Introduction to ML and Classical Models

ML Instruction Team, Fall 2022

CE Department
Sharif University of Technology

Machine Learning: An Overview

- What is Machine Learning?

  Machine learning is the field of study that gives computers the ability to learn without being explicitly programmed.

- Applications of Machine Learning
  - This Person Does not Exist!
  - Github Copilot
  - Imagen
  - Dall-E Open AI
  - DocQuery
  - Zero Shot Object Detection!

Machine Learning Categories

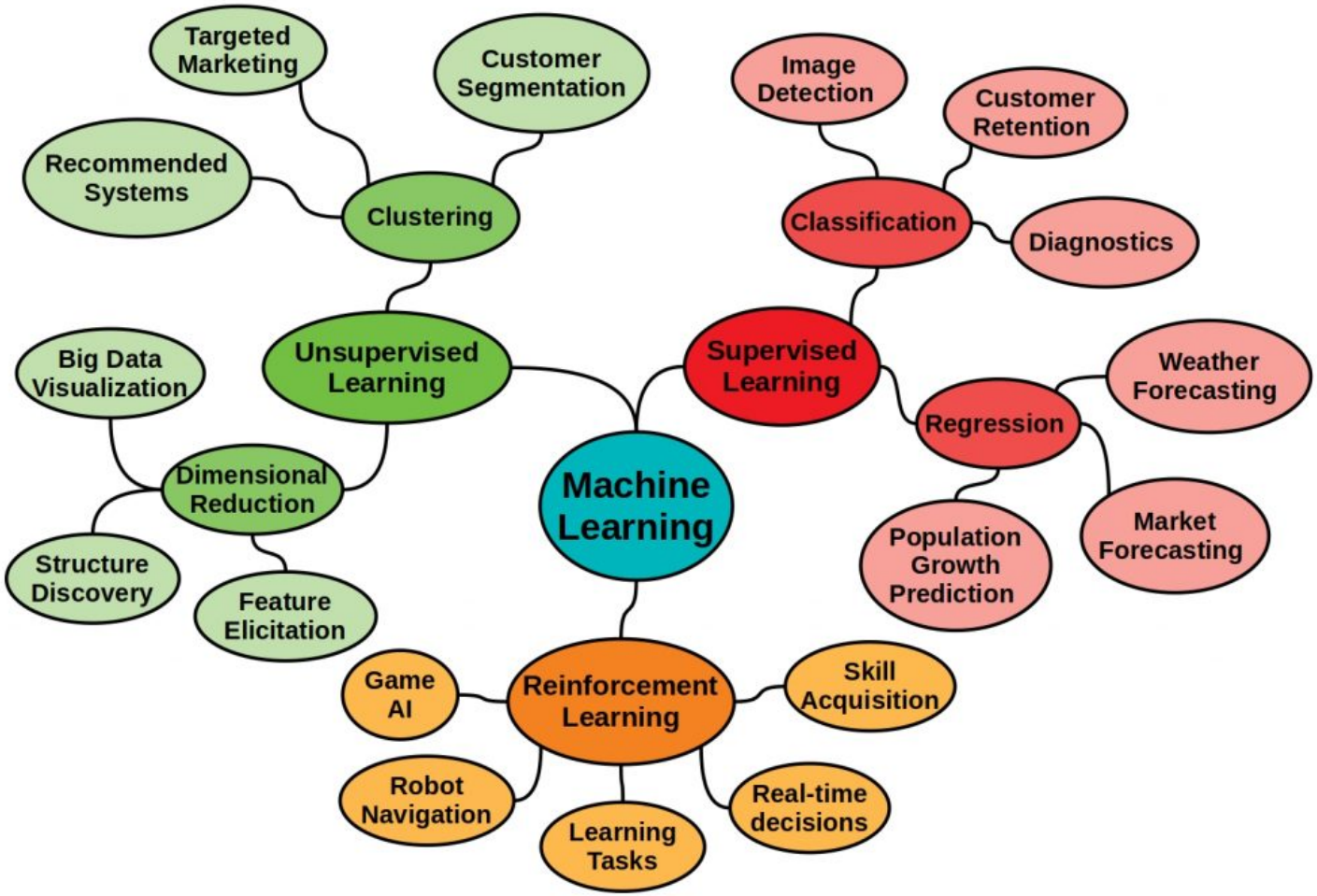


Figure: Classical Machine Learning Paradigm, Source

Machine Learning Categories

- The three broad categories of ML are summarized in:
  - **Supervised Learning**
  - **Unsupervised Learning**
  - **Reinforcement Learning**

