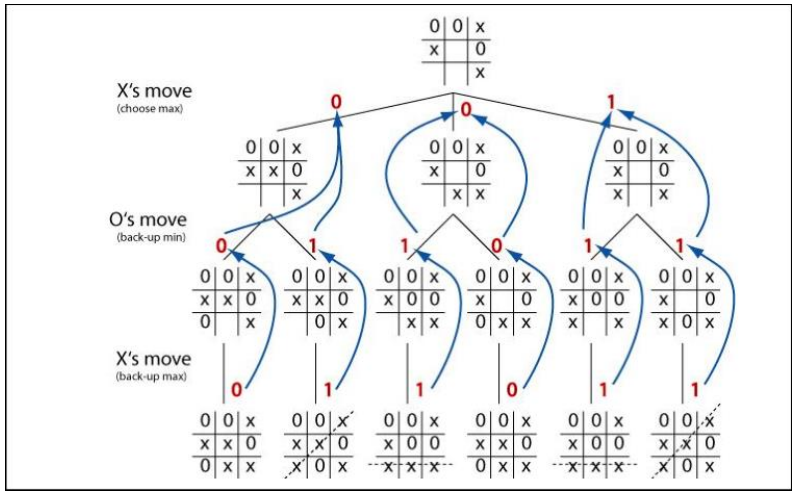
Sources:
https://serokell.io/blog/ai-ml-dl-difference
https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/

Artificial Intelligence - AI

- AI provides optimal or suboptimal solution to a given problem.
- A simple AI example can be seen in the structure of Tic-Tac-Toe AI player.
- if a bot follows the following preprogrammed algorithm, it will never lose a game

> *1. If someone has a "threat" (that is, two in a row), take the remaining square.*
>
> *2. If a move "forks" to create two threats at once, play that move. Otherwise,*
>
> *3. Take the center square if it is free. Otherwise,*
>
> *4. if your opponent has played in a corner, take the opposite corner. Otherwise,*
>
> *5. take an empty corner if one exists. Otherwise,*
>
> *6. take any empty square.*

Some Possible moves in Tic-Tac-Toe game

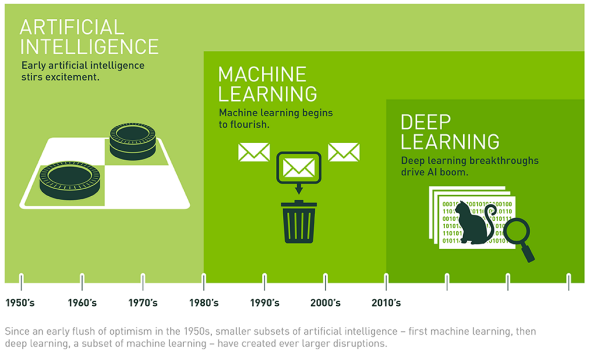


Sources: https://en.wikipedia.org/wiki/Artificial_intelligence
https://becominghuman.ai/ai-machine-learning-deep-learning-explained-in-5-minutes-b88b6ee65846

https://www.researchgate.net/publication/262672371_A_Comparative_Study_of_Game_Tree_Searching_Methods

Artificial Intelligence - AI

- An algorithm like this doesn't possess the cognitive, learning, or problem solving abilities that most people associate an "AI" with.
- And yet, the algorithm is simply an agent that leads to the optimal solution given a problem and its state.
- Agents that fall under AI but not Machine Learning are generally agents that solely utilize decision trees for logic, or agents built with rules and instructions.



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Artificial Intelligence - AI

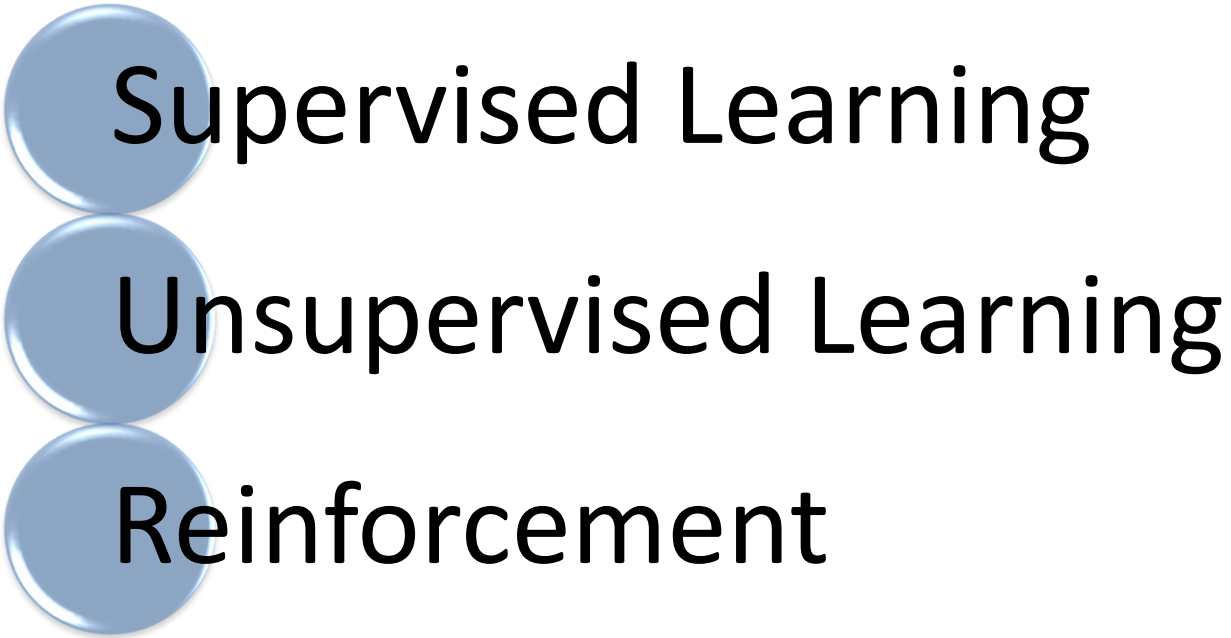
- Some definitions for AI:
- *Any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals* (https://en.wikipedia.org/wiki/Artificial_intelligence)
- *Artificial Intelligence is a branch of computer science dealing with the simulation of intelligent behavior in computers.*
- *Science and technology concerned with imitating, extending, augmenting, and automating the intelligent behaviors of human beings.*
- *Any system of computing capable (in part or in whole) of simulating the decision-making capability of a human being.*
- …
- https://www.igi-global.com/dictionary/artificial-intelligence-ai/1512

