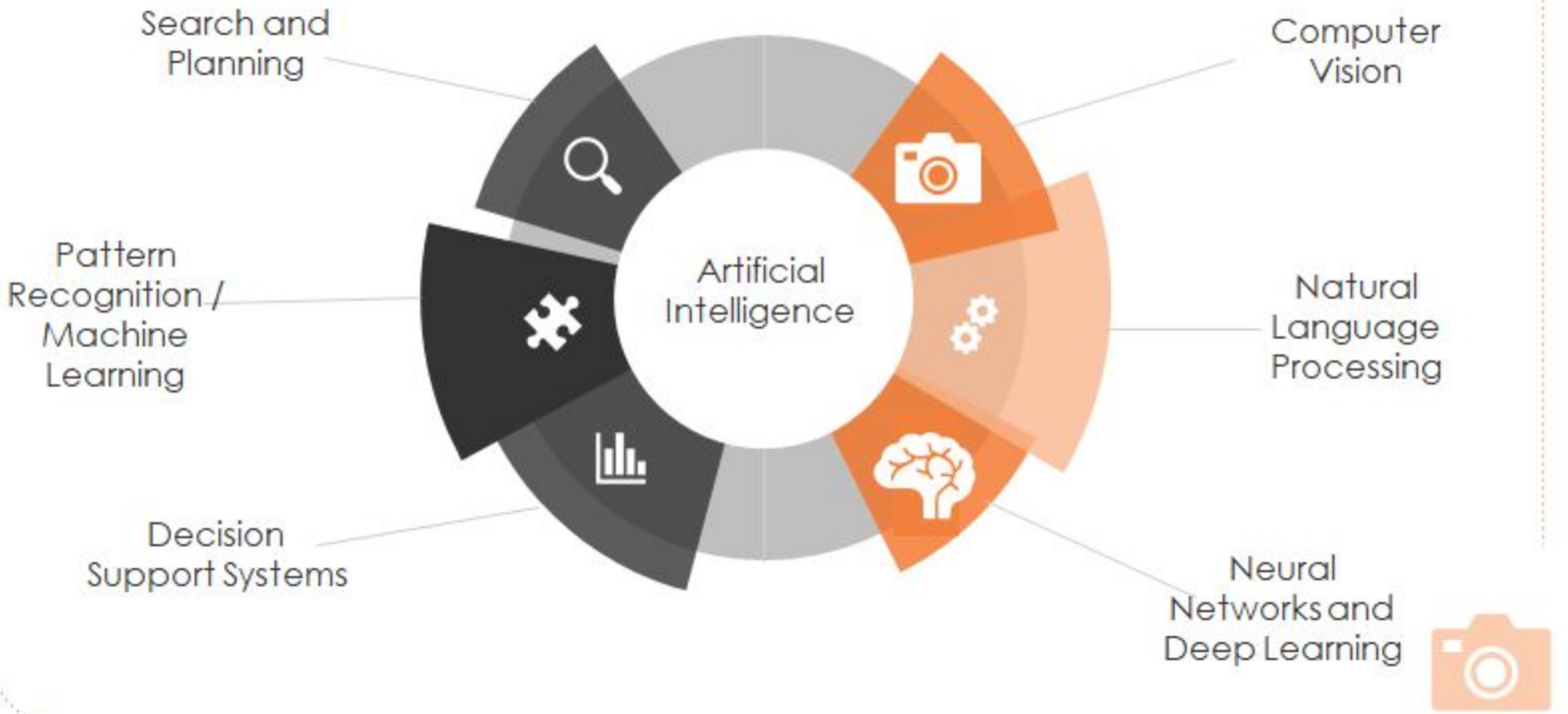
Neural Networks & AI

Pablo Maldonado

Artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.

Encyclopaedia Britannica, 2018


Search and Planning
Computer Vision
Pattern Recognition / Machine Learning
Artificial Intelligence
Natural Language Processing
Decision Support Systems
Neural Networks and Deep Learning

How will it impact us?