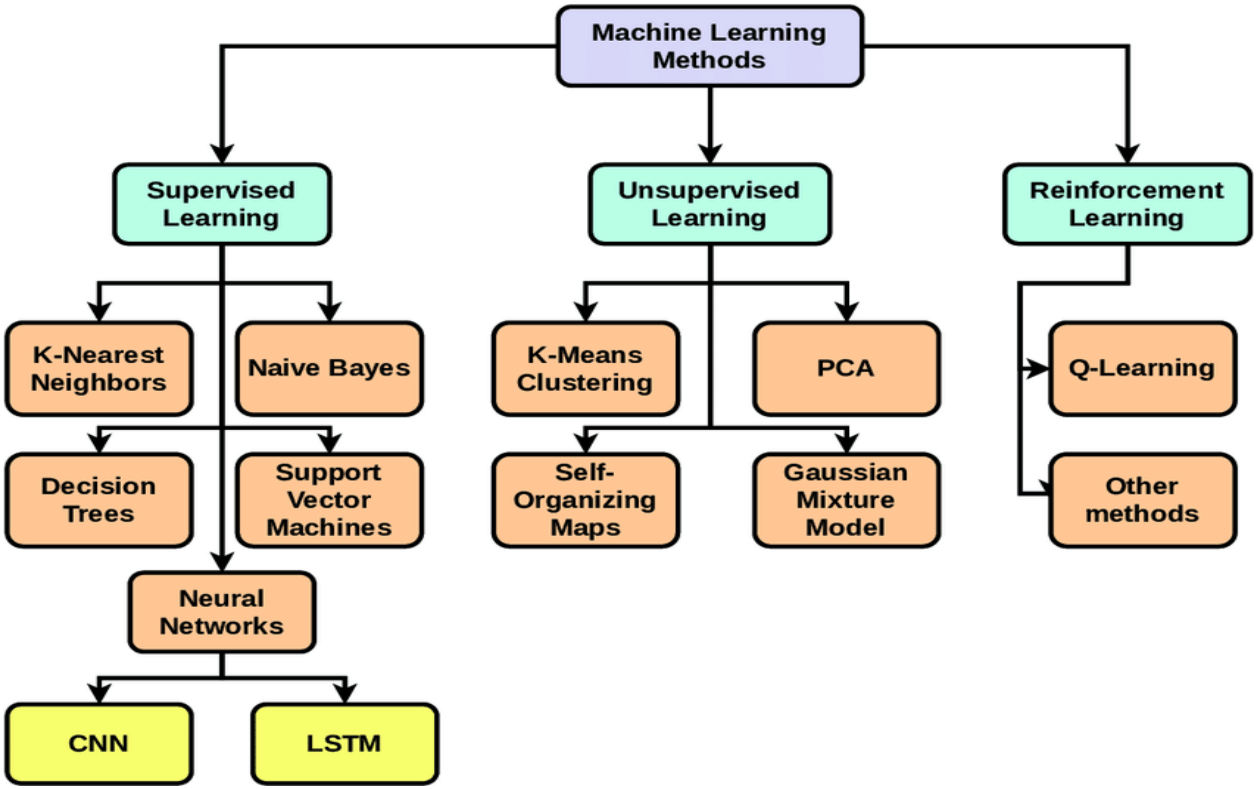


Figure: Categories of ML, Source

Supervised Learning

Whats is Supervised Learning?

Supervised Learning is the subcategory of machine learning that focuses on learning from labeled training data, which can be divided to two main categories:

- Classification : Predicting the discrete values such as male/female, etc.
- Regression : Predicting the continuous values such as price, age, etc.