Machine Learning -ML

- Machine learning gives computers the ability to learn without being explicitly programmed (Arthur Samuel, 1959)
- Machine learning explores the study and construction of algorithms which can learn and make predictions on data
- Such algorithms follow programmed instructions, but can also make based on data. They build a model from sample inputs.
- Machine learning is done where designing and programming explicit algorithms cannot be done. Examples include spam filtering, detection of network intruders or malicious insiders working towards a data breach, optical character recognition (OCR), search engines and computer vision.
- https://simple.wikipedia.org/wiki/Machine_learning

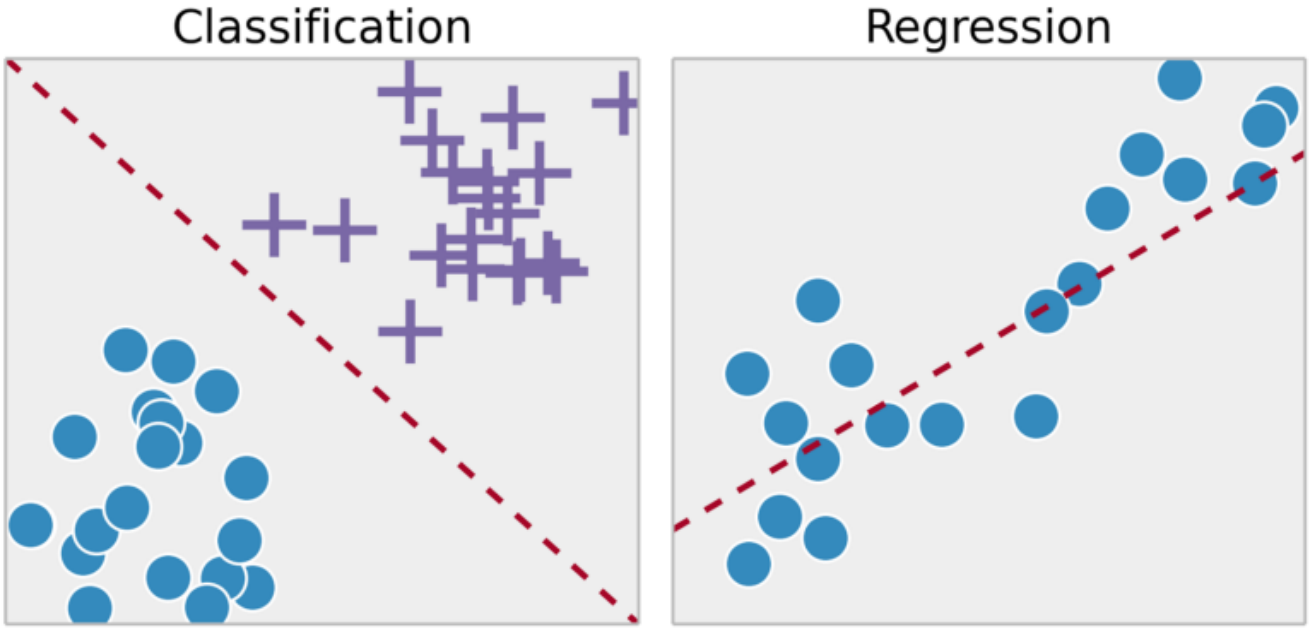
Machine Learning -ML

- There are three types of machine learning :