Autonomous Transportation: Disruption in the distribution networks.

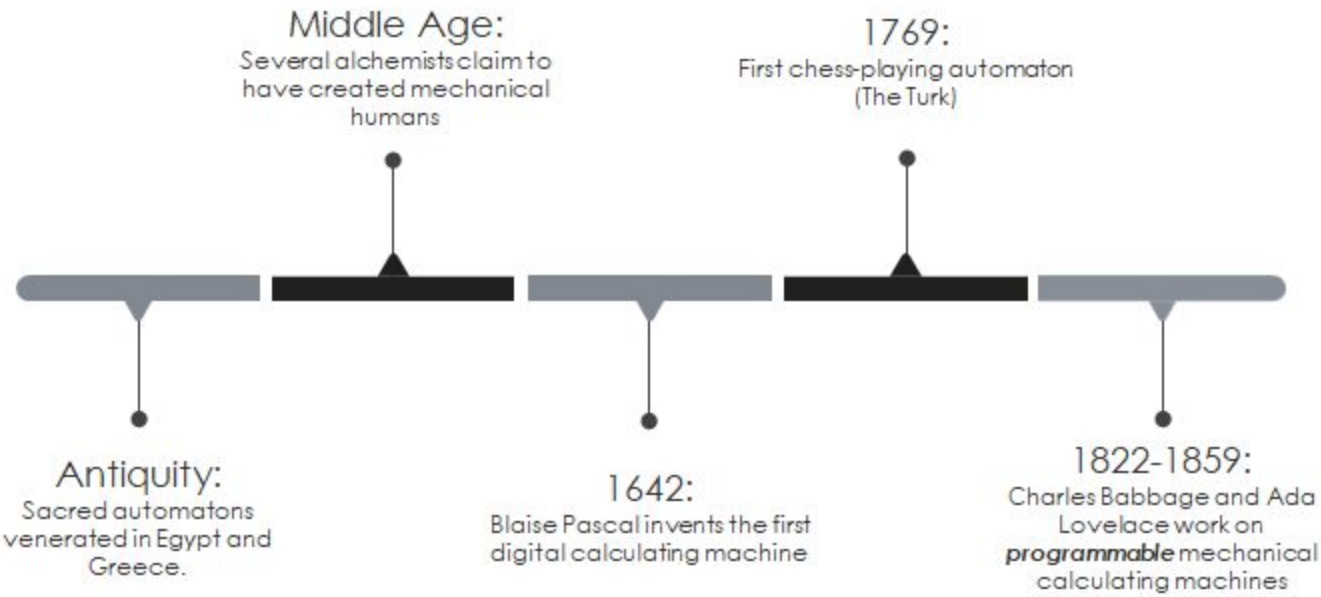
Robots Everywhere: More cooperation between humans and machines.

Complex Queries: „Ok, Google, download and summarize Pablo's book"

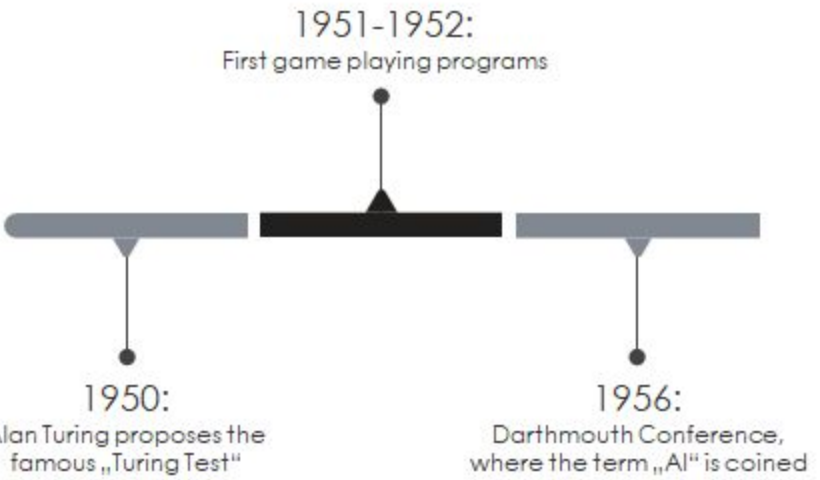
Basic news coverage / cookbok generation: Generate realistic descriptions from video/image.