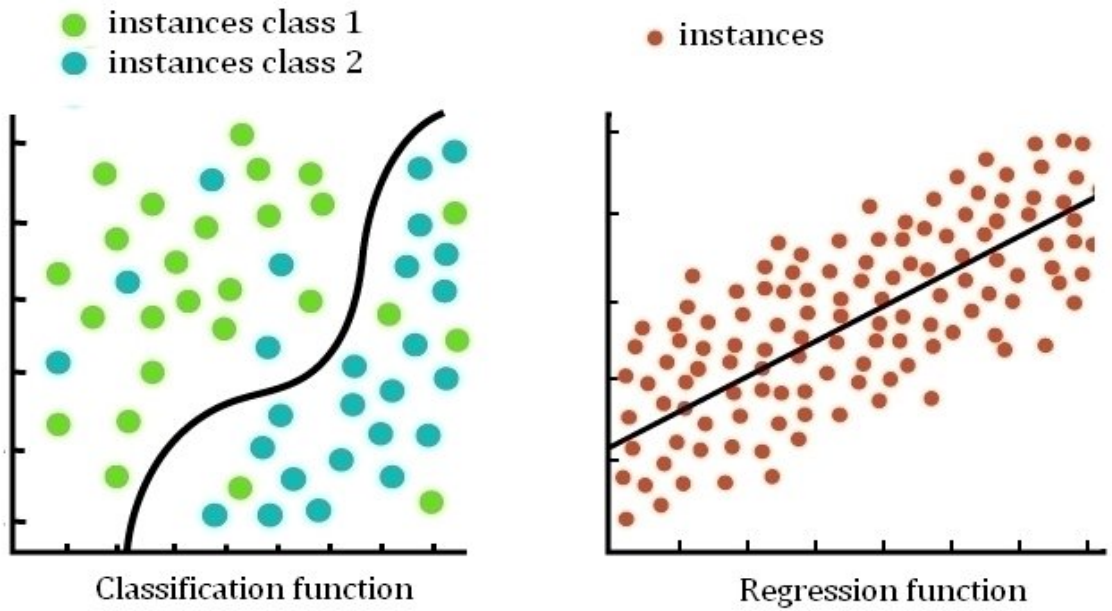


Figure: Classification vs Regression, Source

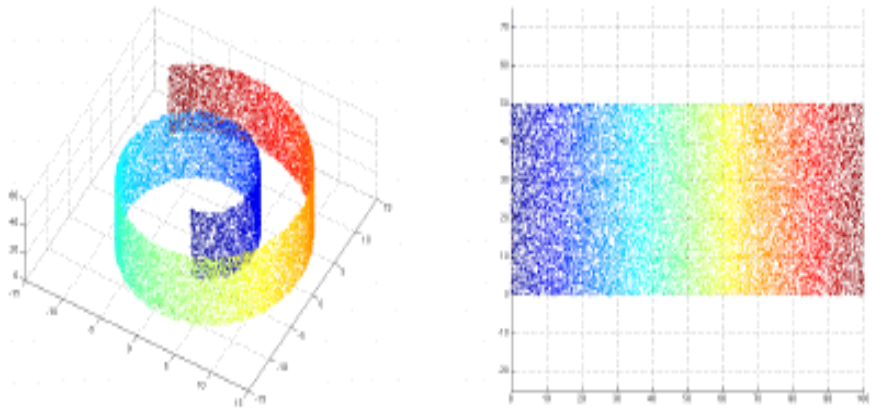
Unsupervised Learning

- What is Unsupervised Learning?

  Unsupervised Learning , in contrast to supervised learning, is concerned with unlabeled data.

- Common tasks in unsupervised learning are:
  - Clustering
  - Dimensionality Reduction

(a) Clsutering, Source



(b) Dimensionality Reduction, Source

Figure: Clustering vs Dimensionality Reduction

Reinforcement Learning

- Reinforcement is the process of learning from rewards while performing a series of actions.
- An agent in this context is a learning system that observes the environment, selects and performs actions, and receives rewards.
- As time goes on, it must learn how to get the most rewards using the best strategy, called a policy.

