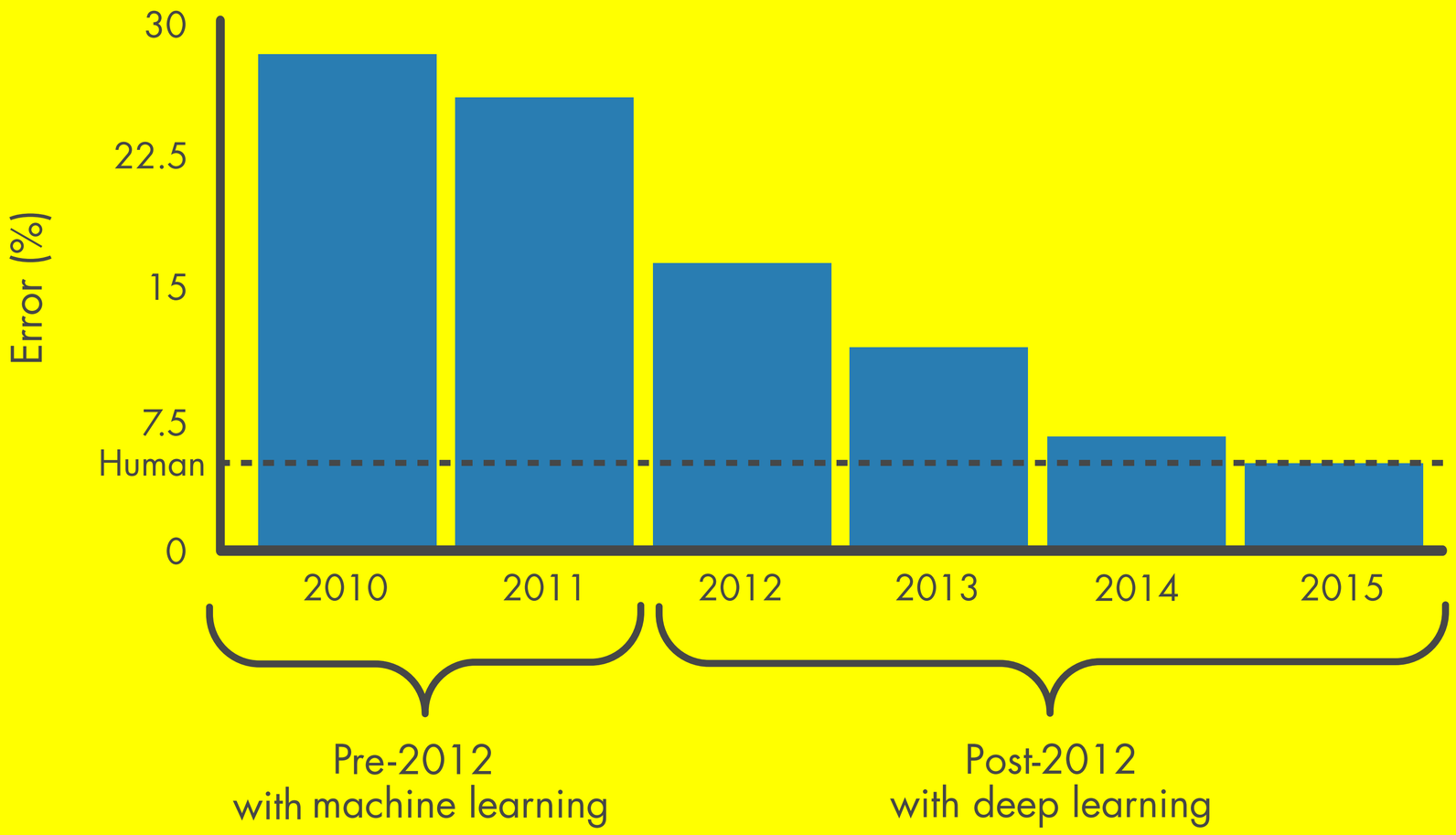
Learning and classification error rate



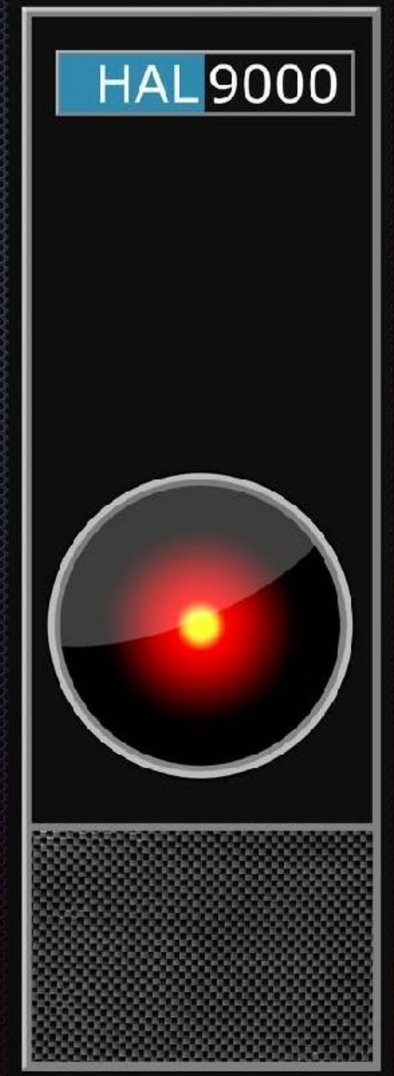
What is AI ?

Artificial Intelligence (AI) is an old Sci-Fi idea which slowly becomes a reality.

This is the capability of a machine to imitate, match or exceed intelligent human behaviour.

Predictions seems to be at the core of creating intelligent behaviour. Prediction is taking information you have and converting it to information you don't have.

Today, this is achieved by **training** a machine to learn the desired behaviour or outcome.



?

Artificial Intelligence (AI)

Artificial Intelligence (AI) is an old Sci-Fi idea which slowly becomes a reality. There has been an **exponential growth** of this idea:

- Written text to ASCII characters
- Speech recognition
- Music recognition (Shazam)
- Siri and Google assistant
- Self-driving cars
- Face identification (passport control, access control, smart phones,…)
- Smart homes

The main reason for such a development is the advancement in programming and computer technology.

Lee Sedol vs AlphaGo (2016)

A World Go Champion Lee Sedol bitten by a computer! Computer won 4 out of 5 Go games against the world champion Lee Sedol.

An actual **deep-learning** algorithm by Google. (over 2 x 10^170 possibilities!)

A programming **break-through**!

AI => ML => DL

Deep Learning is a subset of Machine Learning, which is a subset of Artificial Intelligence science.

AI started being thought of during 1950~60, with the invention of electronics and computers. Around 1980-es, as the computers evolved and became more personal and mobile, the Machine Learning got introduced.