Invoice Processing (OCR,NLP): Traditional transaction monitoring, audit and accounting are ripe for disruption.

AI Timeline


Middle Age:
Several alchemists claim to have created mechanical humans
1769:
First chess-playing automaton (The Turk)
Antiquity:
Sacred automatons venerated in Egypt and Greece.
1642:
Blaise Pascal invents the first digital calculating machine
1822-1859:
Charles Babbage and Ada Lovelace work on programmable mechanical calculating machines

Modern AI Timeline: 1950-1956



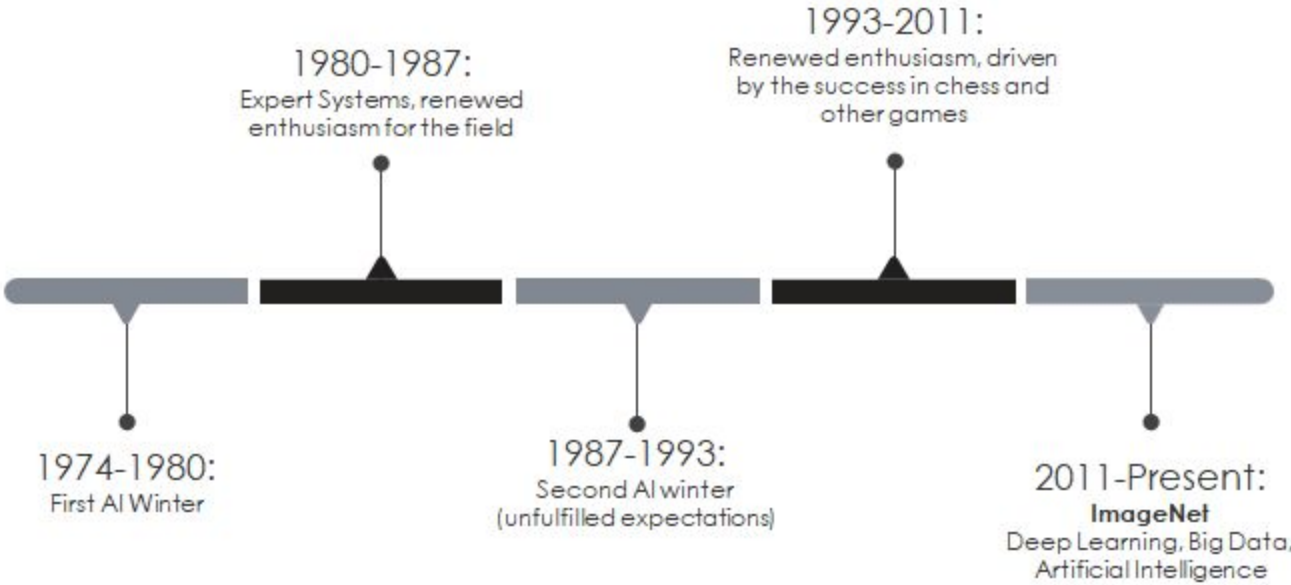
The Golden Years (1956-1964)

1958, H. A. Simon and Allen Newell: "within ten years a digital computer will be the world's chess champion" and "within ten years a digital computer will discover and prove an important new mathematical theorem.„

