Smarter education for smarter planet
IBM Innovation Centre for Education

Welcome to:

Introduction to Machine Learning

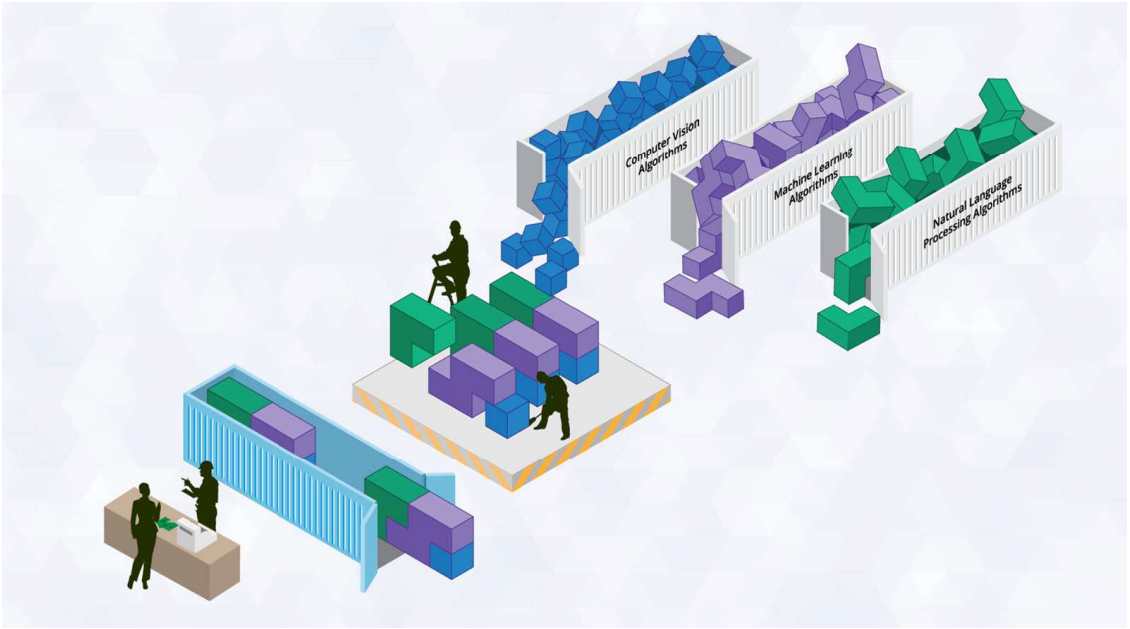
Unit objectives

After completing this unit, you should be able to:

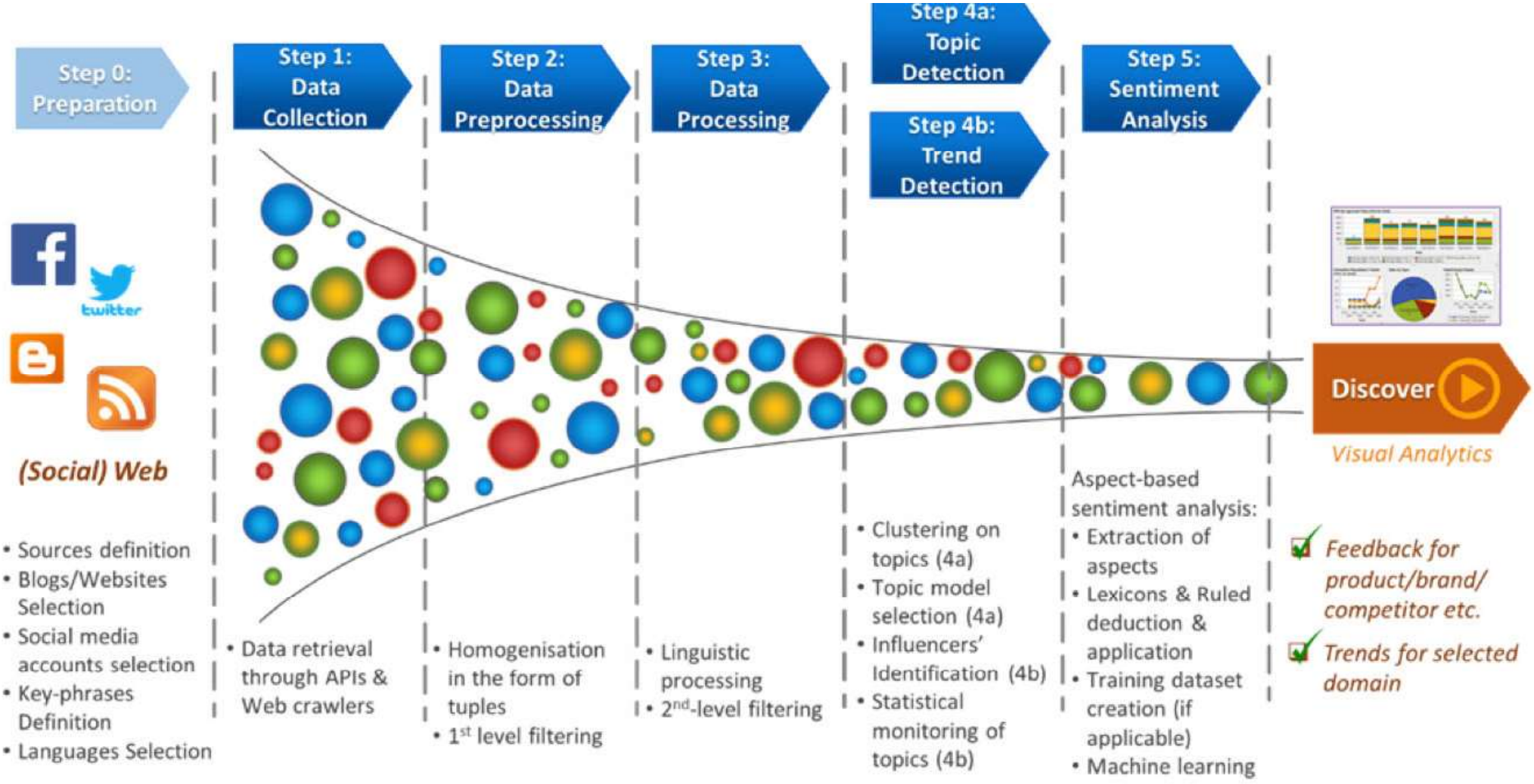
- Understand the history of Machine Learning
- Gain knowledge on the advantages and drawbacks of using Machine learning.
- Understand how machines do learn
- Learn about the steps involved in machine learning
- Gain an insight into the different types of Machine Learning approaches

Introduction

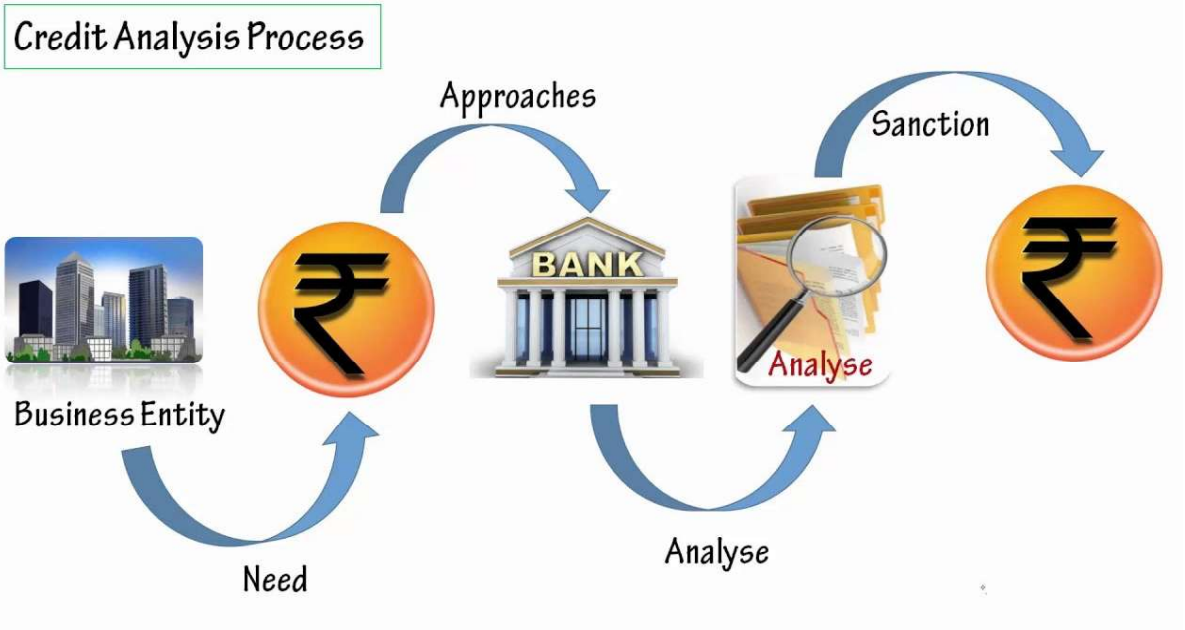
- Computer adopts a systematic approach; an algorithm.
  - Proven sequence of steps : transform the input to output.
- When the Input data is not well defined, the model or algorithm cannot be predefined.
- Build a system by making it learn from the examples.
  - Spam Filtering
  - Face recognition

