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Machine Learning (Overview)

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Summary



1. Introduction
2. Machine Learning
3. Computational Learning Theory
4. Algorithm Types
5. Machine Learning Algorithms

1. Introduction

- Learning is one of the fundamental basis of intelligence.
- Machine learning is used in applications difficult to program manually, or that need flexibility to adapt to the environment:
 - automatic control of autonomous vehicles,
 - speech recognition,
 - natural language processing,
 - information retrieval,
 - indexing and categorization of documents,
 - computer games,
 - artificial vision,
 - autonomous robots,
 - music composition,
 - recommender systems,
 - etc.

2. Machine Learning

- Machine learning concerns the construction and study of systems that can learn from data.
- The core of machine learning deals with representation and generalization:
 - **Representation** of data instances and functions evaluated on these instances are part of all machine learning systems.
 - **Generalization** is the property that the system will perform well on unseen data instances.
- Following Alan Turing's proposal in Turing's paper "Computing Machinery and Intelligence" that the question:
"Can machines think?" should be replaced by:
"Can machines do what we (as thinking entities) can do?"

3. Computational Learning Theory

- The computational analysis of machine learning algorithms is a branch of theoretical computer science known as **computational learning theory**.
- Because training sets are finite and the future is uncertain, learning theory usually provides probabilistic bounds on the performance.
- There are many similarities between machine learning theory and statistical inference, although they use different terms.
- A computation is considered **feasible** if it can be done in polynomial time vs. NP-complete problems.

4. Some Algorithm Types

- **Supervised learning:** algorithms are trained on labeled examples, i.e., input samples where the desired output is already known. The supervised learning algorithm attempts to generalize a function for mapping inputs to outputs.
- **Unsupervised learning:** algorithms operate on unlabeled examples, i.e., inputs where the desired output is unknown. Here the objective is to discover data structures (e.g., through a cluster analysis), or hidden correlations among the data.
- **Semi-supervised learning:** the training set is partially labeled.
- **Reinforcement learning:** algorithms take actions in an unknown environment, in order to maximize the notion of cumulative reward, which is typically modeled as a Markov decision process (MDP).

5. Machine Learning Algorithms I

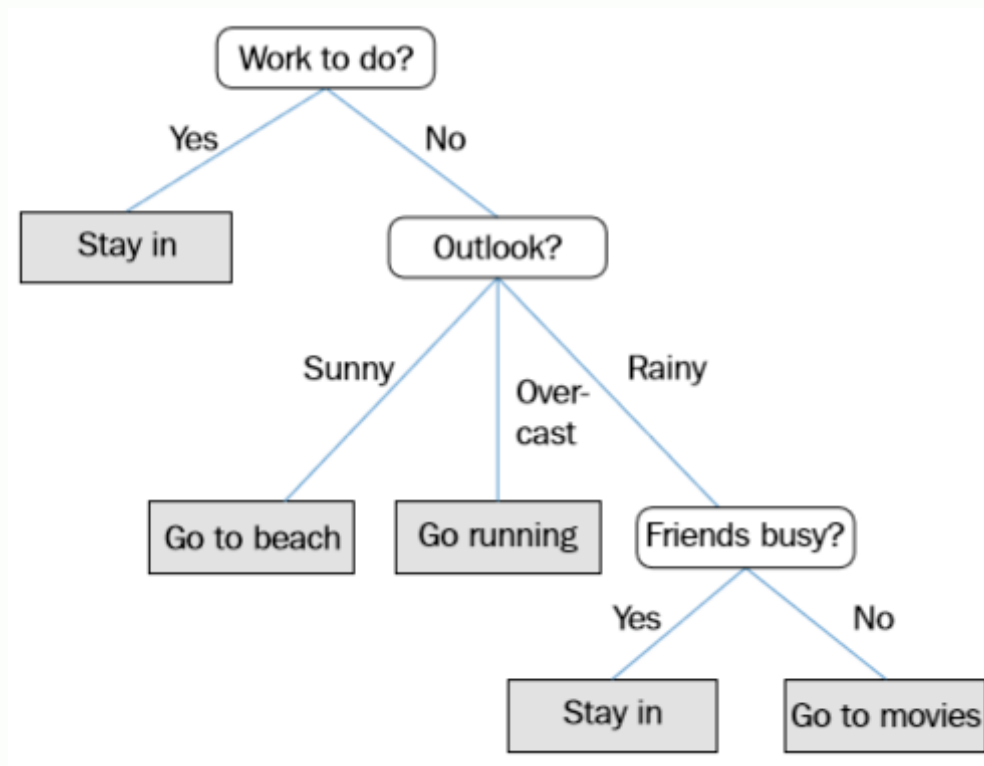
- **Inductive logic programming (ILP)** is an approach to rule learning using logic programming as a uniform representation for examples, background knowledge, and hypotheses.