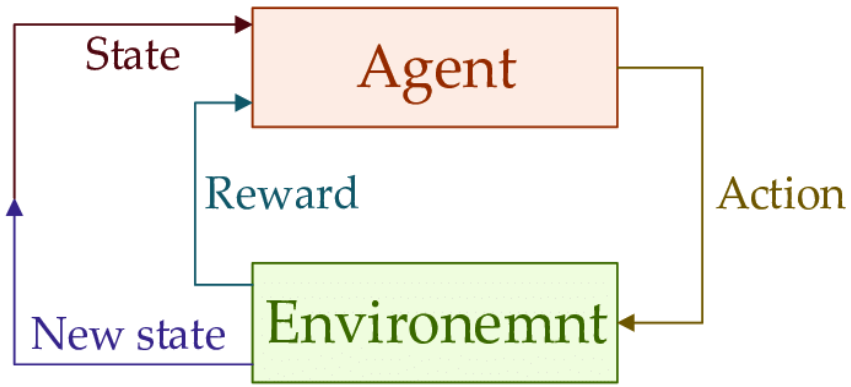


Figure: Reinforcement Learning, Source.

ML Categorization Schemes

- Eager vs Lazy:
  - Eager learners are algorithms that process training data immediately.
  - Lazy learners, however, defer the processing step until the prediction.
- Batch vs Online:
  - Batch learning refers to the fact that the model is learned on the entire set of training examples.
  - Online learners, in contrast, learn from one training example at the time.
- Generative vs Discriminative:
  - Generative models (classically) describe methods that model the joint distribution $\mathbb{P}(X, Y) = \mathbb{P}(Y)\mathbb{P}(X|Y) = \mathbb{P}(X)\mathbb{P}(Y|X)$ for training pairs (x_i, y_i).
  - Discriminative Discriminative models are taking a more "direct" approach, modeling $\mathbb{P}(Y|X)$ directly.

ML Categorization Schemes

- Instance-based vs Model-Based:
  - Instance-based learners learn the training examples by heart and then generalizes to new instances based on some similarity measure.
    - Here, the algorithm looks at a set of training data and tries to find a pattern that can be generalized to new data.
    - This pattern is then used to make predictions on new data.
  - Model-Based learners, on the other hand, learn from a model that is created from the training data.
    - This model can be thought of as a mathematical representation of the training data.
    - The model is then used to make predictions on new data.
- Parametric vs Non-parametric:
  - Parametric Parametric models have ”fixed” number of parameters.
  - Non-parametric models are more ”flexible” and do not have a pre-specfied number of parameters.

How to Solve A Machine Learning Problem

- Collect data.
- Preprocess the data.
- Select a suitable model and train it.
- Evaluate the generalization error on the test dataset.
- Improve the model using various techniques.

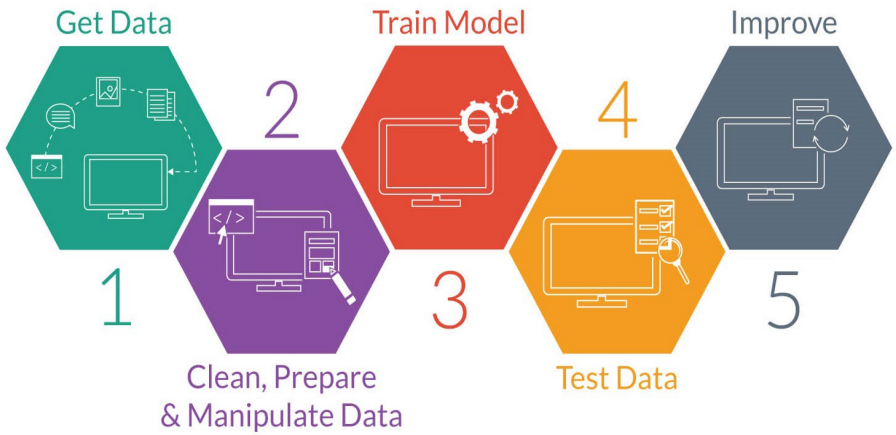


Figure: Required steps to solve an ML problem, Source

Thank You!

Any Question?