

ELC 4028

Artificial Neural Networks and
its Applications

by

Dr. Mona Riyad

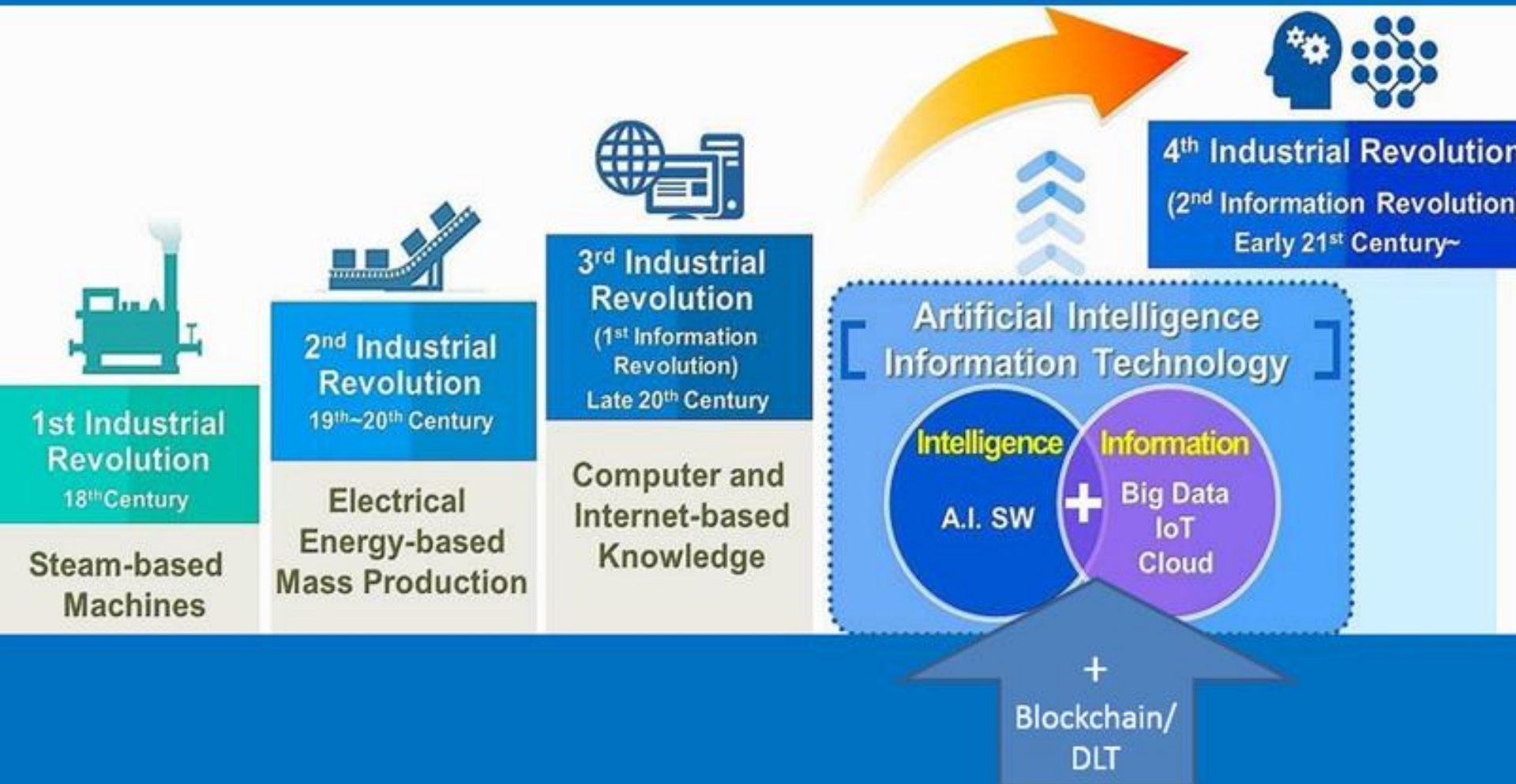
Dr. Mohsen Rashwan

Introduction

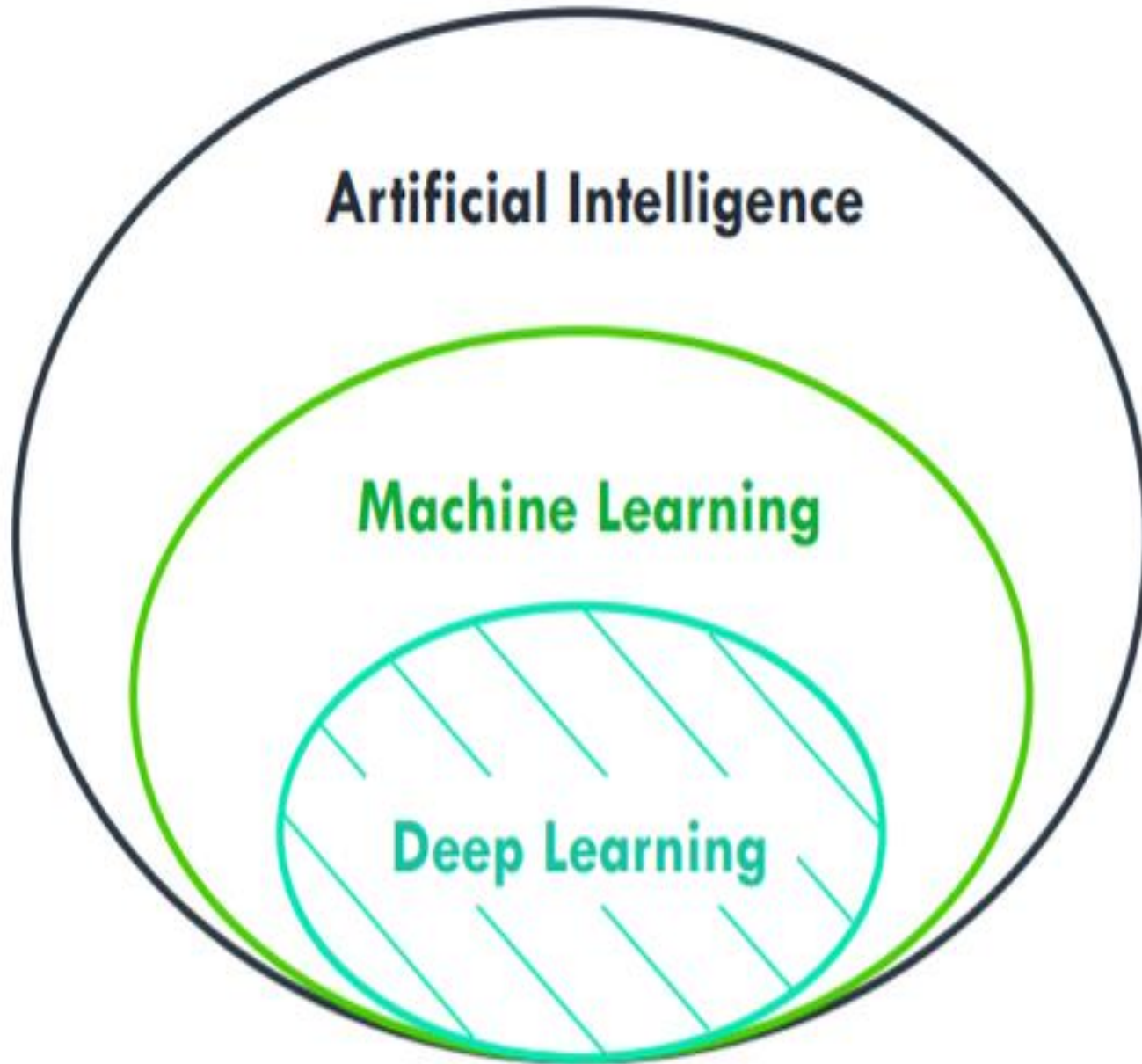
Importance of Machine Learning and Artificial Intelligence