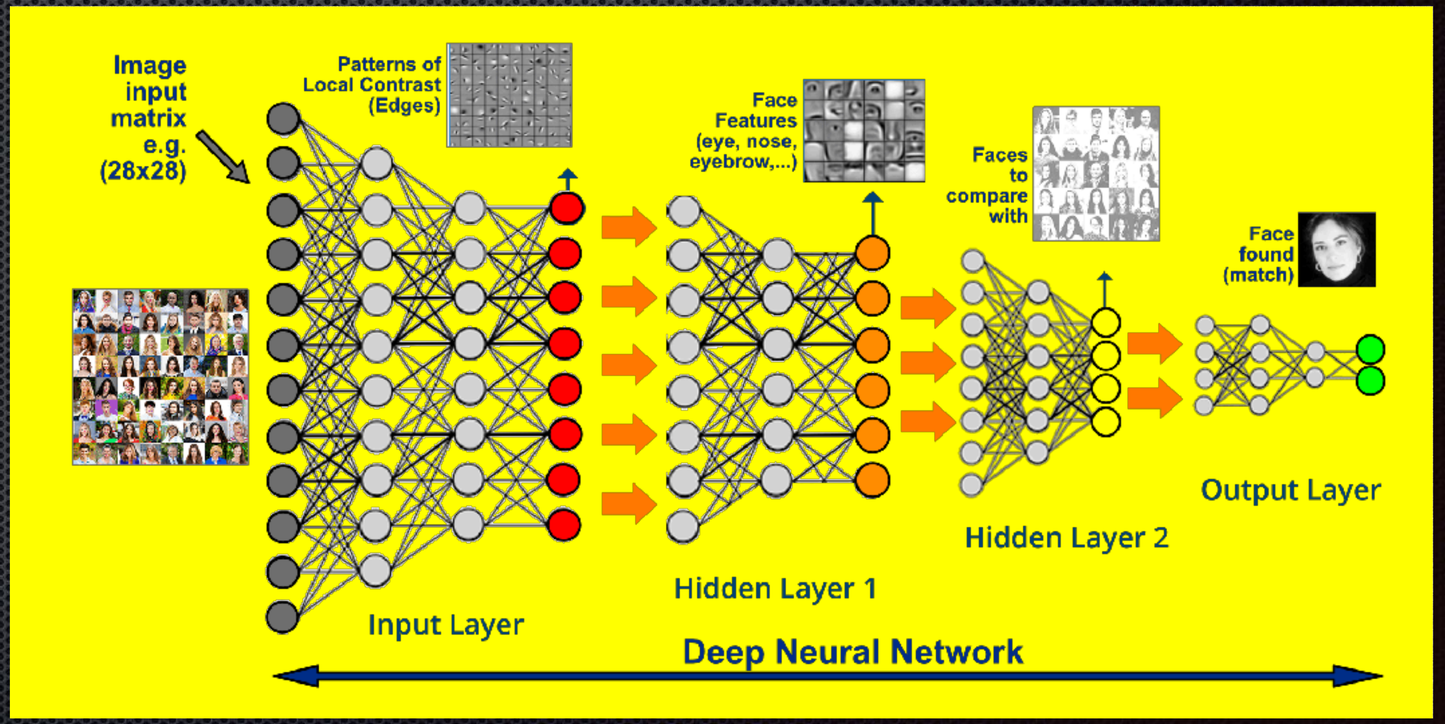
Deep Learning is a type of Machine Learning in which a model learns to perform classification tasks directly from images, text, or sound.

The "deep" in "deep learning" refers to the number of layers through which the data is transformed.

How is Deep learning programmed ?

