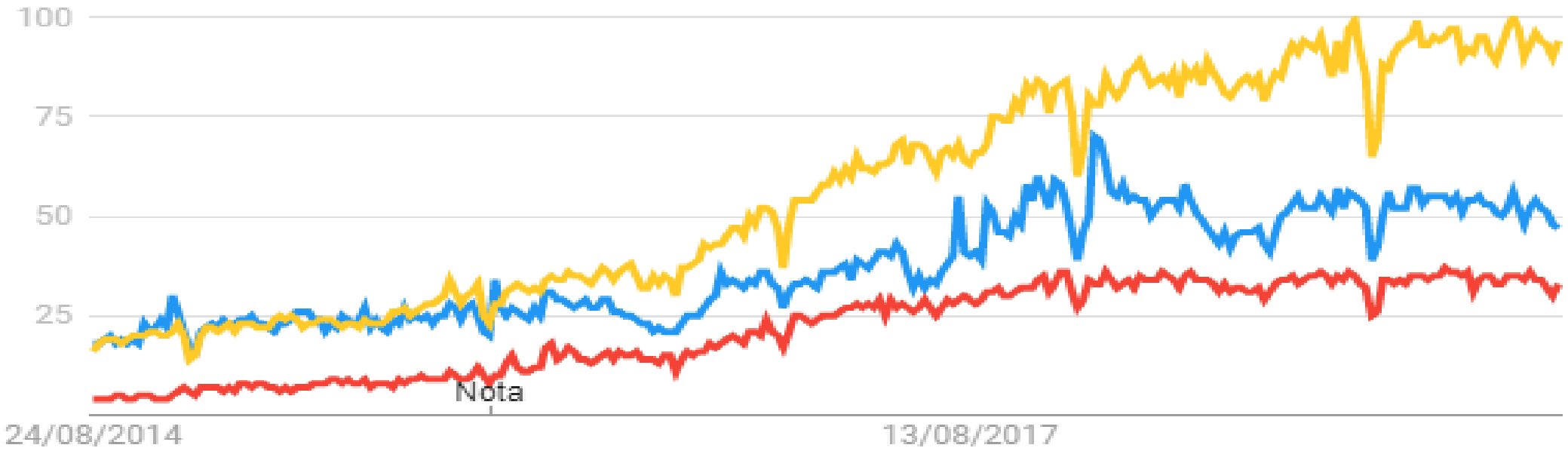
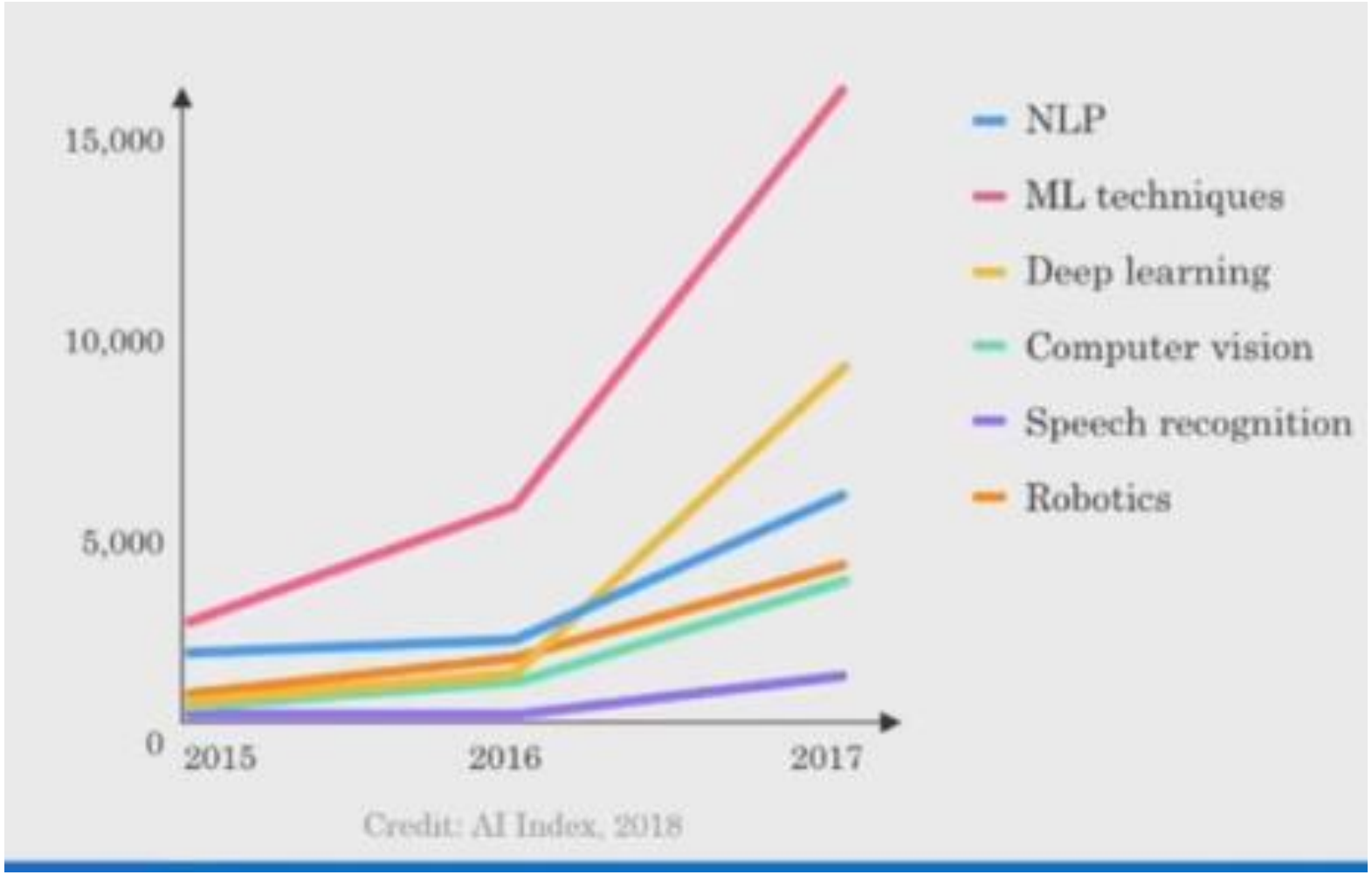
Relationship between AI, machine learning, neural network and Deep learning

Popularity of AI, ML, DL



Popularity of Google Searchs from 2014 to 2019 for artificial intelligence (blue), machine learning (yellow) and deep learning (red).

AI Job openings



AI is more accessible

Artificial Intelligence

- we can define AI as the ability of machines to "mimic" some cognitive abilities of humans, such as solving problems or learning a particular activity.

- Everything is AI

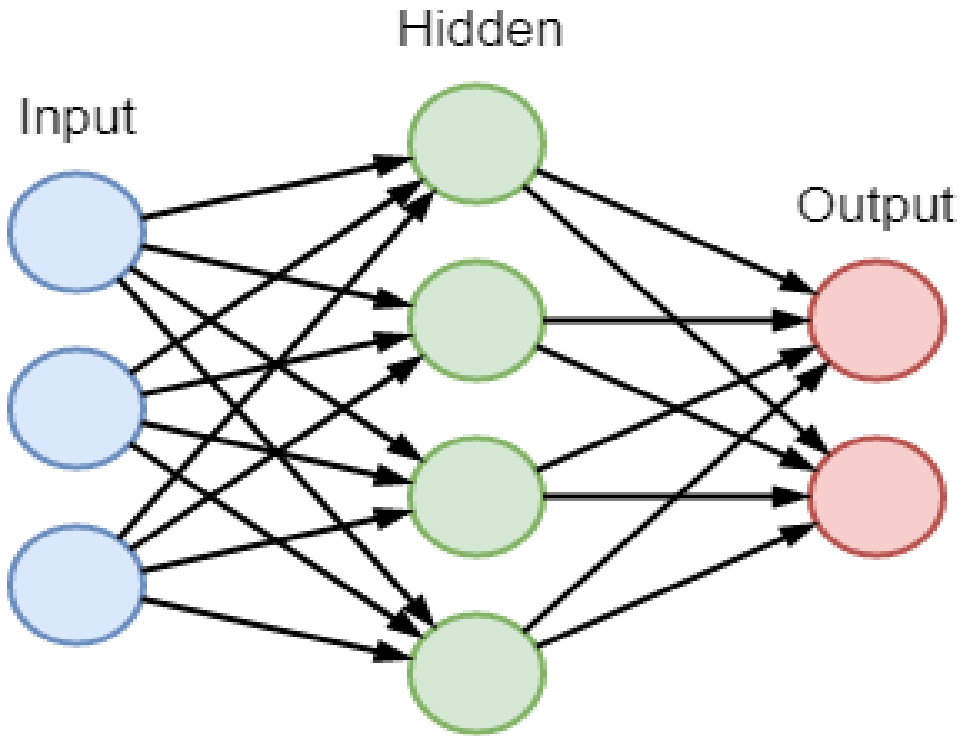
Machine Learning

- Algorithms and statistical models that have the ability to learn from examples.

