Artificial Intelligence

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Content

- Artificial Intelligence
- Data Mining
- Linear Algebra
- Data Processing Tools

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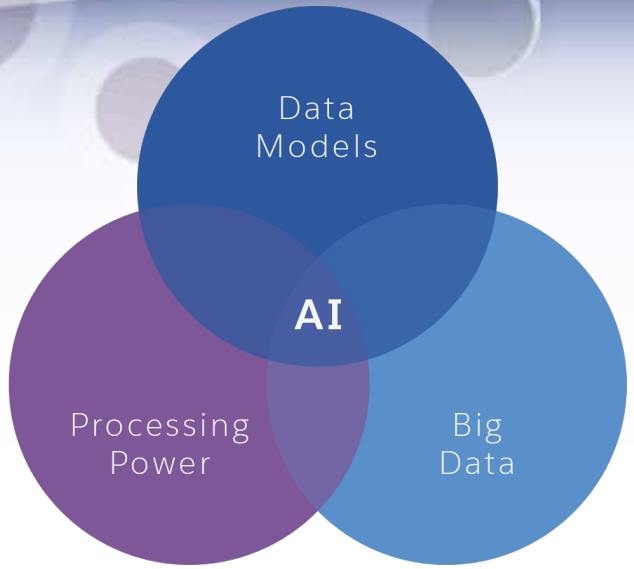
Artificial Intelligence



The theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

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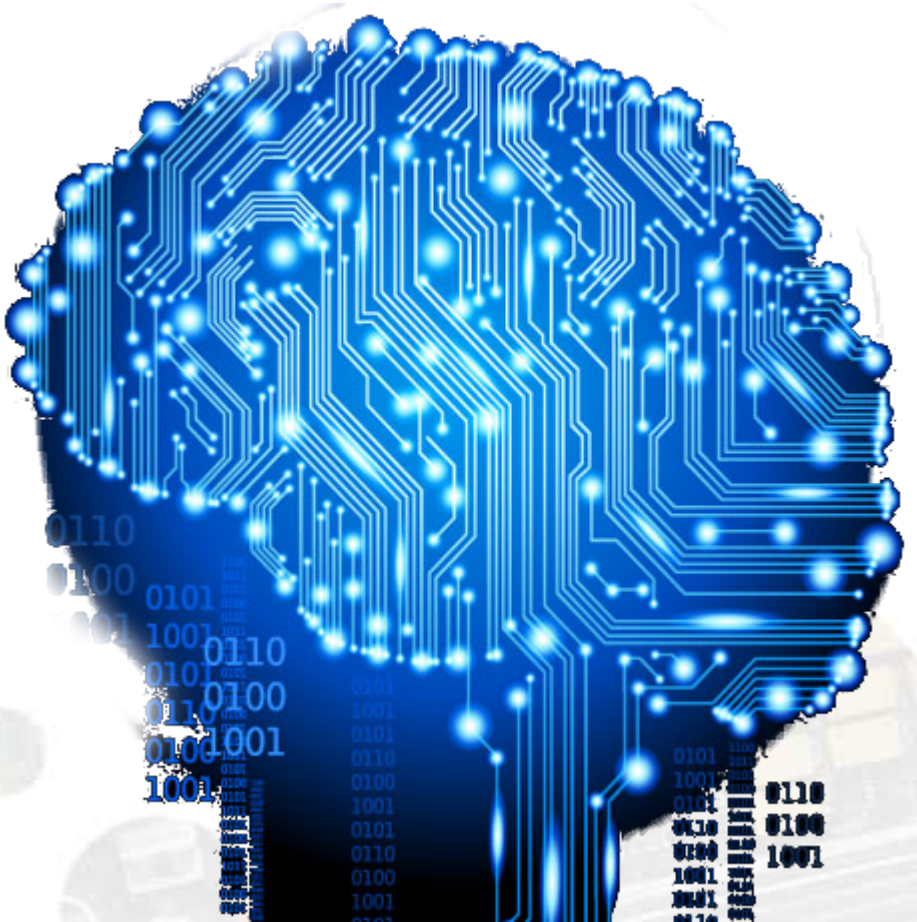
Artificial Intelligence

- Inspired by the brain
  - Input Data
  - Memorize
  - Process
  - Learn
  - Decision