AI is the core of the 4th Industrial revolution

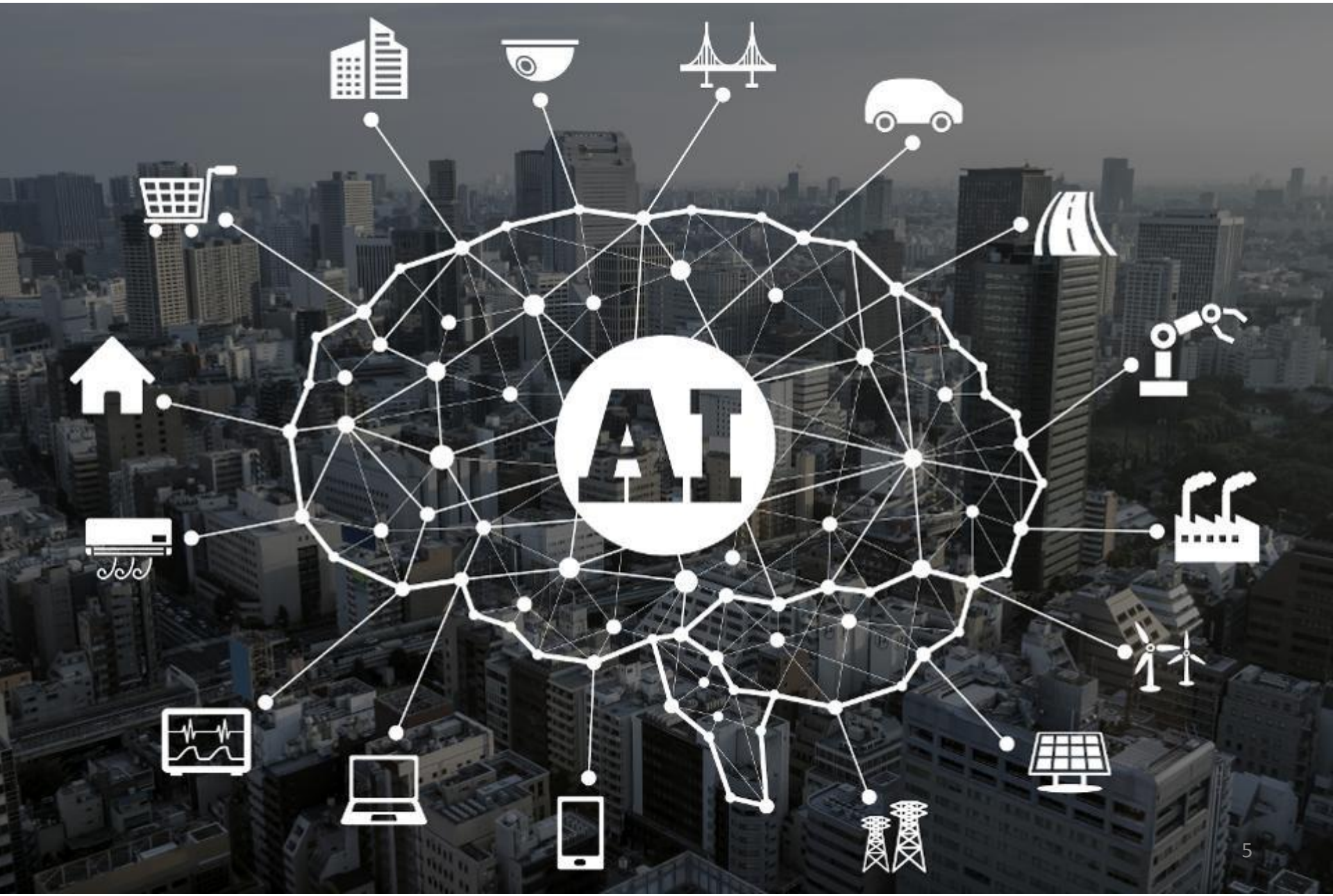
The Fourth Industrial Revolution



The confluence and convergence of emerging technologies



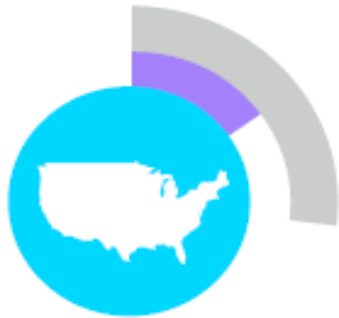
AI impact of Human Life



AI CAN DOUBLE ECONOMIES' SIZE

Number of years for the economy to double in size
(a full circle represents 100 years)

United States



United Kingdom



Germany



France



Japan



Italy



A stylized graphic of a human head profile in brown, facing right. Inside the head, there is a yellow circuit-like pattern with lines and dots. The background is blue with white and yellow circuit-like lines and dots.

AI HELPS PEOPLE BE MORE PRODUCTIVE

40%

INCREASE IN LABOR
PRODUCTIVITY BY 2035

What is AI?

AI involves multiple technologies that can be combined in different ways to sense, comprehend, act and learn.

The Jobs Landscape in 2022

emerging
roles,
global
change
by 2022

**133
Million**

Top 10 Emerging

1. Data Analysts and Scientists
2. AI and Machine Learning Specialists
3. General and Operations Managers
4. Software and Applications Developers and Analysts
5. Sales and Marketing Professionals
6. Big Data Specialists
7. Digital Transformation Specialists
8. New Technology Specialists
9. Organisational Development Specialists
10. Information Technology Services

declining
roles,
global
change
by 2022

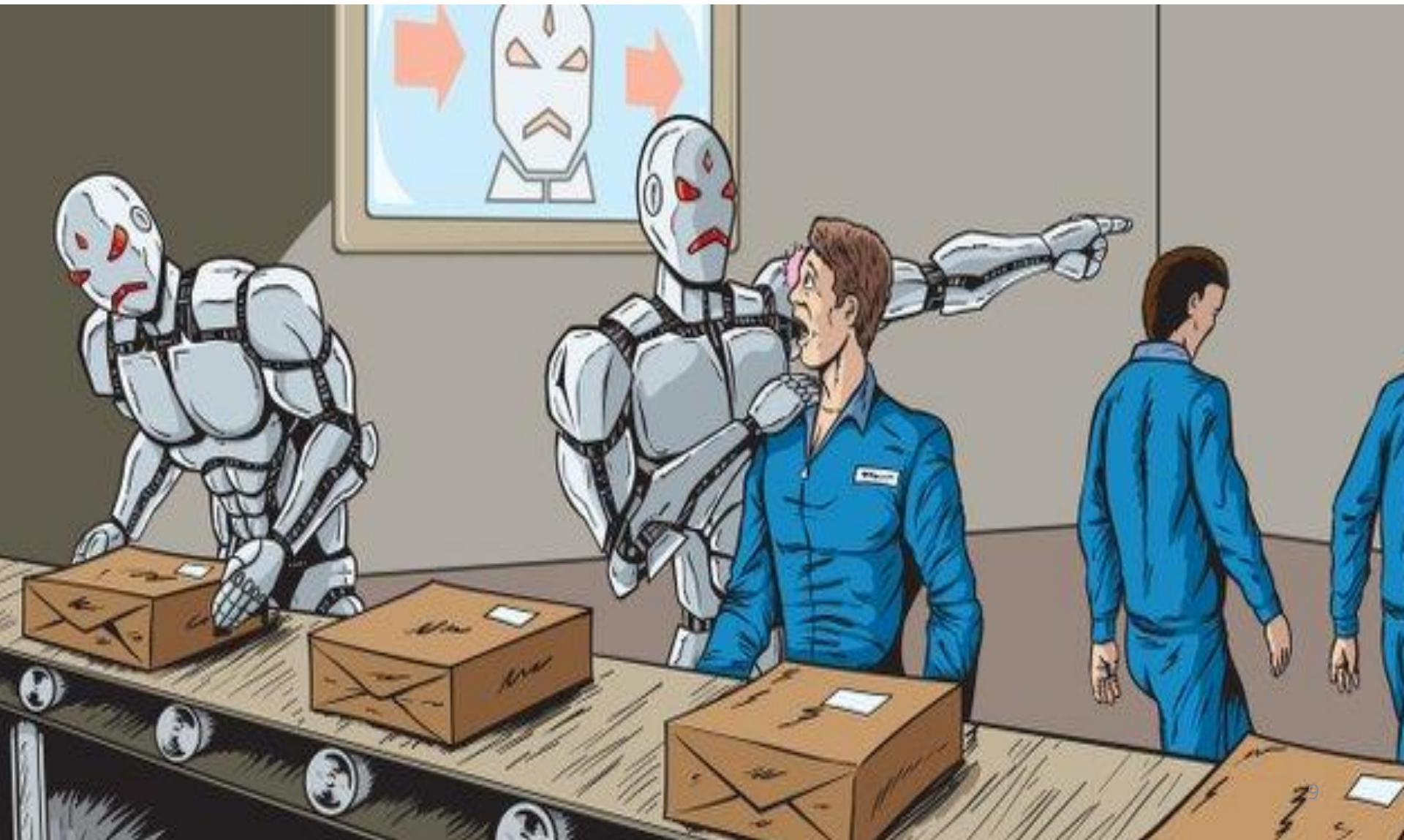
**75
Million**

Top 10 Declining

1. Data Entry Clerks
2. Accounting, Bookkeeping and Payroll Clerks
3. Administrative and Executive Secretaries
4. Assembly and Factory Workers
5. Client Information and Customer Service Workers
6. Business Services and Administration Managers
7. Accountants and Auditors
8. Material-Recording and Stock-Keeping Clerks
9. General and Operations Managers
10. Postal Service Clerks

Source: Future of Jobs Report 2018, World Economic Forum

Many Jobs will disappear



Factors enabling AI Growth (by [Hardik Gohil](#))

1. Availability of huge **Data**

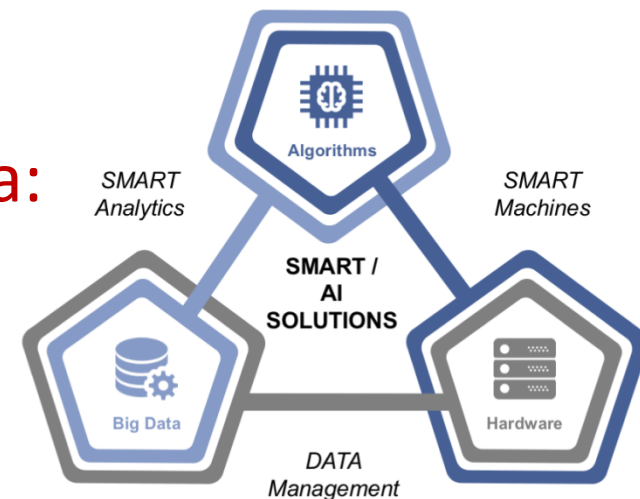
- Data is **Gold**
- World's data **doubles** every **18** months

2. More advanced **Algorithms**

- Algorithms that suits the **big data**:
- More utilization of:
 - **Unsupervised** algorithms
 - **Reinforcing** algorithms