Neural Networks

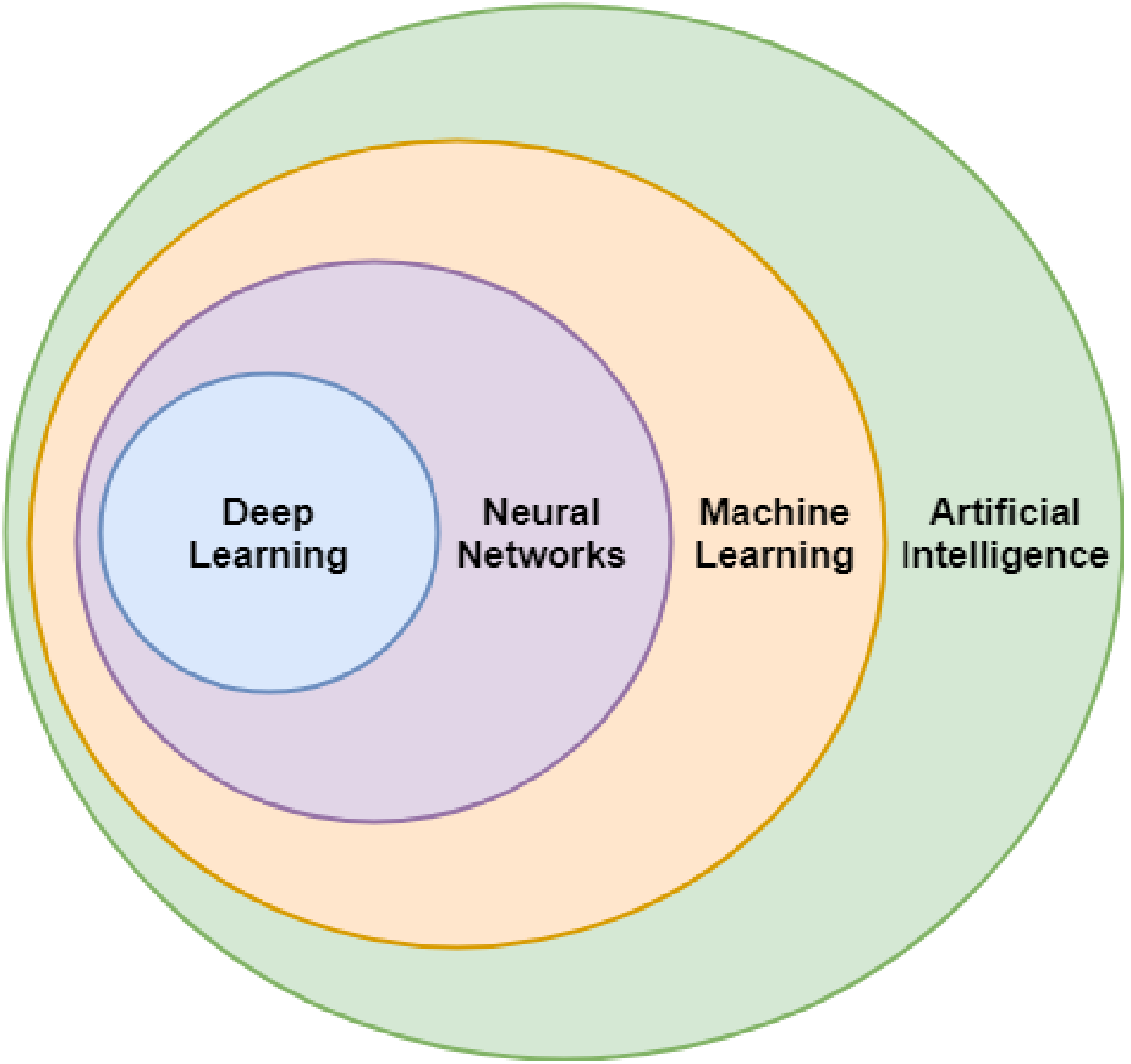
- Mathematics models analogous to a human brain

Neural Networks



Deep Learning

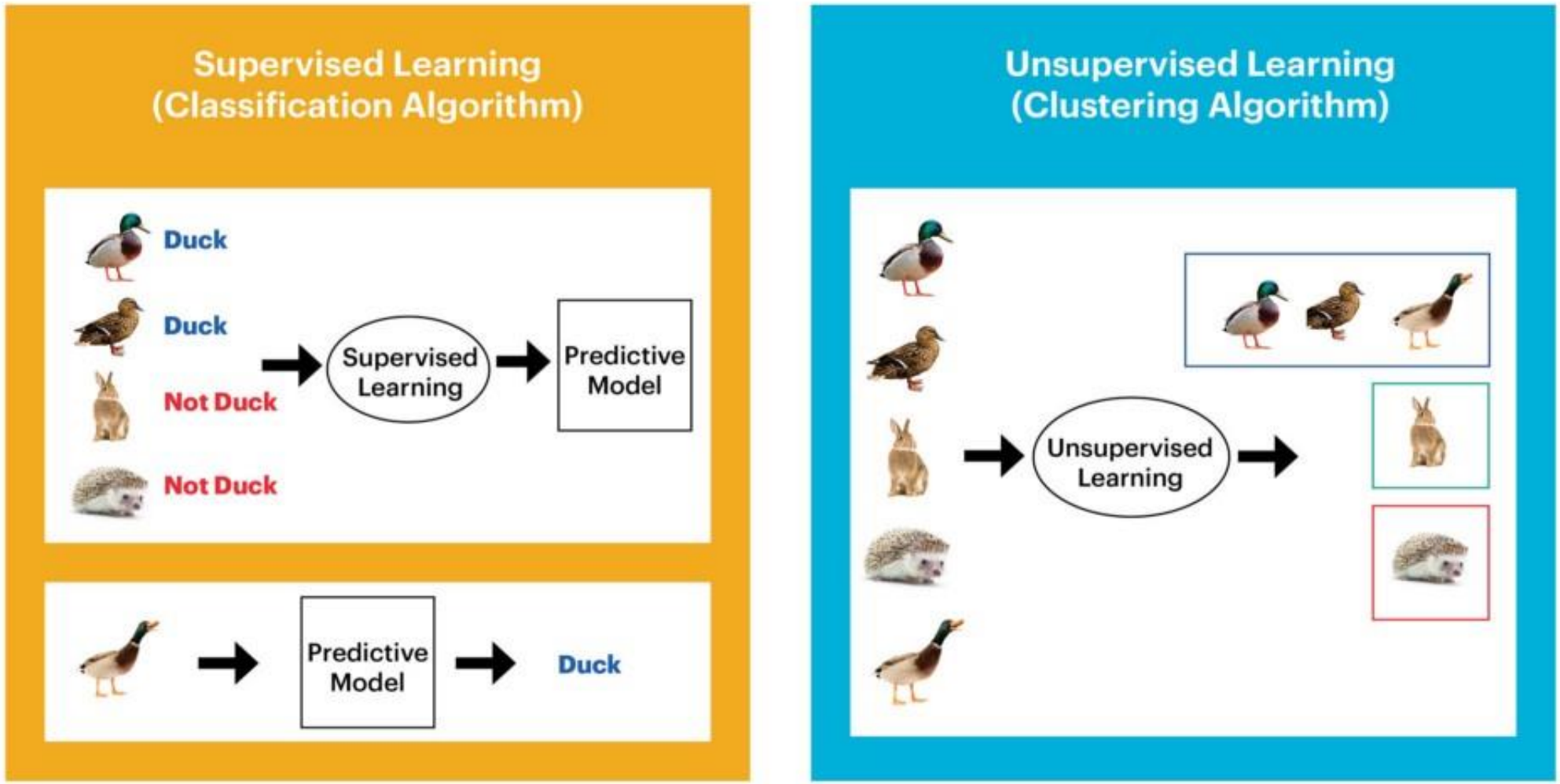
- Neural networks with many hidden layers
- LeNet: 7 layers
- VGG-16: 16 layers
- Inception-v3: 48 layers