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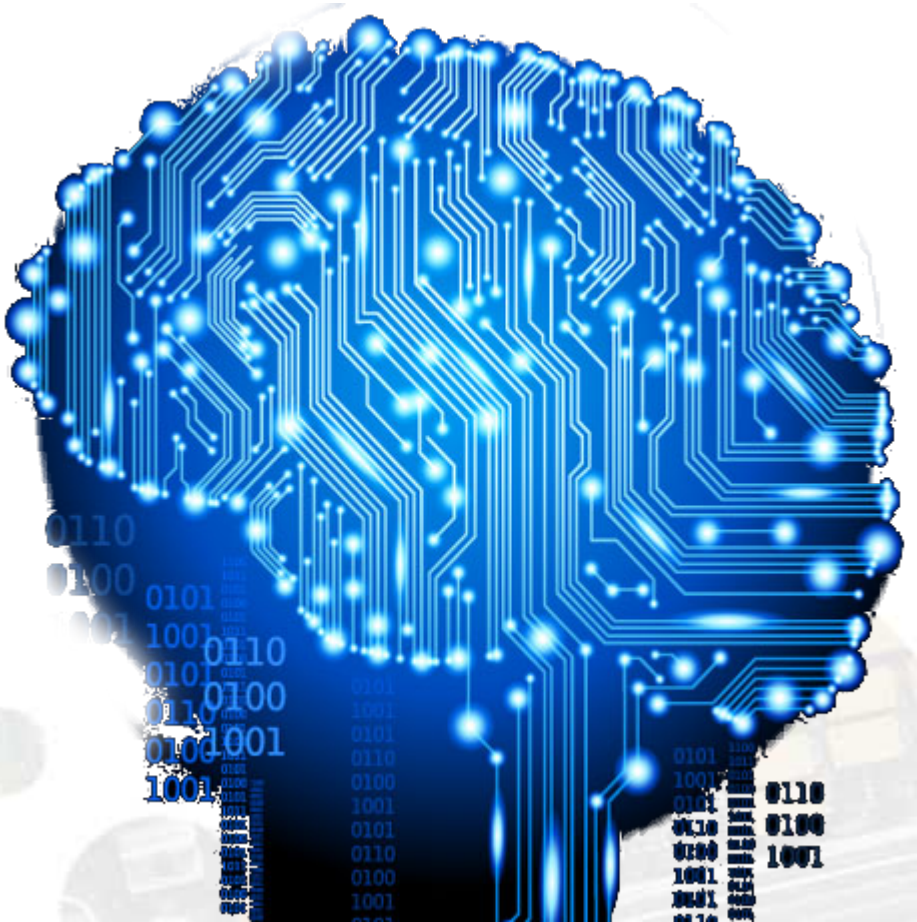
Artificial Intelligence

- Inspired by the brain
  - Input Data — Labeled
  - Memorize
  - Process — Training
  - Learn — Training
  - Decision — Outcome



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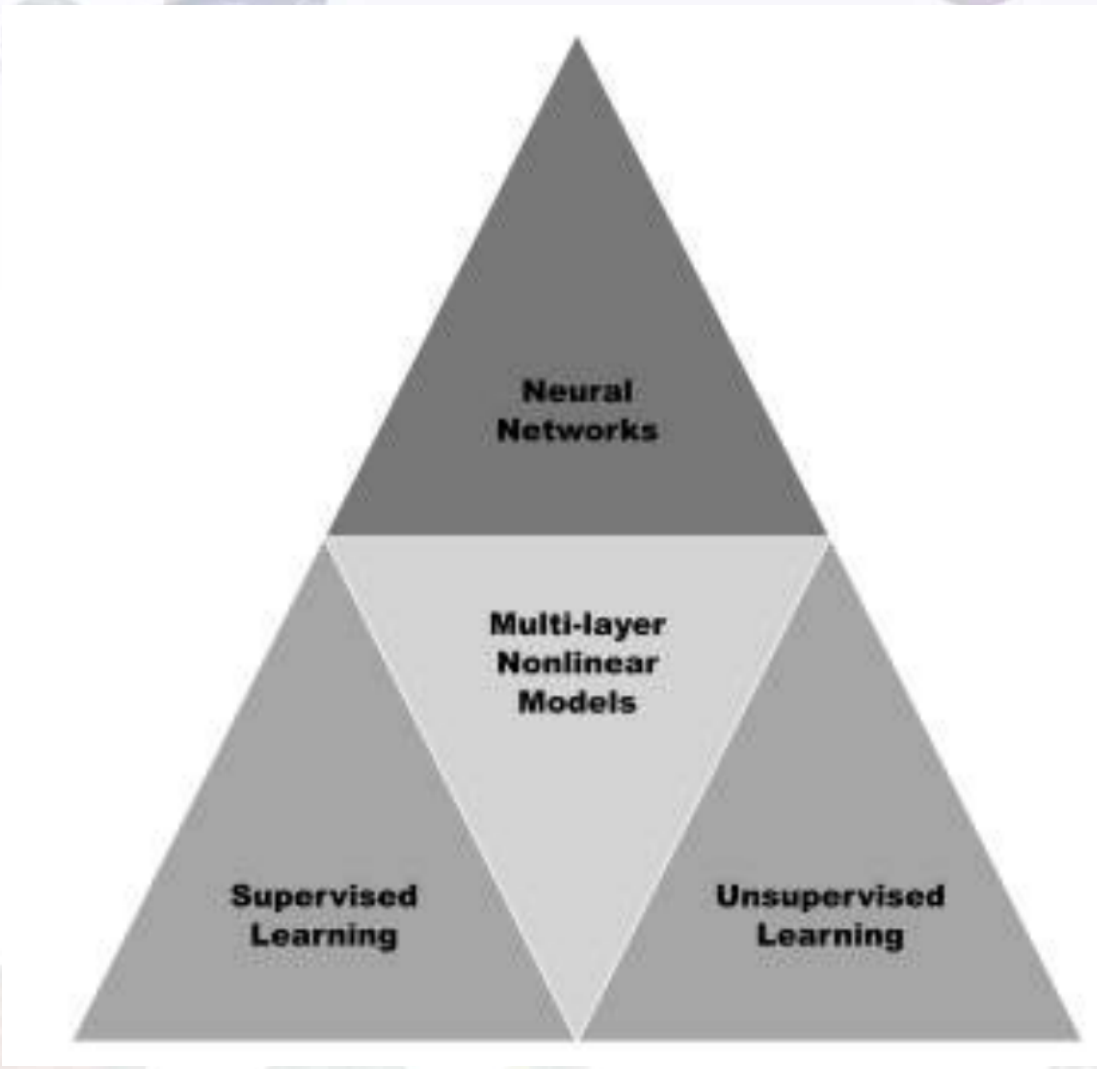
Neural
Networks
Multi-layer
Nonlinear
Models
Supervised
Learning
Unsupervised
Learning