Machine Learning -ML

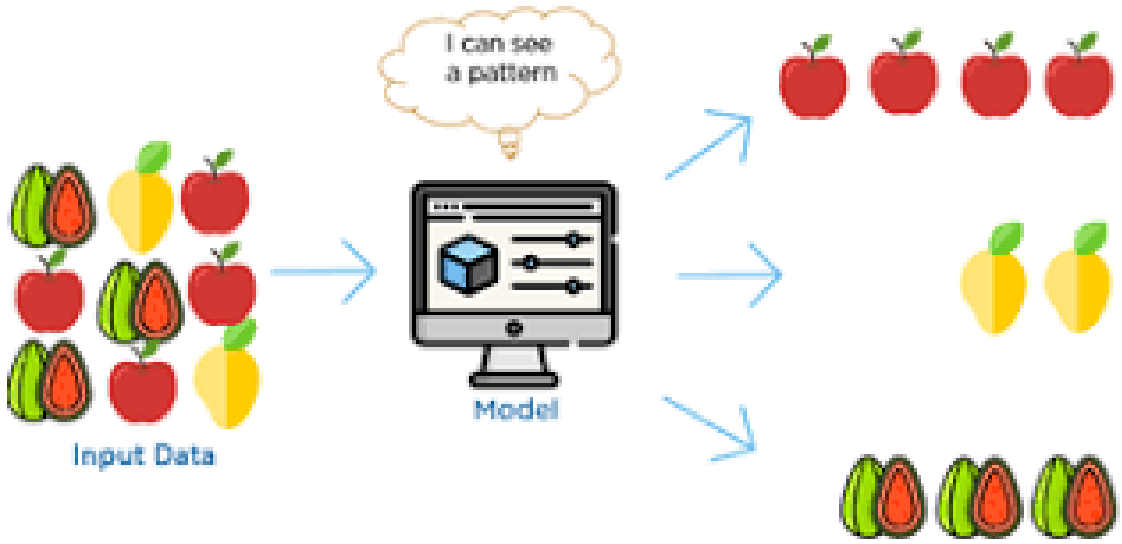
- **Supervised Learning**
- The model is trained using parameters called features and data sets in which outputs are defined for each feature.
- Thus, the model is provided to obtain a correct output for similar inputs that are not used in training.



Source: https://towardsdatascience.com/machine-learning-types-and-algorithms-d8b79545a6ec

Machine Learning -ML

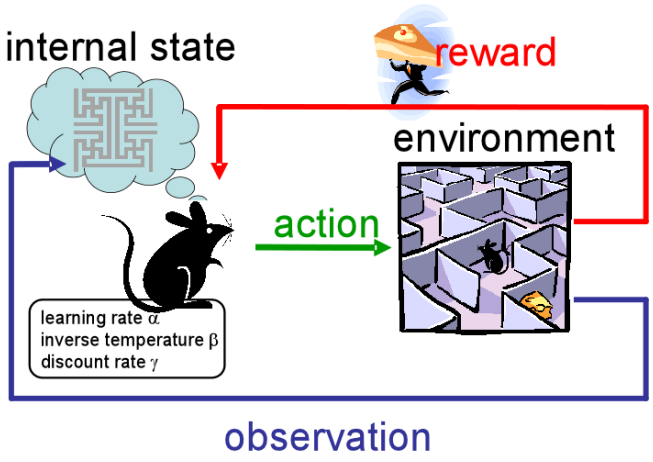
- **Unsupervised Learning**
- It works by finding similarities in the data set.
- In the example of house prices, it can be thought that only the properties of the houses are entered, but the training is carried out without specifying the outputs, that is, the prices.
- For example, by looking at the input parameters with the model, it can be determined that Home1 and Home3 are similar to each other.
- However, the price of the house cannot be predicted.



Source: https://towardsdatascience.com/machine-learning-types-and-algorithms-d8b79545a6ec

Machine Learning -ML

- **Reinforcement Learning:**
- It is about taking appropriate action to maximize reward in a given situation.
- There is no data set for learning and the agent learns through trial and error.



Kay:https://becominghuman.ai/the-very-basics-of-reinforcement-learning-154f28a79071

