

Practical Machine Learning & Neural Nets

Why Machine Learning?



Let's say I want to build a program that knows how to recognize the difference between a picture of a chihuahua and a muffin based on the pixels. I would need to have all the rules.

- Can you guys come up with the rules that I need?

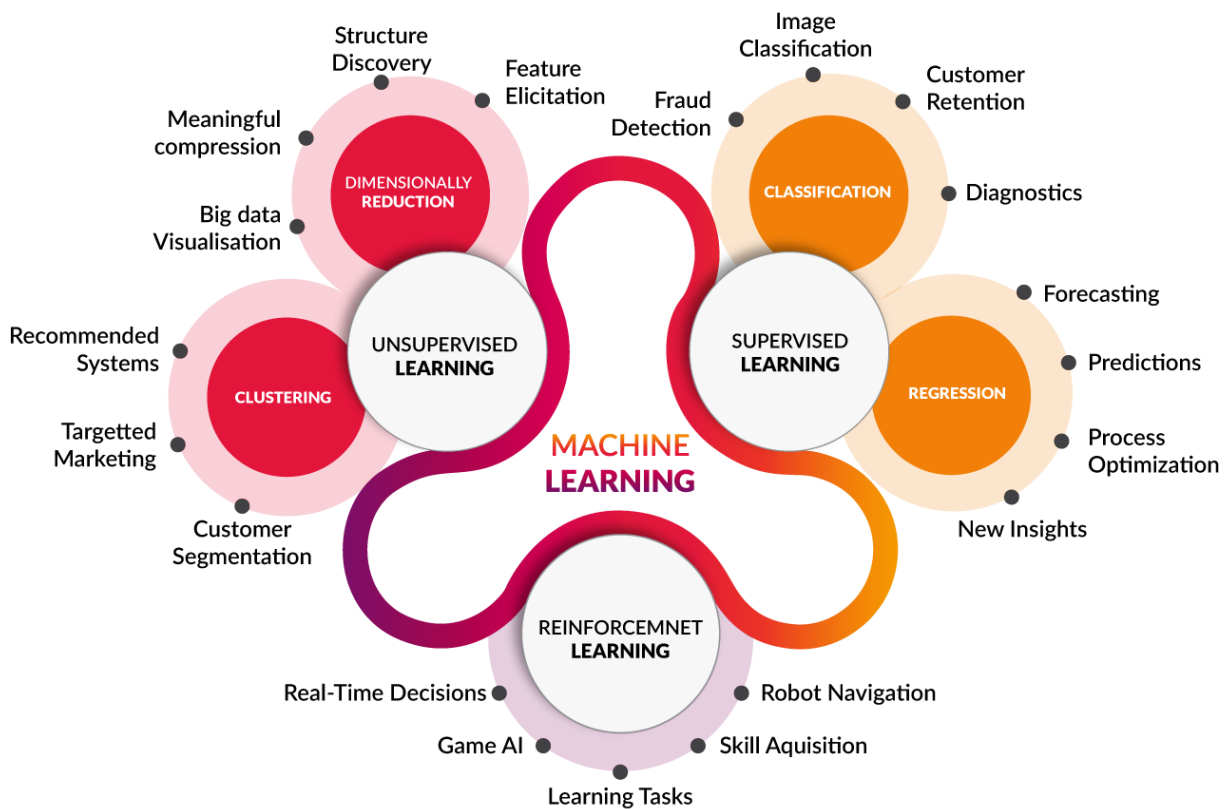
This is part of the reason why machine learning was invented: many problems just don't have clearly defined rules, so the computer has to learn the rules by itself.

What is Machine learning?

- Ask the class
- It's a field of study related to statistics that allows computers to **recognize patterns** by themselves. To allow the computers to 'learn' these patterns, they need to be fed a LOT of **data**.
- 'Normal' computers are programmed **symbolically**, which means that we teach them rules according to which they react to certain inputs with a certain output. The programming could say, for example, '**IF** button 1 is clicked, **THEN** show screen 1'. But this means that as a programmer, I need to know every rule to be able to program it in. This is **useful** for things that have clear, limited **rules**, like a game or a design program. It is very exact, because you always know what the computer is going to do.

- But if there are just **too many rules** and inputs, especially if you as a programmer cannot predict every one of them, you can use machine learning. The computers will learn the rules by itself, and as a programmer you only need to give it a lot of clean input.

Types of Machine Learning



These are the types of machine learning that are currently very popular. They are used a lot in almost everything that you use.

There are many types of machine learning algorithms being used, some of which are better at some things, and others at other things. However, the type of machine learning that is currently the most popular is the neural network.

