Machine Learning and it's Applications

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BI SPECIALIST

AGENDA

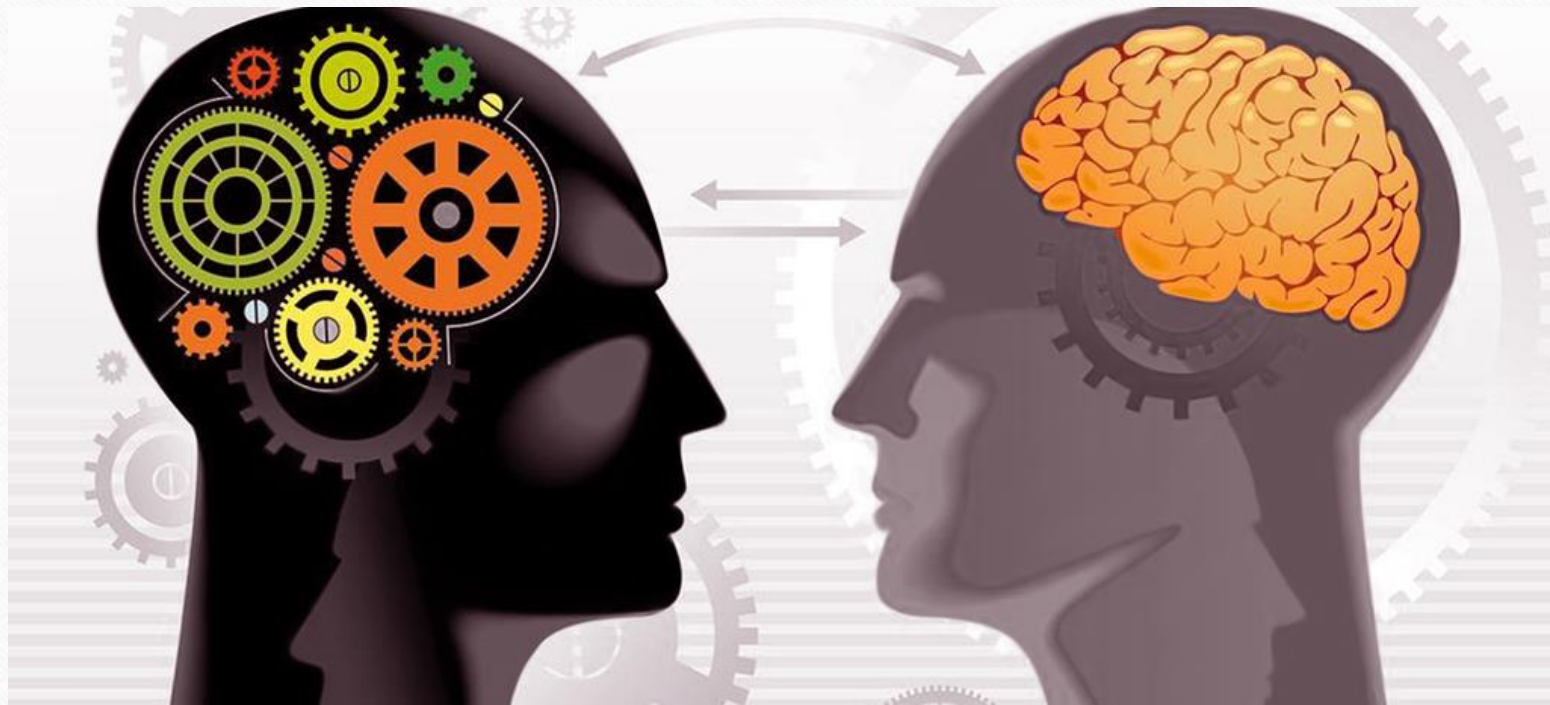- ➤ What is Artificial Intelligence?
- ➤ What is Data Science?
- ➤ What is Machine Learning?
- ➤ Machine Learning Techniques
  - ▪ Supervised Learning
  - ▪ Unsupervised Learning
  - ▪ Reinforcement Learning
- ➤ Machine Learning Workflow

- ➤ Practical Implementations
- ➤ Skill Required for Data Scientist

Our Future!

WAYMO

- Google's Self Driving Car Project

- "WAYMO" stands for a new way forward in mobility.

- Waymo is an autonomous car development company spun out of Google's parent company, Alphabet Inc., in December 2016. It then took over the self-driving car project which Google had begun in 2009.
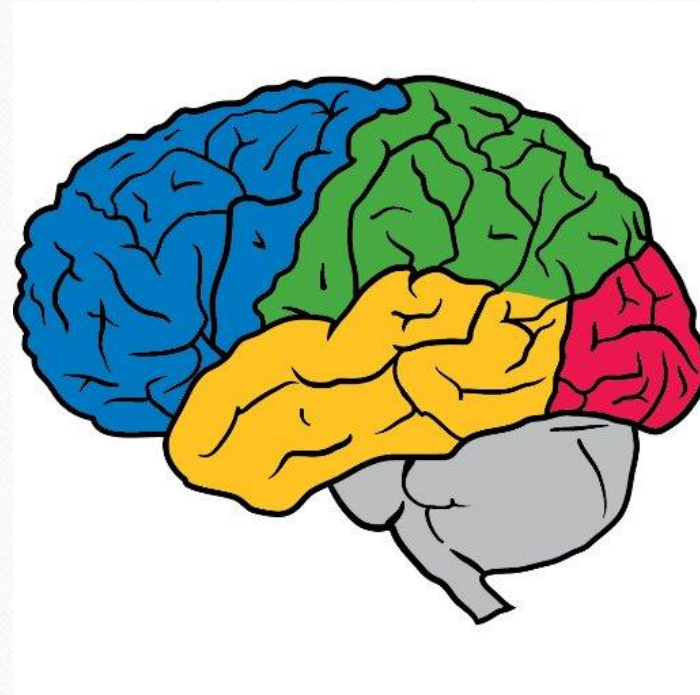
References: https://waymo.com/

Google Brain

- Google Brain is a deep learning artificial intelligence research project at Google.