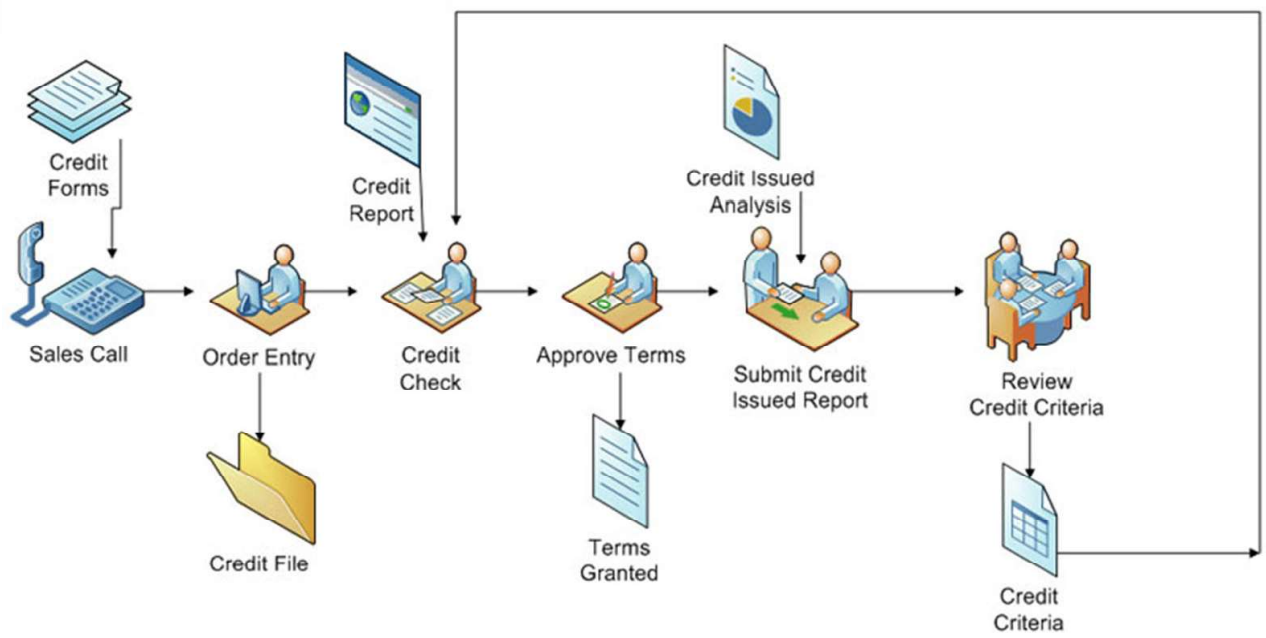


Motivation for machine learning



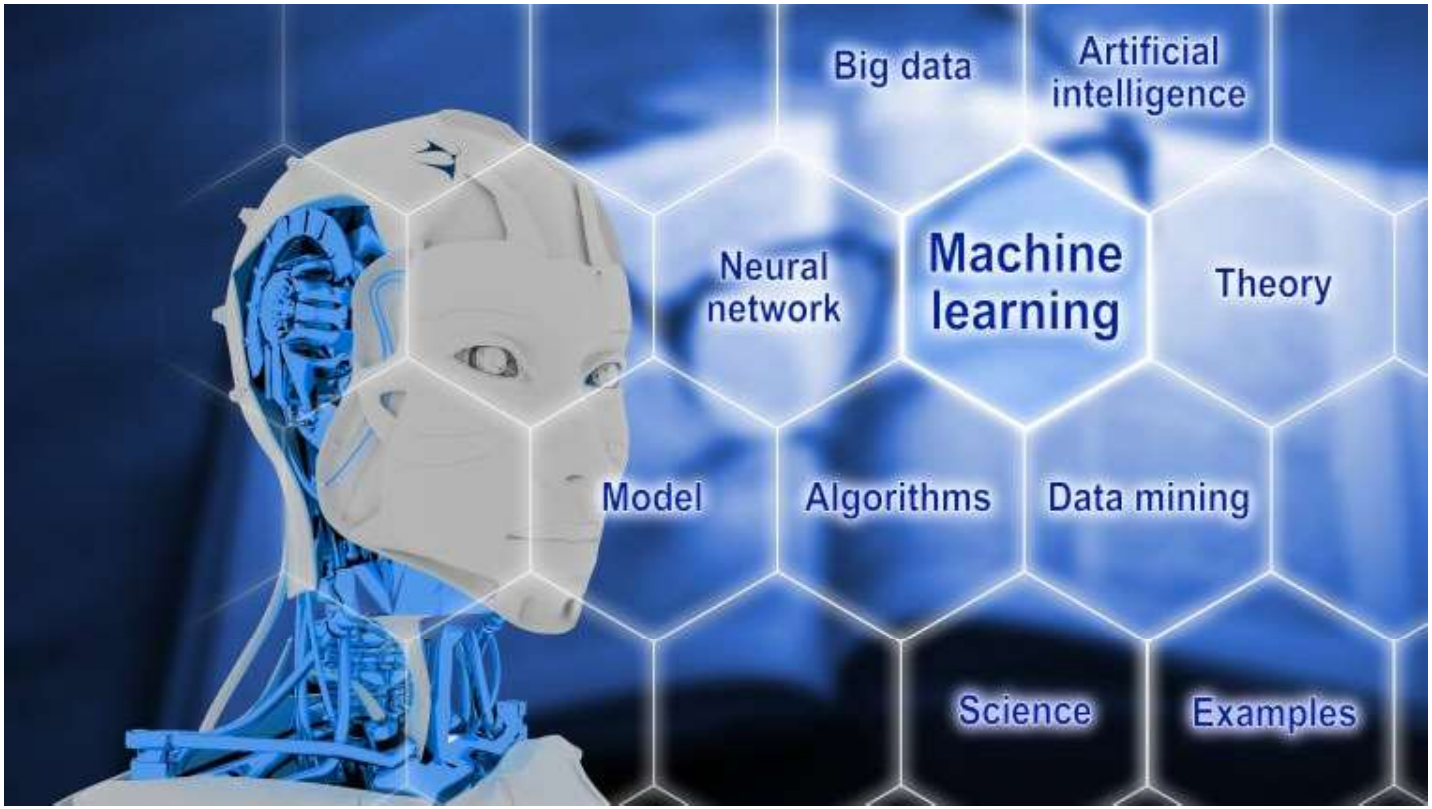
Applications

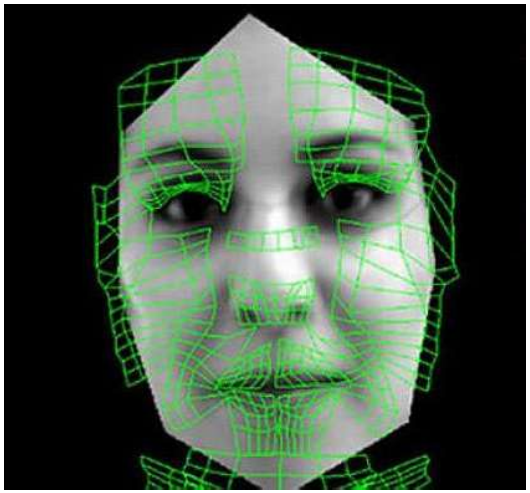




Machine learning

- Machine learning a part of artificial intelligence rather than being a simple database problem.
- It needs to learn from constantly changing environment.

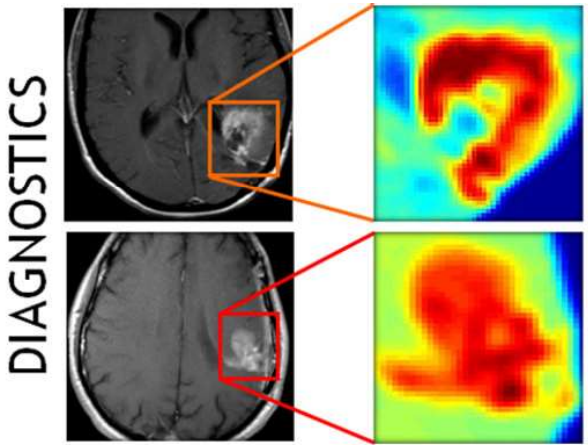


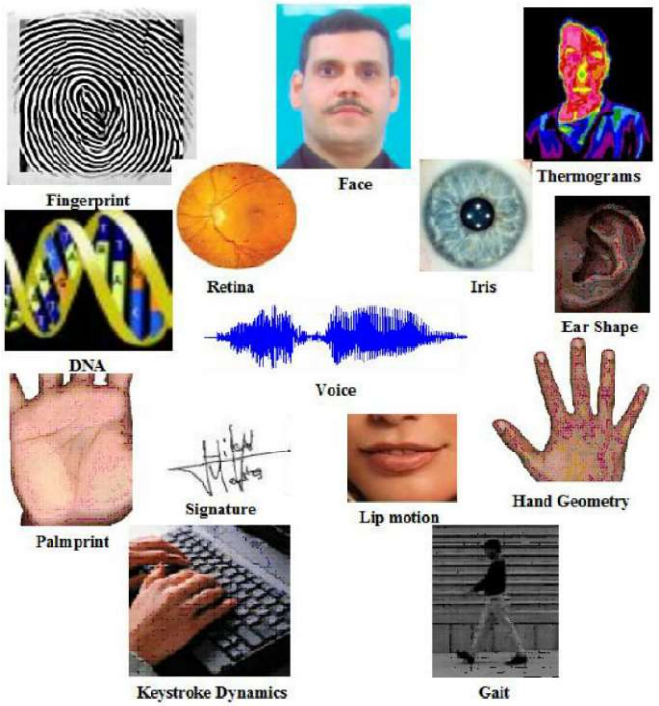


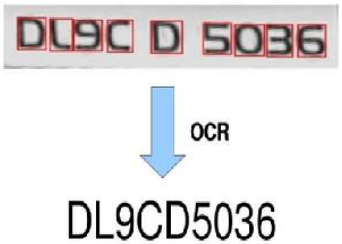
Learning associations

- Basket analysis is one of the applications of machine learning
- An association rule is modelled among the products bought by customers.
- Cross selling or planning the combo offers.