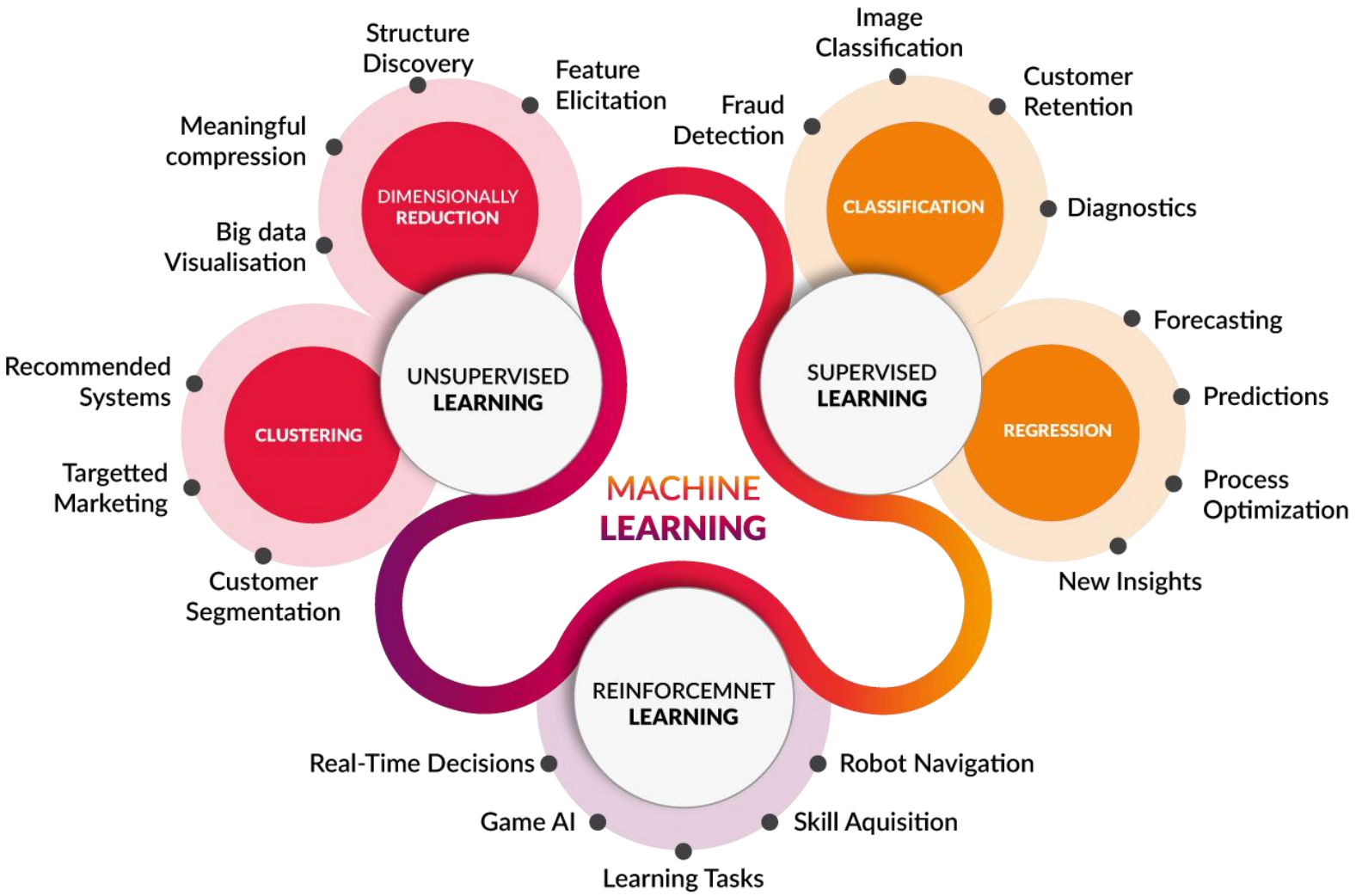
- An agent's action in an environment is interpreted as a reward and state and reported to the agent.
- Giving candy as a result of a baby crying - a reward. Over time, if the child's craving for candy is satisfied, the baby learns to cry every time he asks for candy.

Machine Learning

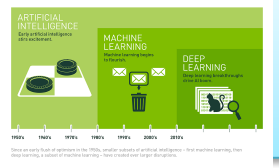
Criteria	Supervised Learning	Unsupervised Learning	Reinforcement Learning
Definition	The machine learns by using labeled data	The machine is trained on unlabeled data without any guidance	An agent interacts with its environment by performing actions & learning from errors or rewards
Type of problems	Regression & classification	Association & clustering	Reward-based
Type of data	Labeled data	Unlabeled data	No predefined data
Training	External supervision	No supervision	No supervision
Approach	Maps the labeled inputs to the known outputs	Understands patterns & discovers the output	Follows the trial-and-error method

Source: https://intellipaat.com/blog/supervised-learning-vs-unsupervised-learning-vs-reinforcement-learning/

Machine Learning



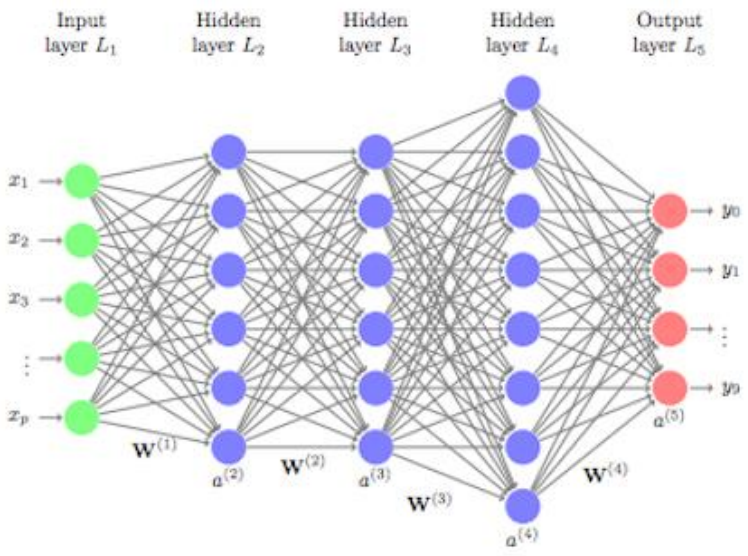
Source: https://towardsdatascience.com/coding-deep-learning-for-beginners-types-of-machine-learning-b9e651e1ed9d



Deep Learning

- Deep learning is inspired by the structure and function of the brain, which consists of many interconnected nerves.
- Most of today's neural networks are organized in layers of nodes and they are "feed-forward", meaning data moves in one direction between them.
- Some layers, such as the Recurrent Neural Network, have feed-backs within themselves.
- There are multiple layers to process features, and generally each layer extracts some information about the applied input.