Deep Learning
Neural Networks
Machine Learning
Artificial Intelligence

Machine Learning Categories

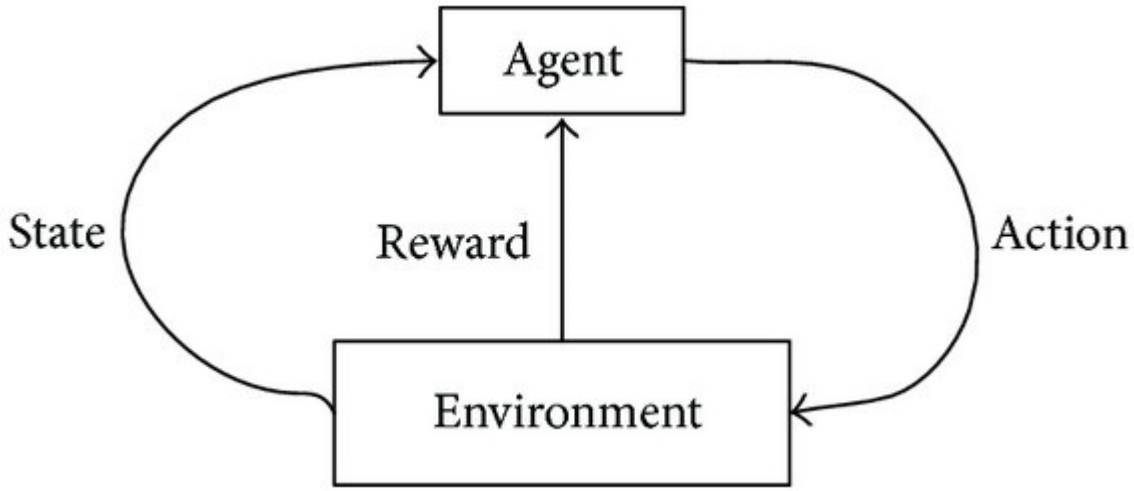
- **Supervised Learning-** each sample of the training set must consist of the desired input and output pairs for the model to be trained

- **Unsupervised Learning-** group unlabeled dataset into classes that follow some pattern



Western Digital.

- **Reinforcement Learning** - Reinforcement learning differs from the others shown by not necessarily being trained with a previously collected dataset, but from the interaction of an agent with an environment. The goal of the RL model is to choose a given action that maximizes the reward in a specific state. Thus, during training the algorithm will explore the environment through agent actions so that after several iterations it recognizes the best action to take for each situation.

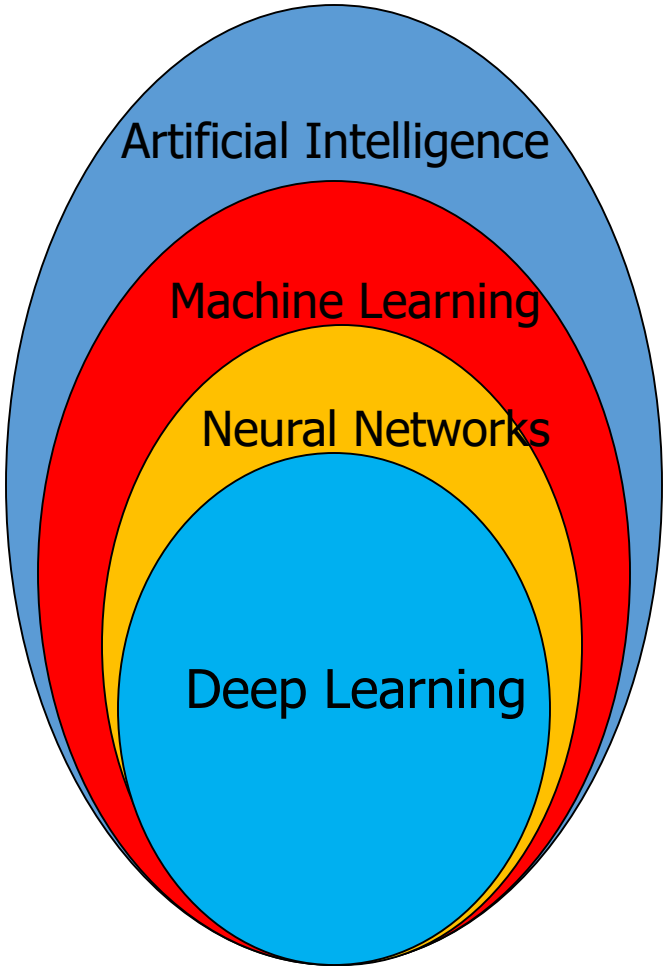


Q-learning, Policy gradients

AI, ML, DL

Deep learning:

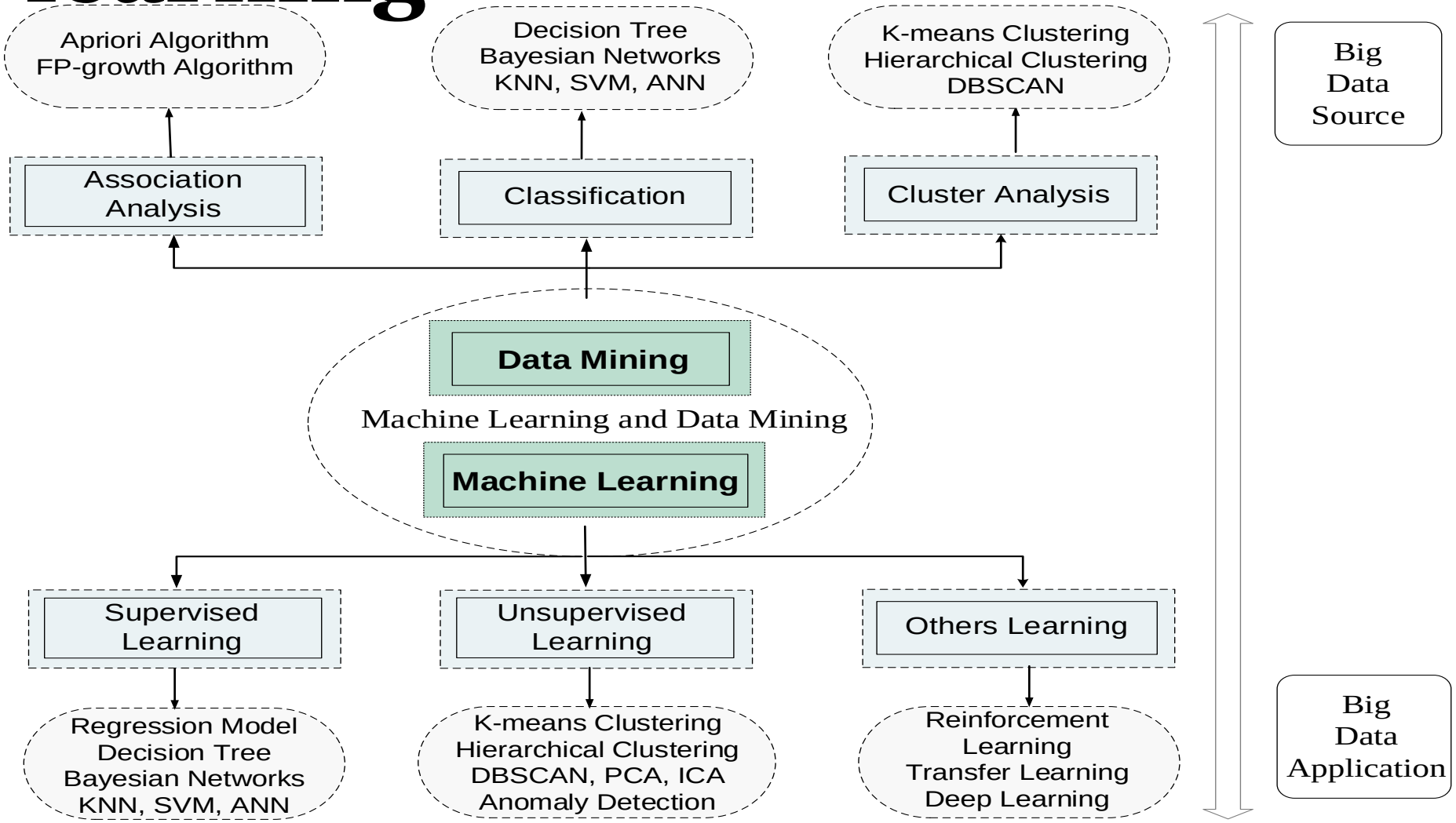
1.Conventional neural networks (CNN)
2.Recurrent neural network (RNN)
3.Long Short-Term Memory (LSTM)
4. Generative Adversarial Networks (GANs, 2014)(生成式對抗網路, very popular recently)
5.Reinforcement learning (強化學習)—AI for game playing, Robot