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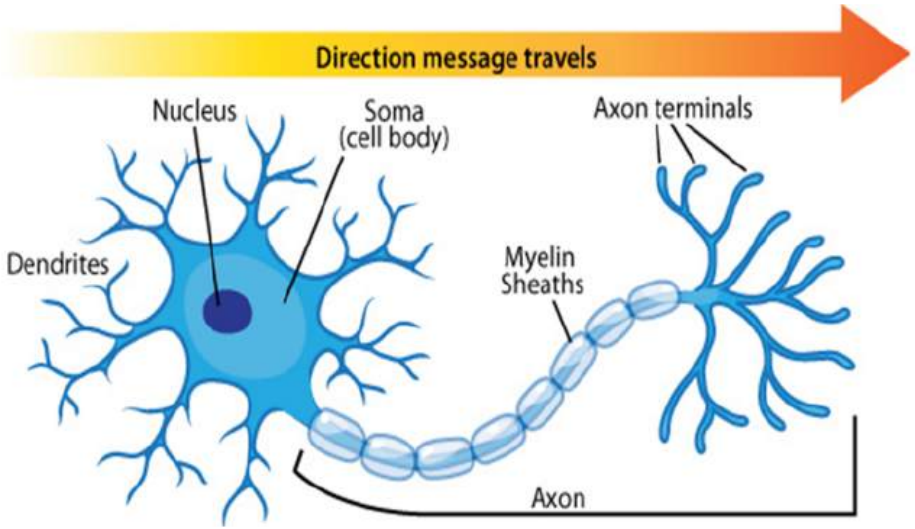
Biological Neuron

- A Biological neurons pass signals or messages to each other via electrical signals.
- Neighboring neurons receive these signals through their dendrites.
- Information flows from the dendrites to the main cell body, known as the soma, and via the axon to the axon terminals.
- In essence, biological neurons are computation machines passing messages between each other about various biological functions.



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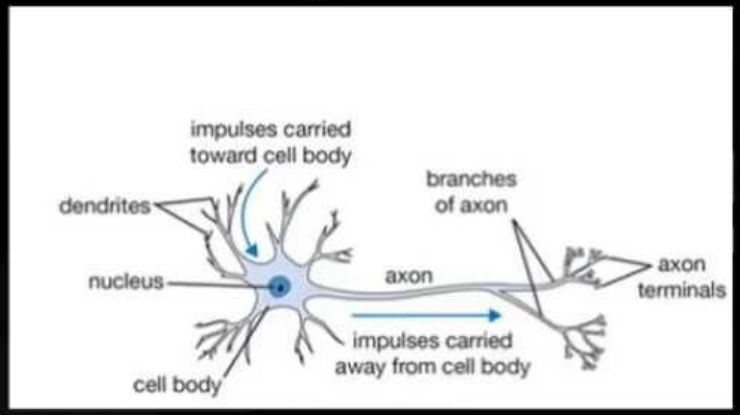
AN: Artificial Neuron

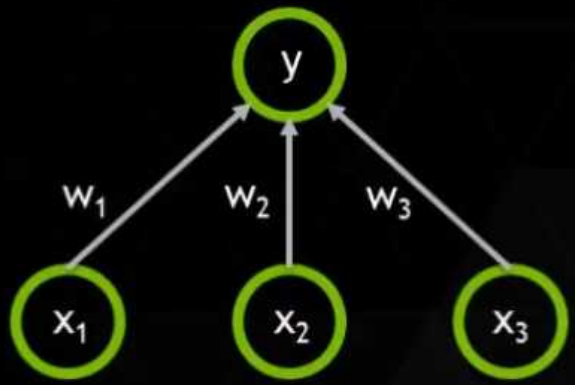
A collection of simple, trainable mathematical units that collectively learn complex functions

Biological neuron



From Stanford cs231n lecture notes

Artificial neuron



$y=F(w_1x_1+w_2x_2+w_3x_3)$

$F(x)=\max(0,x)$

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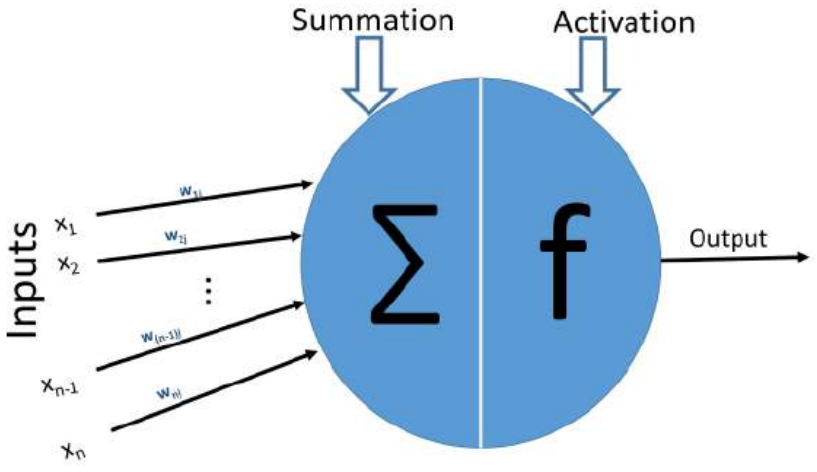
Workings of an individual neuron

- Given a sample of input attributes {x1 ,...,xn} a weight wij is associated with each connection into the neuron; and the neuron then sums all inputs according to:

$$f(u) = \sum_{i=1}^{n} w_{ij} x_j + b_j$$

- The parameter bj is known as the bias and is similar to the intercept in a linear regression model. It allows the network to shift the activation function “upwards” or “downwards”.