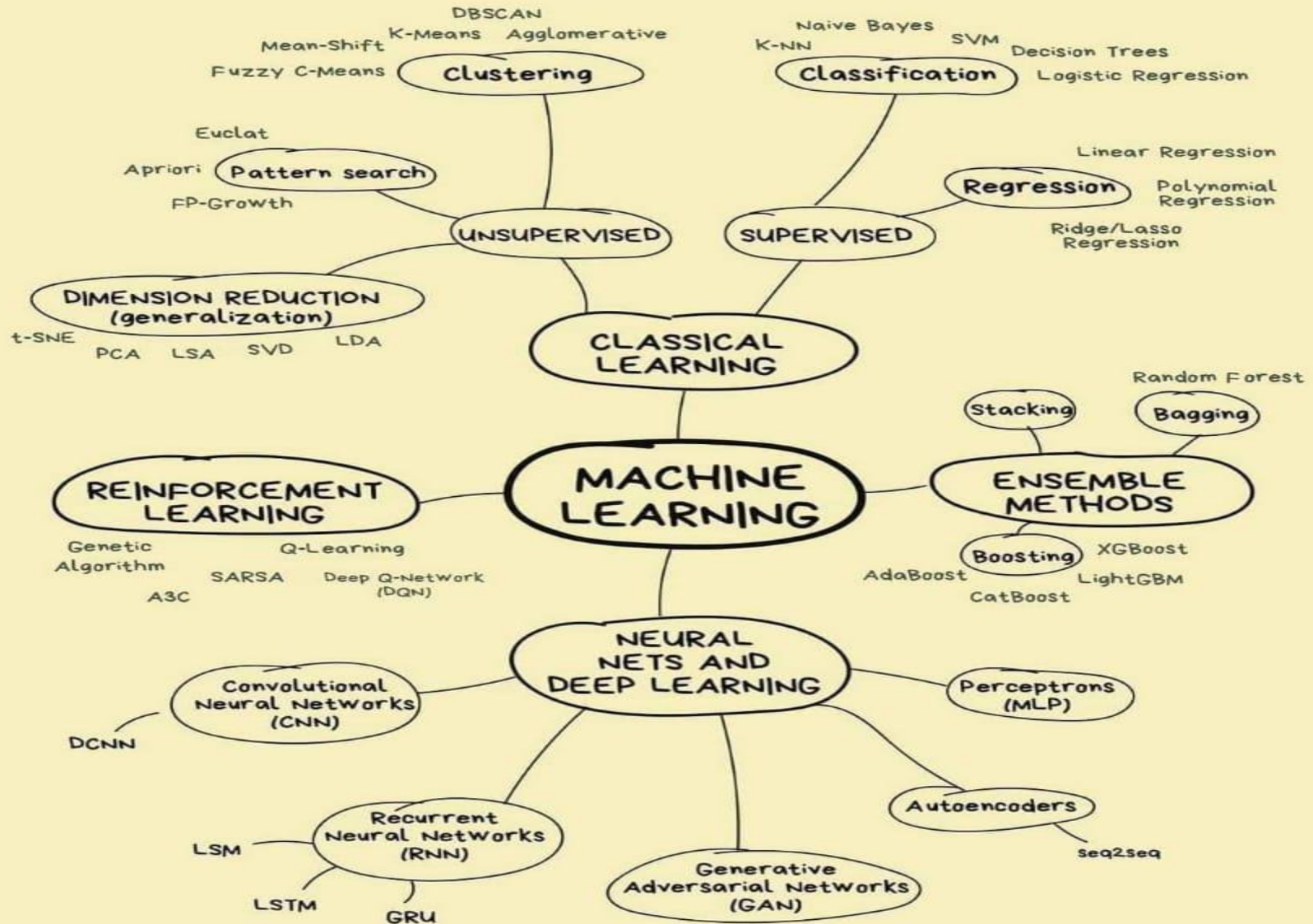
3. Better **hardware** & **Cloud** with AI

- Better **GPUs** and cheaper
- Increasing **cloud** with AI tools

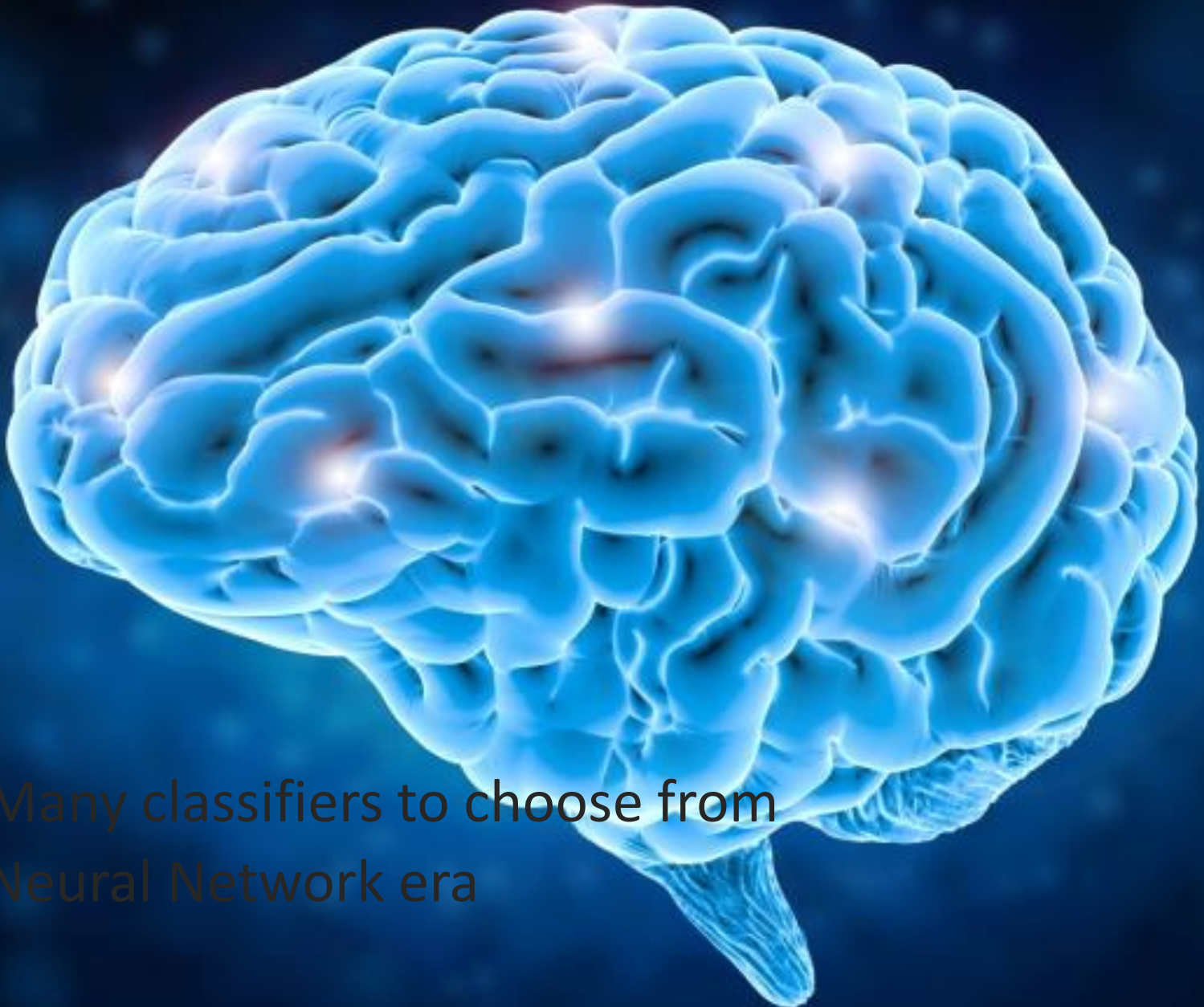


Machine Learning

Machine Learning



The Big Picture

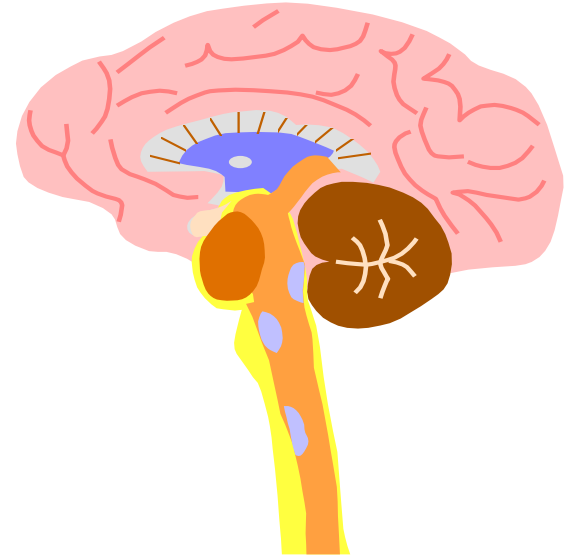
A 3D rendering of a human brain, colored in a vibrant blue. The brain is shown from a slightly elevated, lateral perspective. Several bright, glowing white and yellow spots are scattered across the cortical surface, representing areas of increased neural activity or specific functional regions. The background is a dark, deep blue with a subtle pattern of small, distant white stars, giving it a futuristic or scientific feel.