Fruit fly: 100 thousand neurons
Mouse: 75 million neurons
Cat: 250 million neurons
Chimpanzee: 7 billion neurons
Human brain: 86 billion neurons
Elephant: 257 billion neurons
https://www.verywellmind.com/how-many-neurons-are-in-the-brain-2794889



Deep Learning

- The reasons for the recent developments in deep learning

1952 Stochastic Gradient Descent

1958 Perceptron
- Learnable Weights

1986 Backpropagation
- Multi-Layer Perceptron

1995 Deep Convolutional NN
- Digit Recognition

Neural Networks date back decades, so why the resurgence?

1. Big Data
- Larger Datasets
- Easier Collection & Storage

IMAGENET

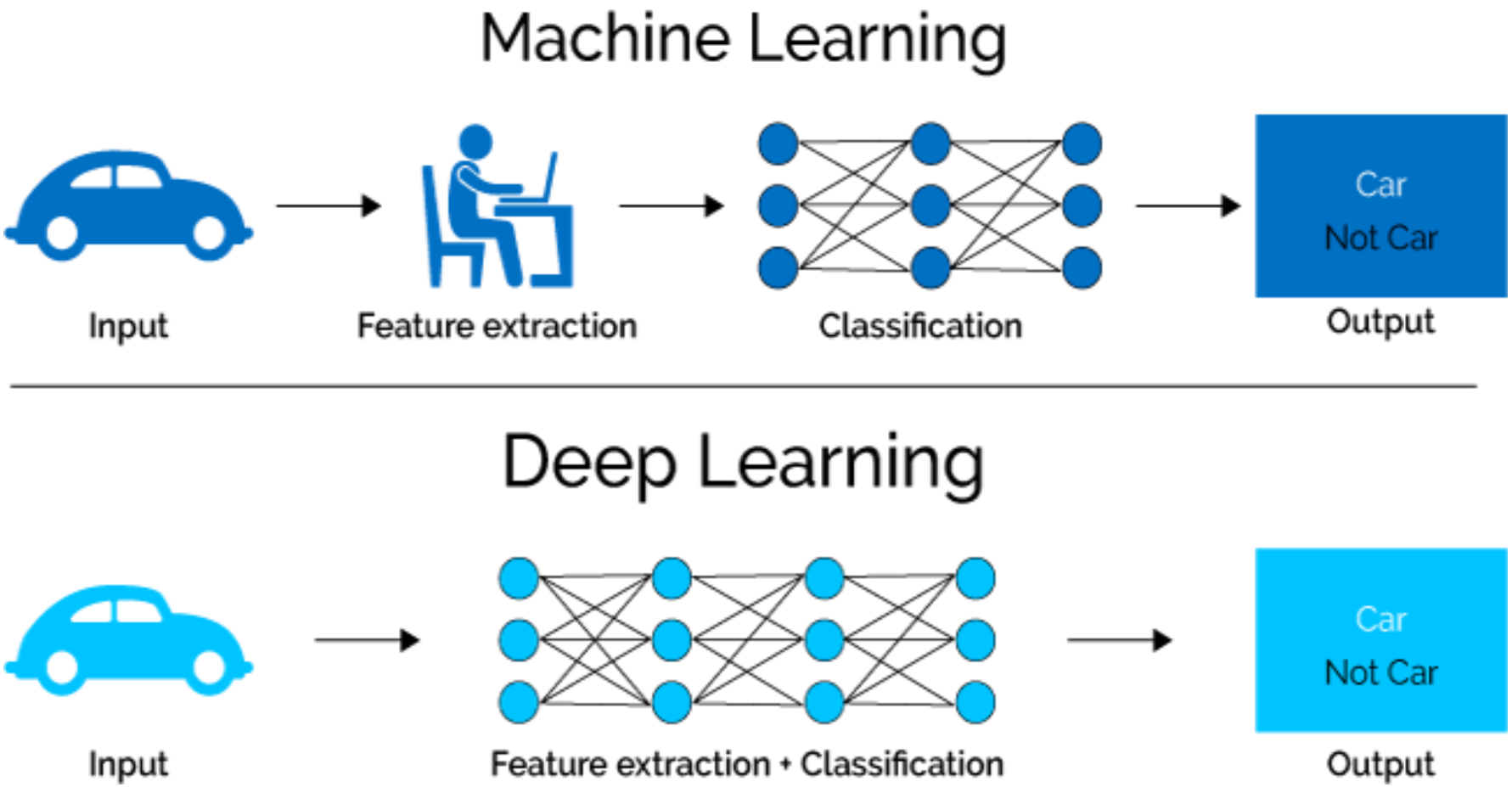
WIKIPEDIA The Free Encyclopedia

2. Hardware