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Neural Network

- A Neural network is constructed from a number of interconnected nodes known as neurons. These are usually arranged into a number of layers.
- A typical feed forward neural network will have at a minimum an input layer, a hidden layer and an output layer.
- The input layer nodes correspond to the number of features or attributes you wish to feed into the neural network.
- These are akin to the co-variates to use in a linear regression model.
- The number of output nodes correspond to the number of items you wish to predict or classify.
- The hidden layer nodes are generally used to perform non-linear transformation on the original input attributes.

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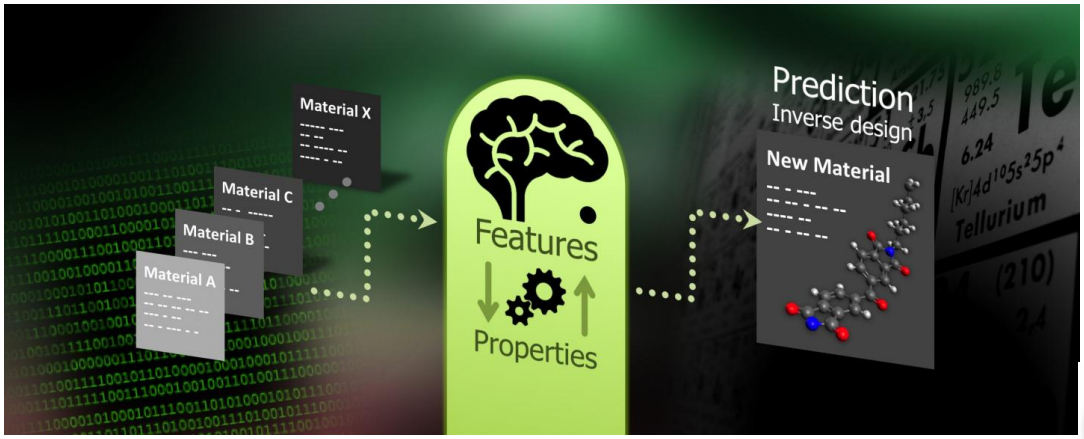
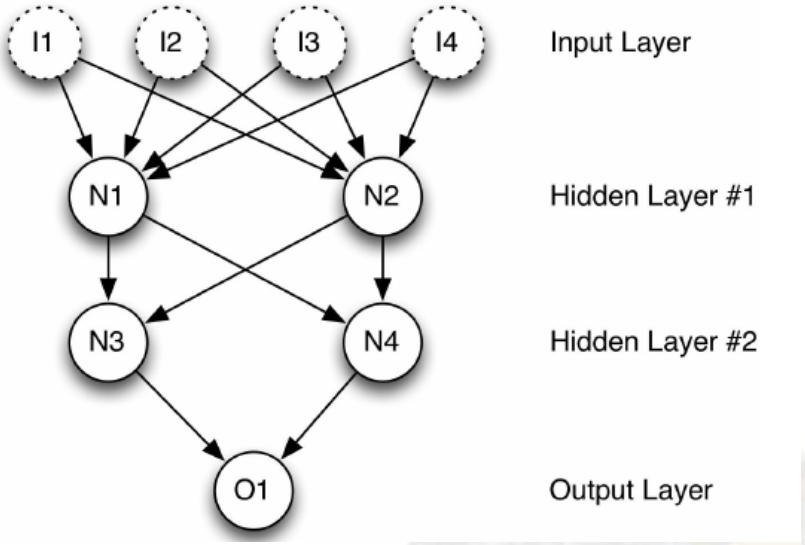
NN: Neural Networks





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Data Analysis/Mining

- Data Mining is about automating the process of searching for patterns in the data.
- Supervised Task (Human Interpretable)
- Unsupervised Task (Find Unknown)

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- Classification is a set of predefined classes and classify an object in which class it belongs to.

- Clustering tries to group a set of objects and find whether there is some relationship between the objects.

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Processing

- Regression
  Predict new values based on the past, inference compute the new values for a dependent variable based on the values of one or more measured attributes
- Association is a data mining function that discovers the probability of the co-occurrence of items in a collection.

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Linear Algebra

- Linear algebra is the mathematics of data. Matrices and vectors are the language of data.
- Linear algebra is about linear combinations.
- That is, using arithmetic on columns of numbers called vectors and arrays
- Numerical Linear Algebra of numbers called matrices, to create new columns and arrays of numbers.

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- Linear algebra is the study of lines and planes, vector spaces and mappings that are required for linear transforms.
- $y = 4 \times x + 1$

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Numerical Linear Algebra

- The application of linear algebra in computers is often called numerical linear algebra.

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Libraries

- Efficient implementations of vector and matrix operations were originally implemented in the FORTRAN programming language in the 1970s and 1980s and a lot of code, or code ported from those implementations, underlies much of the linear algebra performed using modern programming languages, such as Python. Three popular open source numerical linear algebra libraries that implement these functions are:
- Linear Algebra Package, or LAPACK.
- Basic Linear Algebra Subprograms, or BLAS (a standard for linear algebra libraries).
- Automatically Tuned Linear Algebra Software, or ATLAS.

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Linear Algebra and Statistics

The impact of linear algebra is important to consider, given the foundational relationship both fields have with the field of applied machine learning. Some clear fingerprints of linear algebra on statistics and statistical methods include:

- Use of vector and matrix notation, especially with multivariate statistics.
- Solutions to least squares and weighted least squares, such as for linear regression.
- Estimates of mean and variance of data matrices.
- The covariance matrix that plays a key role in multinomial Gaussian distributions.
- Principal component analysis for data reduction that draws many of these elements together.