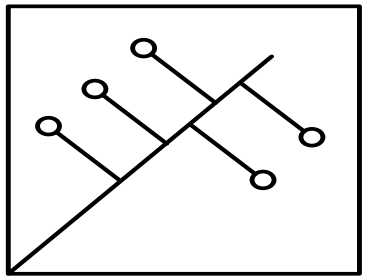
Machine Learning:

1.Regression
2.Decision tree
3.Support vector machine
4.Artificial neural network
5.Deep learning
6.Clustering
7.Bayesian algorithm
8.Genetic algorithm
9.Nature-inspired algorithms
10.Association rules
11.Regularization (to prevent overfitting)
12.Ensemble algorithms

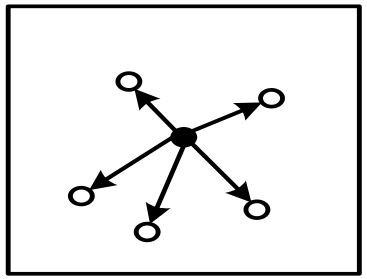
Data Mining and Machine learning



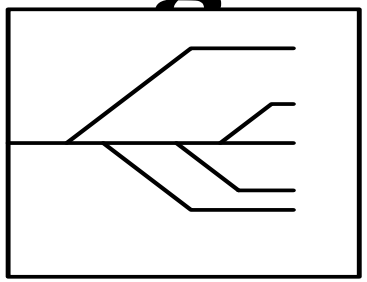
Machine Learning Methods



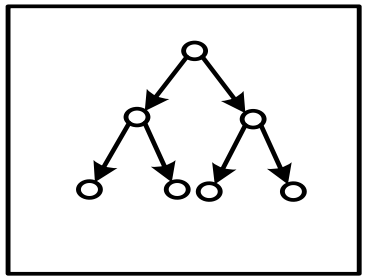
(a)Regression Algorithm



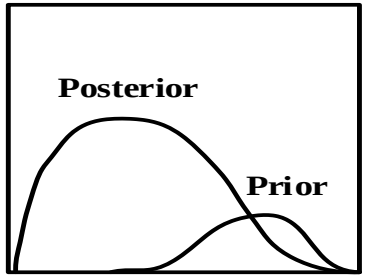
(b)Instance-based Algorithm



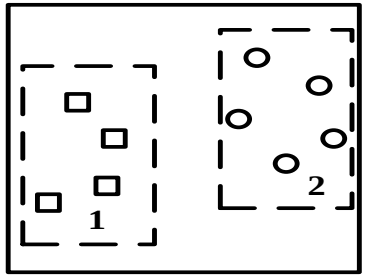
(c)Regularization Algorithm



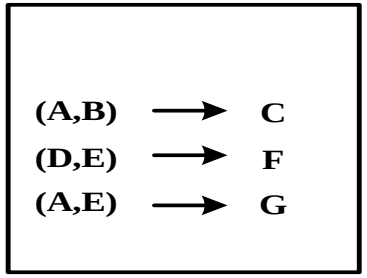
(d)Decision Tree Algorithm



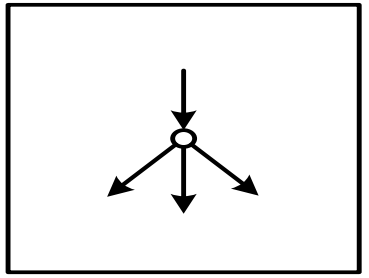
(e)Bayesian Algorithms



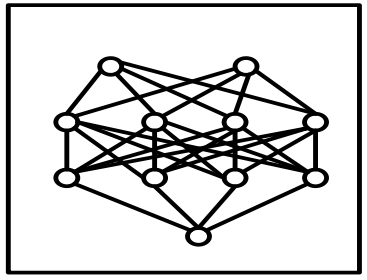
(f)Clustering Algorithms



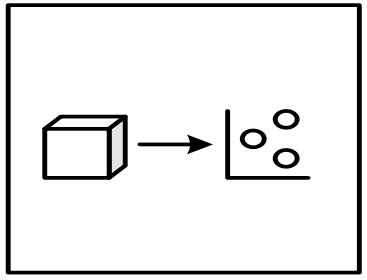
(g)Association Rule Learning Algorithms