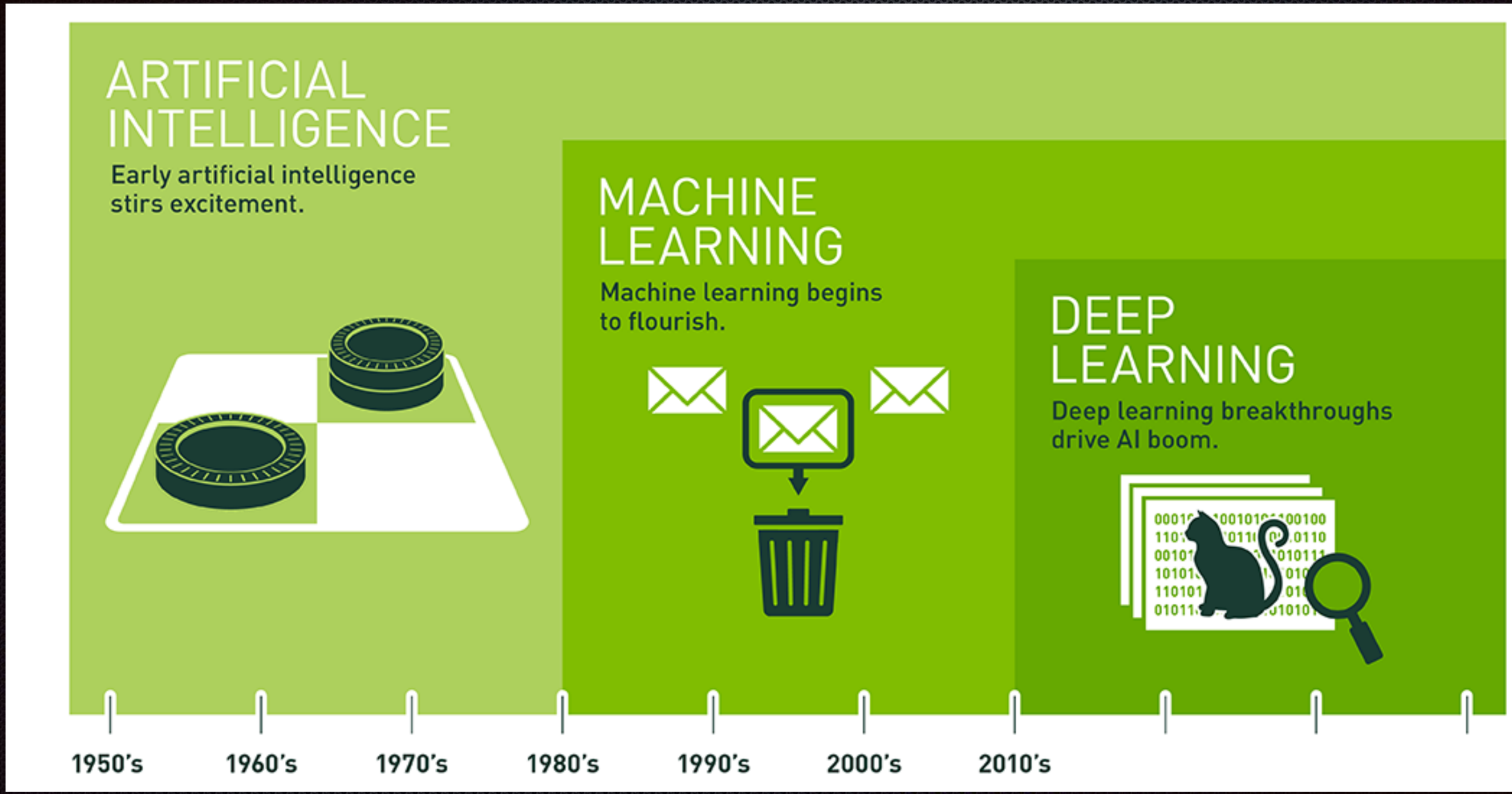
Deep learning is usually implemented using a **neural network** architecture. **Mathematical functions in the programming algorithms which replicate the working of neurons in the human brain.**

The term **“deep” refers to the number of layers** in the network—the more layers, the deeper the network, the better the learning outcome.