Given an encoding of the known background knowledge and a set of examples represented as a logical database of facts, an ILP system will derive a hypothesized logic program which entails all the positive and none of the negative examples.



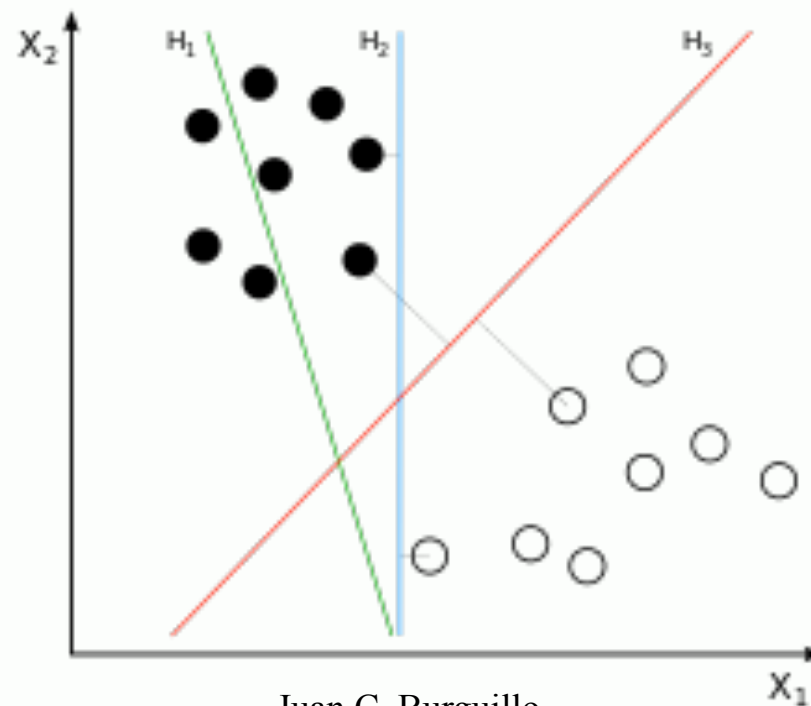
5. Machine Learning Algorithms II

- **Decision tree learning** uses a decision tree as a predictive model which maps observations about an item to conclusions about the item's target value.



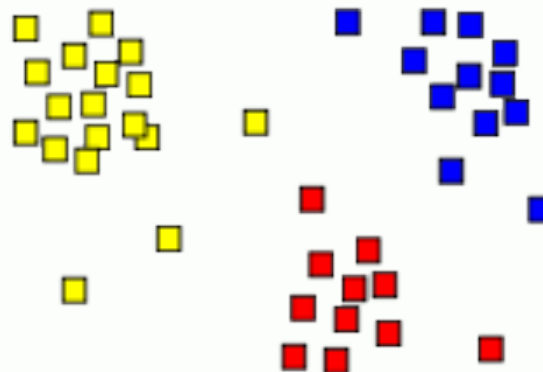
5. Machine Learning Algorithms III

- **Classification, Regression, Prediction:** given a set of training examples, marked as belonging to one of two categories, a training algorithm can build a model to predict whether a new example falls into one category or another.
- **Support vector machines (SVMs)** are a set of related supervised learning methods used for this purpose. Another popular supervised method is **K-Nearest Neighbors (K-NN)**.