Many classifiers to choose from
Neural Network era

Brain and Machine

- The Brain

- Pattern Recognition
- Association
- Complexity
- Noise Tolerance



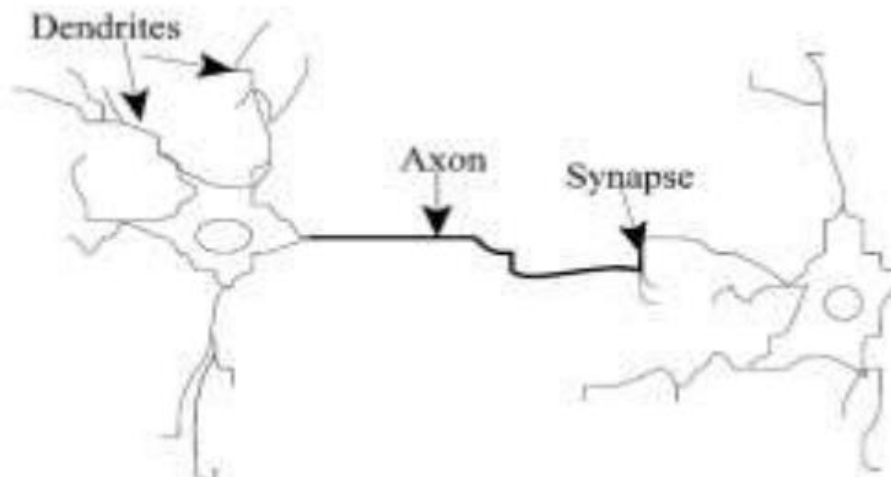
- The Machine

- Calculation
- Precision
- Logic

Contents of the first part

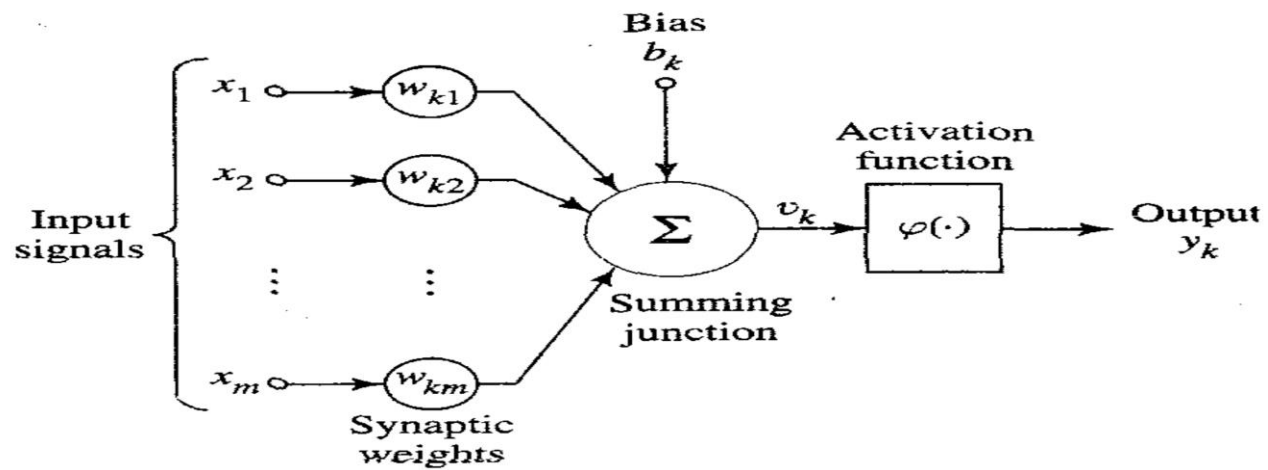
- Introduction
- The structure of the brain
- The perceptron
- Types of activation function
- Single layer and multi-layer networks
- Back-Propagation Algorithm
- Hopfield Network
- Kohonen Self Organized Networks

Introduction



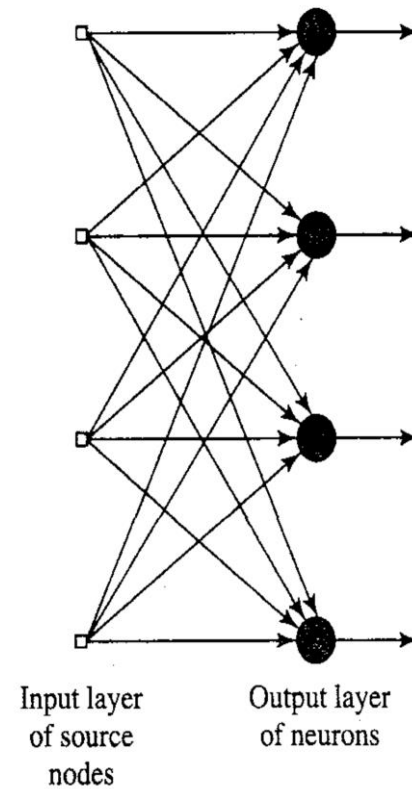
Structure of biological neuron

Artificial neuron

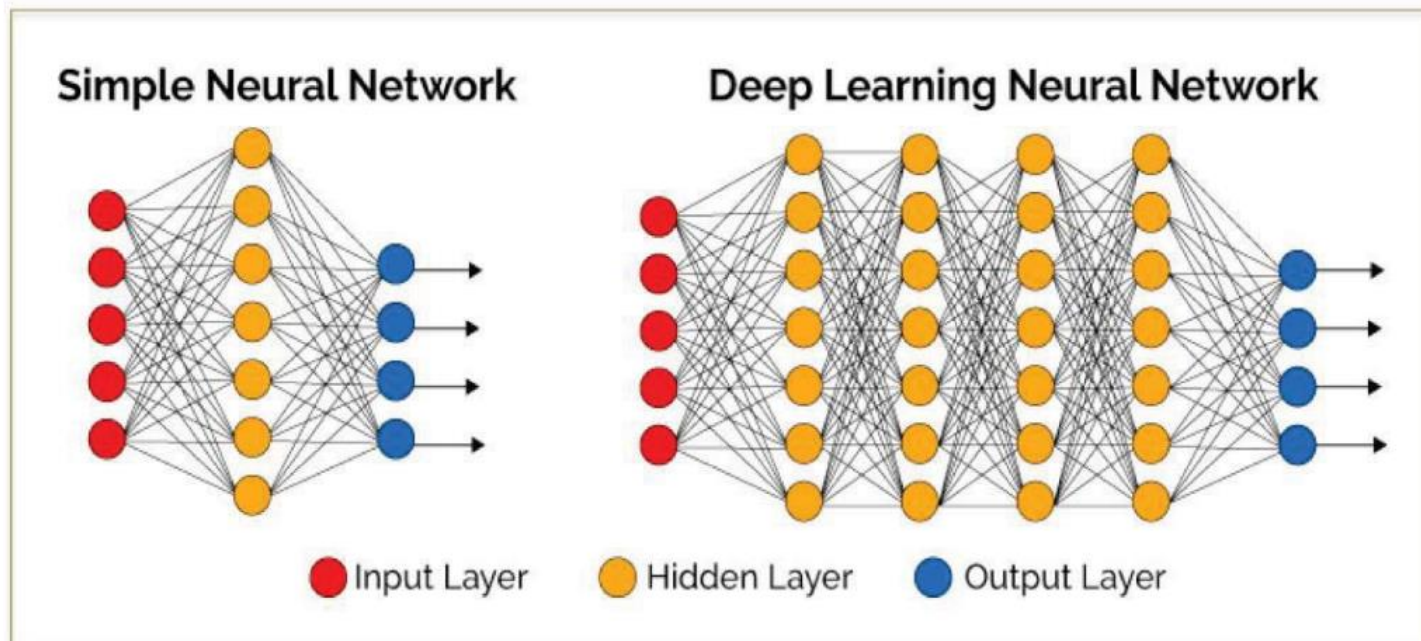


Neural Network Architectures

1- Single layer feedforward networks



- **2- Multilayer feedforward networks**



- 3- Recurrent Network (Hopfield NN)

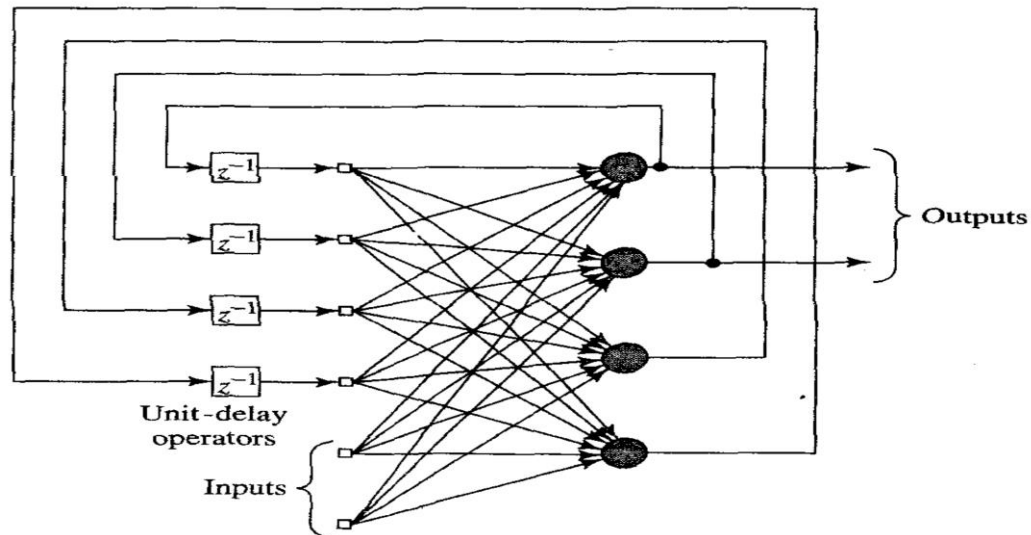


FIGURE 1.18 Recurrent network with hidden neurons.

Contents of the Second part

- Introduction
- Data preparation for machine learning
- Classical machine learning techniques
- Deep Neural Network Structures:
 - CNN with its variants and ImageNet project
 - Attention and Transformers
 - Language Modeling: BERT and GPT projects (ChatGPT project and effect)
 - GAN Models

Data Preparation for Machine Learning

Data Collection

```
graph TD; A[Data Collection] --> B[Data reduction techniques]; B --> C[Data Cleansing];
```

Data reduction techniques

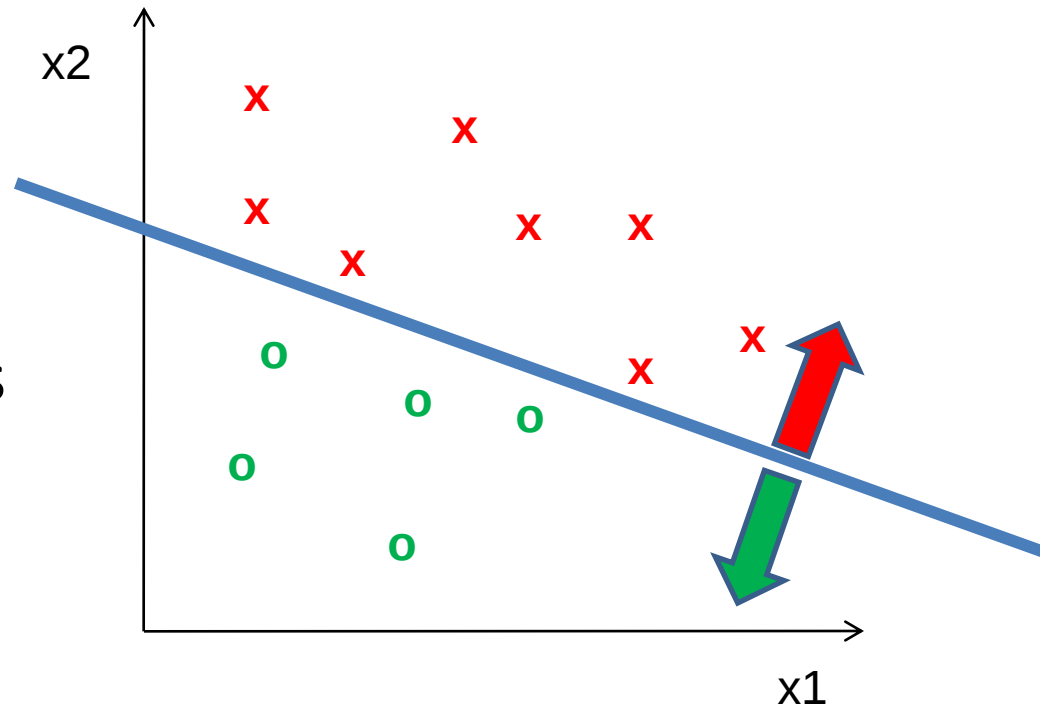
- K-means clustering, Gaussian Mixture Model
- Principal Component Analysis

Data Cleansing

Many classifiers to choose from (Classical Techniques)

- SVM
- Naïve Bayes
- Bayesian network
- Logistic regression
- Randomized Forests
- Boosted Decision Trees
- K-nearest neighbor
- ...etc.