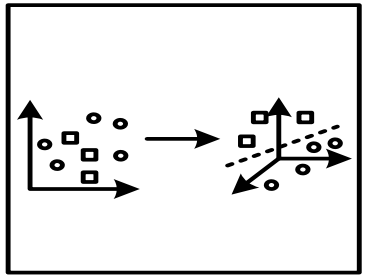
(h)Artificial Neural Network Algorithms



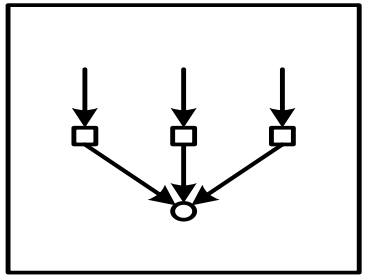
(i)Deep Learning



(j)Dimensional Reduction



(k)Support Vector



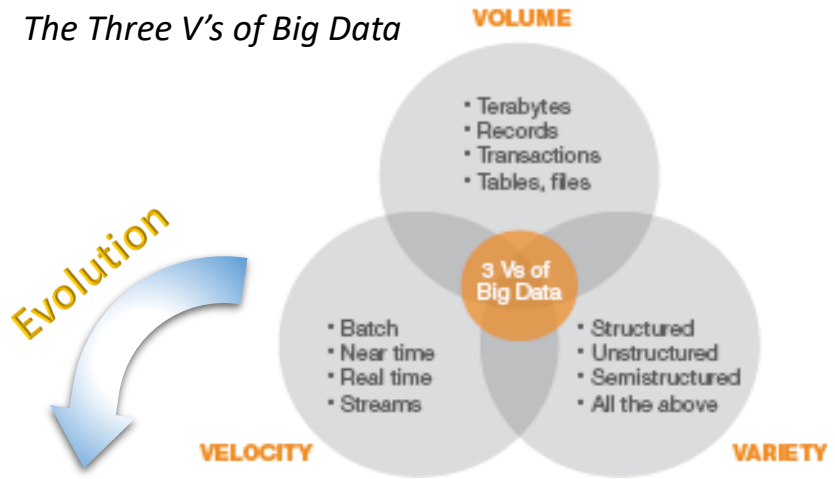
(l)Ensemble Algorithms

Other related terms

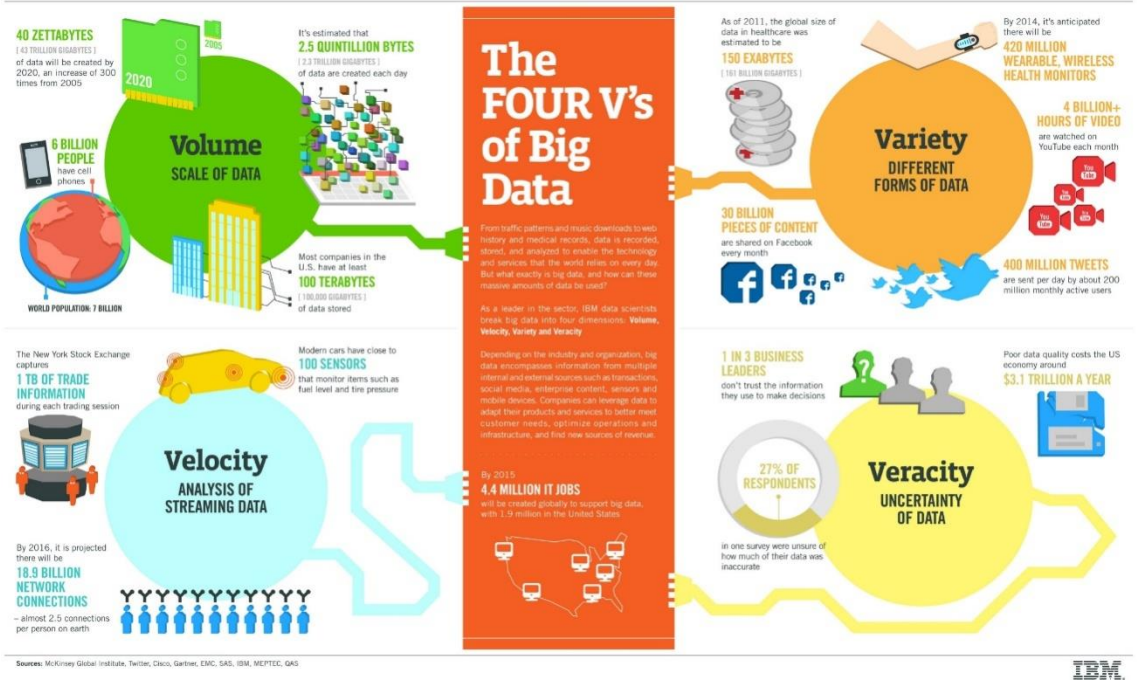
- Big data & Data Science

The Evolution of Big Data

The Three V's of Big Data

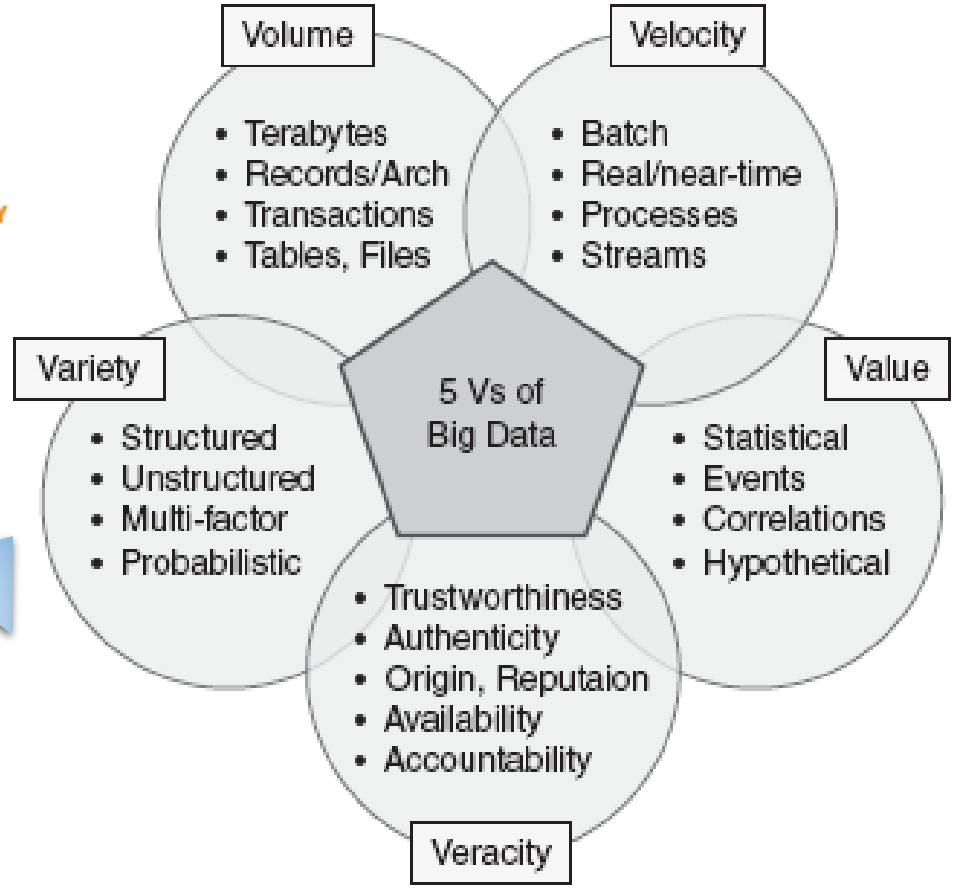


The Four V's of Big Data



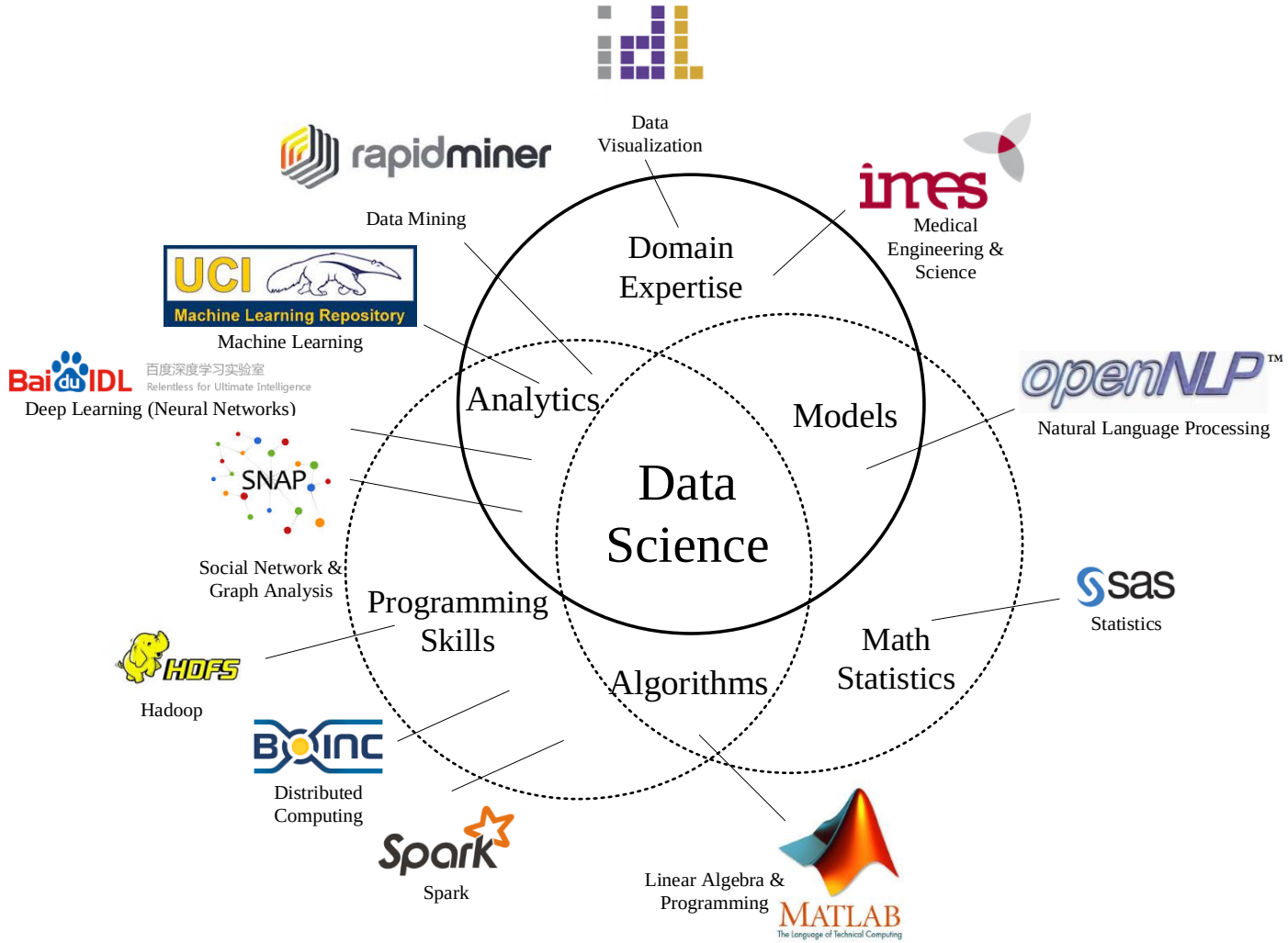
Evolution

The Five V's of Big Data



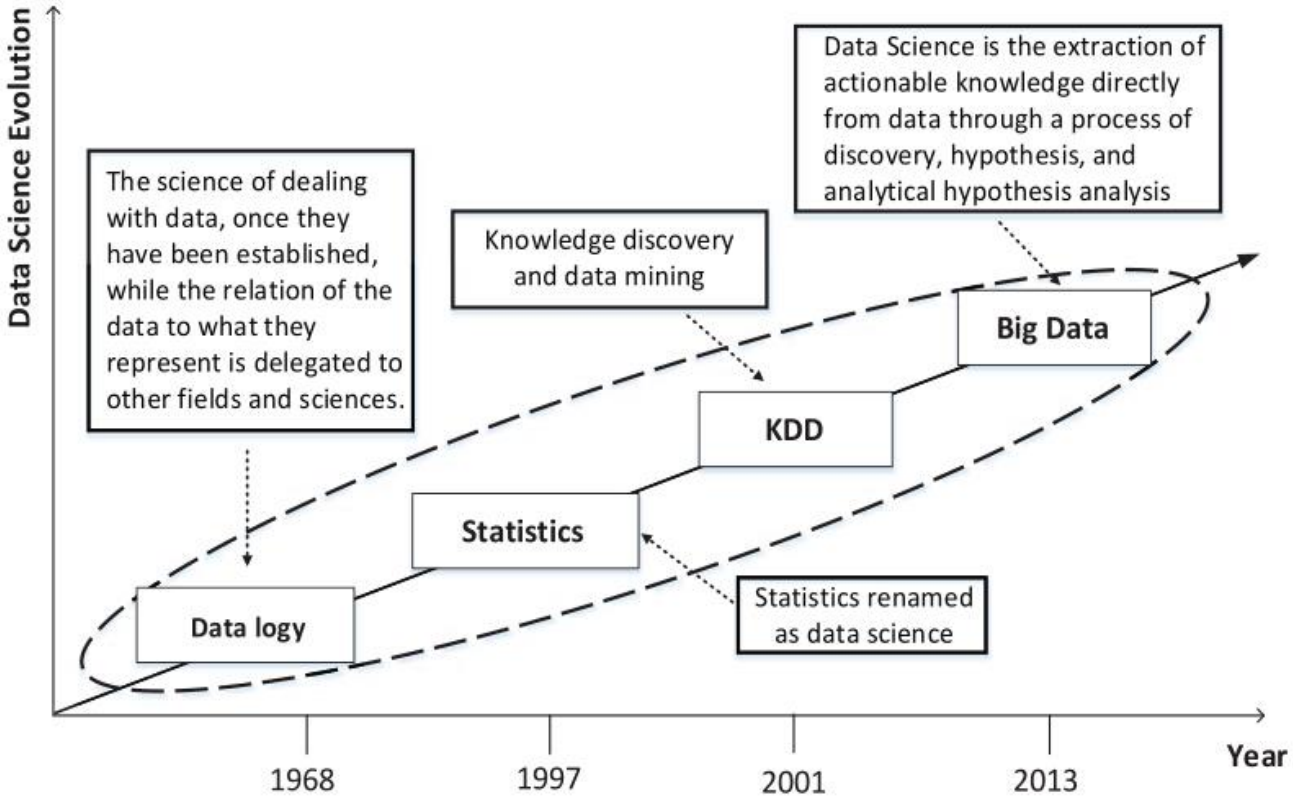
What is Data Science ?

- **Data Science** is the extraction of actionable knowledge directly from data through a process of discovery, hypothesis, and analytical hypothesis analysis.
- A **Data Scientist** is a practitioner who has sufficient knowledge of the overlapping domains of expertise in business needs, domain knowledge, analytical skills and programming expertise to manage the end-to-end scientific method process through each stage in the big data lifecycle.