Classification

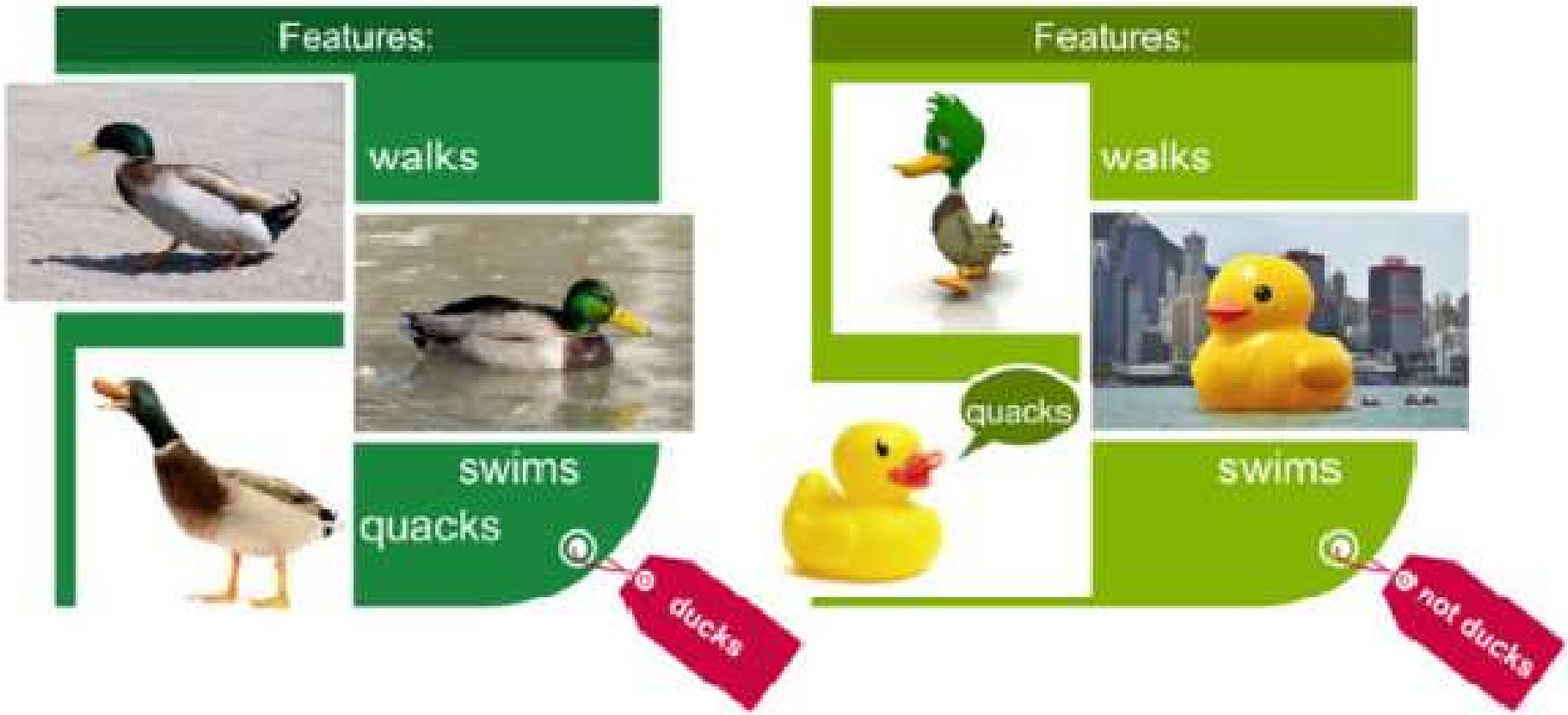




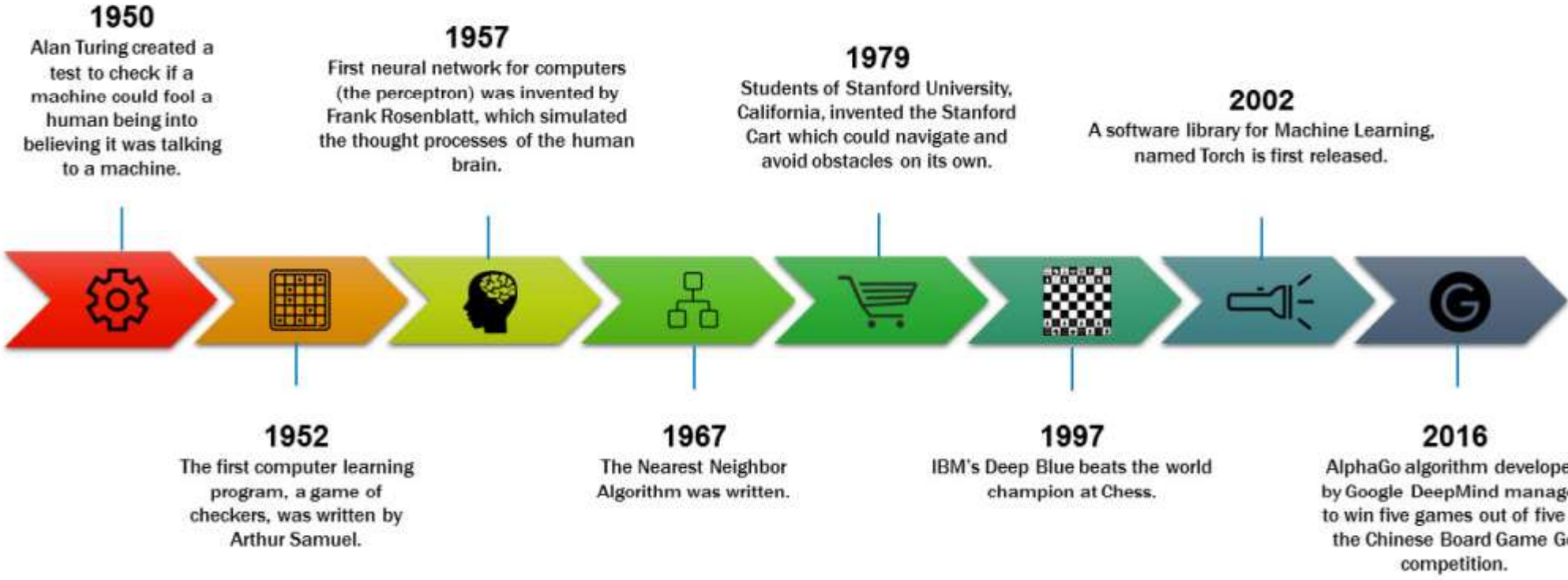


Regression

If it Walks/Swims/Quacks Like a Duck ..... Then It Must Be a Duck



The Origin of machine learning



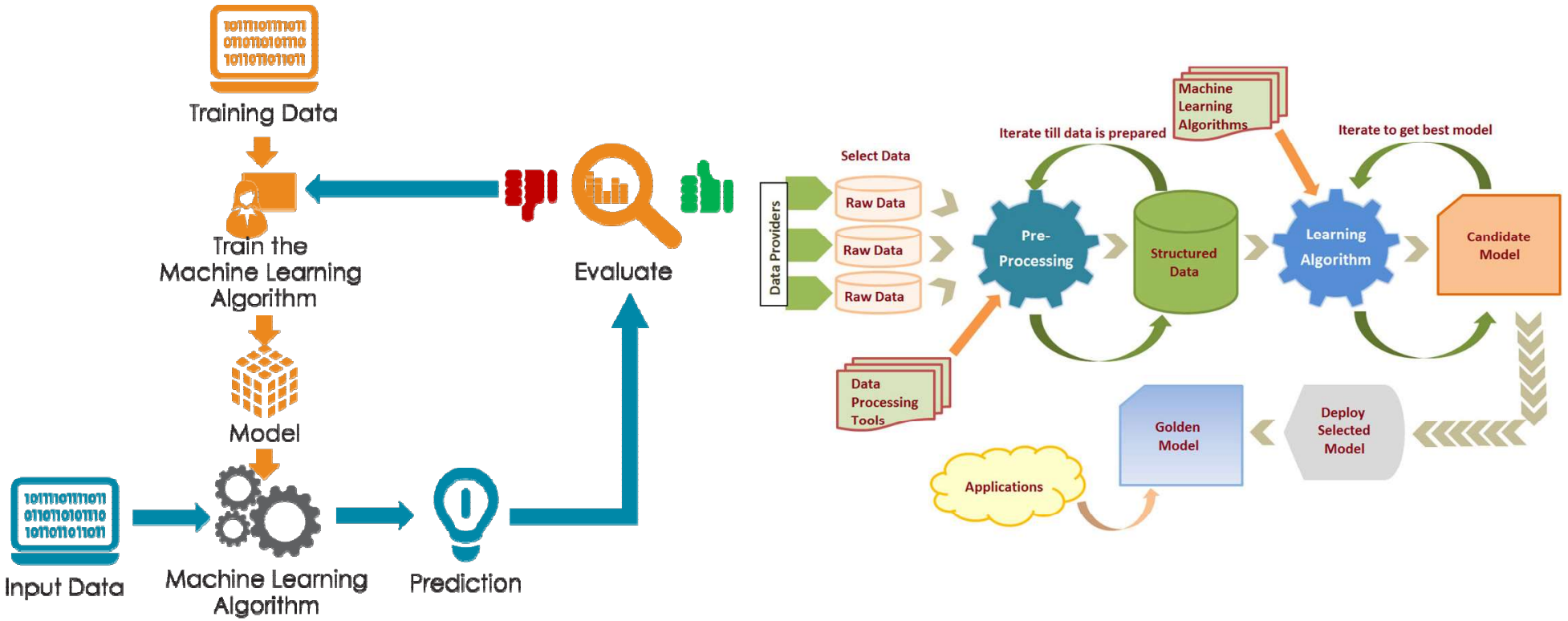
Uses and abuses of machine learning

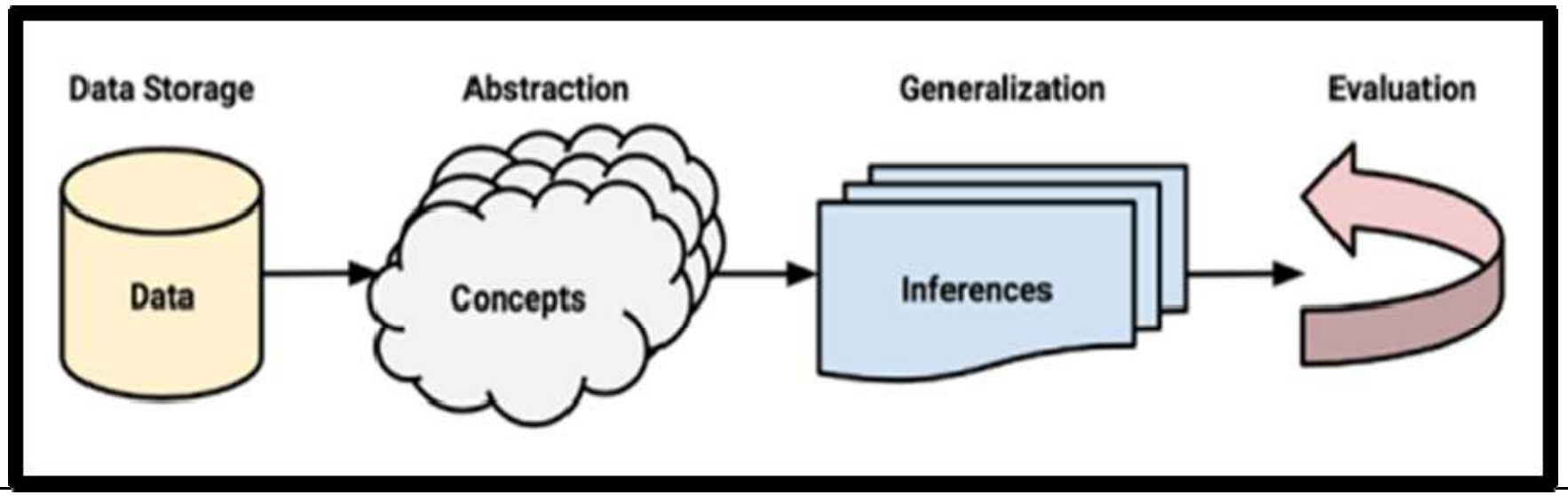
- Machines are still relatively limited in their ability to thoroughly understand a problem.
- Machines are pure intellectual horsepower without guidance.
- Needs a human intervention to motivate the analysis and turn the result into meaningful action.
- Machine learning is highly successful when it augments with a system, rather than replacing the specialized knowledge of a subject-matter expert.
- Machine learning assists medical doctors at the forefront of the fight to eradicate cancer, assists engineers and programmers to create smarter homes and automobiles, and helps social scientists build knowledge of how societies function.
- It is employed in innumerous businesses, scientific laboratories, hospitals, and governmental organizations. Some machine learning algorithm is commonly employed among the organizations which generate or aggregate data make sense of it.

Success cases

- Identification of unwanted spam messages in e-mail
- Segmentation of customer behavior for targeted advertising