- Graphics Processing Units (GPUs)
- Massively Parallelizable

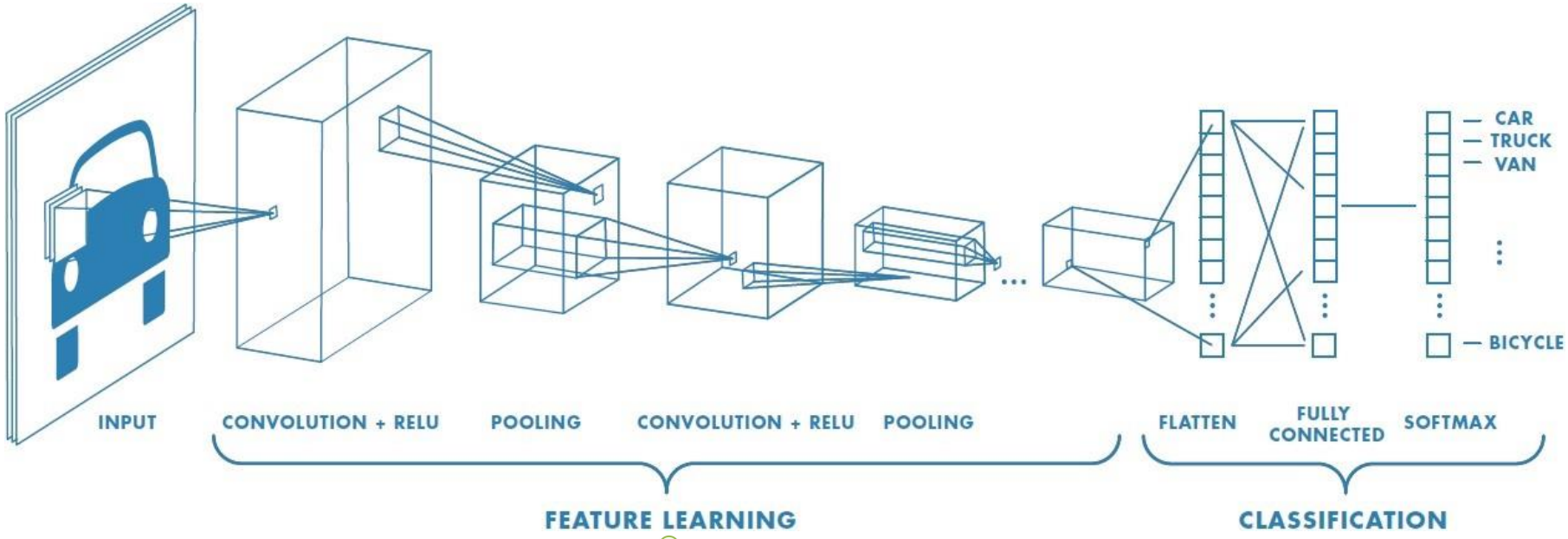
3. Software
- Improved Techniques
- New Models
- Toolboxes

TensorFlow

Deep Learning vs. Machine Learning



Deep Learning



The deep learning model also includes the process of extracting the necessary features of the problem before the decision-making mechanism.

Kaynak: https://medium.com/@RaghavPrabhu/understanding-of-convolutional-neural-network-cnn-deep-learning-99760835f148

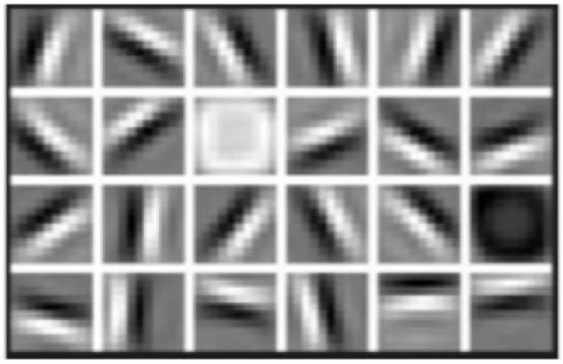
Deep Learning

Why Deep Learning?

Hand engineered features are time consuming, brittle and not scalable in practice

Can we learn the **underlying features** directly from data?