Which is the best one?



Deep Learning using

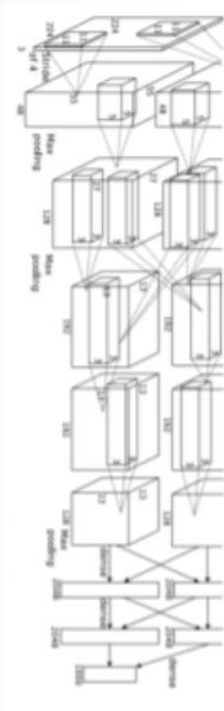
Deep Structures of Neural Network

Deep Neural Network Structures

CNN and its Variants

to deal with images (ImageNet Project)

“AlexNet”



[Krizhevsky et al. NIPS 2012]

“GoogLeNet”



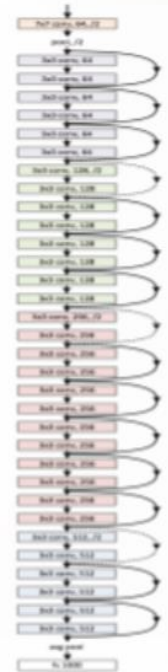
[Szegedy et al. CVPR 2015]

“VGG Net”



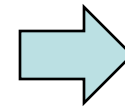
[Simonyan & Zisserman,
ICLR 2015]

“ResNet”



[He et al. CVPR 2016]