- Forecasts of weather behavior and long-term climate changes
- Reduction of fraudulent credit card transactions
- Actuarial estimates of financial damage of storms and natural disasters. Prediction of popular election outcomes
- Development of algorithms for auto-piloting drones and self-driving cars and optimization of energy use in homes and office buildings
- Projection of areas where criminal activity is most likely and discovery of genetic sequences linked to diseases

How do machines learn

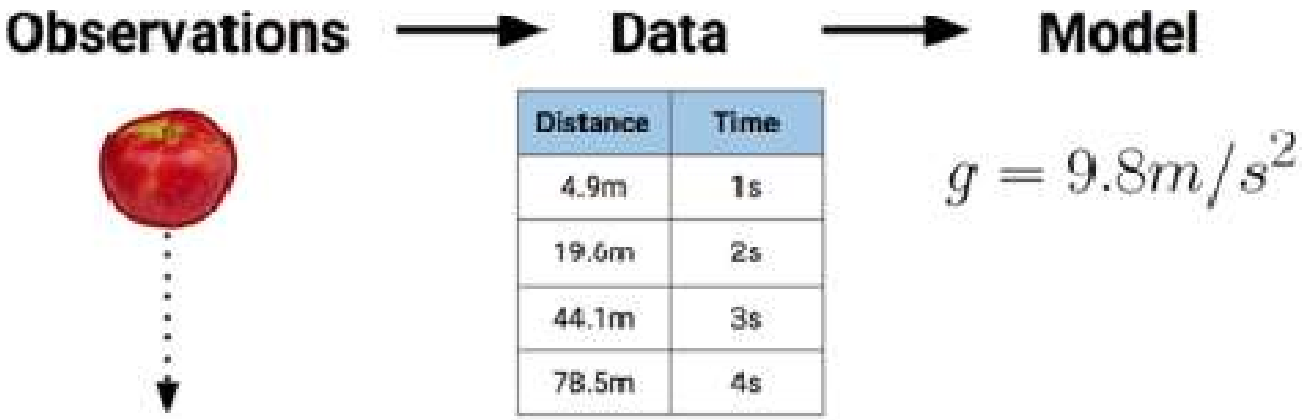




Abstraction and knowledge representation

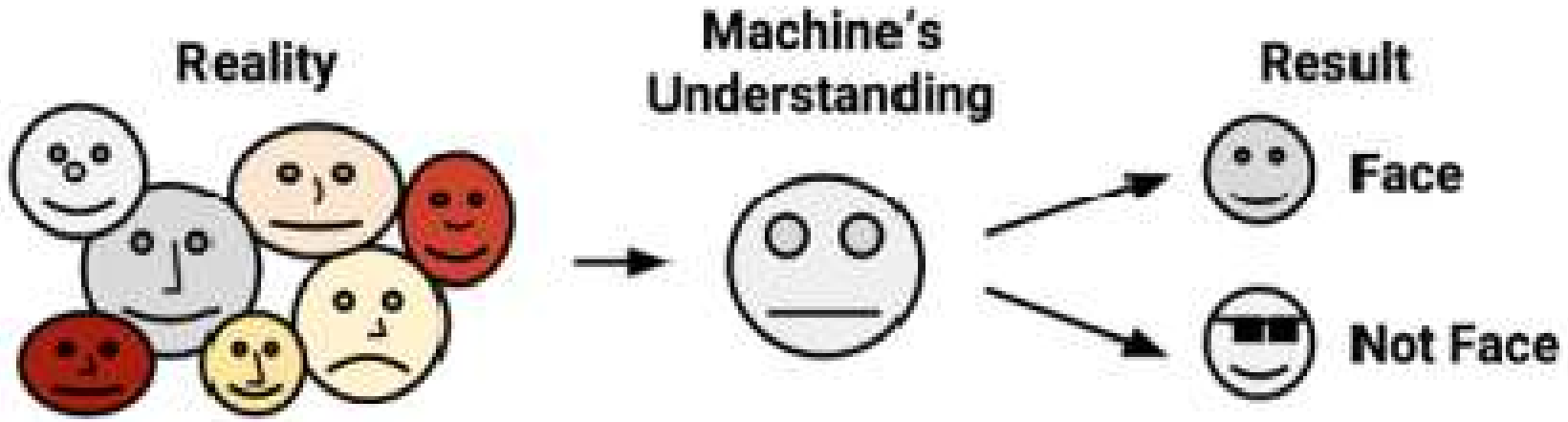
- Assigning meaning to stored data occurs during the abstraction process, in which raw data comes to have a more abstract meaning.

- During a machine's process of knowledge representation, the computer summarizes stored raw data using a model, an explicit description of the patterns within the data.



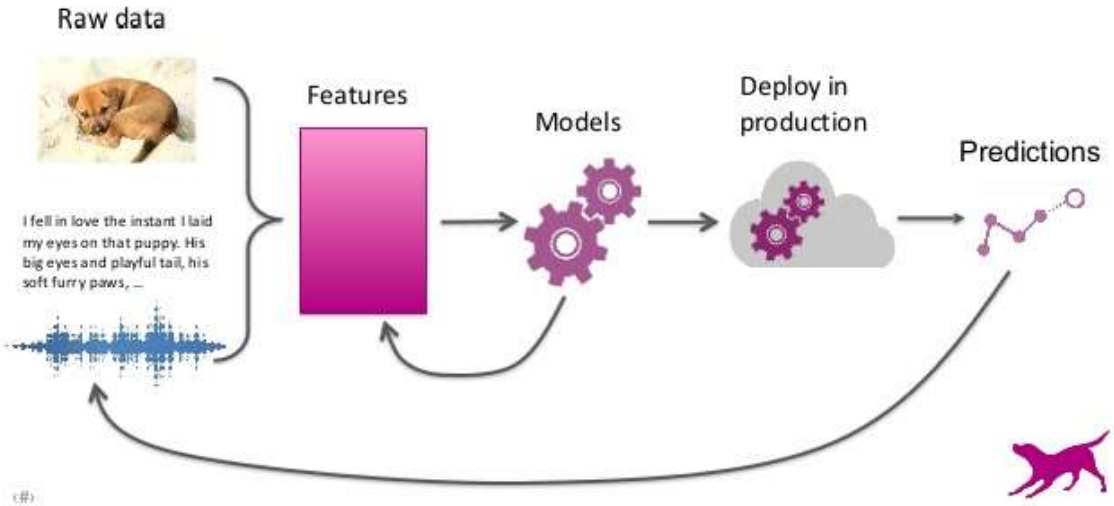
Generalization

- The learning process is not complete until the learner is able to use its abstracted knowledge for future action.
- Unless the production of abstractions is limited, the learner will be unable to proceed.
- It would be stuck where it started-with a large pool of information, but no actionable insight.