Low Level Features



Lines & Edges

Mid Level Features

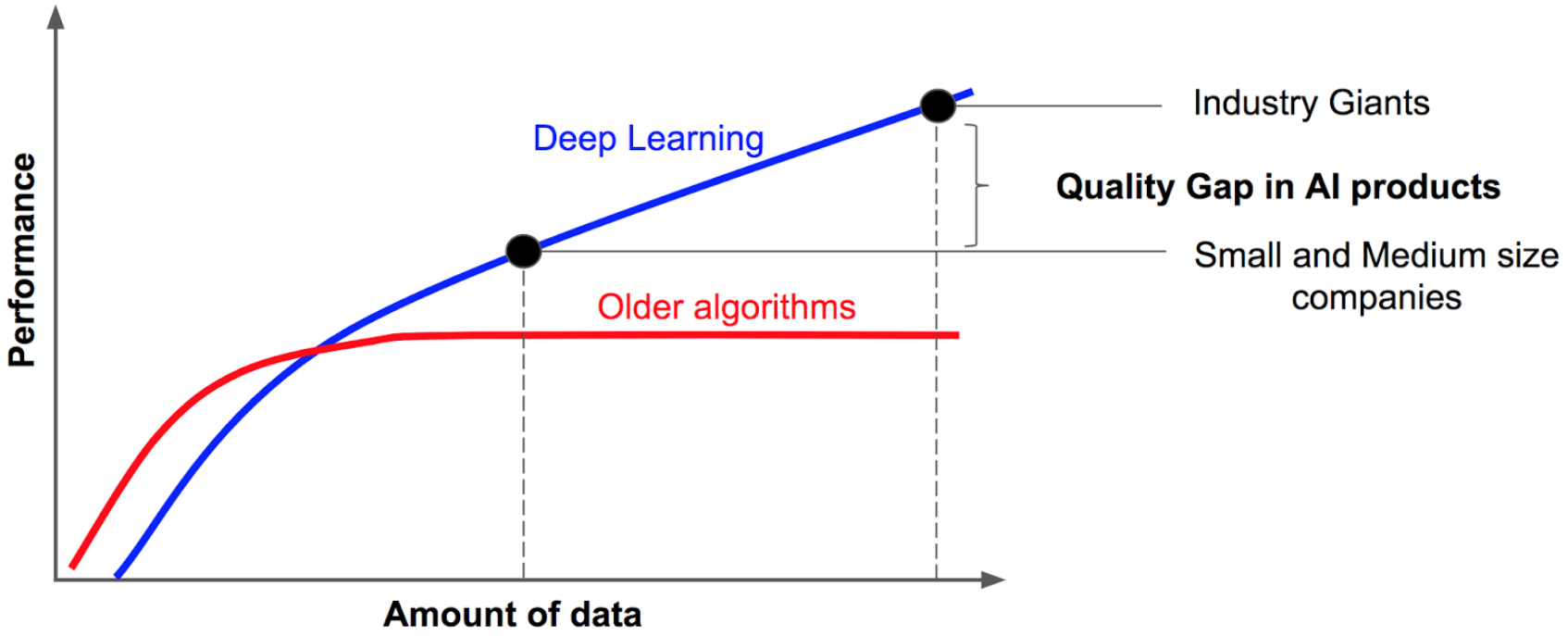
Eyes & Nose & Ears

High Level Features

Facial Structure

Deep Learning

- As the amount of data increases, better generalization is made and the performance of deep learning algorithms increases.



Kaynak: http://hackernoon.storage.googleapis.com/%EF%B8%8F-big-challenge-in-deep-learning-training-data-31a88b97b282