Applications of Linear Algebra

- Matrices in Engineering, such as a line of springs.
- Graphs and Networks, such as analyzing networks.
- Markov Matrices, Population, and Economics, such as population growth.
- Linear Programming, the simplex optimization method.
- Fourier Series: Linear Algebra for functions, used widely in signal processing.
- Linear Algebra for statistics and probability, such as least squares for regression.
- Computer Graphics, such as the various translation, rescaling and rotation of images.

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Linear Algebra and Machine Learning

- Linear Algebra is undeniably a pillar of the field of machine learning, and many recommend it as a prerequisite subject to study prior to getting started in machine learning.

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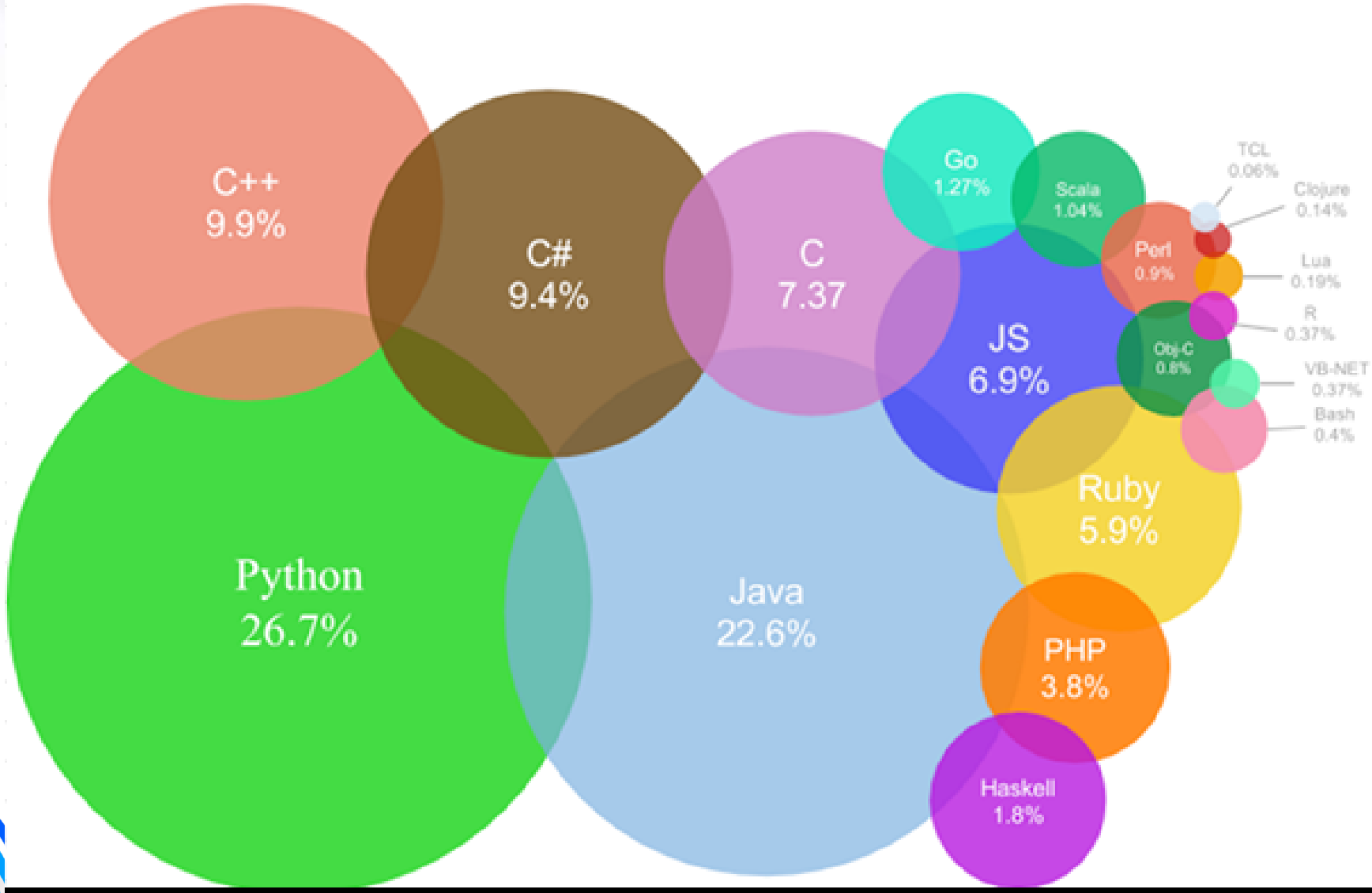
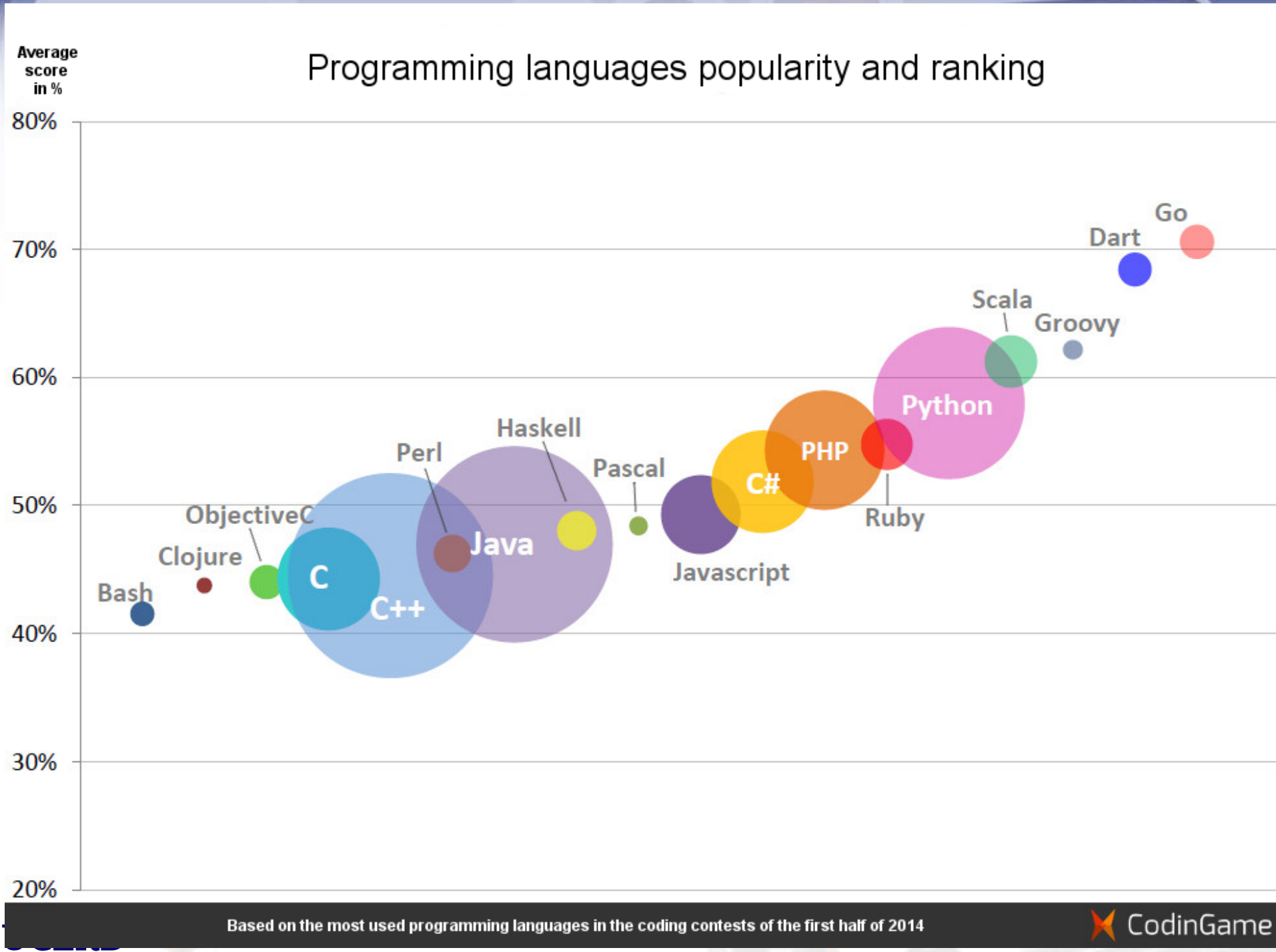
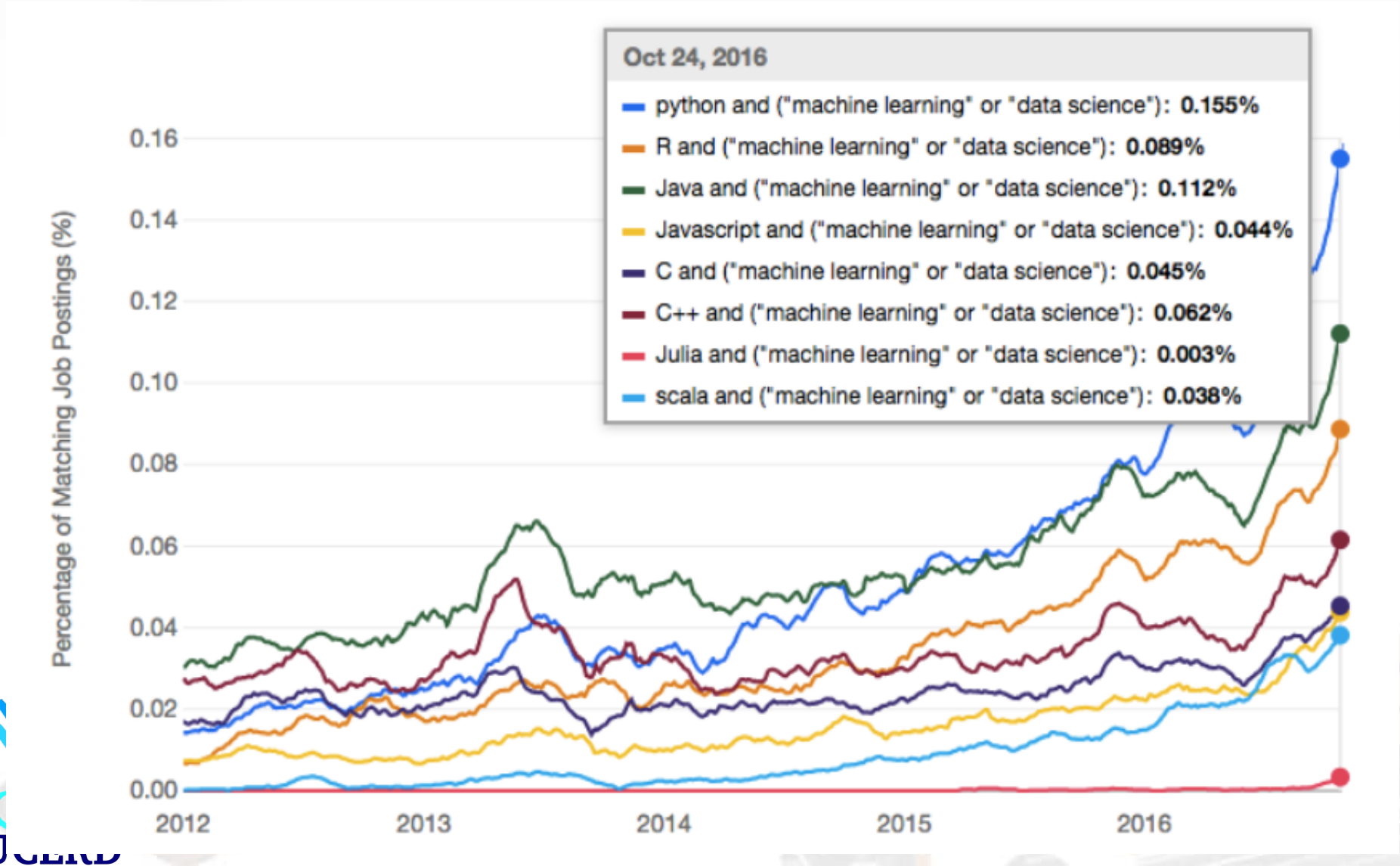
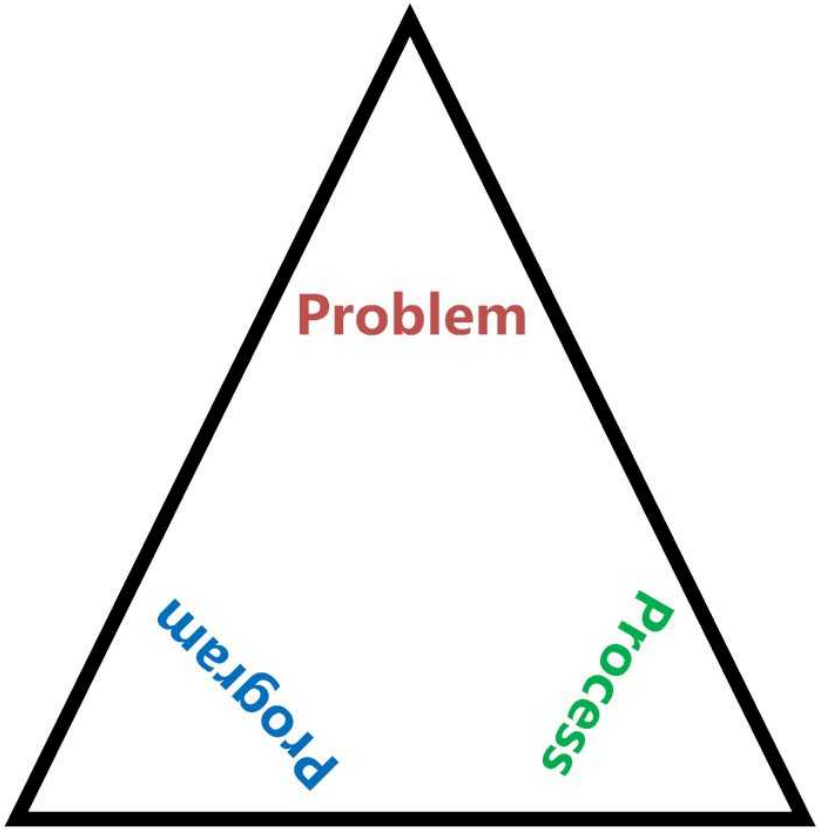
Most Popular Coding Languages of 2016