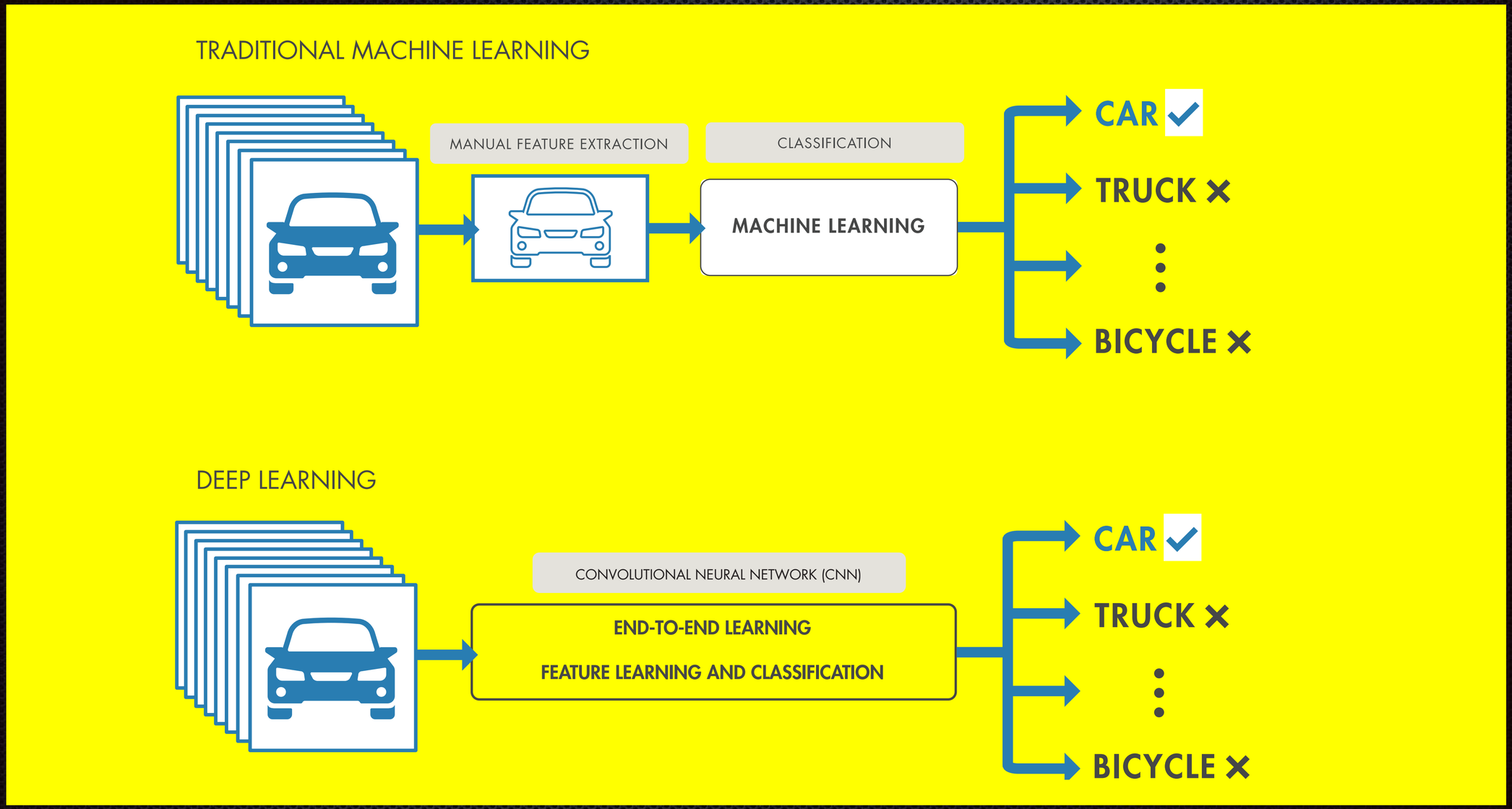


Traditional neural networks contain **only 2 or 3 layers**, while **deep networks** can have **hundreds**. (example with reading and meaning of letters/words)

Artificial Intelligence, Machine and Deep Learning



The difference in programming ML and DL



ML => manual vs DL => automatic

In **Machine Learning**, **the relevant features of an image are manually extracted** via the programming code, piece by piece.

In **Deep Learning**, the raw images are fed directly into the program that **learns the features automatically through convolutional neural network (CNN) algorithms.**

Deep learning often requires hundreds of thousands of images for the best results. Once learnt however, they are easy and quick to use for further processing.

The DL requires huge processing power…

Like a child

A child is initially taught by an adult to correctly identify and classify various shapes, eventually being able to identify shapes without any coaching.

Similarly, a deep learning or neural learning system **needs to be trained** in object recognition and classification, while also **assigning context** to objects in the form of **metadata.**

Like a child, by continually learning, the program continually gets smarter, delivering more accurate results more quickly over time.

Learning from the human brain

The human brain is the centre of thinking, consciences and emotions, and it is built on **neurons** communicating via **synapses.**

Neurons are nerve cells representing **the basic building blocks** of the **nervous system**.
They are similar to other cells in the human body but are **specialized** in **transmitting information.**

The information transmission is made by way of **electrical pulses** and **chemical reactions**.