Example DL architecture

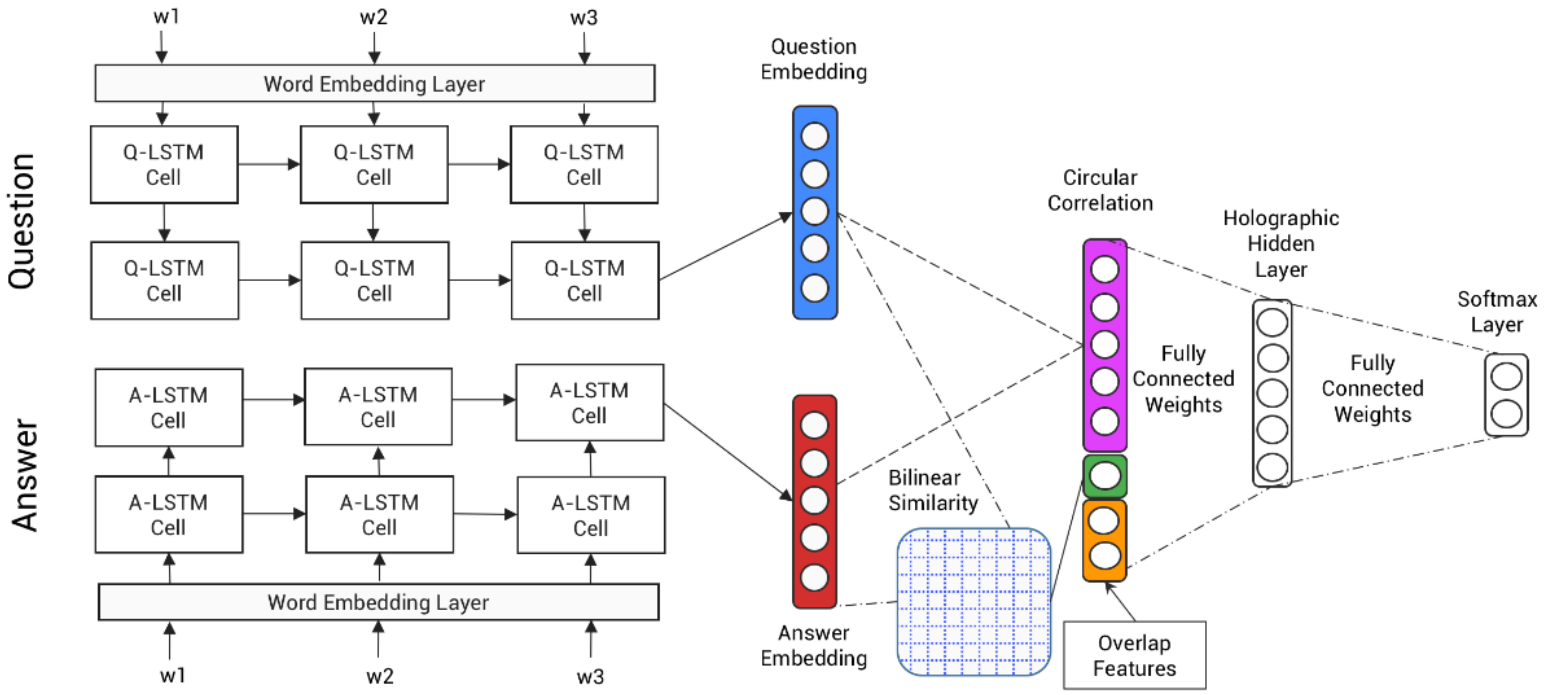
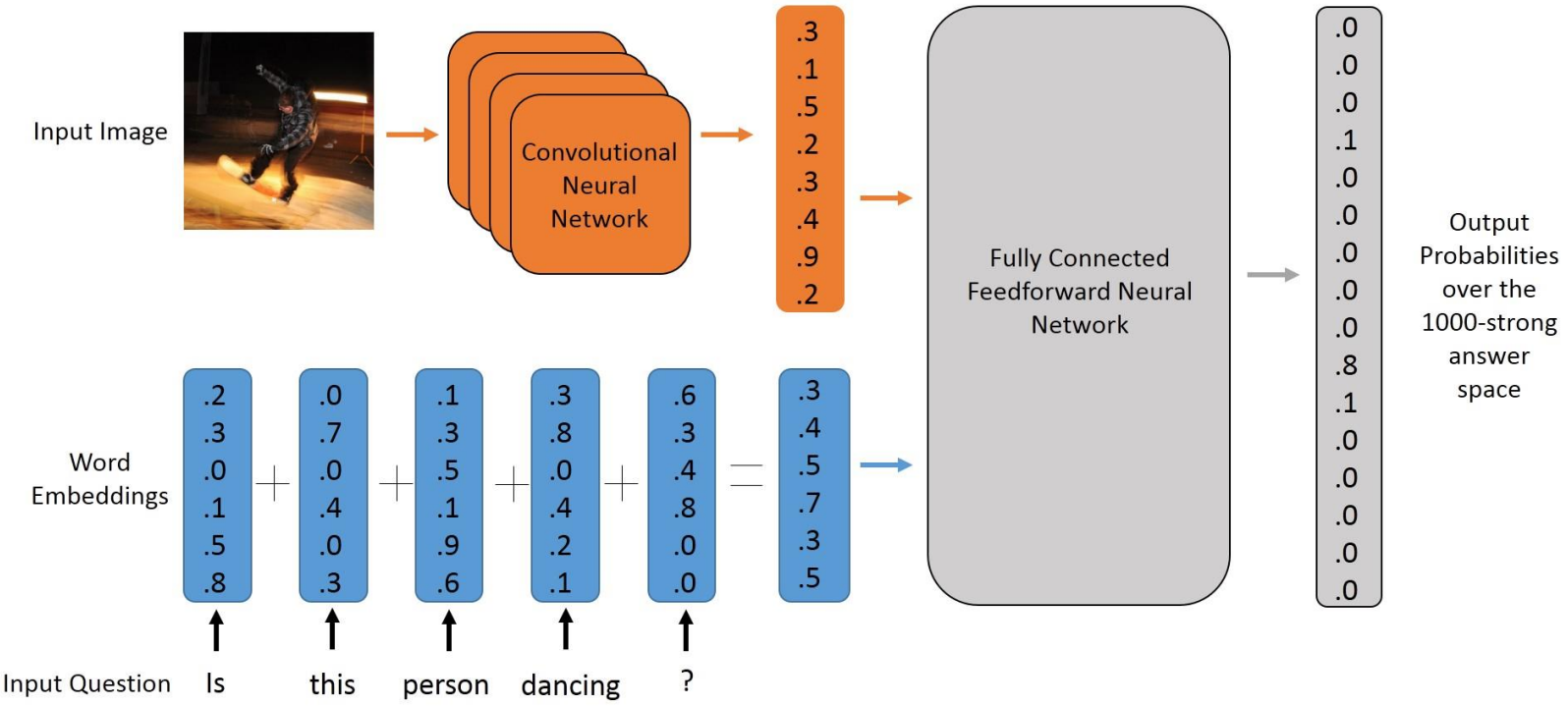


Figure 1: Holographic Dual LSTM Deep Learning Model for Ranking of QA Pairs

Source: https://arxiv.org/pdf/1707.06372.pdf

Example DL architecture



Source: https://www.kdnuggets.com/2015/11/deep-learning-visual-question-answering.html