- Google Brain's mission is to improve people's lives by making machines smarter.
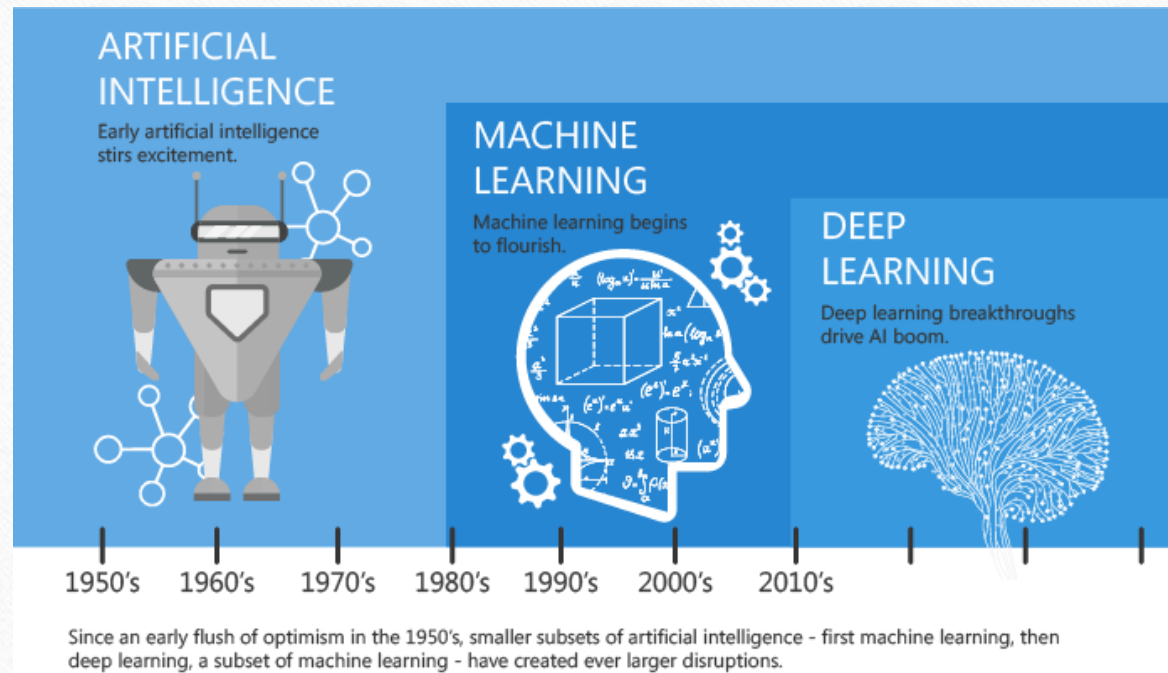
Microsoft Research in AI

WHAT IS ARTIFICIAL INTELLIGENCE?

ARTIFICIAL INTELLIGENCE
Early artificial intelligence stirs excitement.

MACHINE LEARNING
Machine learning begins to flourish.

DEEP LEARNING
Deep learning breakthroughs drive AI boom.

1950's 1960's 1970's 1980's 1990's 2000's 2010's

Since an early flush of optimism in the 1950's, smaller subsets of artificial intelligence - first machine learning, then deep learning, a subset of machine learning - have created ever larger disruptions.

- Artificial Intelligence is the capability of machine to imitate the intelligence of human behavior.

- AI is accomplished by studying how human brain thinks, how human learn, decide and work while trying to solve a problem.

Application of Artificial Intelligence

Speech Recognition   Understanding Natural Language   Image Recognition
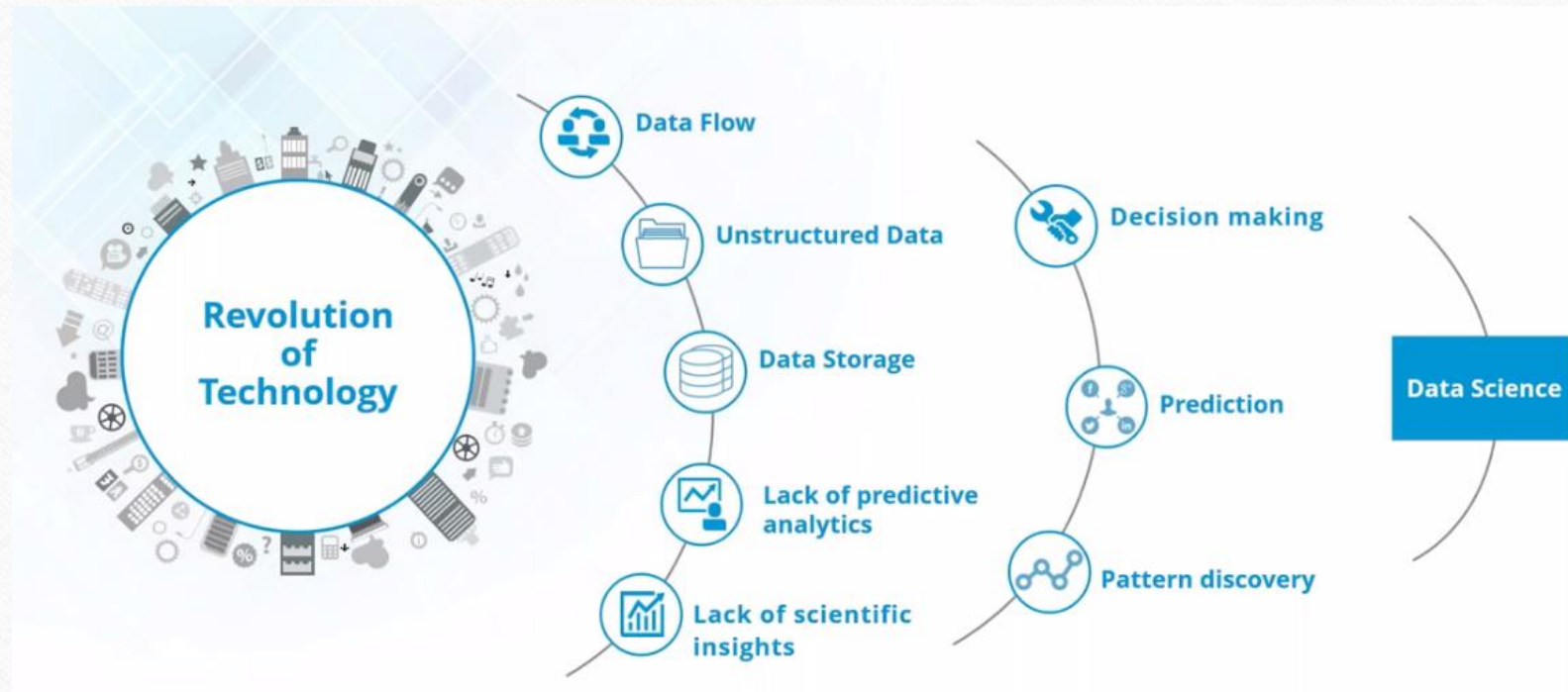
And Many More....

What is Data Science?