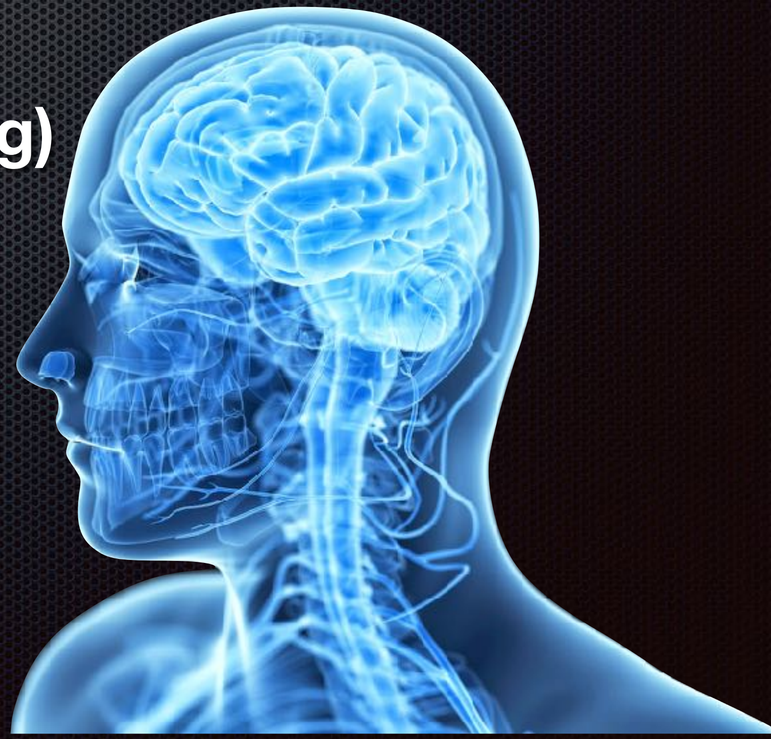
High powered yet small mass

Many believed that there were around **100 Billion** neurons in an average brain.

Dr.Suzanna Hercualno-Houzel, a researcher from Brazil, actually did a more accurate experiment and counted that an adult brain contains approximately **86 Billion** neurons.

Although only 2% of the body mass (around 1.4kg) the brain consumes approximately 20% of the total human body energy.

Human body average consumption is 100W => brain = 20W.
Comparison: Intel i7 processor (6B transistors) 77W