- **Big Data** refers to digital data volume, velocity and/or variety whose management requires scalability across coupled horizontal resources



Functional components of data science supported by some software libraries on the cloud in 2016

The Evolution of Data Science



The evolution of data science up to the big data era

- Summarized below are some open challenges in big data research, development and applications.

- Structured versus unstructured data with effective indexing;
- Identification, de-identification and re-identification;
- Ontologies and semantics of big data;
- Data introspection and reduction techniques;
- Design, construction, operation and description;
- Data integration and software interoperability;
- Immutability and immortality;
- Data measurement methods;
- Data range, denominators, trending and estimation.

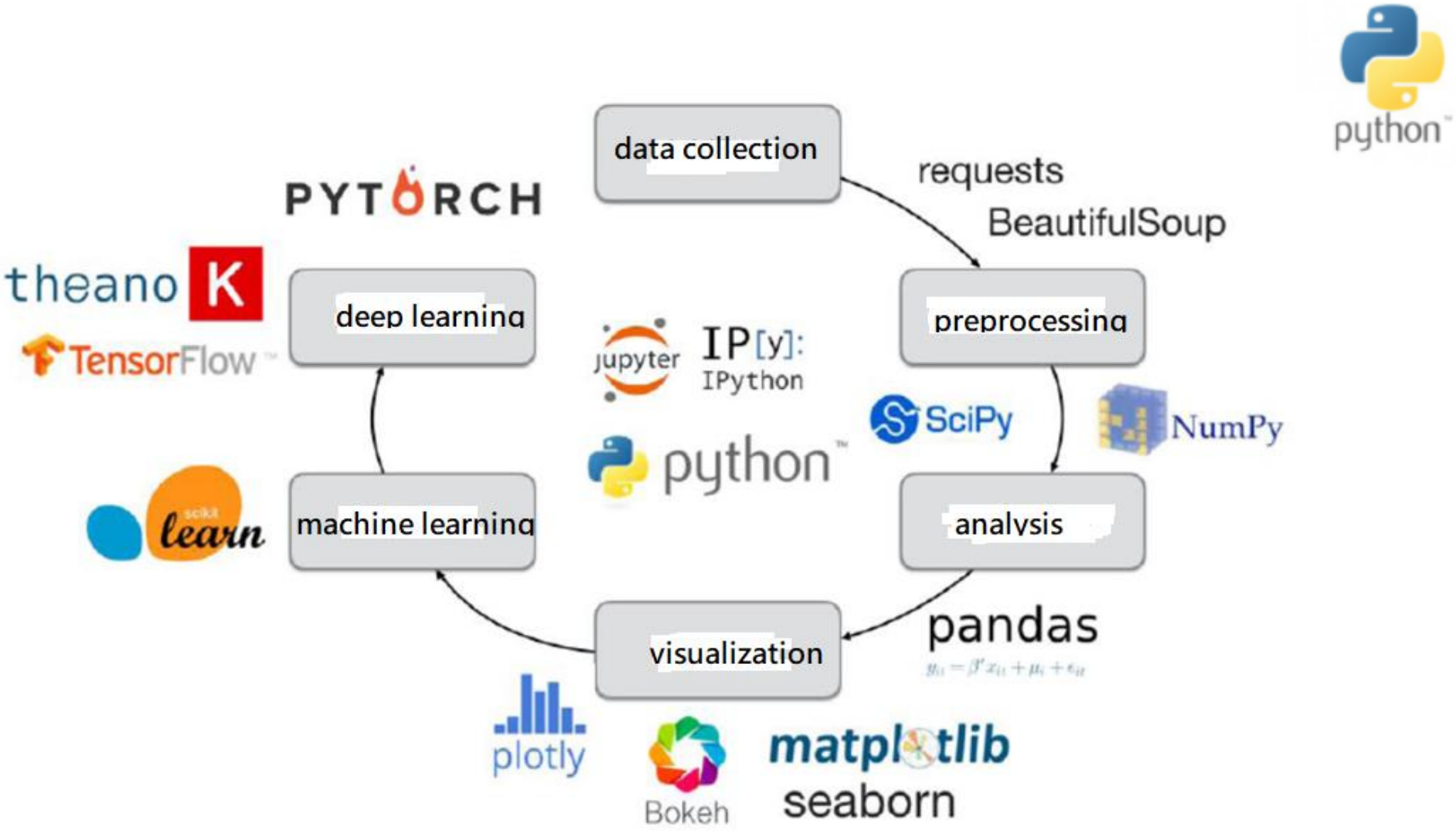
AI definition is vague?