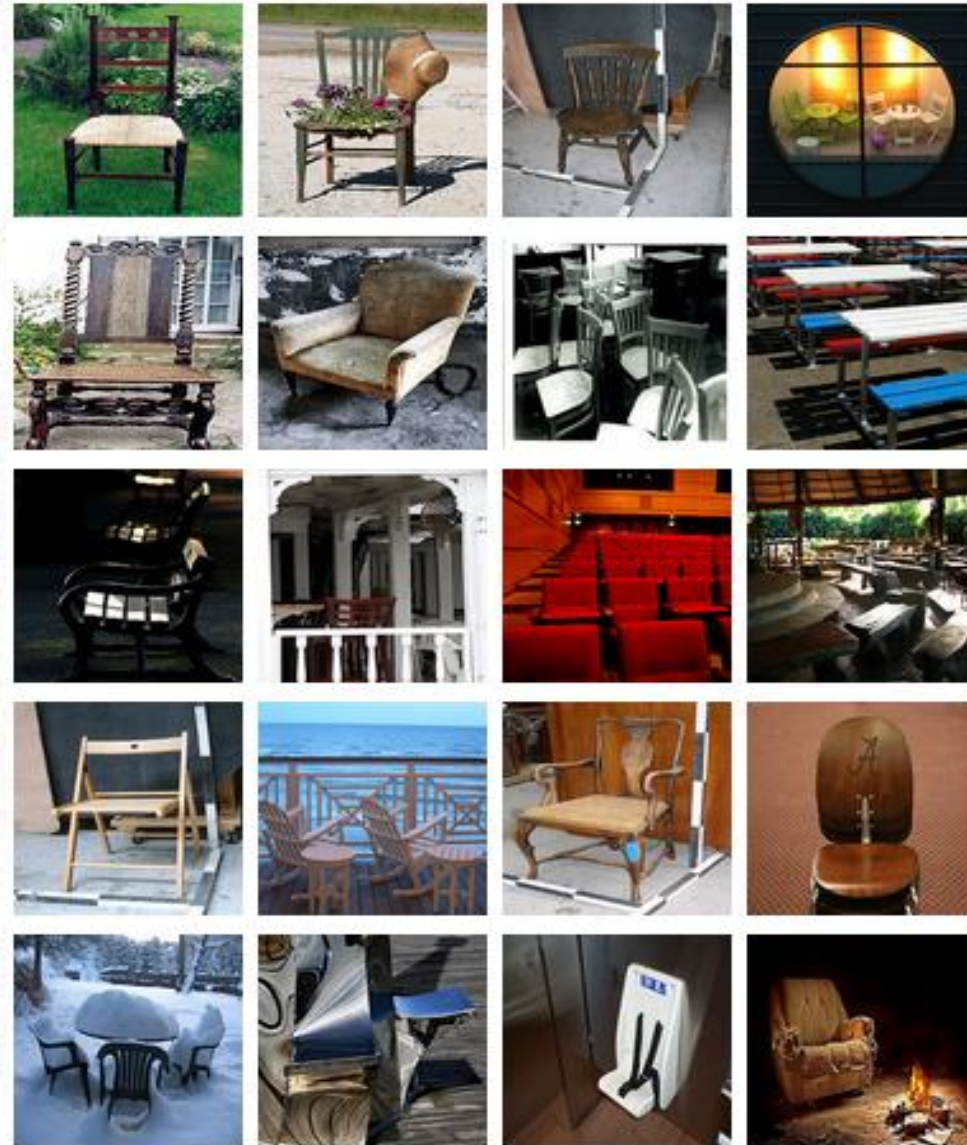
ImageNet Challenge

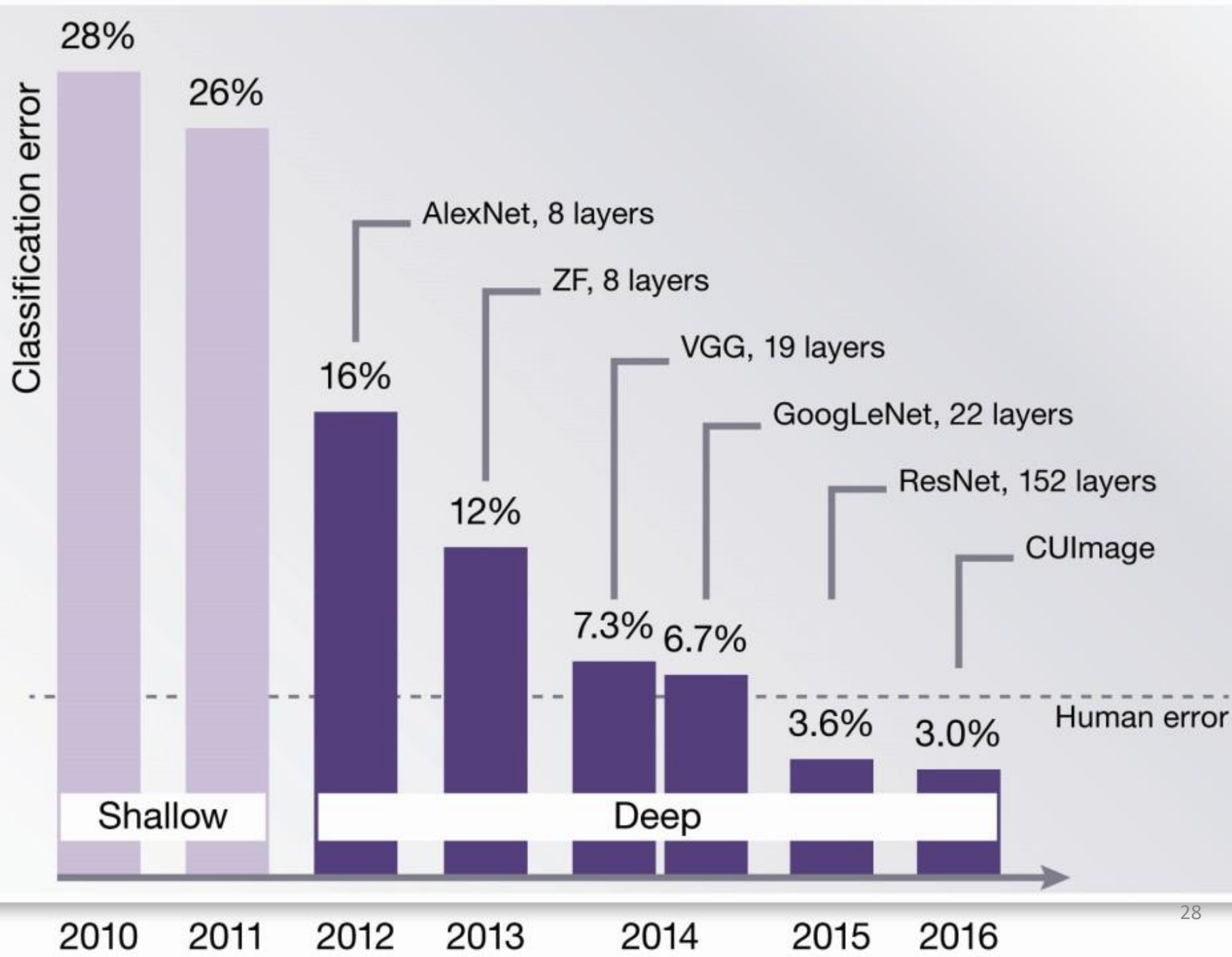


Useful in many Image
Application

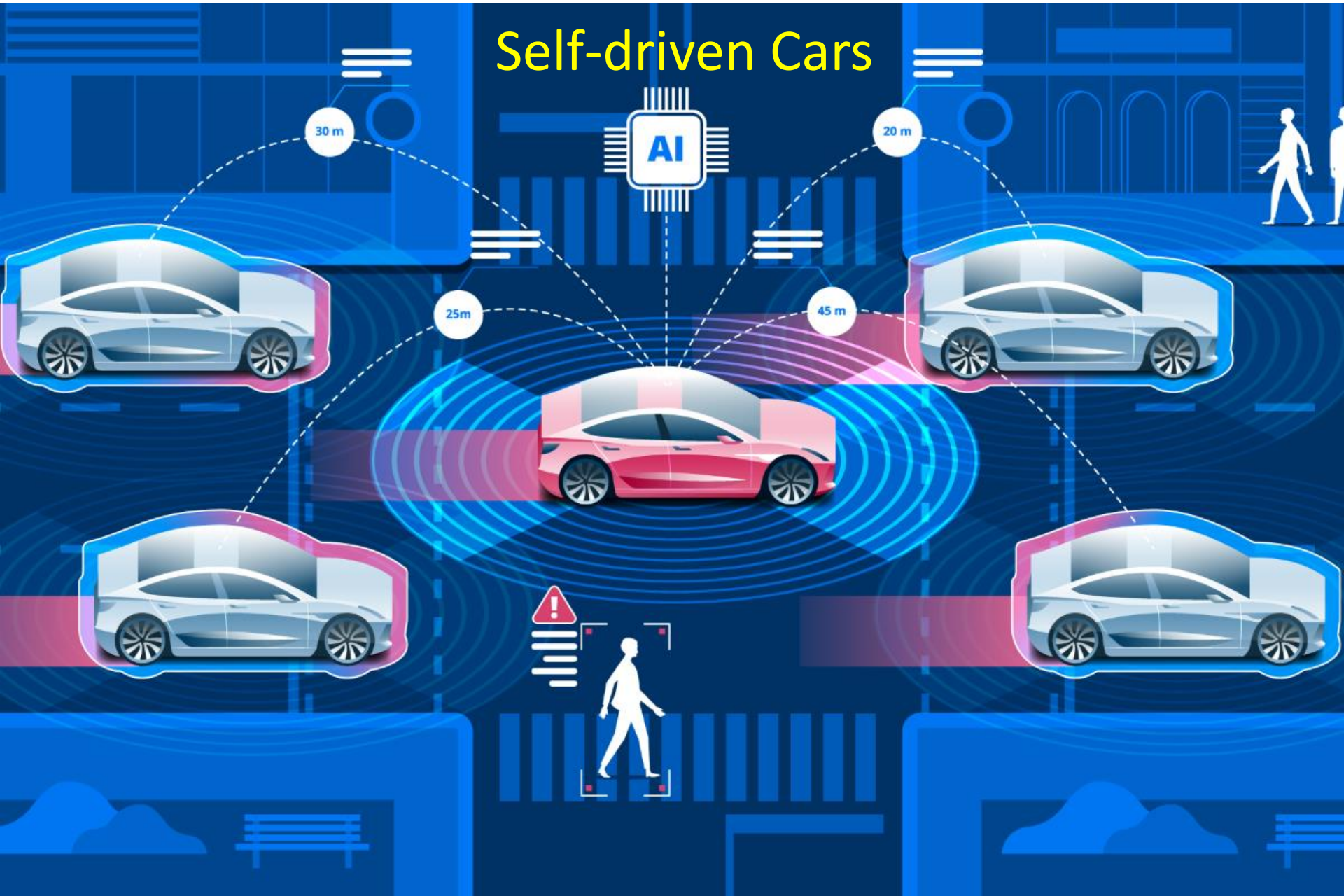
IMAGENET

- 1,000 object classes (categories).
- Images:
 - 1.2 M train
 - 100k test.