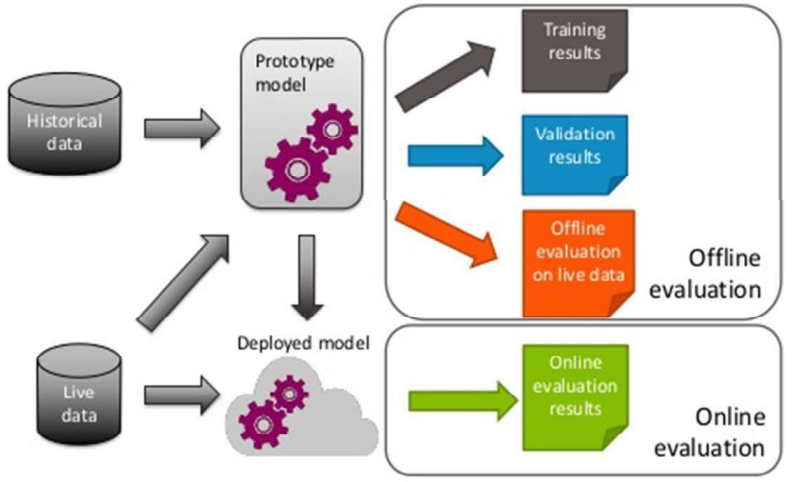


Factors to be considered

The machine learning pipeline

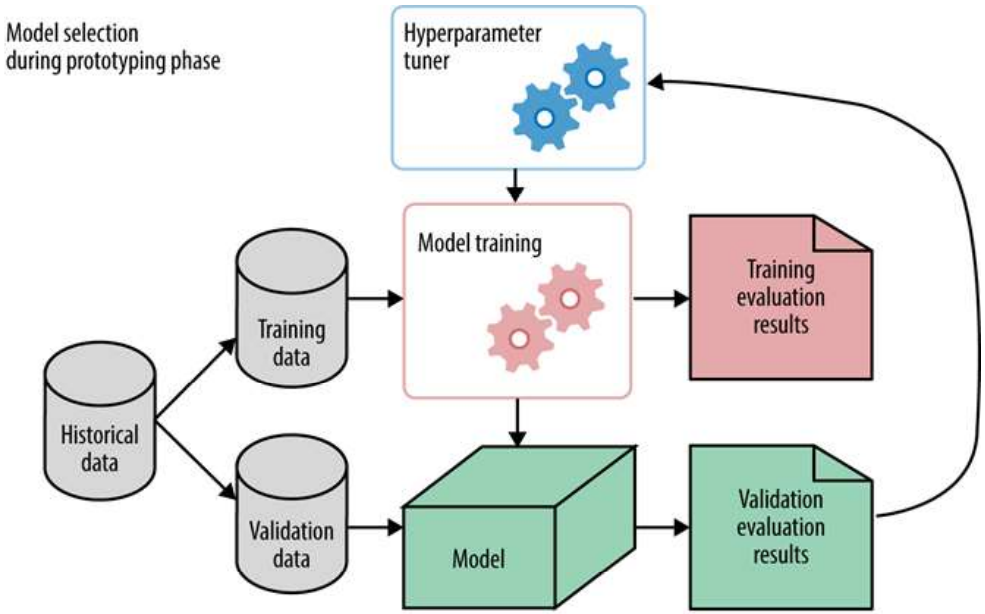


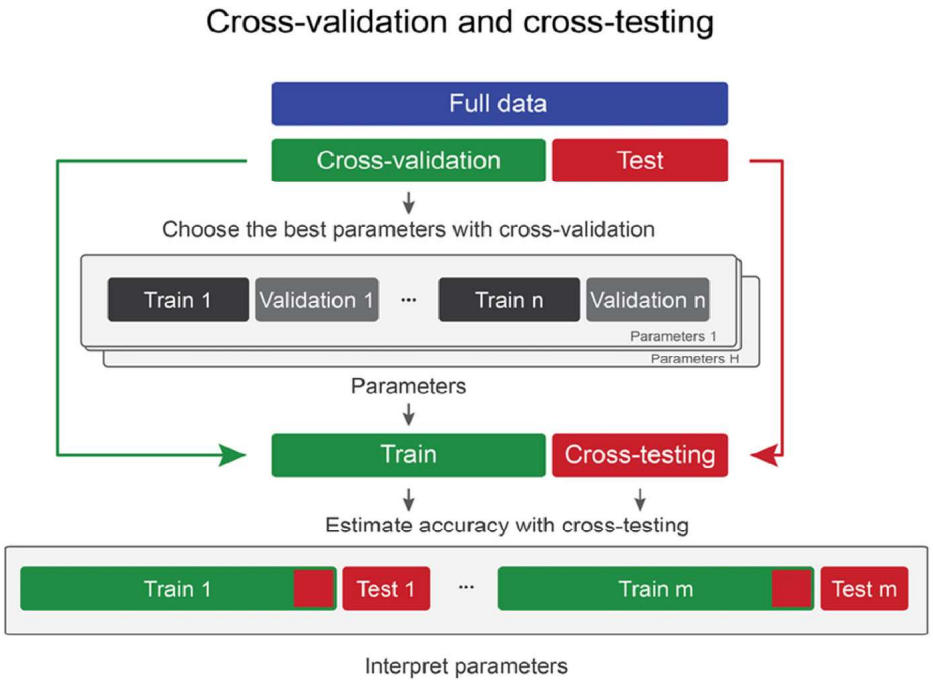
When to evaluate

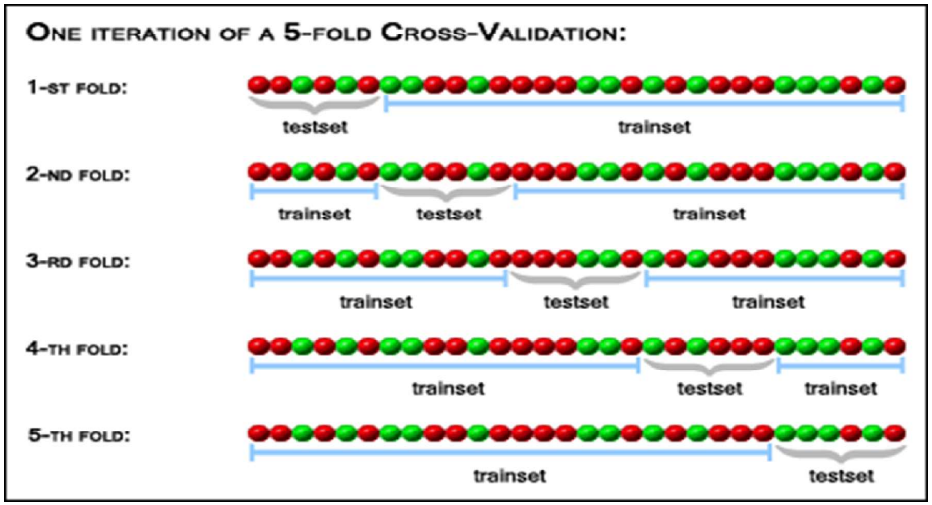


Assessing the success of learning

- Weka machine learning workbench: Evaluation
  - Training Dataset
  - Supplied Test Set
  - Percentage Split
  - Cross Validation