- Data Science is a blend of various tools, algorithms, and machine learning principles with the goal to discover hidden patterns from the raw data.
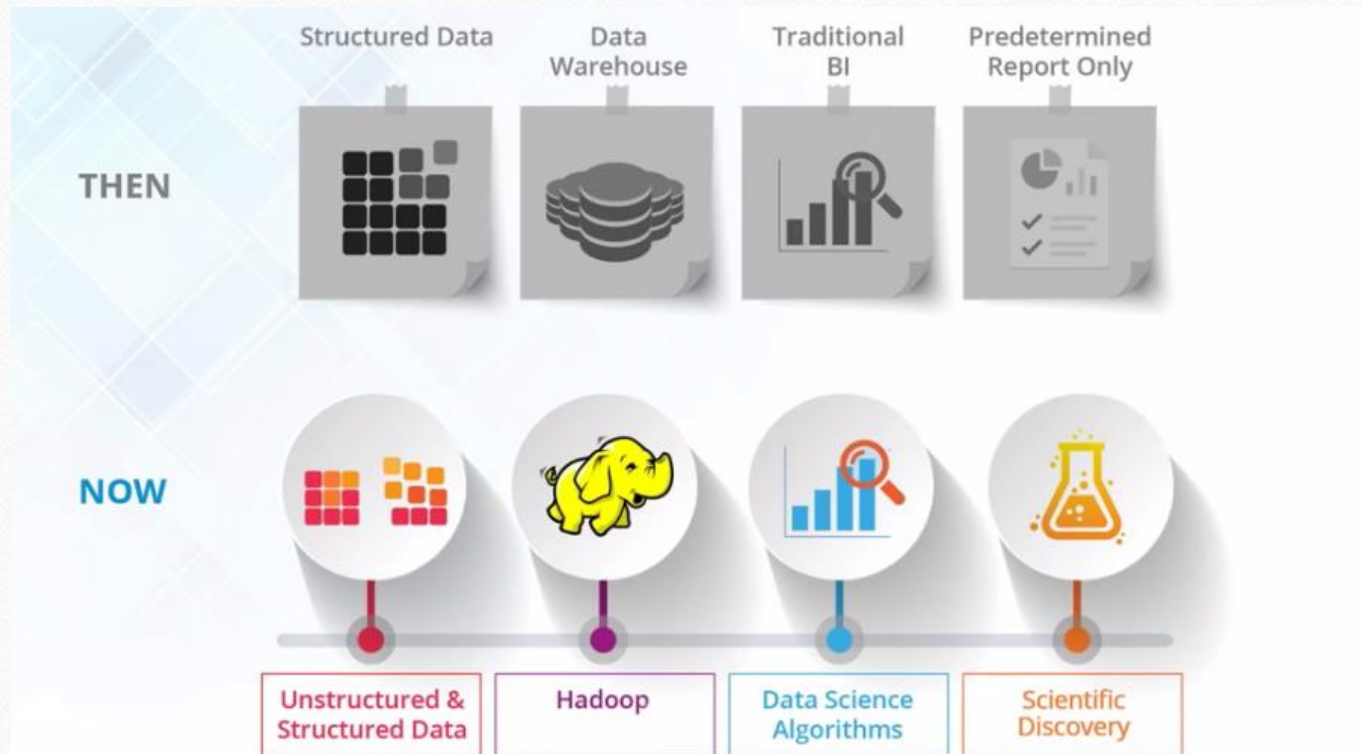- Data Science is primarily used to make decisions and predictions.

Need for Data Science

Need for Data Science

Data Science Applications

Artificial Intelligence
633 Companies
and many more....

WHAT IS MACHINE LEARNING?
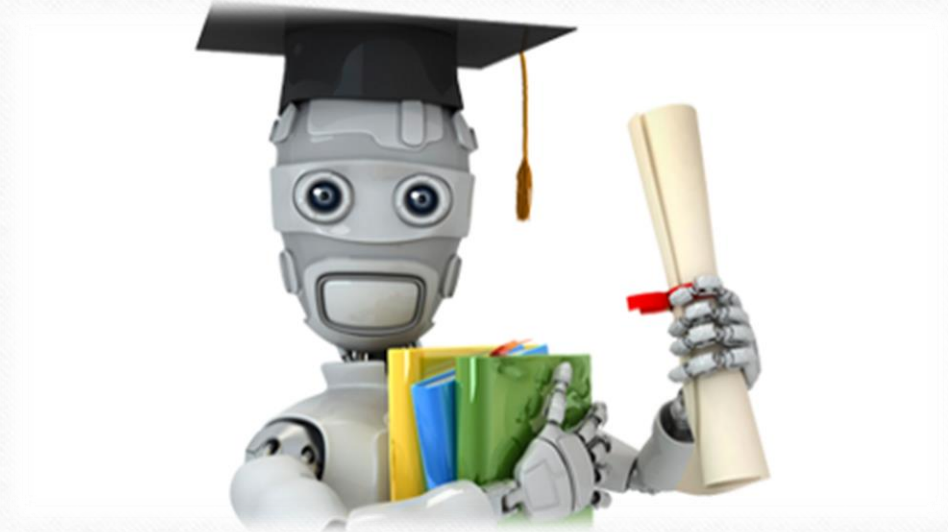

- Machine Learning is a Type or Subset of Artificial Intelligence that provides machines the ability to learn without being explicitly programmed.

Informal Definition

- **Arthur Samuel -** Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

Modern Definitions

- **Tom Mitchell** provides a more modern definition: "A computer program is said to learn from **Experience E** with respect to some class of **Tasks T** and **Performance Measure P**, if its performance at tasks in **T**, as measured by **P,** improves with experience **E**."

- **Example: Playing Checkers.**

- E = the experience of playing many games of checkers

- T = the task of playing checkers.

- P = the probability that the program will win the next game.
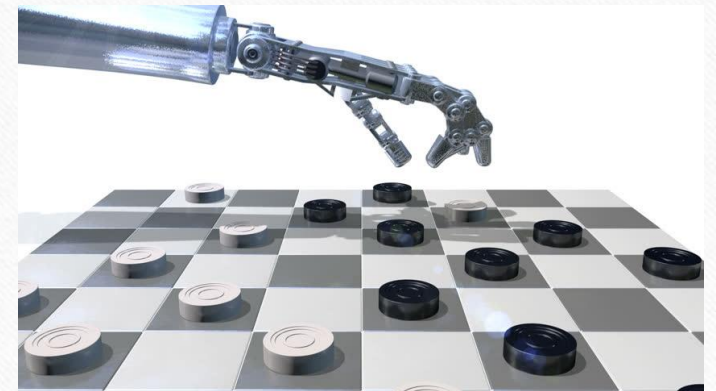
Practical Machine Learning Problems

- Spam Detection

- Credit Card Fraud Detection

- Digit Recognition

- Speech Understanding

- Face Detection

- Product Recommendation

- Medical Diagnosis

- Stock Trading

- Customer Segmentation

- Shape Detection

Machine Learning Techniques

Supervised Learning

- Makes machine learn explicitly
- Data with clearly defined output is given
- Direct feedback is given
- Predicts outcome/ future
- Resolves classification & regression problems

Training
Inputs → [laptop] → Outputs

Unsupervised Learning

- Machine understands the data (Identifies patterns/ structures)
- Evaluation is qualitative or indirect
- Does not predict / find anything specific

Inputs → [laptop] → Outputs

Reinforcement Learning

- An approach to AI
- Reward based learning
- Learning from +ve & -ve reinforcement
- Machine learns how to act in a certain environment
- To maximize rewards

Rewards ←
Inputs → [laptop] → Outputs

Supervised learning

- Supervised Learning is used to build a model that makes predictions based on evidence in the presence of uncertainty.