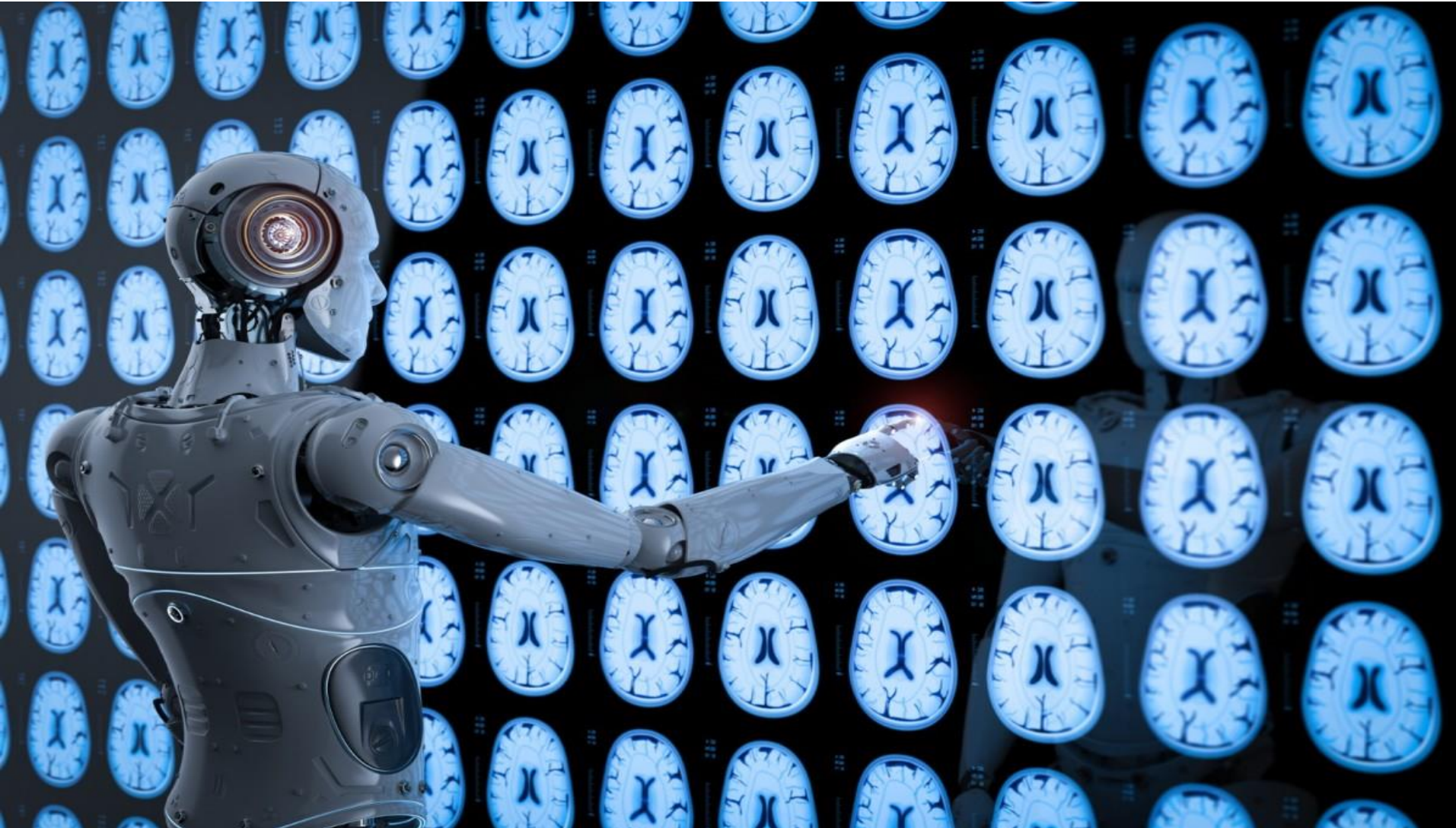




Self-driven Cars



Medical Imaging Automatic Diagnosis



Medical Operations

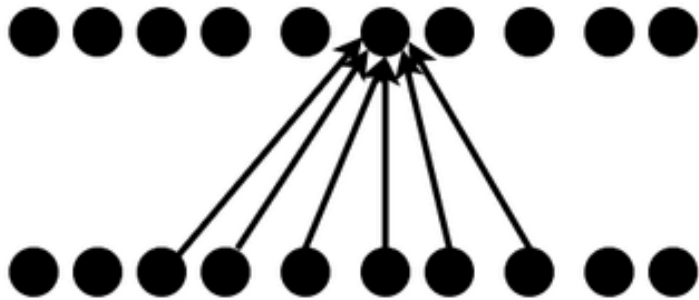


Deep Neural Network Structures

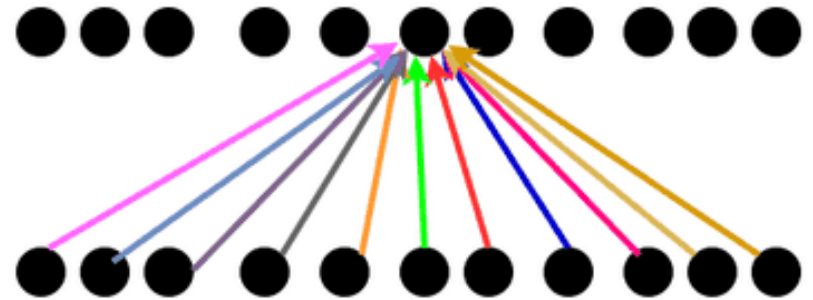
Attention & Transformers

Attention

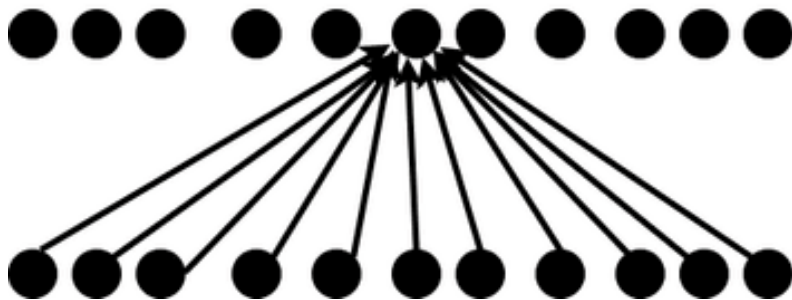
Convolution



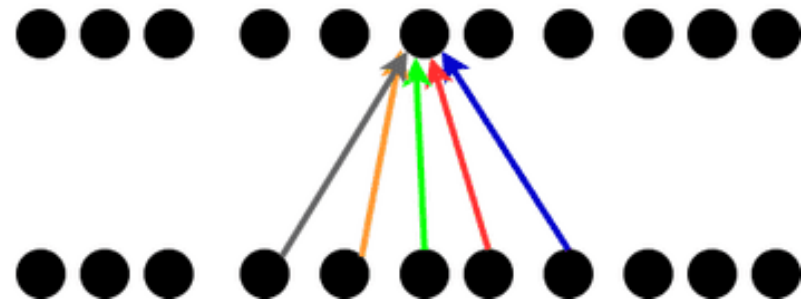
Global attention



Fully Connected layer

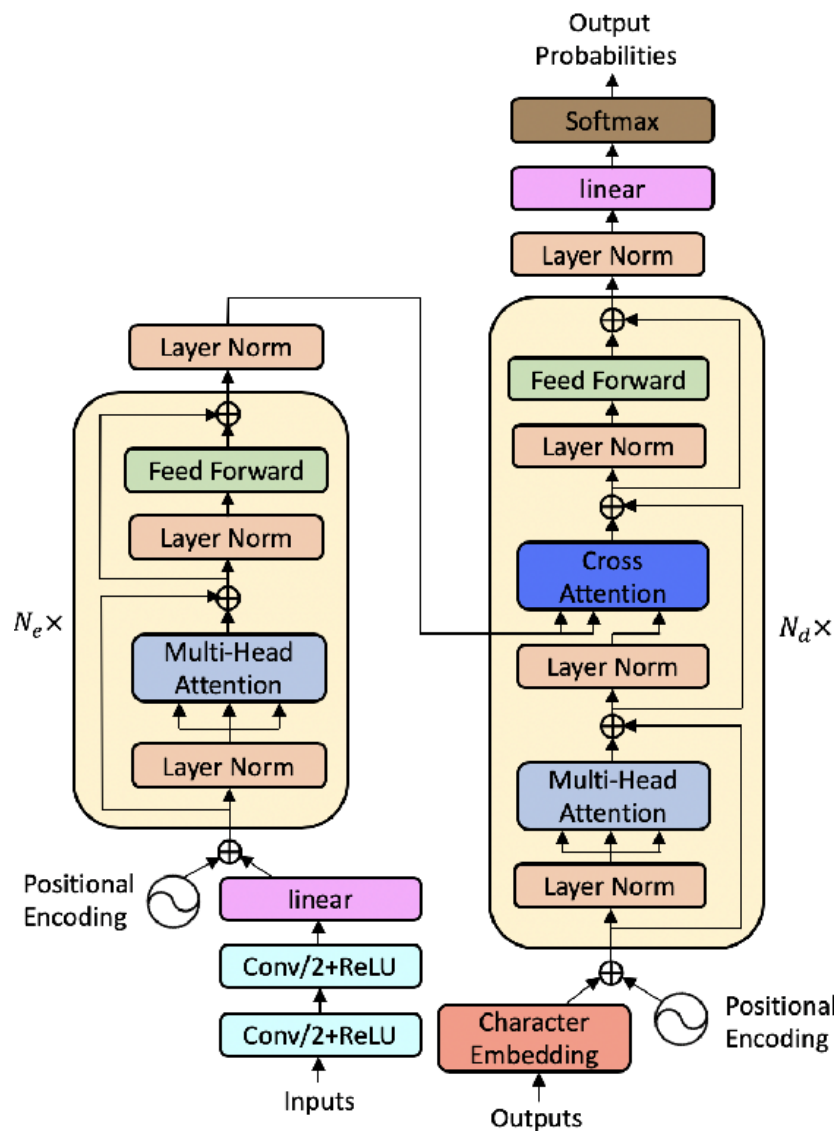


Local attention



Deep Neural Networks Structures

Transformers

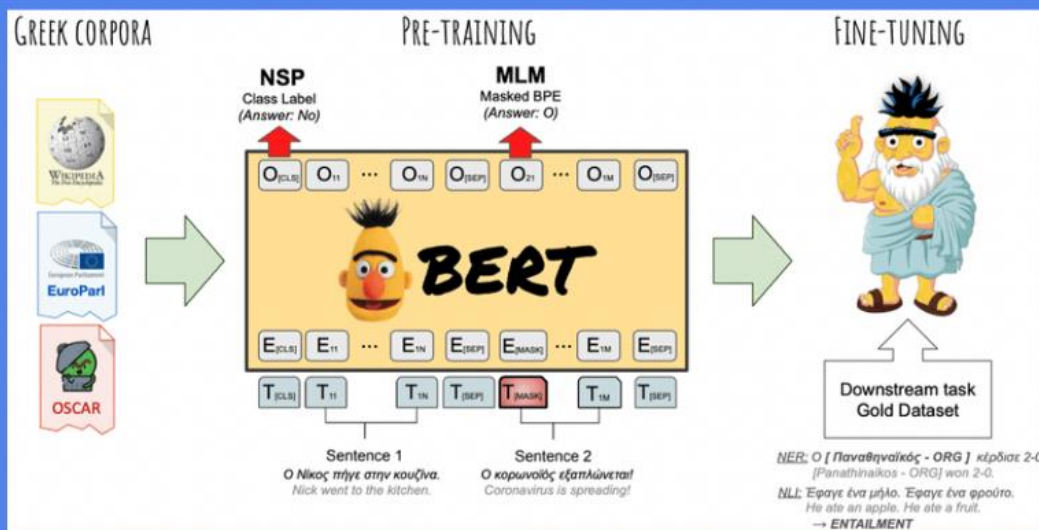


Deep Neural Network Structures

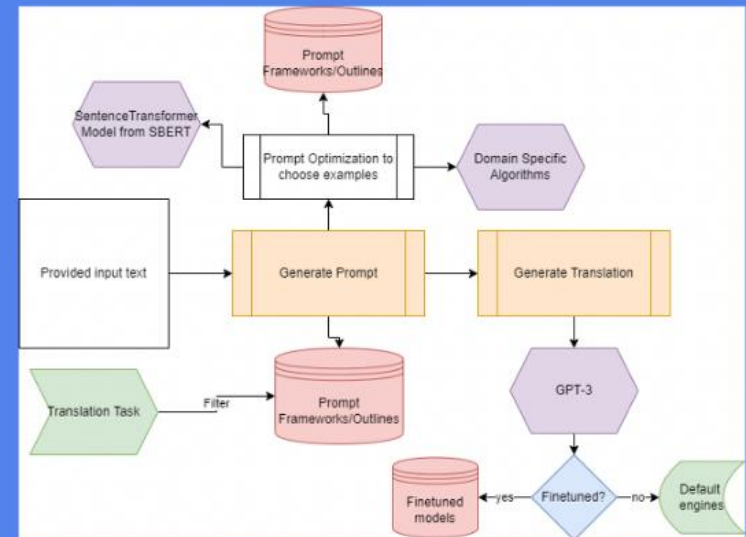
Foundation Models

Language Modeling: BERT and GPT Models

BERT



GPT-3



ChatGPT

 New chat

 New chat

 Gamification in Education Imp

 الذكاء الصناعي التعليم  

 الذكاء الصناعي في التعليم.

 Help Request Received

 Clear conversations

 Dark mode

 OpenAI Discord

 Updates & FAQ

 Log out



how important data in AI?



Data is extremely important in artificial intelligence (AI) as it is the foundation upon which AI models are built and trained. Without data, AI models would not be able to learn and make predictions or decisions.



In supervised learning, which is the most common approach used in AI, a model is trained on a labeled dataset, which contains input-output pairs. The model uses this data to learn the relationship between the input and output, and then makes predictions or decisions based on this relationship.

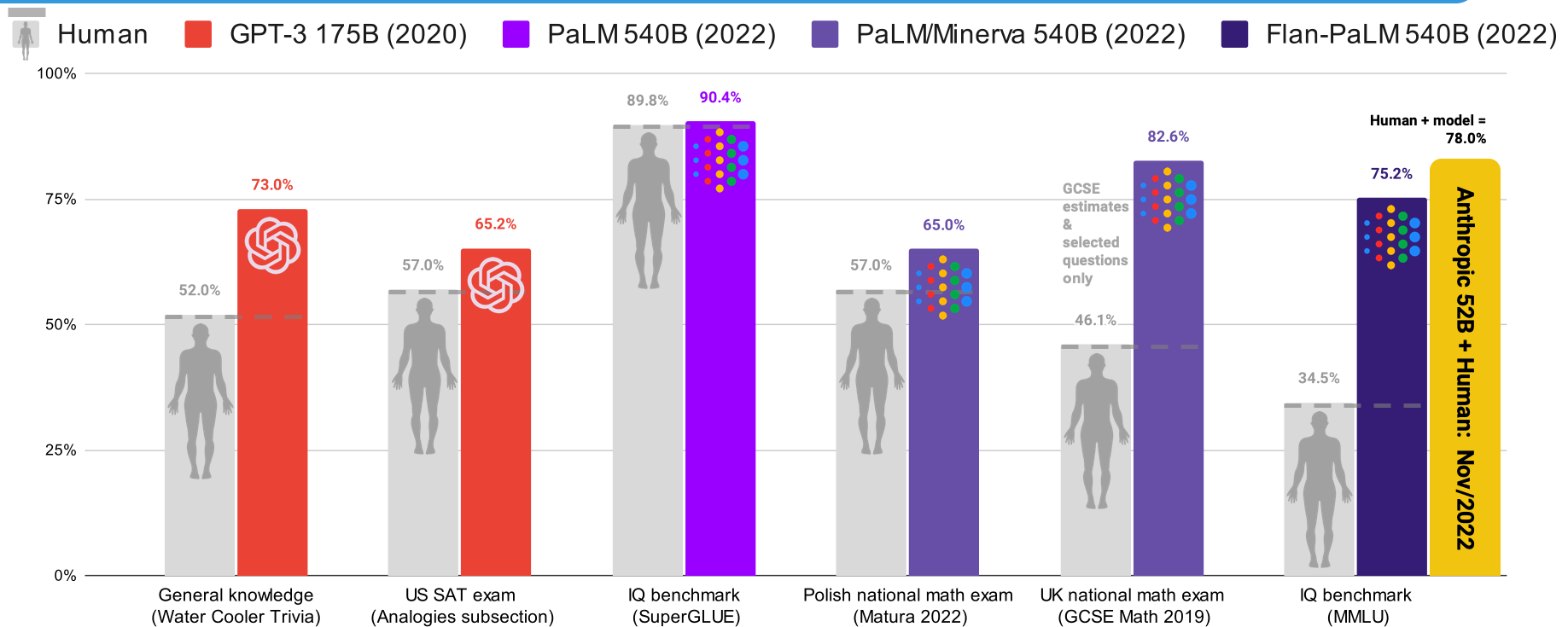
In unsupervised learning, the model is not provided with labeled data, but it is given a dataset with only inputs, the model then tries to identify the patterns and relationships within the

 Regenerate response

[ChatGPT Jan 9 Version](#). Free Research Preview. Our goal is to make AI systems more natural and safe to interact with. Feedback will help us improve.