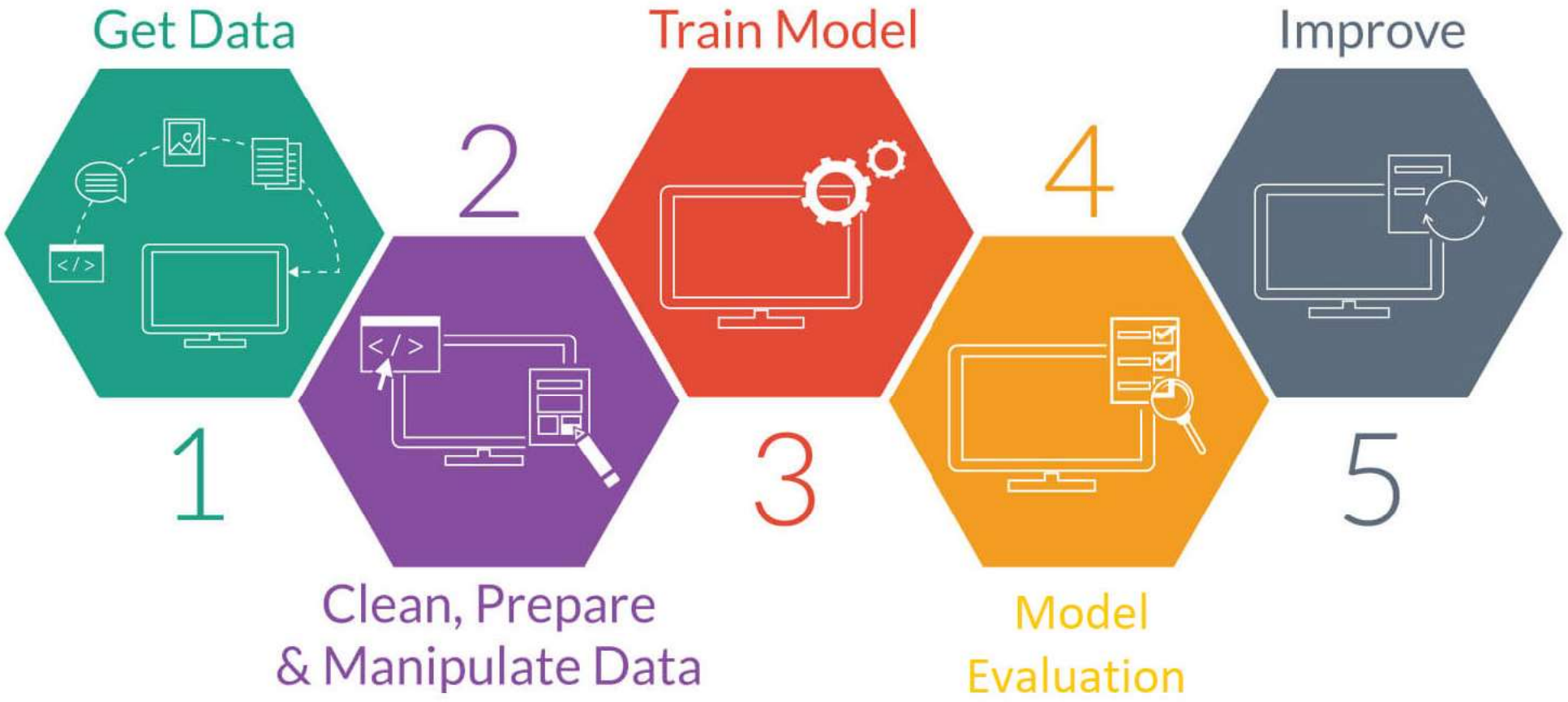




Metrics for evaluation of classification method

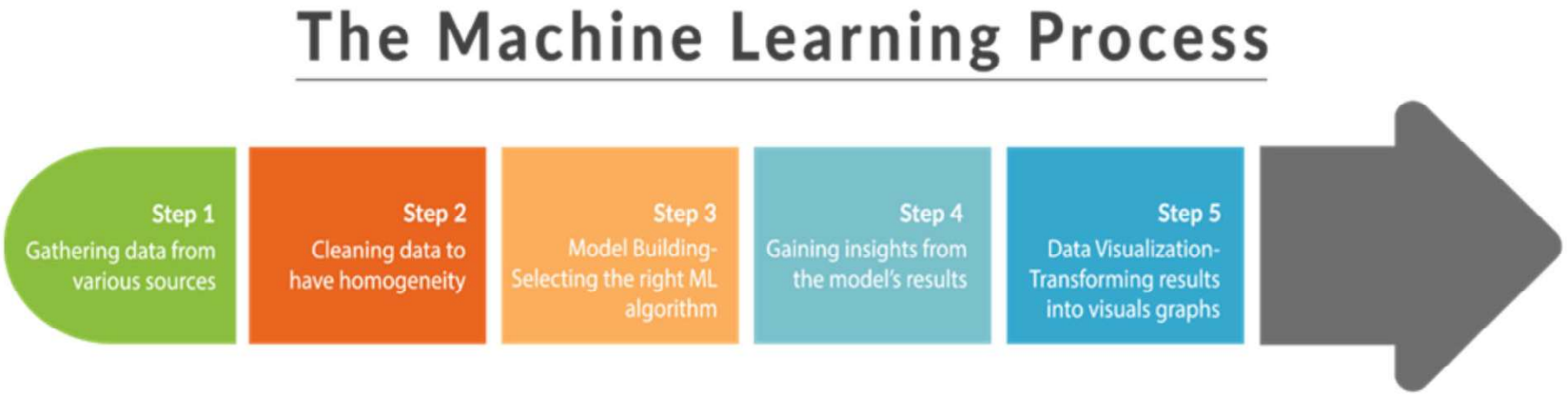
- Classification accuracy
- Accuracy by class
- Confusion matrix
- Correlation Coefficient
- Root Mean Squared Error

Steps to apply machine learning to data



Machine learning process

- Representation
- Evaluation
- Optimization

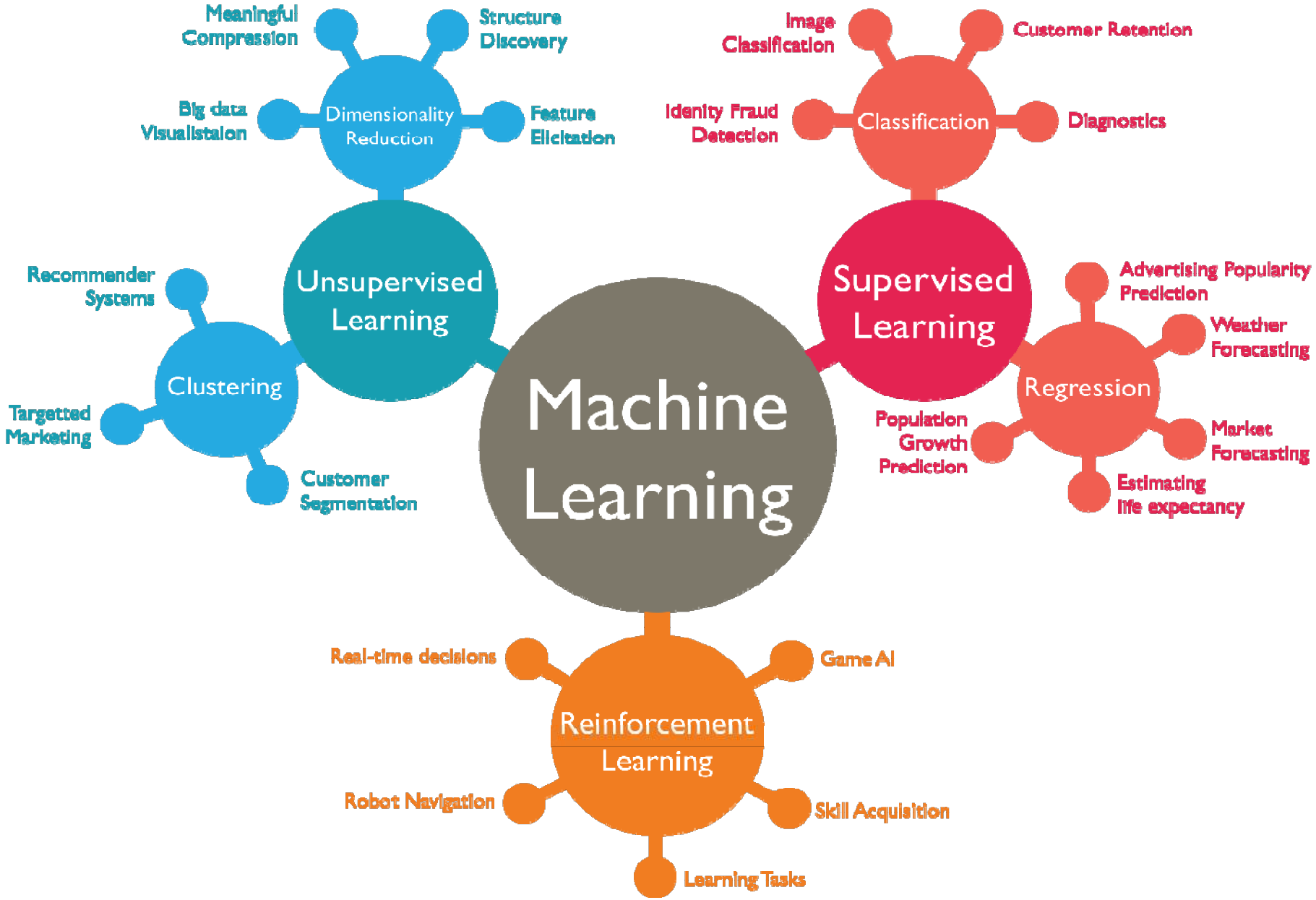


Representation	Evaluation	Optimization
Instances	Accuracy/Error rate	Combinatorial optimization
K-nearest neighbor	Precision and recall	Greedy search
Support vector machines	Squared error	Beam search
Hyperplanes	Likelihood	Branch-and-bound
Naive Bayes	Posterior probability	Continuous optimization
Logistic regression	Information gain	Unconstrained
Decision trees	K-L divergence	Gradient descent
Sets of rules	Cost/Utility	Conjugate gradient
Propositional rules	Margin	Quasi-Newton methods
Logic programs		Constrained
Neural networks		Linear programming
Graphical models		Quadratic programming
Bayesian networks		
Conditional random fields		