5. Machine Learning Algorithms IV

- **Clustering** is the assignment of a set of observations into subsets (called clusters), so that observations within the same cluster are similar, according to some pre-designed criteria. Clustering algorithms belong to the **unsupervised learning** category and are a common technique for statistical data analysis
- A good example of clustering algorithm is **K-MEANS**.

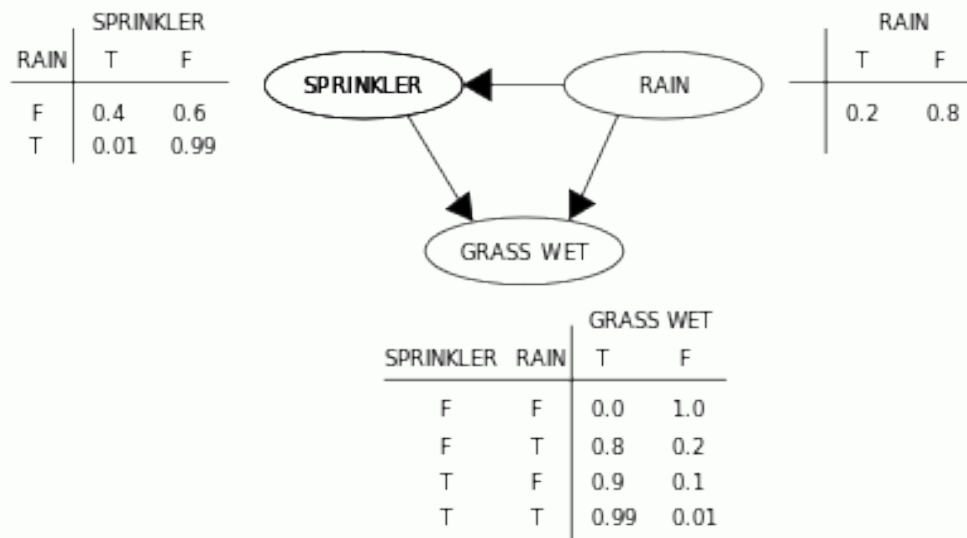


5. Machine Learning Algorithms V

- **Bayesian network**, belief network or directed acyclic graphical model, is a probabilistic graphical model that represents a set of random variables and their conditional independencies via a directed acyclic graph (DAG) using the Bayes theorem:

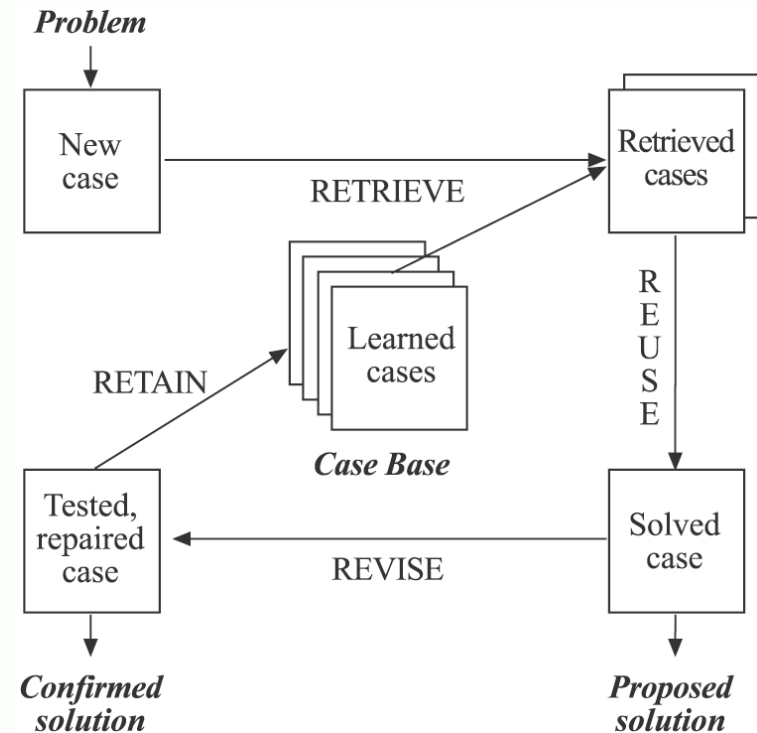
$$P(A/B) = P(B/A).P(A).P(B)^{-1}$$

For example, a Bayesian network could represent the probabilistic relationships between diseases and symptoms. Given symptoms, the network can be used to compute the probabilities of various diseases.