Programming languages popularity and ranking
Average score in %
80%
70%
60%
50%
40%
30%
20%
Go
Dart
Scala
Groovy
Python
PHP
Haskell
Perl
Pascal
C#
ObjectiveC
Ruby
Clojure
Java
C
C++
Javascript
Bash
Based on the most used programming languages in the coding contests of the first half of 2014
CodinGame


Oct 24, 2016
python and ("machine learning" or "data science"): 0.155%
R and ("machine learning" or "data science"): 0.089%
Java and ("machine learning" or "data science"): 0.112%
Javascript and ("machine learning" or "data science"): 0.044%
C and ("machine learning" or "data science"): 0.045%
C++ and ("machine learning" or "data science"): 0.062%
Julia and ("machine learning" or "data science"): 0.003%
scala and ("machine learning" or "data science"): 0.038%
Percentage of Matching Job Postings (%)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2012
2013
2014
2015
2016

Problem Program and Process



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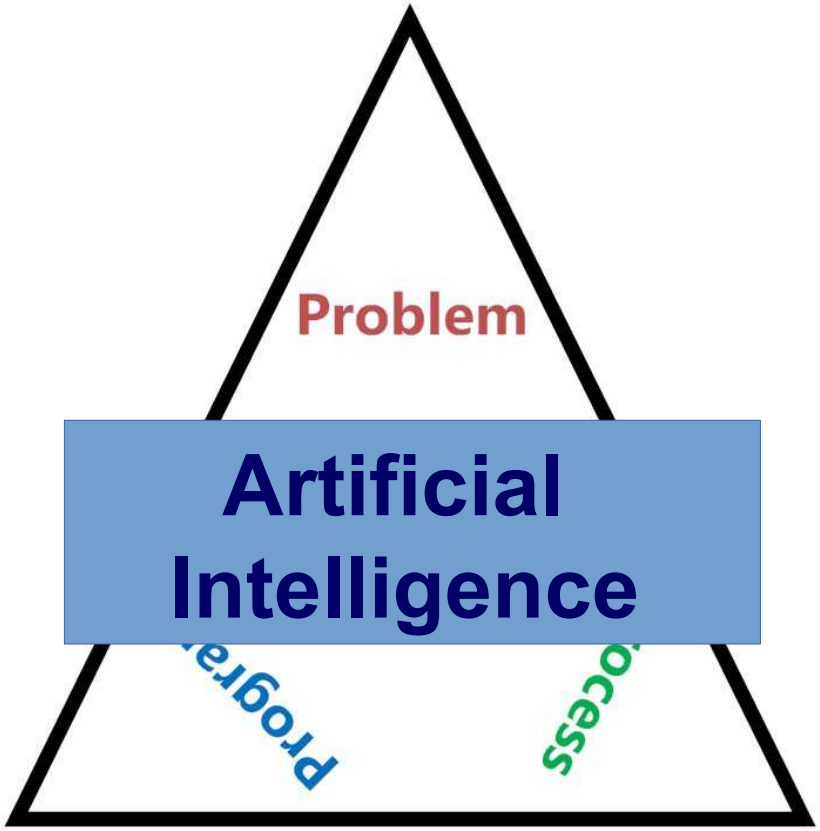
Problem Program and Process