- When you're fundraising, it's AI. When you're hiring, it's ML. When you're implementing, it's logistic regression. —everyone on Twitter ever
- Due to the advance in deep learning, some define…

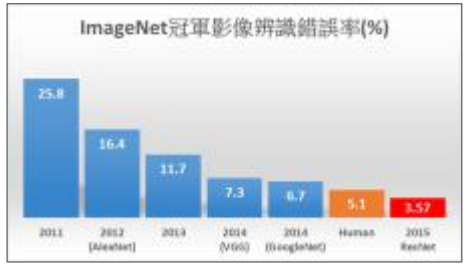
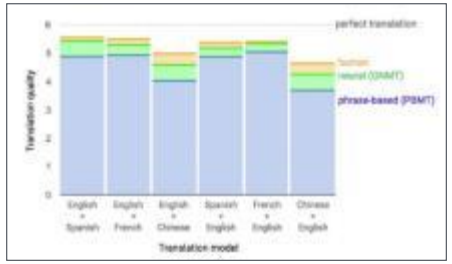
  AI= Deep Learning + Big Data

- In March 2019, three Deep Learning Masters--- Jeoffery Hinton, LeCun Yann and Yoshua Bengio won the Tuning Awards

& Machine Learning



Recent breakthrough of AI

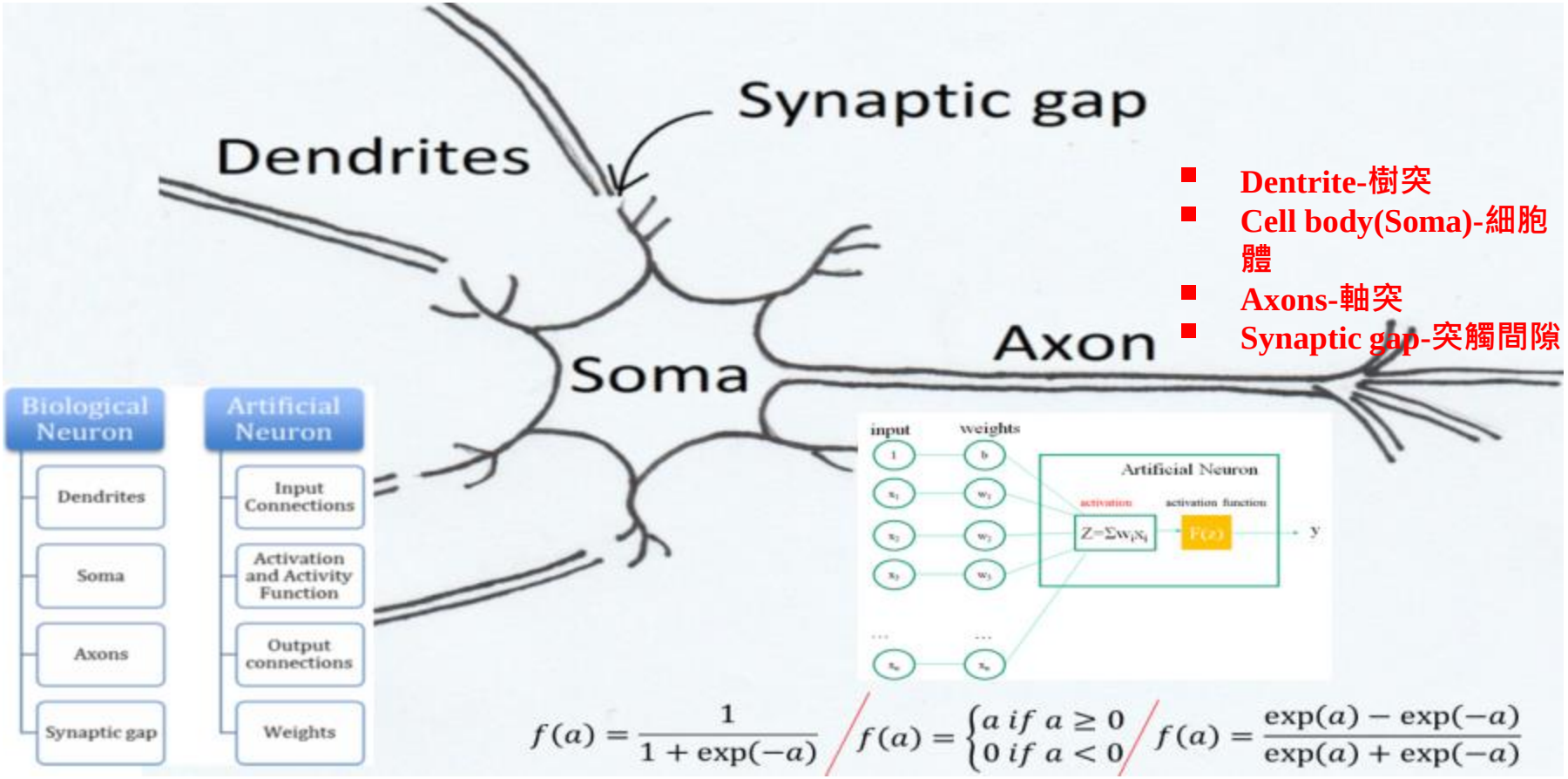
2015/12	2016/3	2016/9	2016/10
Vision	**Gaming**	**Machine Translation**	**Speech Recognition**
Microsoft in ImageNet Compition (ILSVRC) Reduces the error rate to 3.57%, better than human eyes.[1]	**AlphaGo beats Go champion Lee with 4 games to 1; beats Chinese Champion Ker with 3 to nothing (2017/4)**	**Google Translate use "Neural Machine Translation" technology to translate natural languages achieves the quality of human translation [3]**	**Microsoft speech recognition tech. reduces the error rate to 5.9%, which is the level of a human expert.[4]**
			
Deeper Neural Networks	**Deep Reinforcement Learning、Monte Carlo Tree Search**	**End-to-End Learning、Deep LSTM (Long Short-Term Memory) Network**	**CNN (Convolutional Neural Network)、RNN (Recurrent Neural Network)**

Picture source：TechNews(2016/03)、Business Recorder(2016/10)

[1] K. He, X. Zhang, S. Ren, and J. Sun, "Deep Residual Learning for Image Recognition," *CVPR, 2016*.
[2] D. Silver, A. Huang, C. J. Maddison, A. Guez, and L. Sifre, "Mastering the game of Go with deep neural networks and tree search," Nature, vol. 529, no. 7587, pp. 484–489, 2016.
[3] M. Johnson, M. Schuster, Q. V. Le, M. Krikun, Y. Wu, Z. Chen, N. Thorat, F. Viégas, M. Wattenberg, G. Corrado, M. Hughes, and J. Dean, "Google's Multilingual Neural Machine Translation System: Enabling Zero-Shot Translation," arXiv preprint arXiv:1611.04558, 2016.
[4] W. Xiong, J. Droppo, X. Huang, F. Seide, M. Seltzer, A. Stolcke, D. Yu, and G. Zweig, "Achieving Human Parity in Conversational Speech Recognition.," arXiv preprint arXiv:1610.05256, 2016.