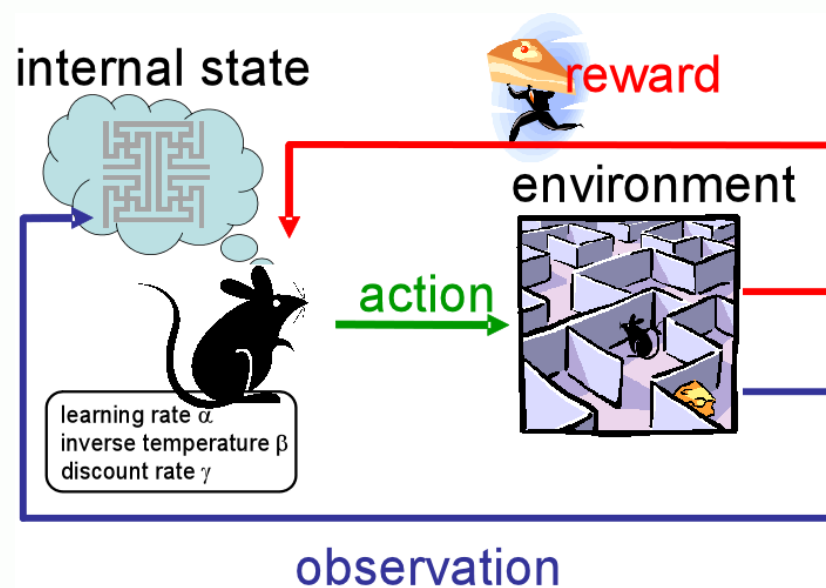
5. Machine Learning Algorithms VI

- **Case-based reasoning (CBR)** is the process of solving new problems based on the solutions of similar past problems.
- CBR consist in four phases: retrieve, reuse, revise and retain.



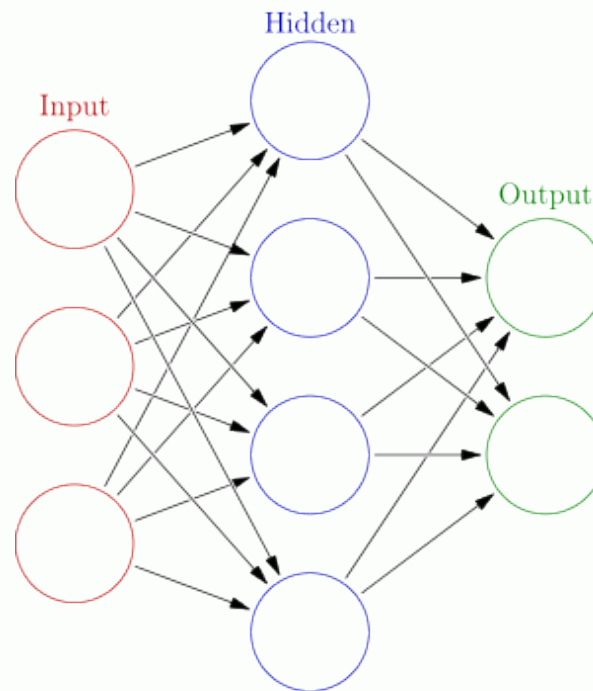
5. Machine Learning Algorithms VII

- **Reinforcement learning:** Through a sequence of actions, the agent attempts to gather knowledge about how the environment responds to its actions, and attempts to synthesize a sequence of actions that maximizes a cumulative reward.
- The focus is on finding a balance between exploring a huge space of actions, and exploiting the knowledge already acquired.