- A Supervised Learning Algorithm takes a known set of **Input Data** and known responses to the data (**Output**) and trains a **Model** to generate reasonable **Predictions** for the response to new data.
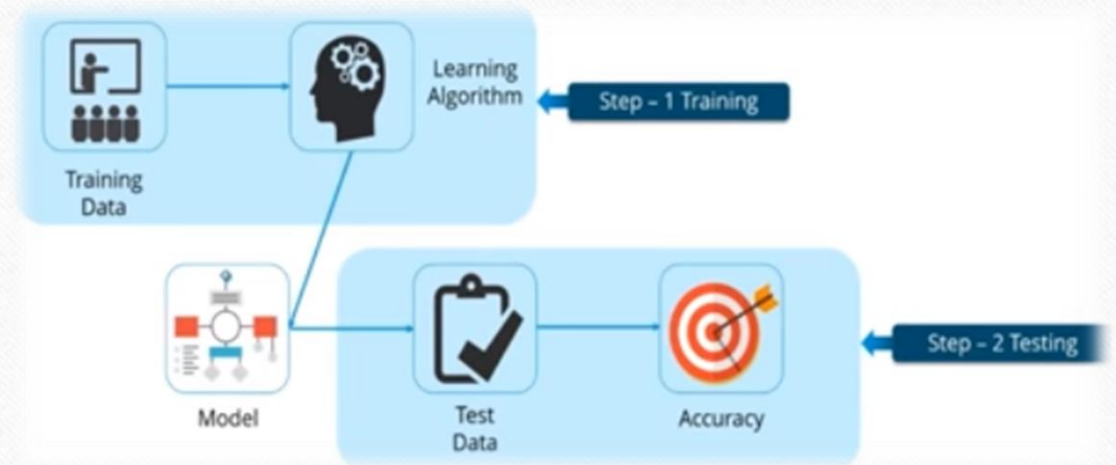
Supervised Learning Techniques

❑ Classification Techniques [Predict Discrete Response]

For Example :

- Email - Genuine / Spam

- Tumor - Cancerous / Benign

❑ Regression Techniques [Predict Continuous Responses]

For Example :

- Changes in temperature

- Fluctuations in power demand

- Price of the House

Supervised Learning - Example

- Suppose clinicians want to predict whether someone will have a heart attack within a year.

- They have data on previous patients, including age, weight, height, and blood pressure.

- They know whether the previous patients had heart attacks within a year.

- So the problem is combining the existing data into a model that can predict whether a new person will have a heart attack within a year.
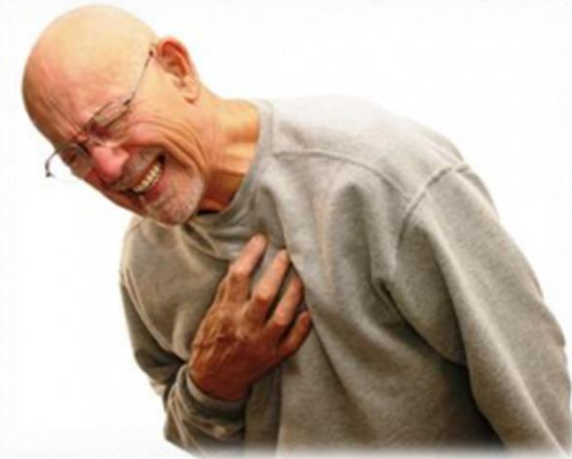
Supervised Learning - Example

- Cancer has been characterized as a heterogeneous disease consisting of many different subtypes.

- The early diagnosis and prognosis of a cancer type have become a necessity in cancer research, as it can facilitate the subsequent clinical management of patients.

Benign vs. Malignant Tumors

Benign (not cancer) tumor cells grow only locally and cannot spread by invasion or metastasis

Malignant (cancer) cells invade neighboring tissues, enter blood vessels and metastasize to different sites

Normal cells

Normal cells

Benign Cells

Malignant Cells
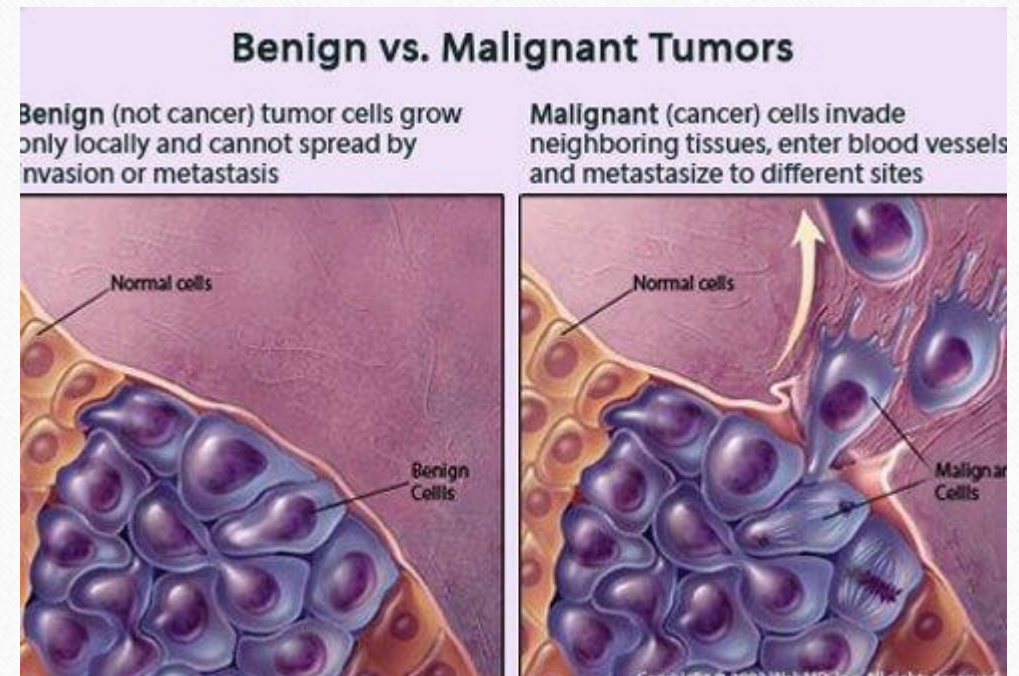
Supervised Learning Algorithms