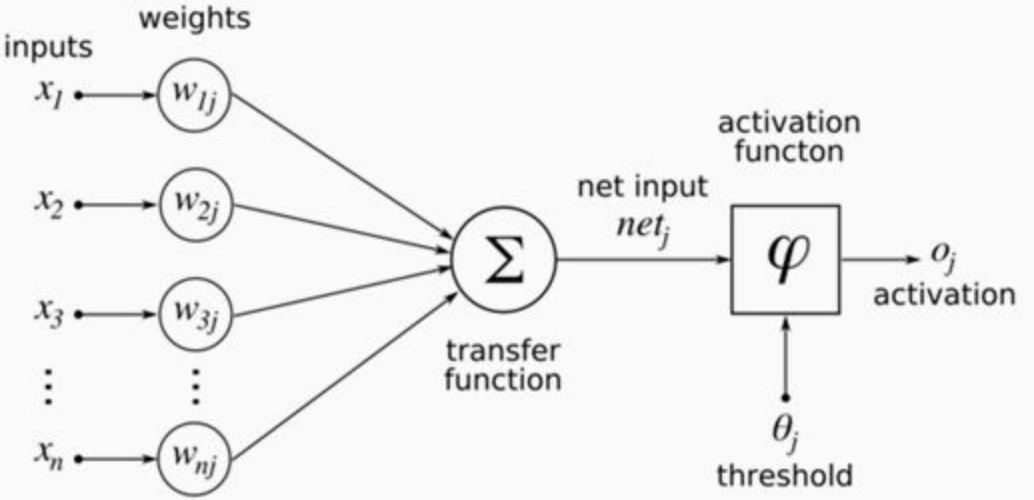
1965, H. A. Simon: "machines will be capable, within twenty years, of doing any work a man can do.„

1970, Marvin Minsky (in Life Magazine): "In from three to eight years we will have a machine with the general intelligence of an average human being."

AI Timeline


1974-1980:
First AI Winter
1980-1987:
Expert Systems, renewed enthusiasm for the field
1987-1993:
Second AI winter
(unfulfilled expectations)
1993-2011:
Renewed enthusiasm, driven by the success in chess and other games
2011-Present:
ImageNet
Deep Learning, Big Data, Artificial Intelligence

Neural Networks



Machine Learning

Machine Learning is the study and production of algorithms that can learn from and make predictions on data

Different Types of Learning

Supervised Learning: Estimate a target variable from input data using collected samples.

Unsupervised Learning: Deduce structure within the data.

Reinforcement Learning: Learn from an environment through indirect feedback about the correct choice.

Different Types of Algorithms

Supervised Learning: Linear Regression, Decision Trees, Support Vector Machines, ...

Unsupervised Learning: K-Means, hierarchical clustering, ...

Reinforcement Learning: Q-Learning, Sarsa, Policy Gradients, Evolutionary Computation ...

How much do algorithms matter?

Getting the data in a suitable shape for modelling is time consuming and error prone.

In addition to data reshaping, some higher-level abstraction from those features is often needed. This is also a manual and error-prone task.

Under certain conditions, all that complexity can be removed using more powerful algorithms... enter **Deep Learning.**

Deep Learning

Deep learning algorithms seek to exploit the unknown structure in the input distribution in order to discover good representations, often at multiple levels, with higher-level learned features defined in terms of lower-level features

Yoshua Bengio

Tensorflow Demo

playground.tensorflow.org

Why not “normal” machine learning?

•Deep Learning allows us to learn more complicated relationships between the data.

•The performance of a deep learning model **increases** when you add more data, as opposed to other machine learning algorithms.

•**Not a silver bullet: Issues will be discussed later.**

Different Types of ~~Algorithms~~ Architectures

- **Supervised Learning:** Linear Regression, Decision Trees, Support Vector Machines, **Multi-Layer Perceptron, Convolutional Neural Networks, Recurrent Neural Networks** ...

- **Unsupervised Learning:** K-Means, hierarchical clustering, **Autoencoders**...