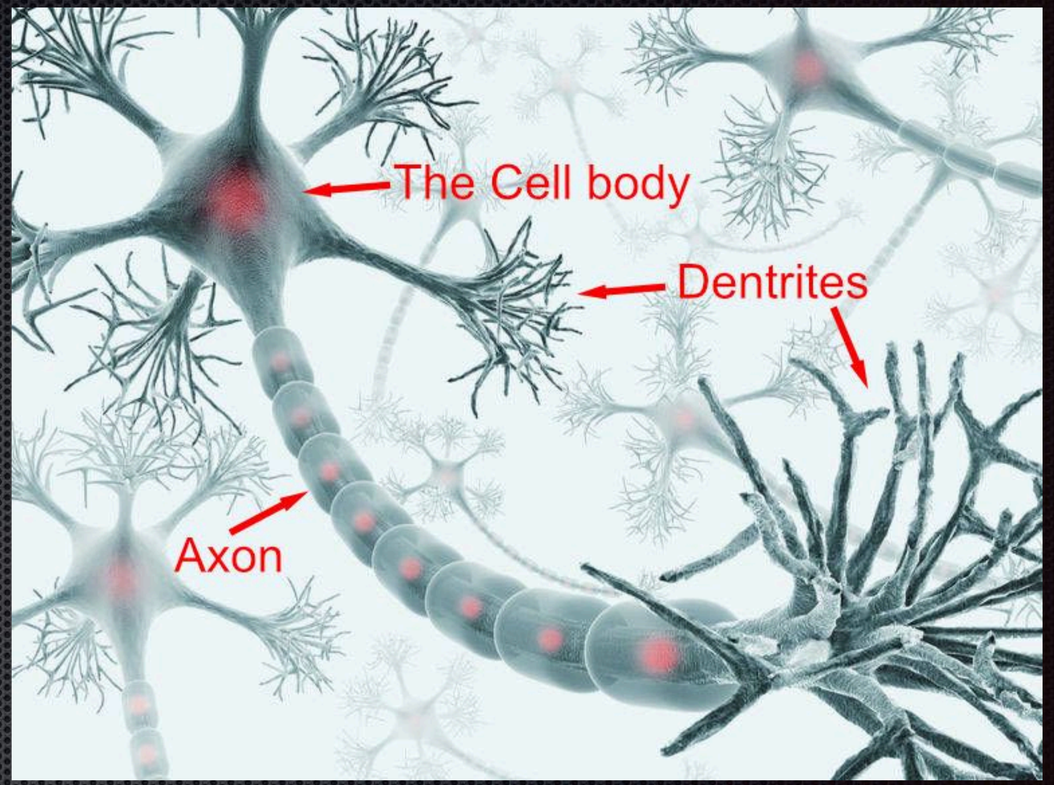


The neuron structure

There are three basic parts of a neuron:

- **Cell body**
- **Axon**
- **Dendrites**

Neurons vary somewhat in size, shape, and characteristics depending on the function and role.



The axon and dendrites are specialised structures designed to **transmit** and **receive** information.
The connections between cells are known as **synapses**.
Neurons release chemicals known as **neurotransmitters** into these synapses to communicate with other neurons.

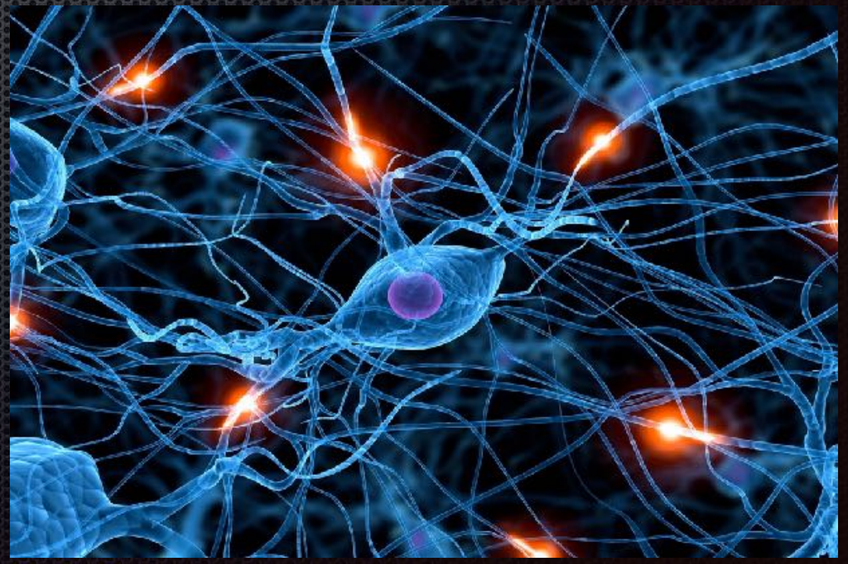
Digital Information Transmission in our brains!

Neurons transmit information using **electrical signals** and **chemical neurotransmitters**.

Electrical signals are used for passing information inside the neuron along the axon. **Chemical neurotransmitters** are used for passing information **between neurons**, via the **synapses**.

The resting potential of the average neuron is around -70mV and **it fires only when it reaches -55mV, but not below this level.** When it fires - it **peaks to 30mV**.

This is known as **all-or-none law**, which in fact means neurons communicate **digitally (binary)**.



Video Content Analytics (VCA)

Video Content Analytics (VCA) is a set of image analysis algorithms with the purpose of automatically detecting an object or event within a picture or video.

This is a new and broader development in CCTV where the video content is analysed by a computer program (no longer CVBS) for a variety of objects or events. It is also referred to as **Video Analysis**, although we will agree on using **Video Content Analytics,** since we are not analysing the video signal itself.

Instead of having hundreds of set-up parameters, various look-up tables, the **programming algorithms mimic how human brain learns.**

This is called **Deep Learning.**