Here are few algorithms used for supervised learning;

- Decision tree

- Linear regression

- Logistic regression

- The Naive Bayes classifier

Supervised Learning Model

Training Text, Documents, Images, etc → Feature Vectors → Machine Learning Algorithm

Labels → Machine Learning Algorithm

New Text, Document, Image, etc. → Feature Vector → Predictive Model → Expected Label
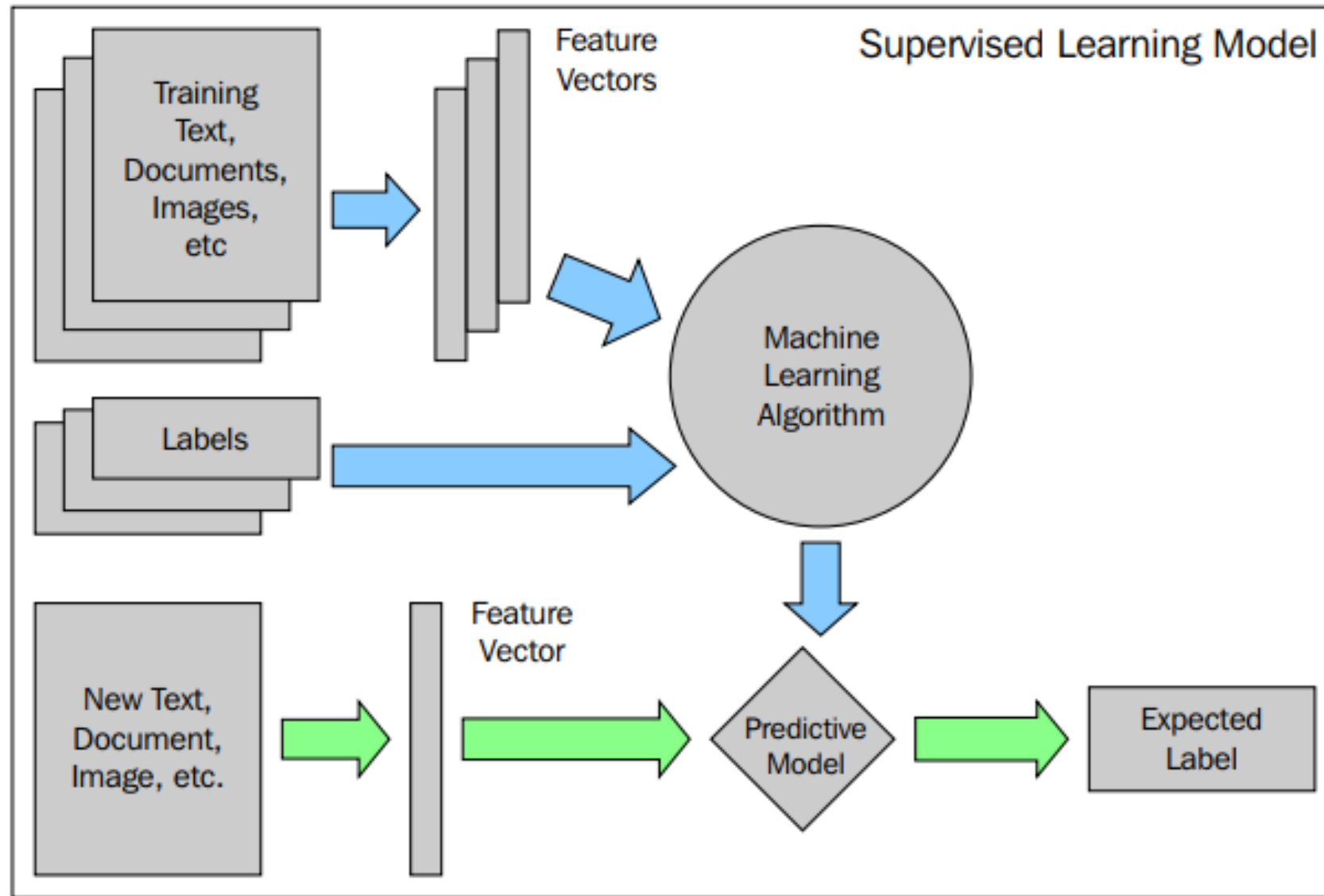
Supervised Learning - Demo

- Problem : Simple R Program demonstrates the use of LOGISTIC regression model.

- This uses the sample dataset (mtcars) provided in R.

- Tools Used – R Programming

- Algorithm – Linear Regression

Cumulative Probability Function
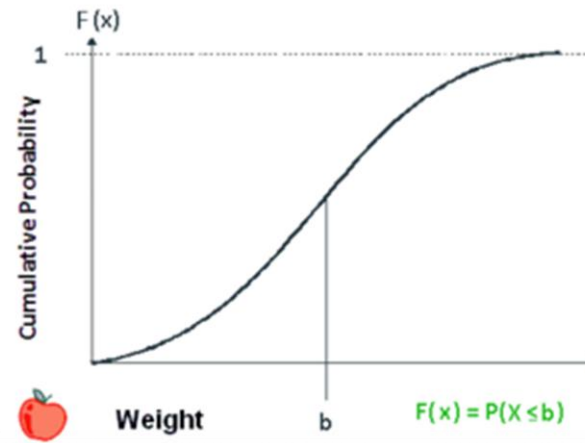
Unsupervised Learning

❑ Allows us to approach problems with little or no idea what our results should look like.

❑ We can derive this structure by clustering the data based on relationships among the variables in the data.

❑ With unsupervised learning there is no feedback based on the prediction results, i.e., there is no teacher to correct you.
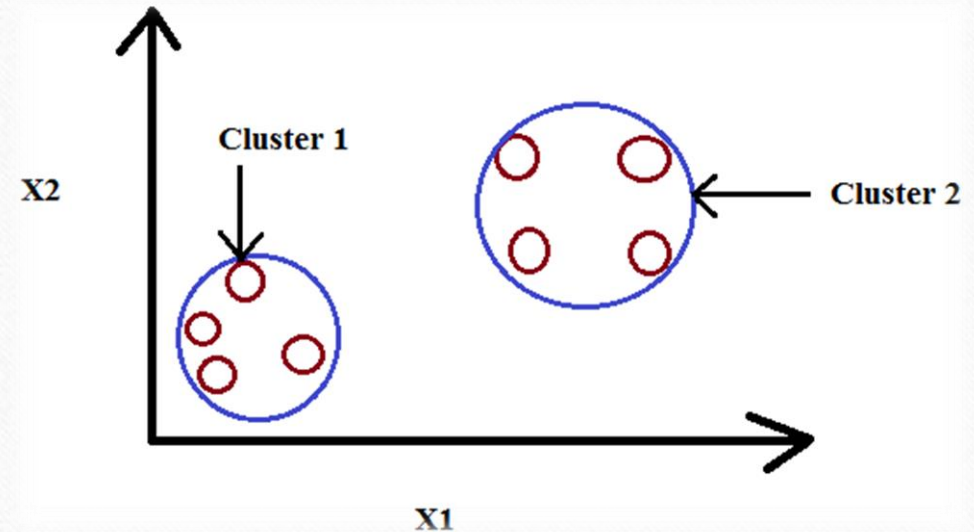
Unsupervised Learning - Example

❑ Take a collection of 1000 essays written on the US Economy, and find a way to automatically group these essays into a small number that are somehow similar or related by different variables, such as word frequency, sentence length, page count, and so on.