- **Reinforcement Learning:** Q-Learning, Sarsa, Policy Gradients, Evolutionary Computation, **Deep Q-Learning, Deep Cross Entropy Method** ...

Neural Network Architectures

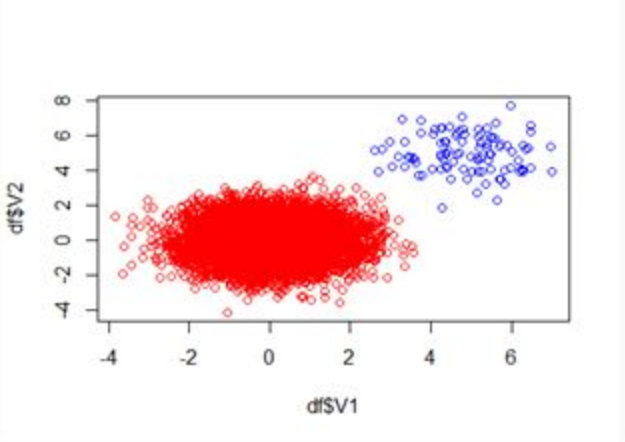
Autoencoders

- Autoencoders consist of two parts: an **encoder** and a **decoder** network.

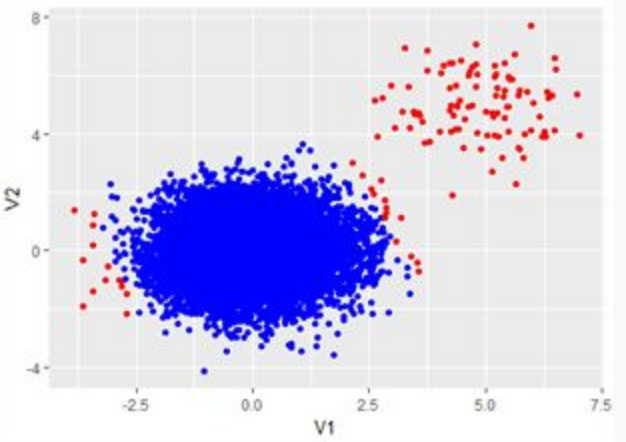
- The goal is to create a model that detects abstract features in the data by projecting to a lower dimensional space, and then decompressing that information.