The current favourite: Neural Networks

Other (buzz)words that (more or less) mean the same thing are Deep Learning, ANN, Multilayer perceptrions, DNN. Since around 2010, Neural networks have become very popular again. Many things that were previously impossible became possible or even easy:

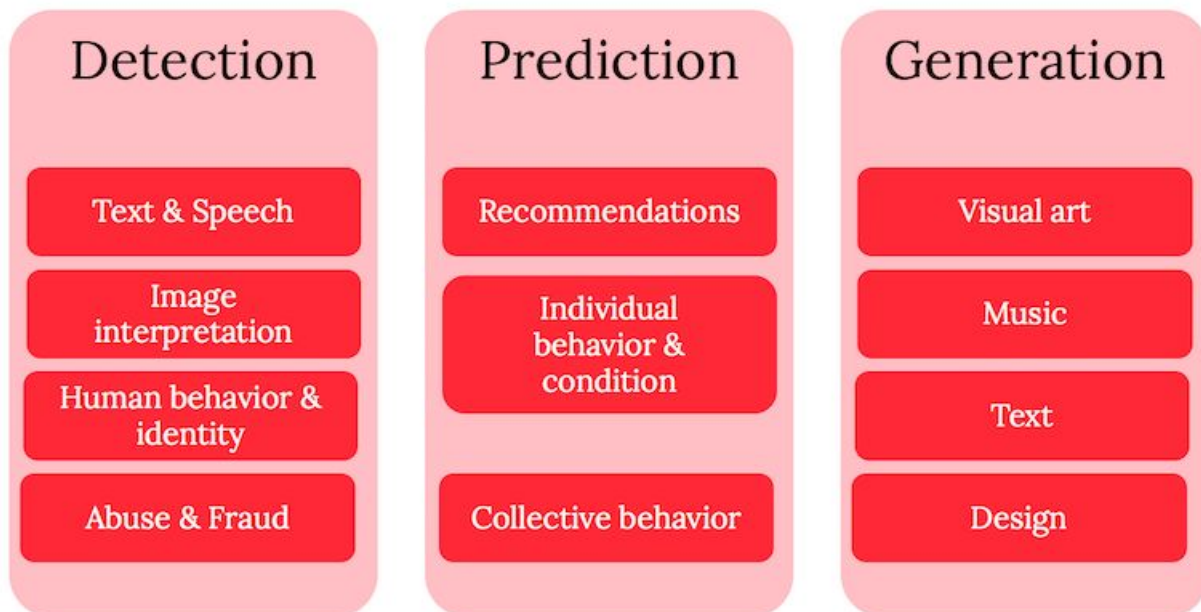
- Google winning GO

- Medical progress like more robust and earlier cancer detection
- Apple's face detection
- Vastly improving Google translate

Most of this has become possible because we now have more data, computers (especially GPU's) have become faster and cheaper and a lot of research is being done on the algorithms.

What can Neural Networks do?

Neural networks are a pretty universal Machine Learning tool. They can basically solve any problem that can be expressed in numbers. Below are several of the areas where Neural Networks are used the most:



What exactly are neural networks?

(Artificial) Neural networks are a machine learning method that is loosely based on the working of our brain. They consist of a network of simulated brain cells that individually are very dumb, but together can solve complex problems. They are especially useful for problems where lots of data is available but the rules and underlying relations are unclear. Even though Neural networks are starting to outperform humans in many areas, it is good to remember that in terms of general intelligence, they are not even close to even the simplest organisms.

How do Neural Networks work?

A large collection of **cells**, all of which use a **simple statistical formula** that mimics the working of a **neurons**.

Many **layers of cells** are connected to each other and can send each other **signals**. Every cell receives some **input** and reacts to it with a certain **output**. In the beginning the relation between their input and output is kind of **random**. After all the cells have given their output, they get a **reward** if their output was **right**, and **punishment** if their output was **wrong**. If they were wrong, they will try another output, but if they were right, they will continue to give their correct output.

If this is continued, all cells will eventually learn what output is expected of them for every input.