Raw Data   Algorithm   Automated Clusters   Manual Review   Production
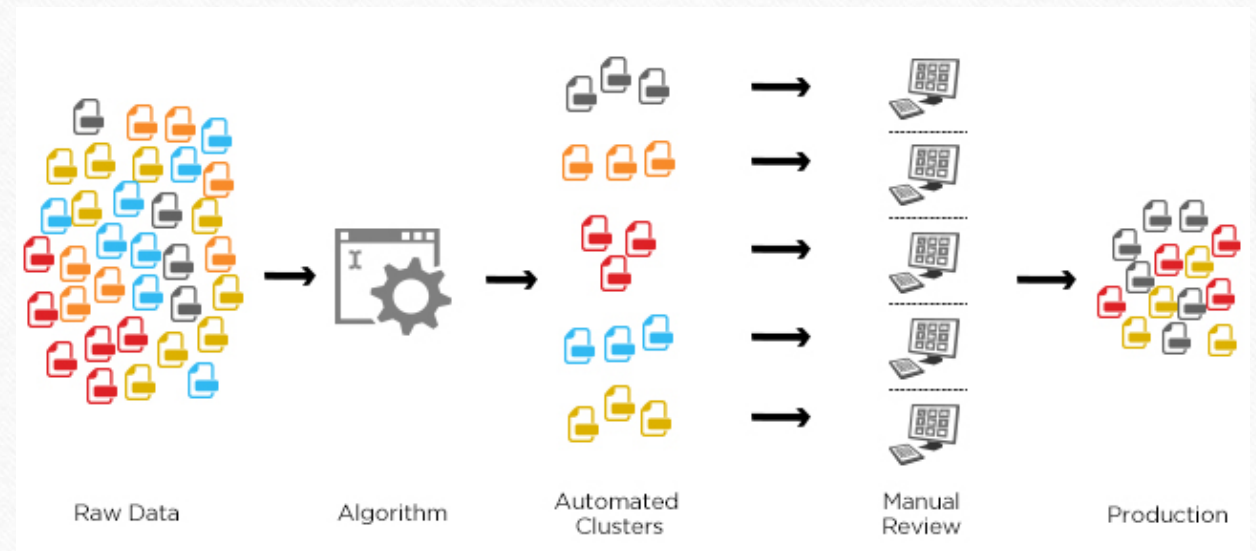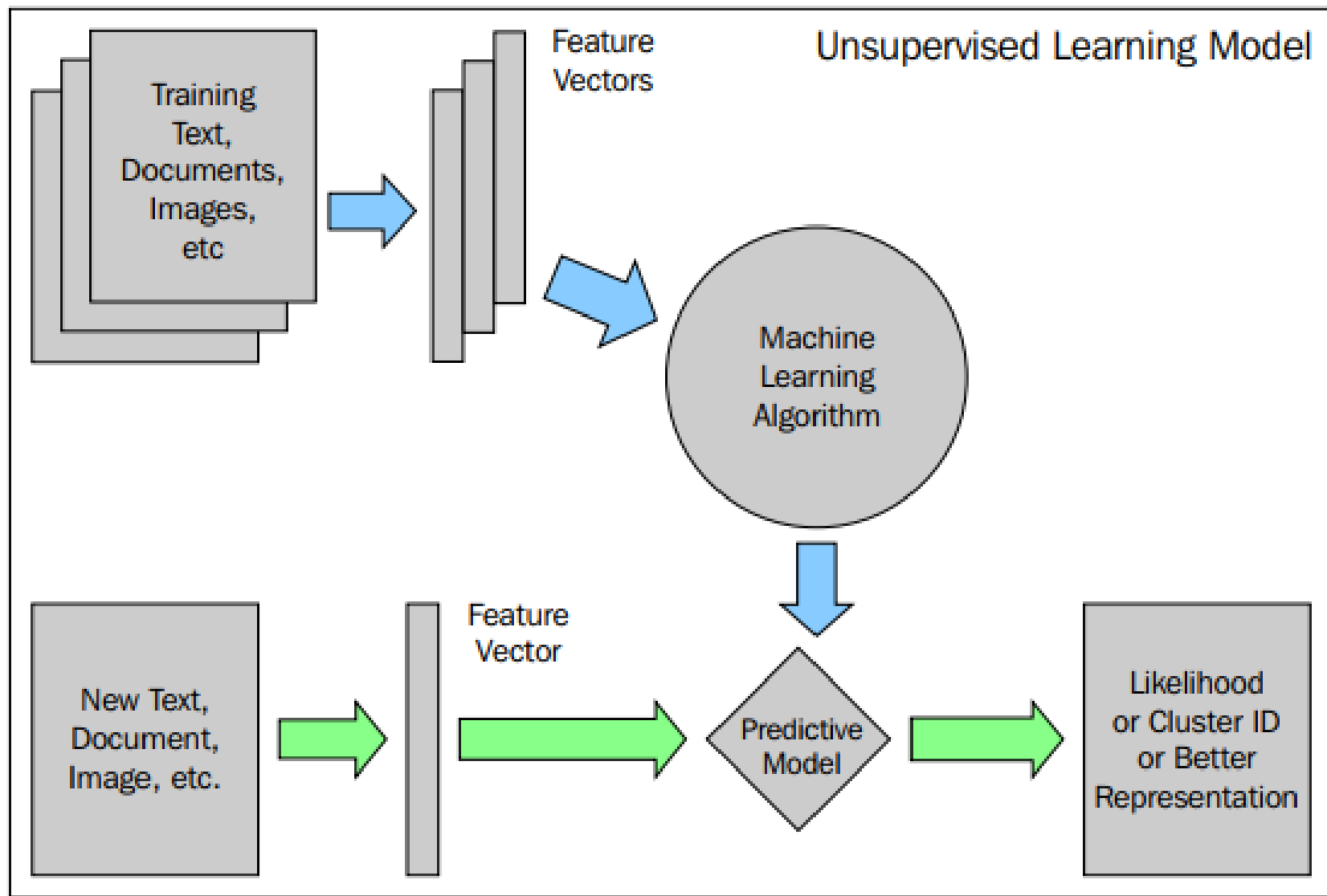
Unsupervised Learning Algorithms

Here are few algorithms used for unsupervised learning;

- The k-means clustering
- Hierarchical clustering

Unsupervised Learning - Demo

- Problem : Simple Python Program demonstrates the use of K- Means clustering model.