- This can be useful for ***outlier detection.***

Autoencoders

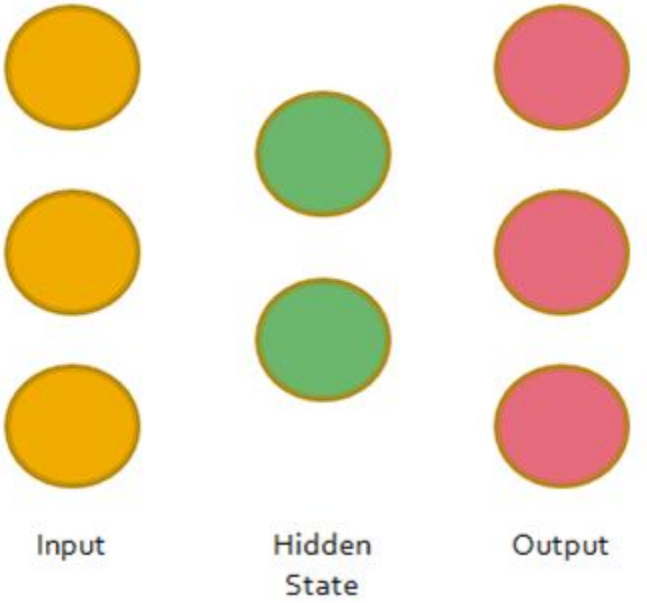


Original



Reconstructed

Architecture



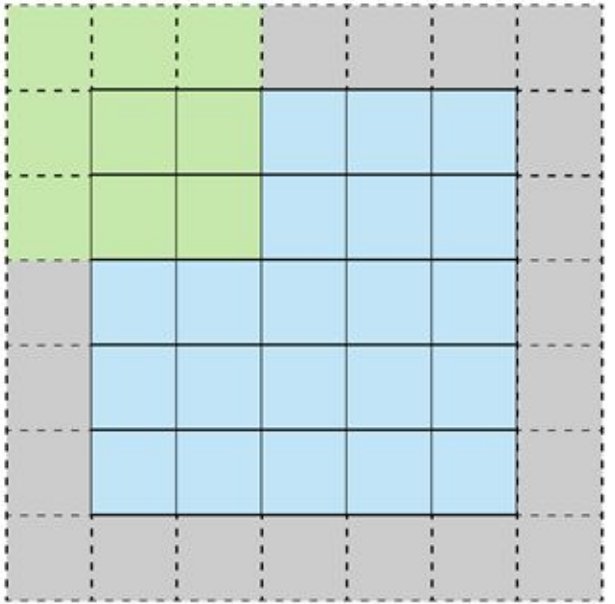
Convolutional Neural Networks

- **ImageNet Project:** Largely seen as the project that brought neural networks to the main stage.

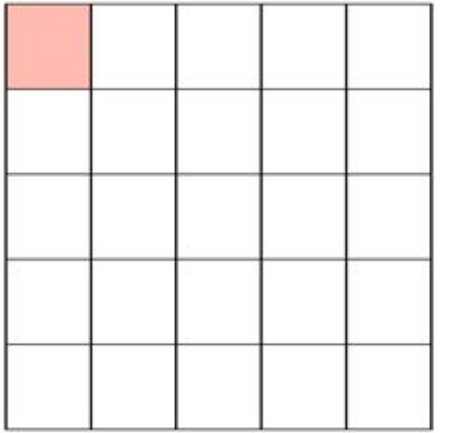
- ImageNet consists of around 14 million URLs of images manually annotated in over 20 thousand ambiguous categories.

- AlexNet, GoogleNet, VGG and more recently, ResNet.