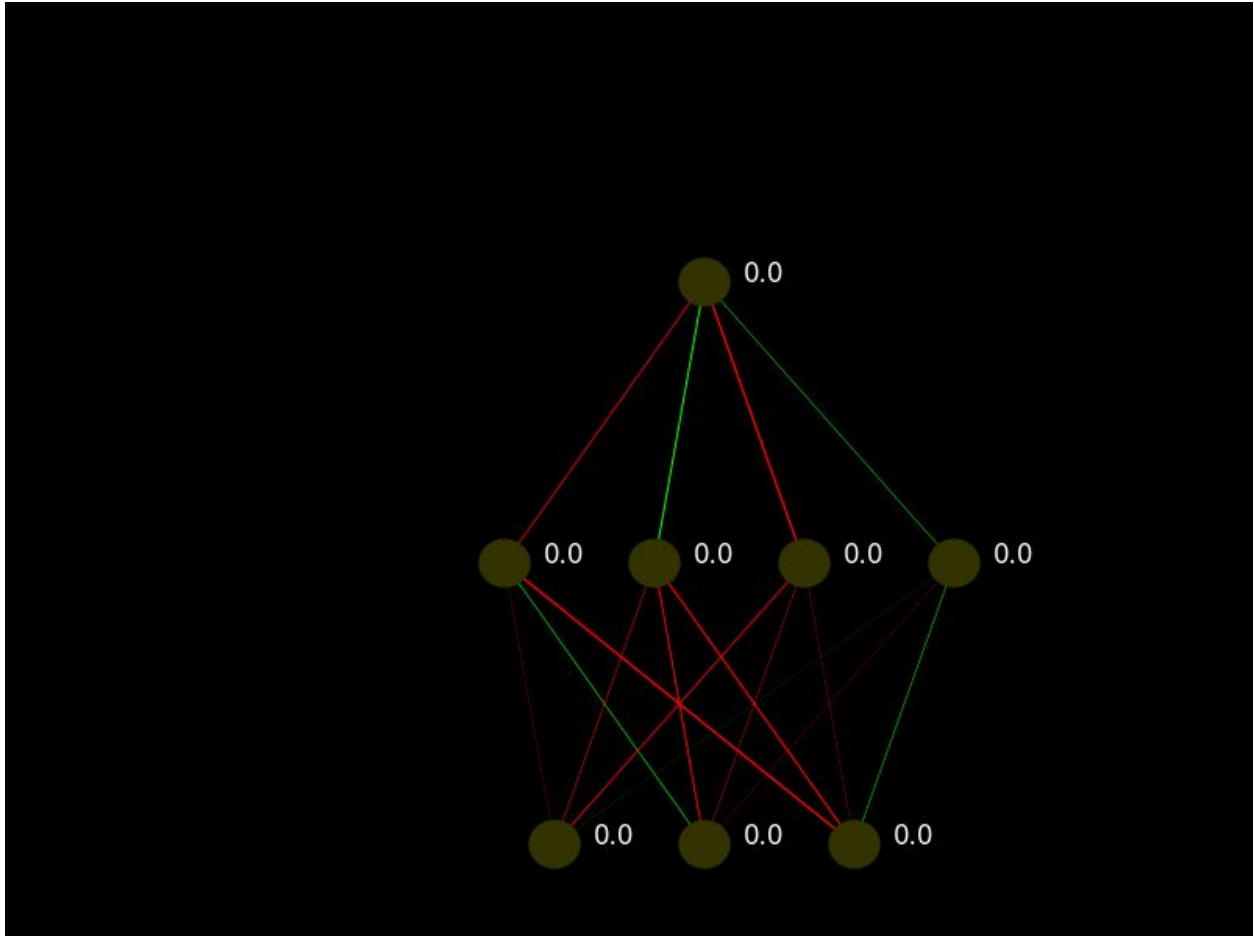
Basically, you can see it as a baby: If they get rewarded for every time they shit on a toilet, they will eventually stop shitting everywhere else. However, this doesn't mean they understand what a toilet is or why you want them to use it.

Let's take a look at the problem below, that is often used in things like IQ tests. Humans can solve this problem, but they are not particularly good at it. Because the data is clear but the underlying rules are not, a neural network should be quite capable of solving it.

	Input			Output
Example 1	0	0	1	0
Example 2	0	1	1	1
Example 3	1	0	1	1
Example 4	0	1	0	1
Example 5	1	0	0	1
Example 6	1	1	1	0
Example 7	0	0	0	0

New situation	1	1	0	?
----------------------	---	---	---	----------

It is good to realize that this problem is also a pretty good abstraction of human intuition. We encounter a lot of problems in our life, and basically learn from them by trial and error. If we do this often enough, we will also be able to solve new problems.



Follow this link to see the NN in action: <https://www.youtube.com/watch?v=nrnxZVEHZCo>

Follow this link to read the full explanation:

<https://medium.com/deep-learning-101/how-to-generate-a-video-of-a-neural-network-learning-in-python-62f5c520e85c>

How do you build or use one?

In the **past**, neural networks were huge, **dedicated machines**. **Nowadays** you can just **program** them on **any computer**. For this purpose, there are many libraries for many programming languages. You may already have heard of **tensorflow**, **keras** or others. If you know how to program or want to learn it, these frameworks are perfect.

But for this class I would like to use a tool that is simpler to use: CreateML. CreateML is Apple's implementation of neural networks. It is aimed at iPhone app development, but can also be used for other purposes. It is very easy to use, but the customisation is quite limited.

You need a computer running macOS 10.14 or higher. Install Xcode and follow these tutorials:

https://developer.apple.com/documentation/createml/creating_an_image_classifier_model

https://developer.apple.com/documentation/createml/creating_a_text_classifier_model