source：ITRI Big Data Center工研院巨

Neural network



- Dentrite-樹突
- Cell body(Soma)-細胞體
- Axons-軸突
- Synaptic gap-突觸間隙

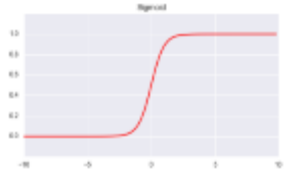
$$f(a) = \frac{1}{1+\exp(-a)} \qquad f(a) = \begin{cases} a \; if \; a \geq 0 \\ 0 \; if \; a < 0 \end{cases} \qquad f(a) = \frac{\exp(a) - \exp(-a)}{\exp(a) + \exp(-a)}$$

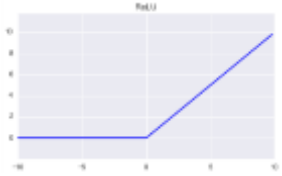
Sigmod　　ReLU　　Hyperbolic tangent

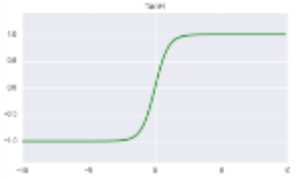
(Rectifier, or Rectified Linear Unit)

一個神經元(感知器)

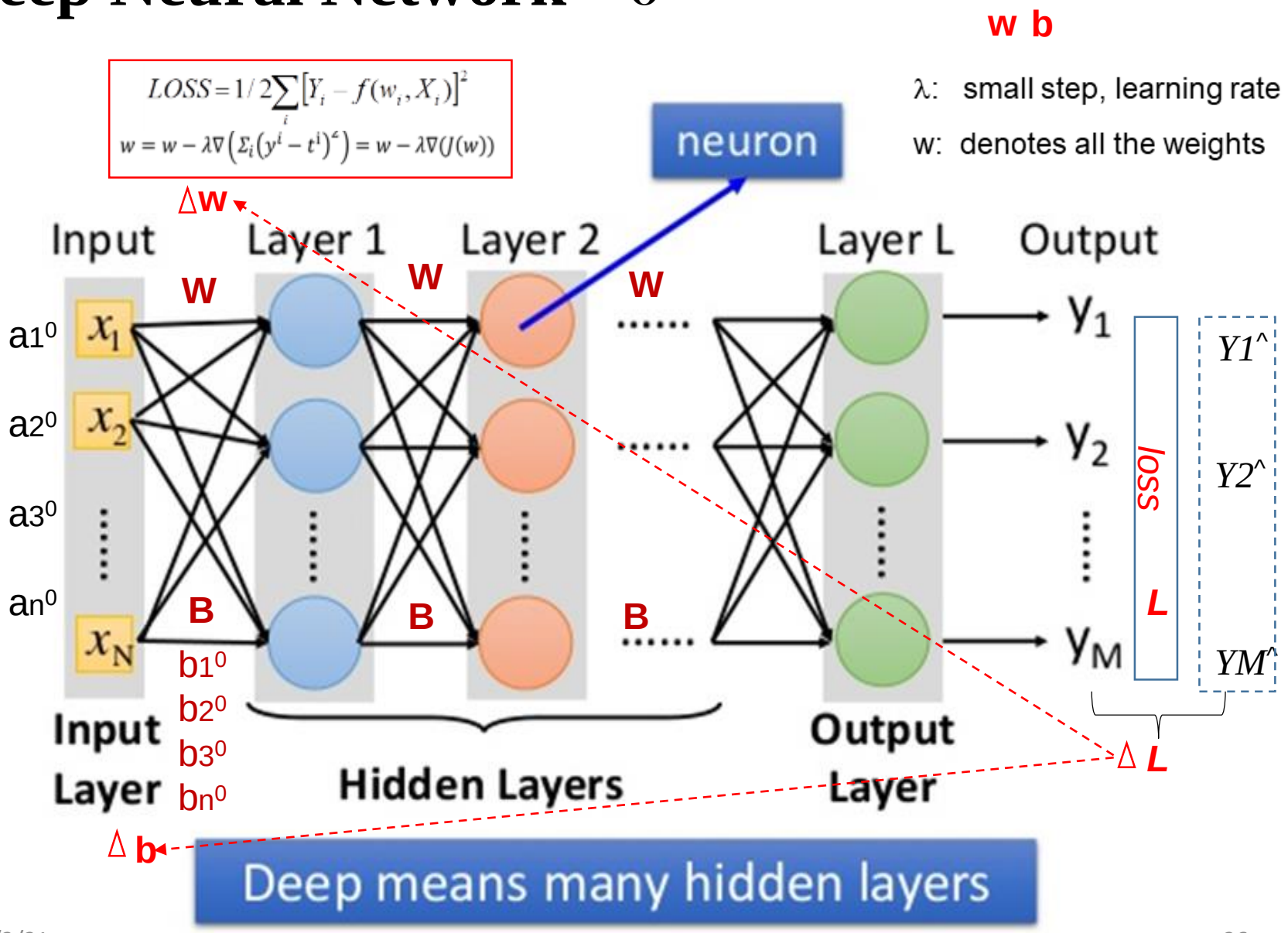
perceptron







Fully connect Freed Forward Network
Deep Neural Network -- ɵ



正向餵資料，反向傳遞修正模型，測試模型可用性，使用

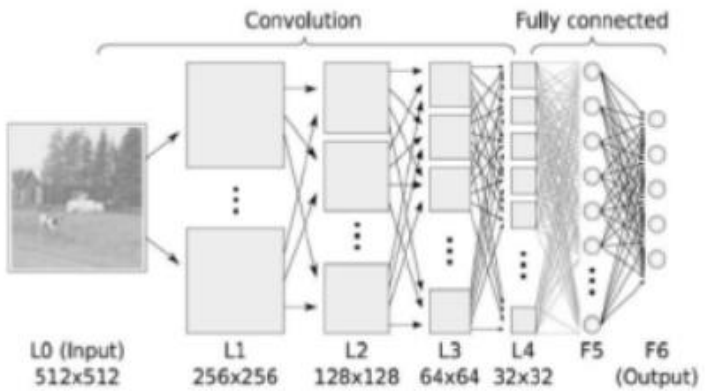
Deep Learning for CNN, RNN

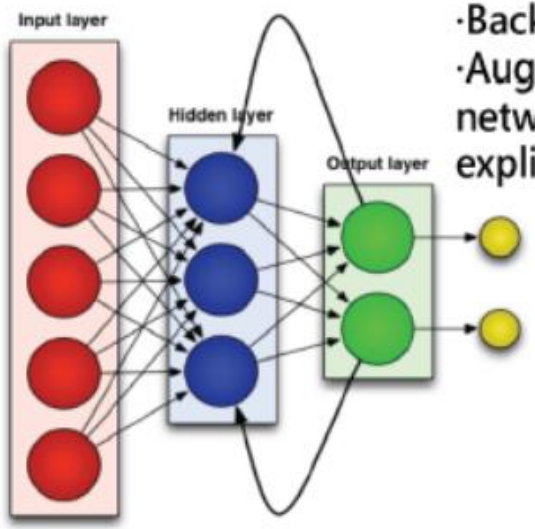
CNN - some convolutional layers

Image recogntion ; local connections, shared weights, pooling and the use of many layers.

RNN - recurrent neural network, LSTM (long short-term memory networks)

Used for speech recognition and NLP





·Backpropagation
·Augment the network with an explicit memory.

Deep Learning – Review by LeCun, Bengio, and Hinton, Nature 521, 436–444 (28 May 2015)

Optional textbook:

•Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Free online e-book

• Practical Data Science Cookbook by Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta, Free online e-book

• Python Data Science Handbook by Jake VanderPlas, Free online e-book