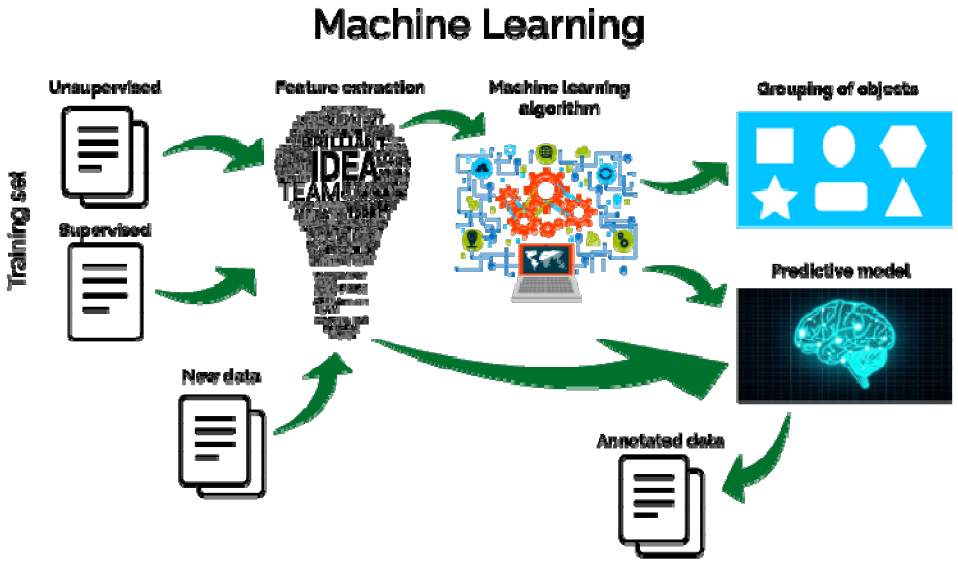
Input data and ML algorithm

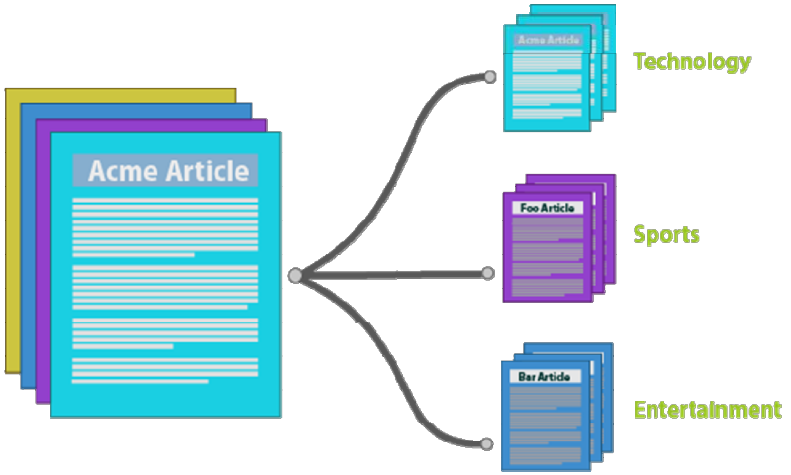
- The characteristics of input data
- Understand the terminology that distinguishes among input datasets.
  - The unit of observation is in the form of persons, objects or things, transactions, time points, geographic regions, or measurements
- Datasets that store the units of observation and their properties
- Understand features and examples through real-world cases
- Algorithms are categorized based on their purpose.
  - For example, a predictive model is employed on the cases of tasks which involve, the prediction of one value using other values in the dataset.
- Model the relationship between the target feature (the feature being predicted) and the other features.

Classification of machine learning algorithms



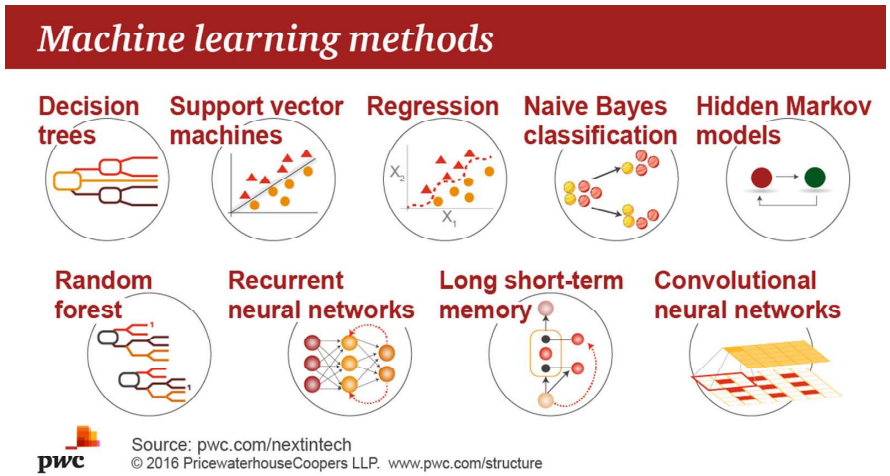
General ML architecture



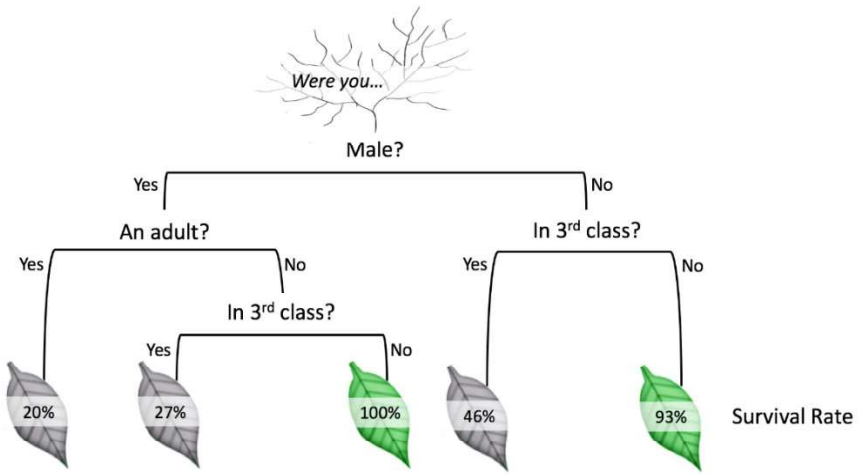


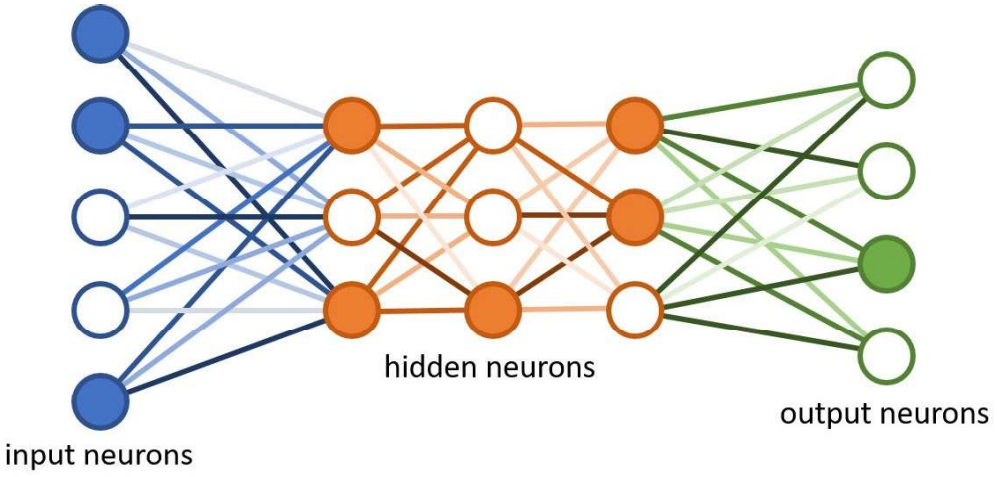
Group of algorithms

- Group of Algorithms based on Learning Style



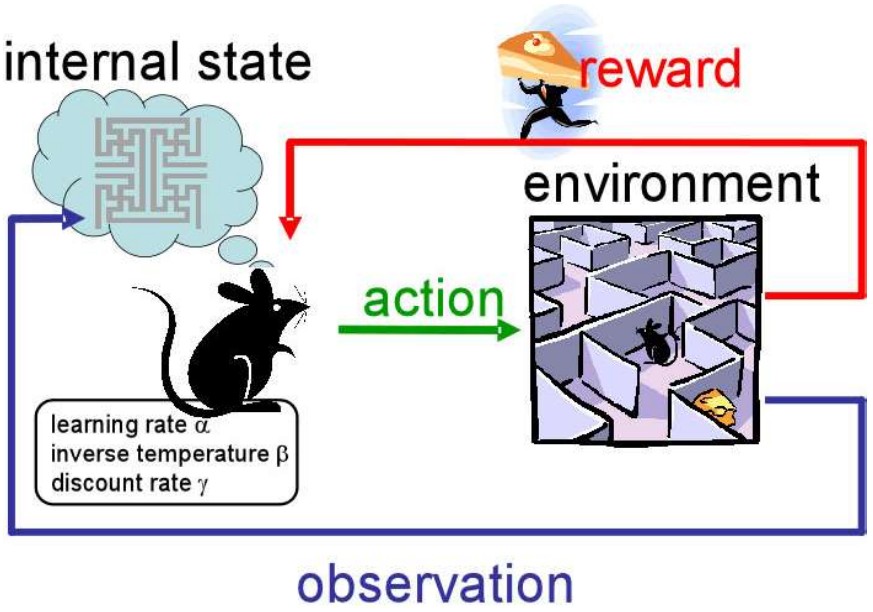
- Group of Algorithms based on Similarity