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Types of Learning

- **Supervised learning:** The training data contain the known outcomes. The model is trained relative to these outcomes.
- **Unsupervised learning:** The training data does not contain any known outcomes. In this case the algorithm self-discovers relationships in your data.
- **Reinforcement Learning**: This type of learning focus on the end outcome to learn e.g. chess. The learning does not have any labeled data or action. It generates the labels based on success or failure of action.

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Artificial Intelligence Techniques

Machine and Deep Learning
Bother offers ways to train models and classify data.

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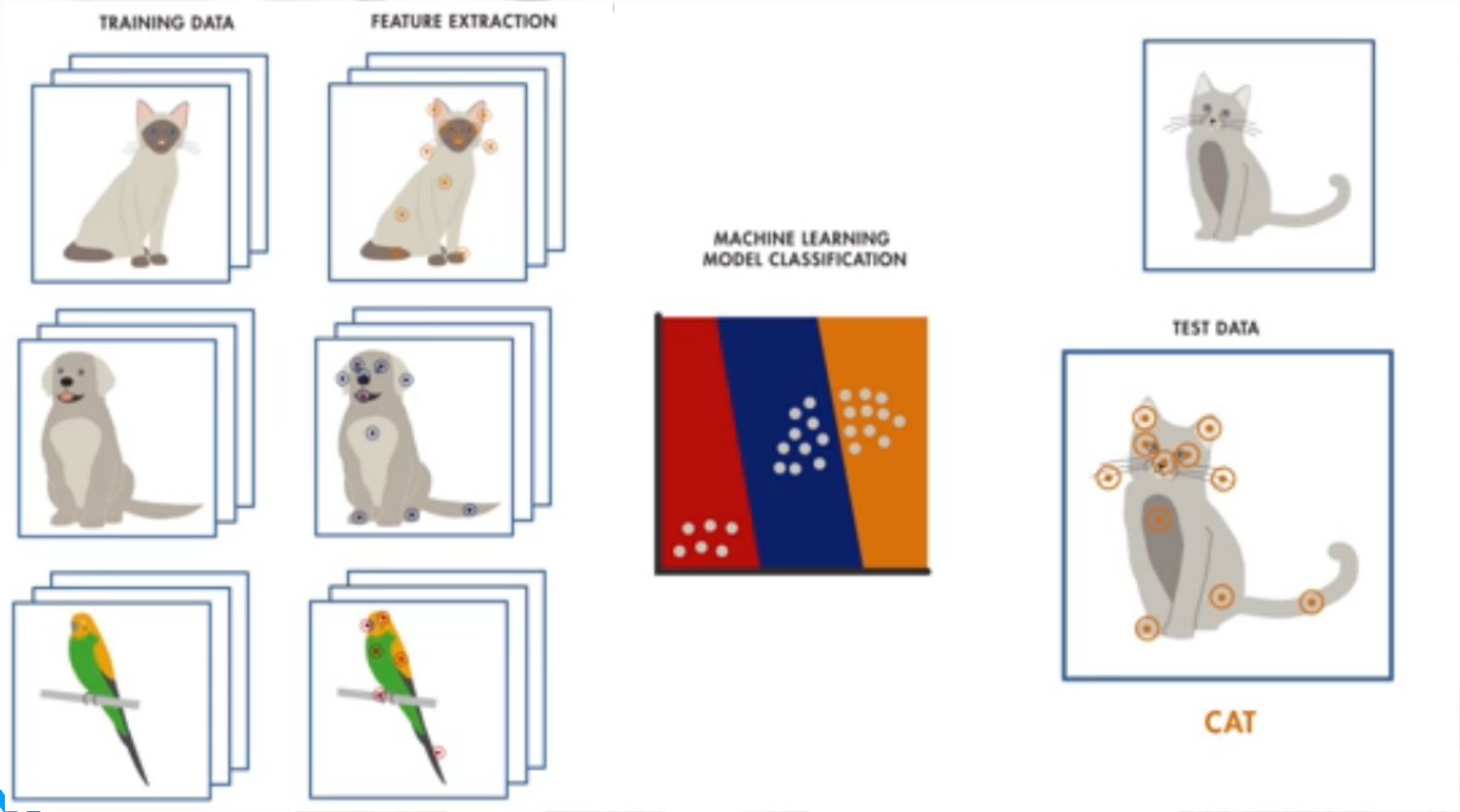
Machine Learning



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Steps Learning

- Define Problem.
- Prepare Data.
  - Classify Data
- Evaluate Algorithms.
  - Apply Classifier (CNN, DNN etc)
- Improve Results.
- Present Results.

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