GPT3 → ChatGPT

LANGUAGE MODEL TESTS (NOV/2022)



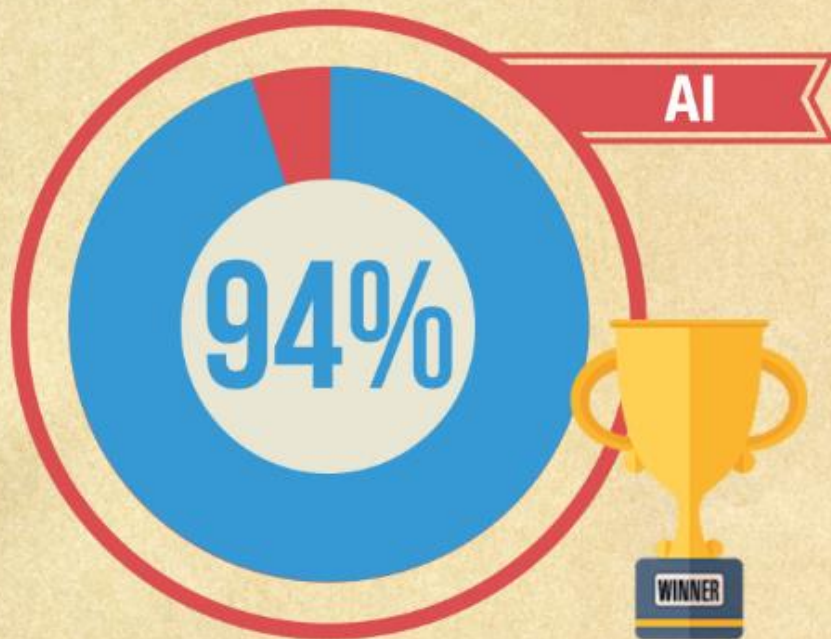
Selected highlights only. Sources: <https://lilearchitect.ai/iq-testing-ai/>, Anthropic paper: <https://arxiv.org/abs/2211.03540>, Other papers: <https://lilearchitect.ai/papers>, Alan D. Thompson, November 2022. <https://lilearchitect.ai/>



LifeArchitect.ai/iq-testing-ai



ACCURACY LEVEL



The AI achieved an accuracy level of 94%, compared to an average accuracy level of 85% across 20 human lawyers.

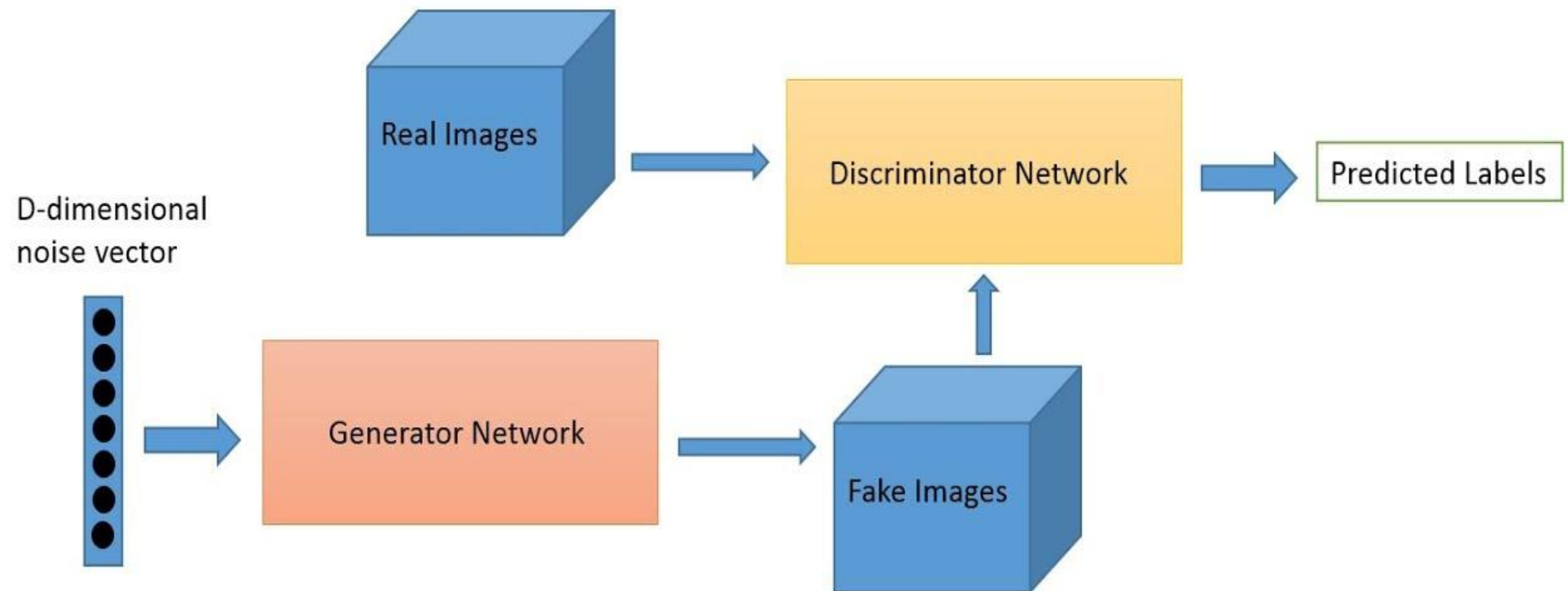
<https://www.youtube.com/watch?v=sTeoEFzVNSc>



Deep Neural Network Structures

Generative Adversarial network (GAN)

Generative Adversarial network (GAN)



An artwork created by AI (GAN Network) program has been [sold at auction for \\$432,000](#)

Portrait of Edmond Belamy





Course outline

Course outline

Part I: Artificial Neural Networks (4 weeks)

- Introduction to NN
- Single-layer perceptron
- Multilayer perceptron
- Back propagation algorithm
- The Hopfield Network
- The self-organizing network

Course outline

Part-II:

- **Data Representation and Data reduction techniques: (1.5 weeks)**
 - K-means clustering, Gaussian Mixture Model
 - Principal Component Analysis
- **Review of Classical Machine Learning: (1.5 weeks)**
 - Review of Machine learning (classical classifiers)
 - Regression Models
 - KNN, SVM, NBC, ...etc.

Course outline

Deep Neural Networks Structures: (3 weeks)

- CNN and its variants (ImageNet)
- Transformers
- Other DNN Models: Auto encoders, GANs Models
- Training DNN and how to avoid overfitting

Applications on DNN: (2 weeks)

- Foundation Models
- Language Modeling: BERT and GPT
- ChatBots: **ChatGPT**

Course outline

- ❖ Reviewing and presenting a paper 10 Marks
- ❖ Assignment (mostly Group assignments) 10 Marks
 - ❖ Examples of the Assignments:
 - ❖ Regression and Classical Classifiers
 - ❖ CNN
- ❖ The course project (No midterm exam) 20 marks
- Attendance is important

ELC-4028 Course Project

Guidelines:

1. Each group will select just one of the project ideas below.
2. Each group will search on the web for the most cited (at least 8 references (like papers, book chapters or websites...etc.), among these references at least 4 must be very recent within the last 3 years.
3. Be careful not to copy and paste from any reference except quoted parts.
4. The expected report size is 12+ pages written in IEEE format in English (<https://essaypro.com/blog/ieee-format>).
5. A presentation of about 20+ slides is also needed. The more graphics and figures to explain the ideas the better.
6. Excellent written projects will get rewarded. Excellent project means:
 - a. the depth and the quality of the work are high.
 - b. and the written paper is good enough to be accepted for publication.

Project ideas to select from

Idea-1: ChatGPT

The purpose of this project is to **test the level of maturity of the ChatGPT**. Do that by:

- Use ChatGPT to solve an exam of one of the courses that you have learned, and you should know the correct answers to the questions.

Example: I asked ChatGPT this question:

A coin is thrown 3 times. What is the probability that at least one head is obtained?

I got this correct answer:

The probability of obtaining at least one head when a coin is thrown 3 times is the complement of the probability of obtaining no heads, which is the same as getting tails for all 3 tosses. Since each toss is independent, the probability of getting tails for all 3 tosses is $(1/2) * (1/2) * (1/2) = 1/8$. So, the probability of getting at least one head is $1 - 1/8 = 7/8$.

- Redo the above process with a few students who have already studied this course (those could be the team before referring to the answers). You may also ask one of your professors to help to compare the ChatGPT answers with the answers of his students.
- Compare the ChatGPT answers and the students' answers.
- You must include in your answers:
 - How do you select your test questions and why, for what course for which year...etc.
 - How do you select the students
 - Comparison of the answers
 - Add your comments and suggestion to use ChatGPT and how to lower its bad effect of there will be.

Idea-2: Test of an Arabic Technology

Select **one of these Arabic technologies:**

1. Automatic Speech Recognition (ASR)
 2. Typewritten Optical Character Recognition (OCR)
 3. Handwritten Optical Character Recognition (OCR)
 4. Text to Speech (TTS)
 5. Automatic Diacritization (تشكيل آلي) (AD)
 6. English to Arabic Machine Translation (MT)
- You should select at least 3-5 products from different suppliers and compare them regarding the accuracy and any other aspect.
 - You must design a test dataset (you may need to design it to include different genres and quality). Your selection for the test dataset should be comparable to what other research papers do. A good part of the evaluation will be on the selection and processing of the test dataset. Do not use existing datasets. You must develop your own.

Thank You