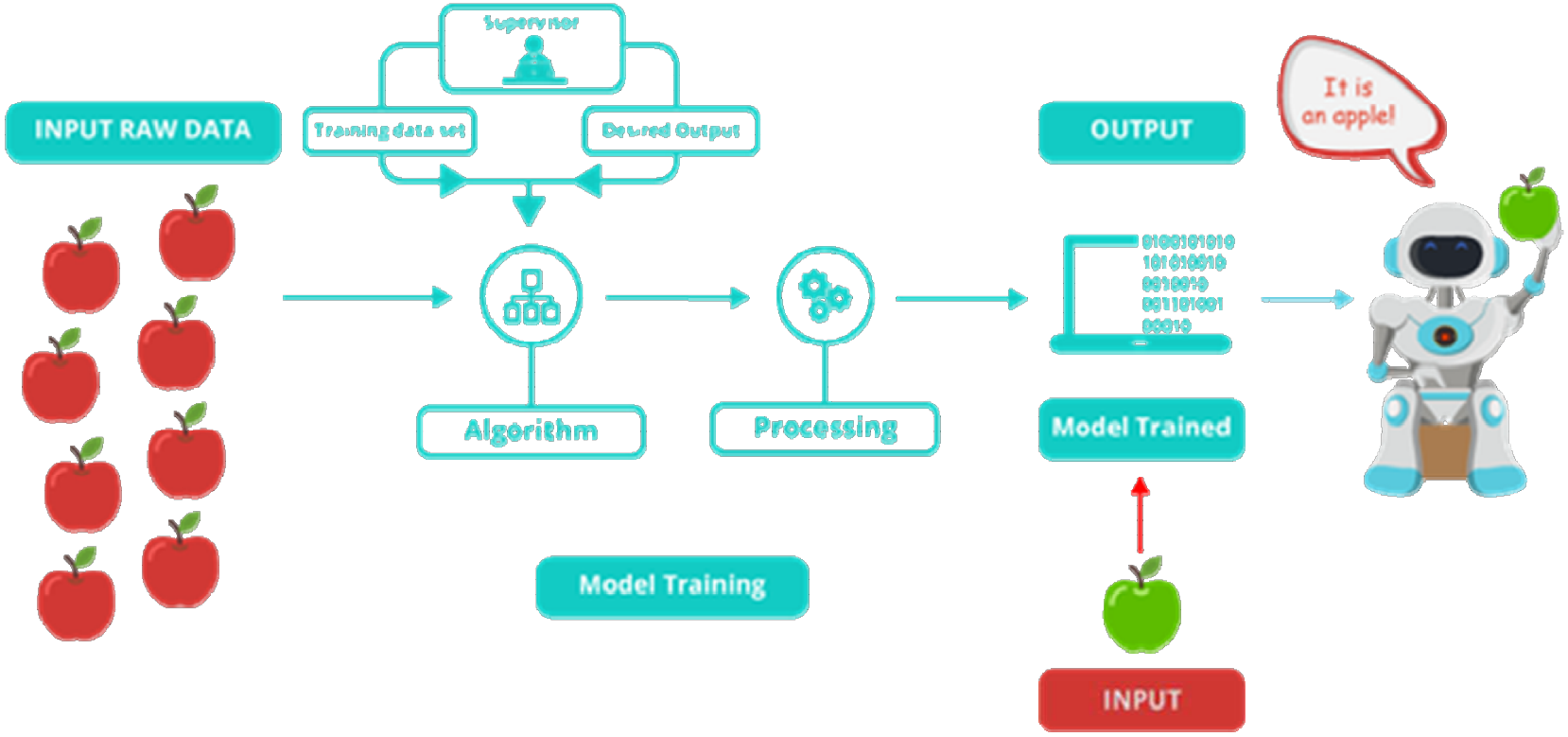


Reinforcement learning

- The output of the system is a sequence of actions.
- A single action is not important; what is important is the policy that is the sequence of correct actions to reach the goal.
- There is no such thing as the best action in any intermediate state; an action is good if it is part of a good policy.
- Assess the goodness of policies and learn from past good action sequences to be able to generate a policy. Such learning methods are called reinforcement learning algorithms.

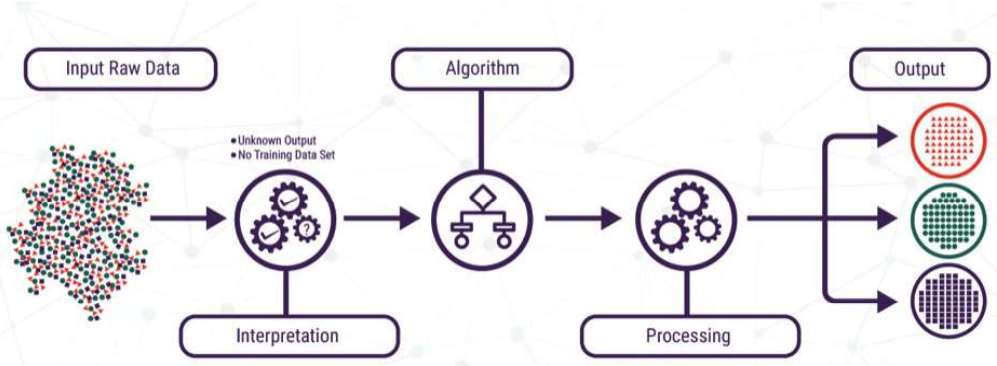


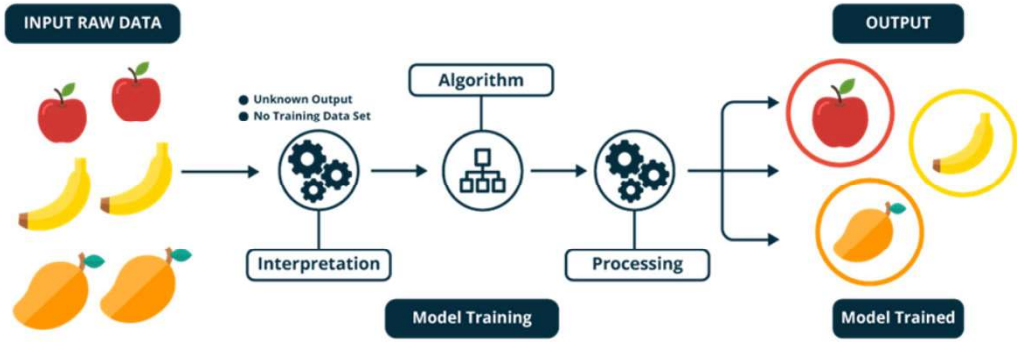
Supervised learning



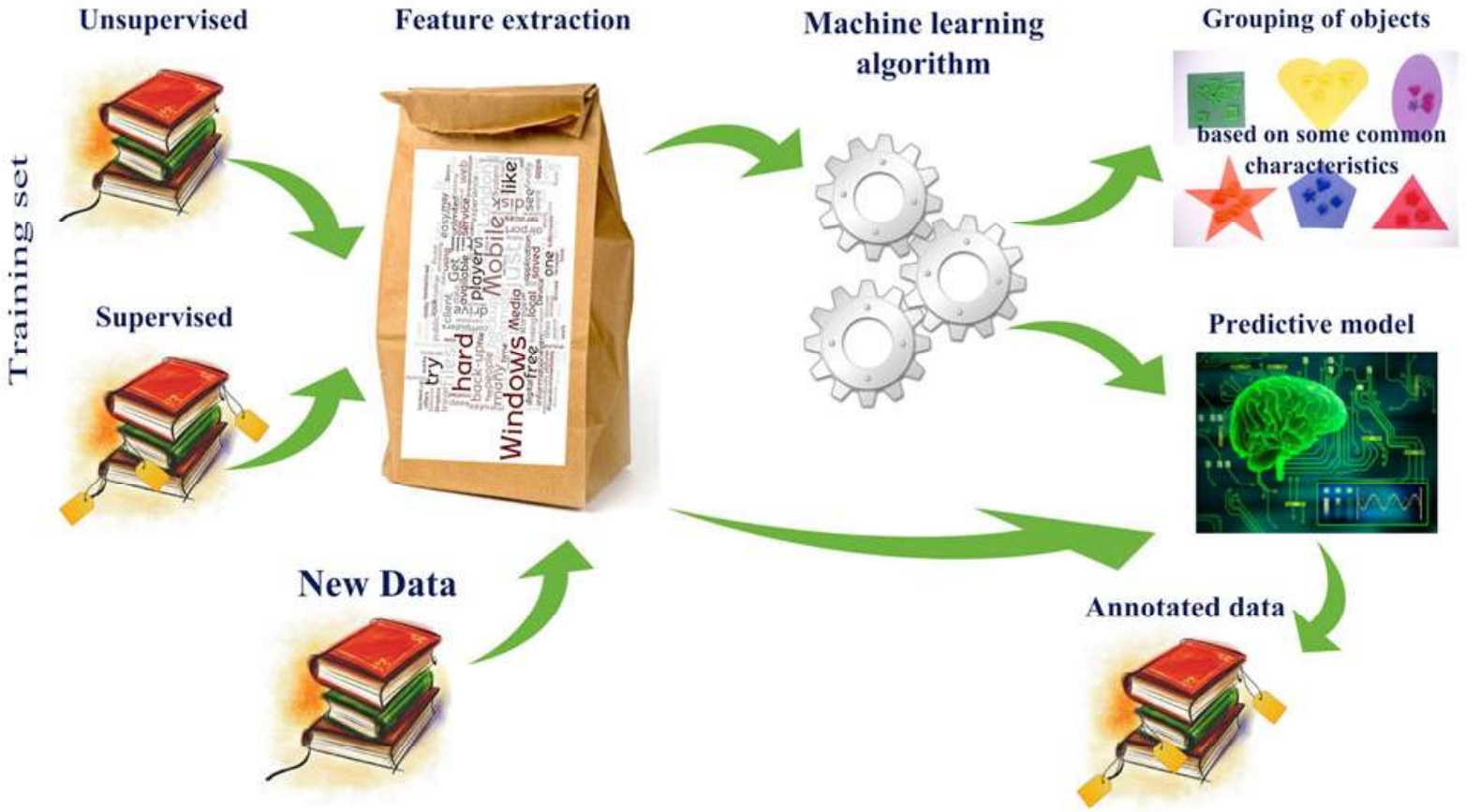
Unsupervised learning

- Supervised learning, teaches a mapping from the input to an output where the correct values are provided, by a supervisor.
- In the cases of unsupervised learning, we are provided with only the data, without labels.
- The goal is to find the regularities in the input.
- The input space follows certain patterns, our goal is to build a model to identify these patterns.





Semi-Supervised learning



Algorithms

- Regression Algorithms
- Instance-based Algorithms
- Regularization Algorithms
- Decision Tree Algorithms
- Bayesian Algorithms
- Clustering Algorithms
- Association Rule Learning Algorithms
- Artificial Neural Network Algorithms
- Deep Learning Algorithms
- Dimensionality Reduction Algorithms
- Ensemble Algorithms

Ensemble learning

Matching data to an appropriate algorithm

IBM