- This uses the sample dataset (prepared for demonstration).

- Tools Used – Python Programming

- Algorithm – K-Means Clustering
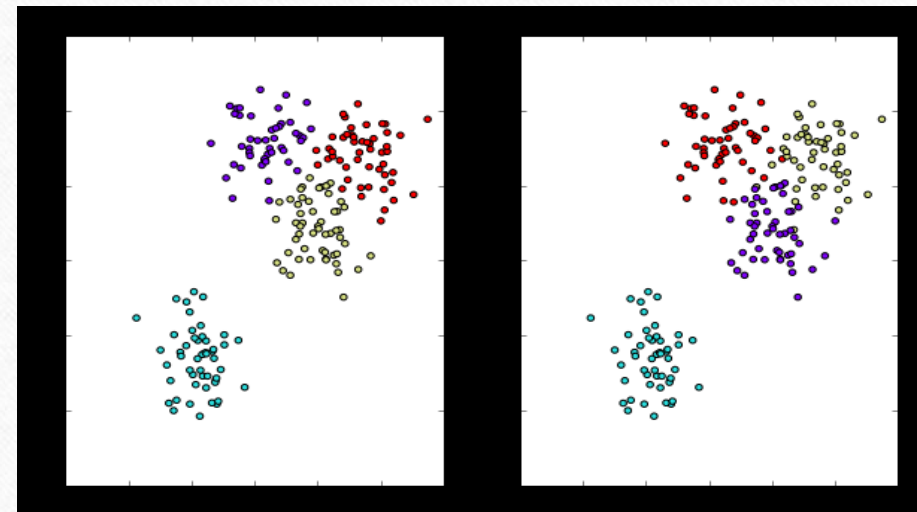
Reinforcement Learning

- These algorithms were designed as to how human brains or rats respond to punishments or rewards.

- Feedback is provided not like a teaching process as in the case of supervised learning, but as punishments and rewards in the environment.

- The agent receives the reinforcement signal in the form of a numerical reward that encodes the success and the agent seeks to teach itself to take actions that will increase the accumulated reward over time.

Reinforcement Learning Algorithms

➢ Reinforcement learning is used heavily in robotics and not much in data science.

➢ The following are the algorithms that come under reinforcement learning:

- Temporal difference learning

- Q learning

Machine Learning Algorithms

Deep Learning
- Deep Boltzmann Machine (DBM)
- Deep Belief Networks (DBN)
- Convolutional Neural Network (CNN)
- Stacked Auto-Encoders

Ensemble
- Random Forest
- Gradient Boosting Machines (GBM)
- Boosting
- Bootstrapped Aggregation (Bagging)
- AdaBoost
- Stacked Generalization (Blending)
- Gradient Boosted Regression Trees (GBRT)

Neural Networks
- Radial Basis Function Network (RBFN)
- Perceptron
- Back-Propagation
- Hopfield Network

Regularization
- Ridge Regression
- Least Absolute Shrinkage and Selection Operator (LASSO)
- Elastic Net
- Least Angle Regression (LARS)

Rule System
- Cubist
- One Rule (OneR)
- Zero Rule (ZeroR)
- Repeated Incremental Pruning to Produce Error Reduction (RIPPER)

Regression
- Linear Regression
- Ordinary Least Squares Regression (OLSR)
- Stepwise Regression
- Multivariate Adaptive Regression Splines (MARS)
- Locally Estimated Scatterplot Smoothing (LOESS)
- Logistic Regression

Bayesian
- Naive Bayes
- Averaged One-Dependence Estimators (AODE)
- Bayesian Belief Network (BBN)
- Gaussian Naive Bayes
- Multinomial Naive Bayes
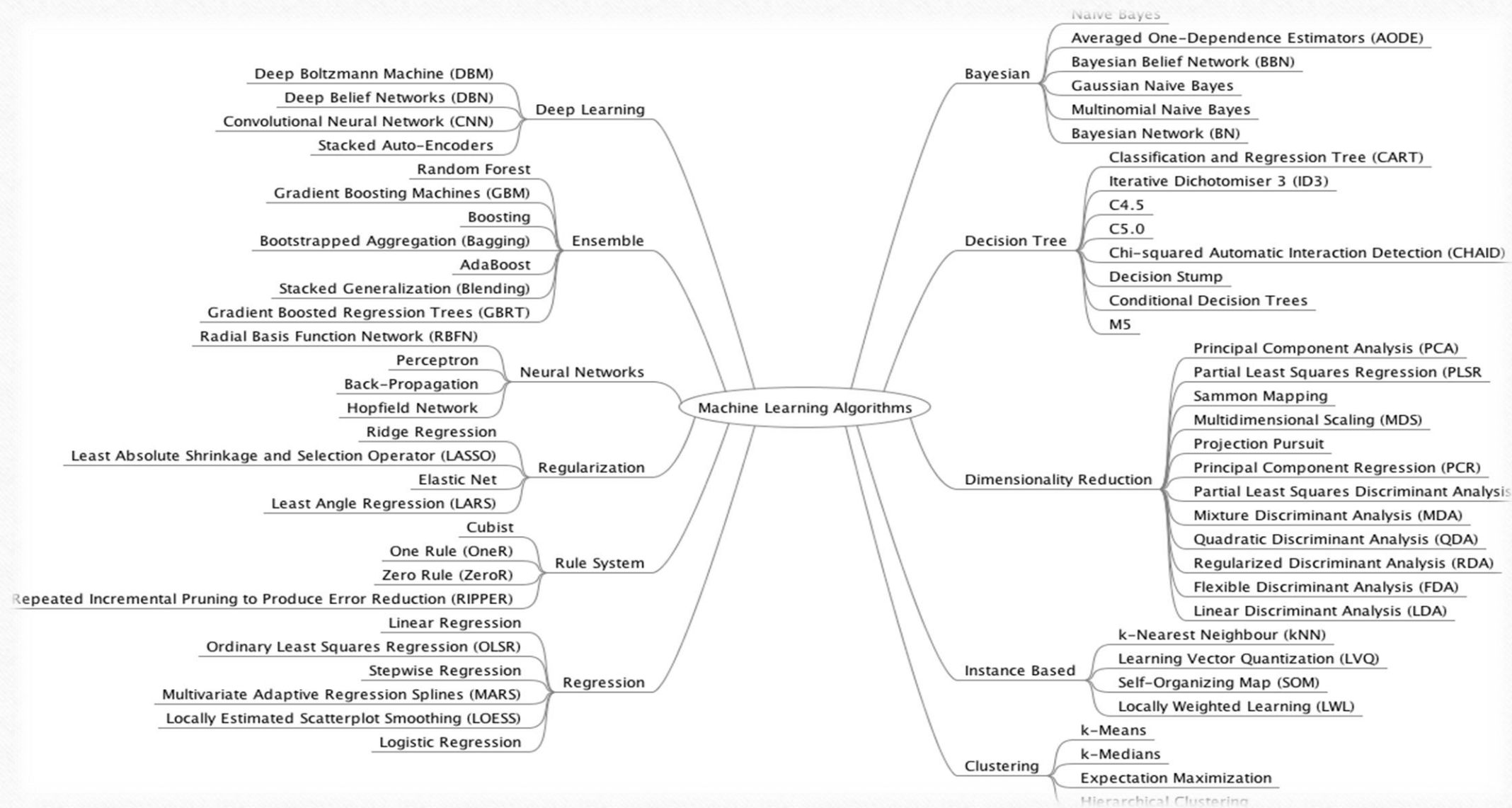- Bayesian Network (BN)