Convolutional Neural Networks

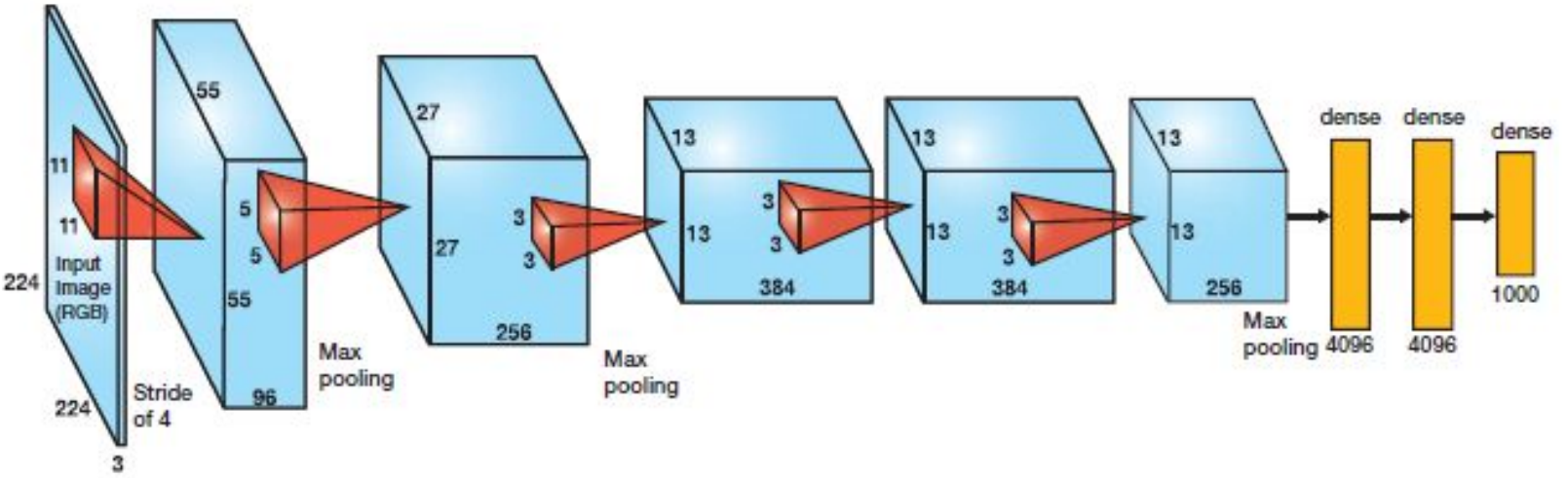


Stride 1 with Padding



Feature Map

AlexN


224
224
3
Input Image (RGB)
11
11
55
55
96
5
5
Stride of 4
Max pooling
27
27
256
3
3
Max pooling
13
13
384
3
3
13
13
384
3
3
13
13
256
Max pooling
dense
4096
dense
4096
dense
1000

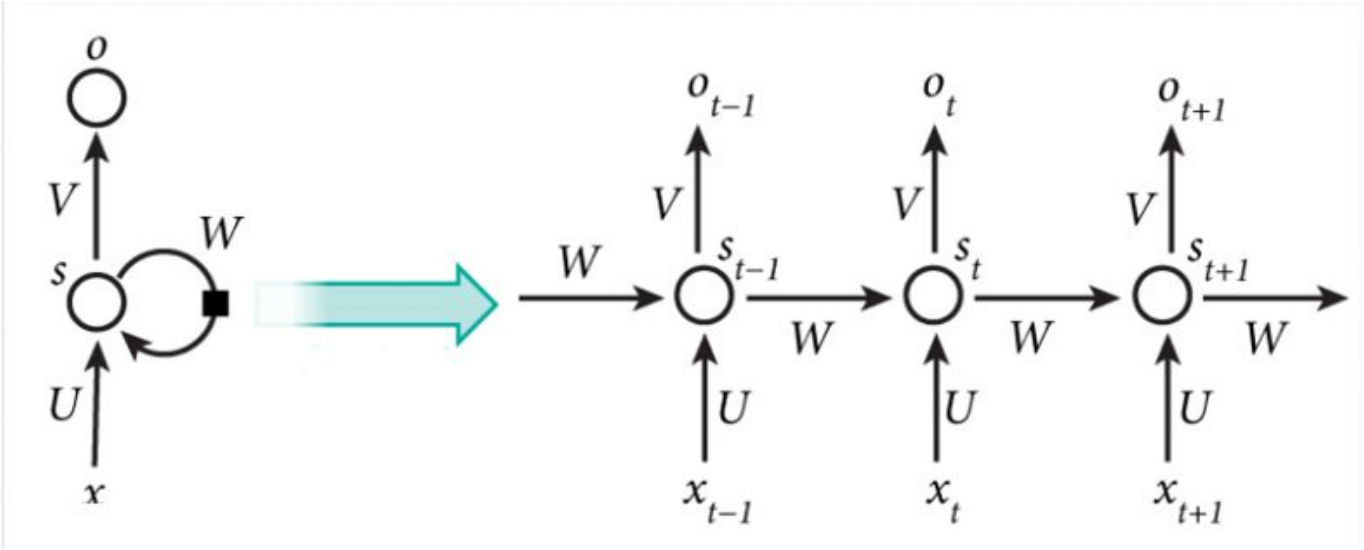
Recurrent Neural Networks

Recurrent Neural Networks mimic a distinctive characteristic of intelligence: **memory**.

This allows them to capture long-term dependencies between the data.

Example applications

- Sequence-to-sequence translation
- Text generation
- Automatic caption generation
- Music generation



http://karpathy.github.io/2015/05/21/rnn-effectiveness/

Soccer Match Prediction

playground.tensorflow.org