Decision Tree
- Classification and Regression Tree (CART)
- Iterative Dichotomiser 3 (ID3)
- C4.5
- C5.0
- Chi-squared Automatic Interaction Detection (CHAID)
- Decision Stump
- Conditional Decision Trees
- M5

Dimensionality Reduction
- Principal Component Analysis (PCA)
- Partial Least Squares Regression (PLSR)
- Sammon Mapping
- Multidimensional Scaling (MDS)
- Projection Pursuit
- Principal Component Regression (PCR)
- Partial Least Squares Discriminant Analysis
- Mixture Discriminant Analysis (MDA)
- Quadratic Discriminant Analysis (QDA)
- Regularized Discriminant Analysis (RDA)
- Flexible Discriminant Analysis (FDA)
- Linear Discriminant Analysis (LDA)

Instance Based
- k-Nearest Neighbour (kNN)
- Learning Vector Quantization (LVQ)
- Self-Organizing Map (SOM)
- Locally Weighted Learning (LWL)

Clustering
- k-Means
- k-Medians
- Expectation Maximization
- Hierarchical Clustering

How to Choose an Algorithm?

We take a top down approach to answer the same:

These are the 5 questions which can be answered in data science.

Q1.	Is this A or B?	→ Classification Algorithm
Q2.	Is this weird?	→ Anomaly Detection Algorithm
Q3.	How much or how many?	→ Regression Algorithms
Q4.	How is this organized?	→ Clustering Algorithms
Q5.	What should I do next?	→ Reinforcement Learning

5 Ways Machine Learning Is Reshaping Our World

Search Engine Algorithm, Sentiment Analysis

Review a Breast Cancer Scan, Driverless Cars

Siri, Cortana, and Google Now

Real Time Language Translations

Writing photo captions describing the pictures

1

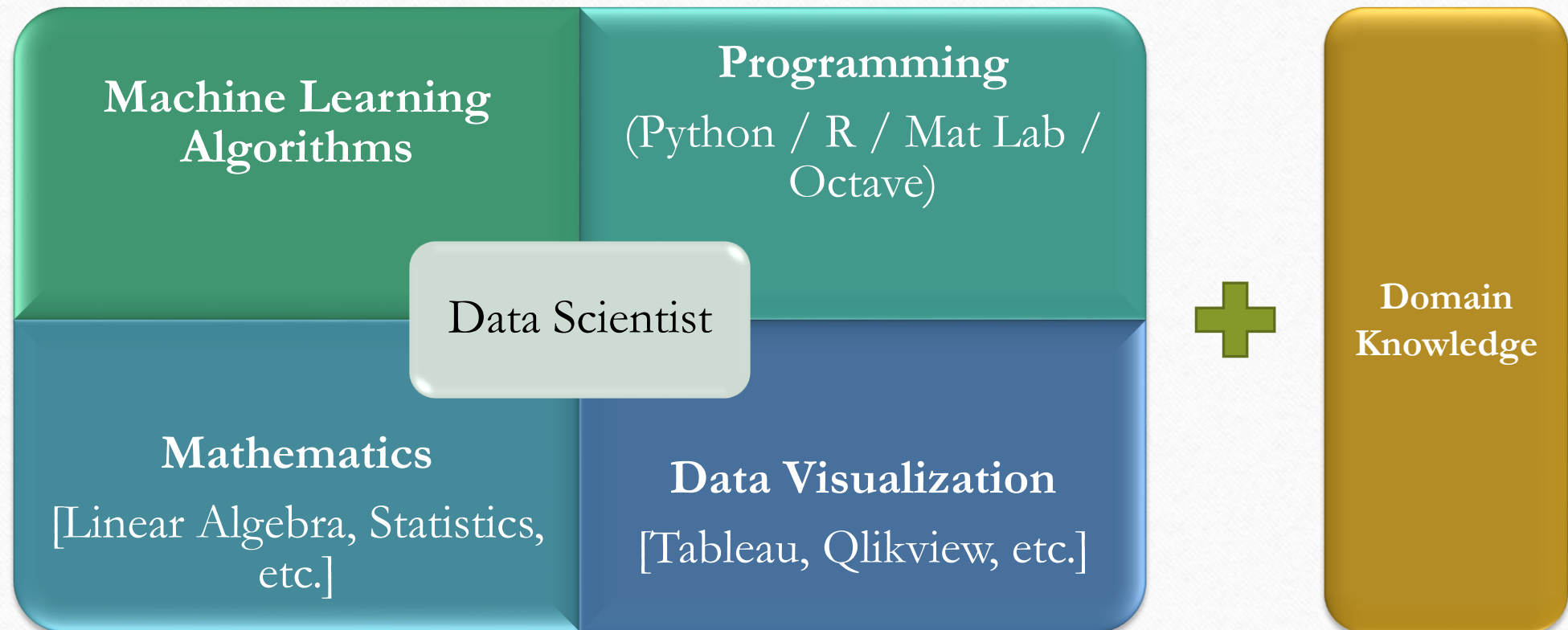Machine Can Read

Machine Can See

2

3

Machine Can Listen

Machines Can Talk

4

5

Machines Can Write

SKILLS REQUIRED FOR DATA SCIENTISTS

Machine Learning Algorithms

Programming (Python / R / Mat Lab / Octave)

Data Scientist

Mathematics [Linear Algebra, Statistics, etc.]

Data Visualization [Tableau, Qlikview, etc.]

+ **Domain Knowledge**

Q & A

Thank You!