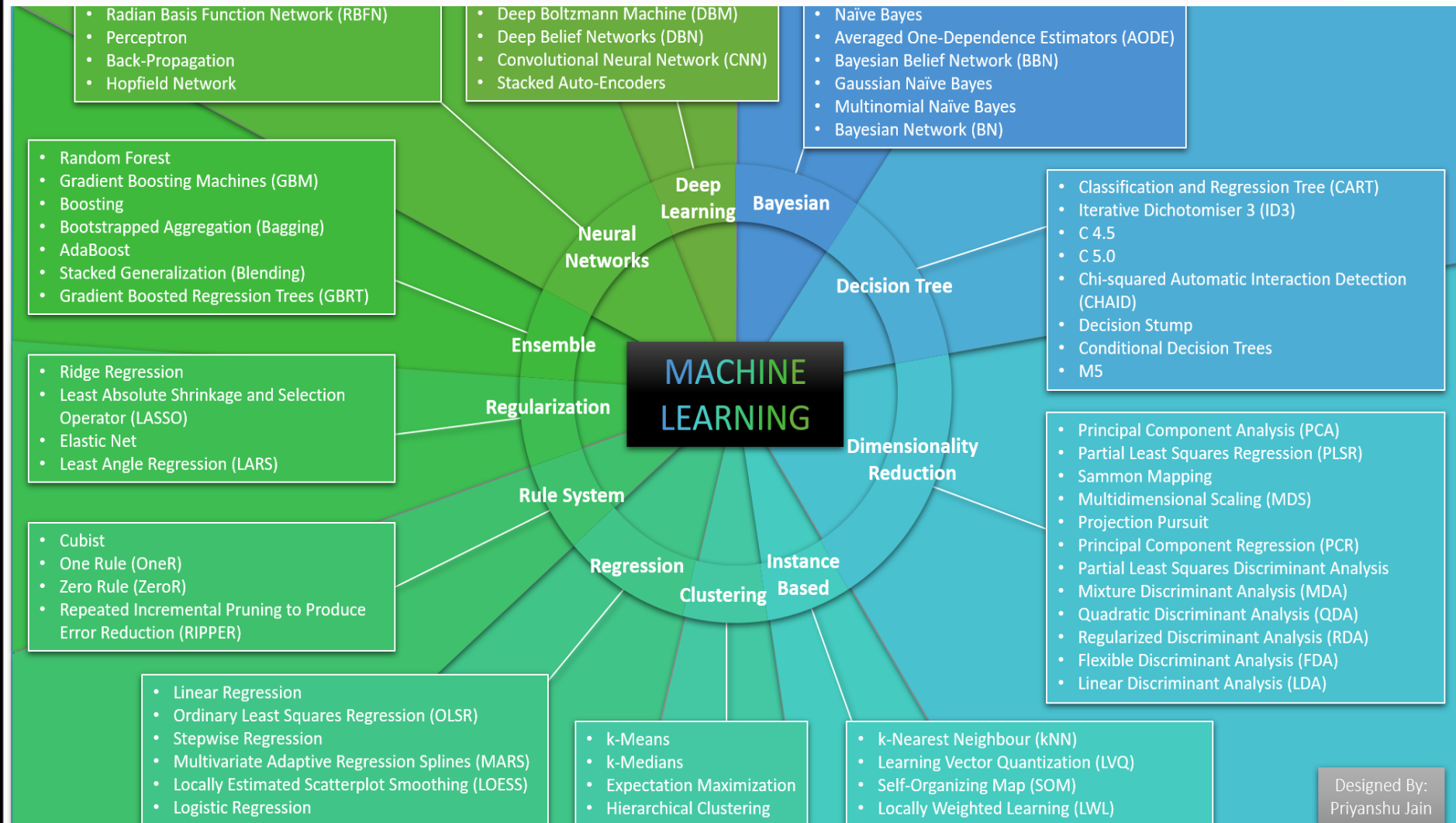


5. Machine Learning Algorithms VIII

- **Artificial neural networks (ANN)** use learning algorithms inspired by the structure and functional aspects of biological neural networks. Computations are structured in terms of an interconnected group of artificial neurons, processing information using a connectionist approach to computation.

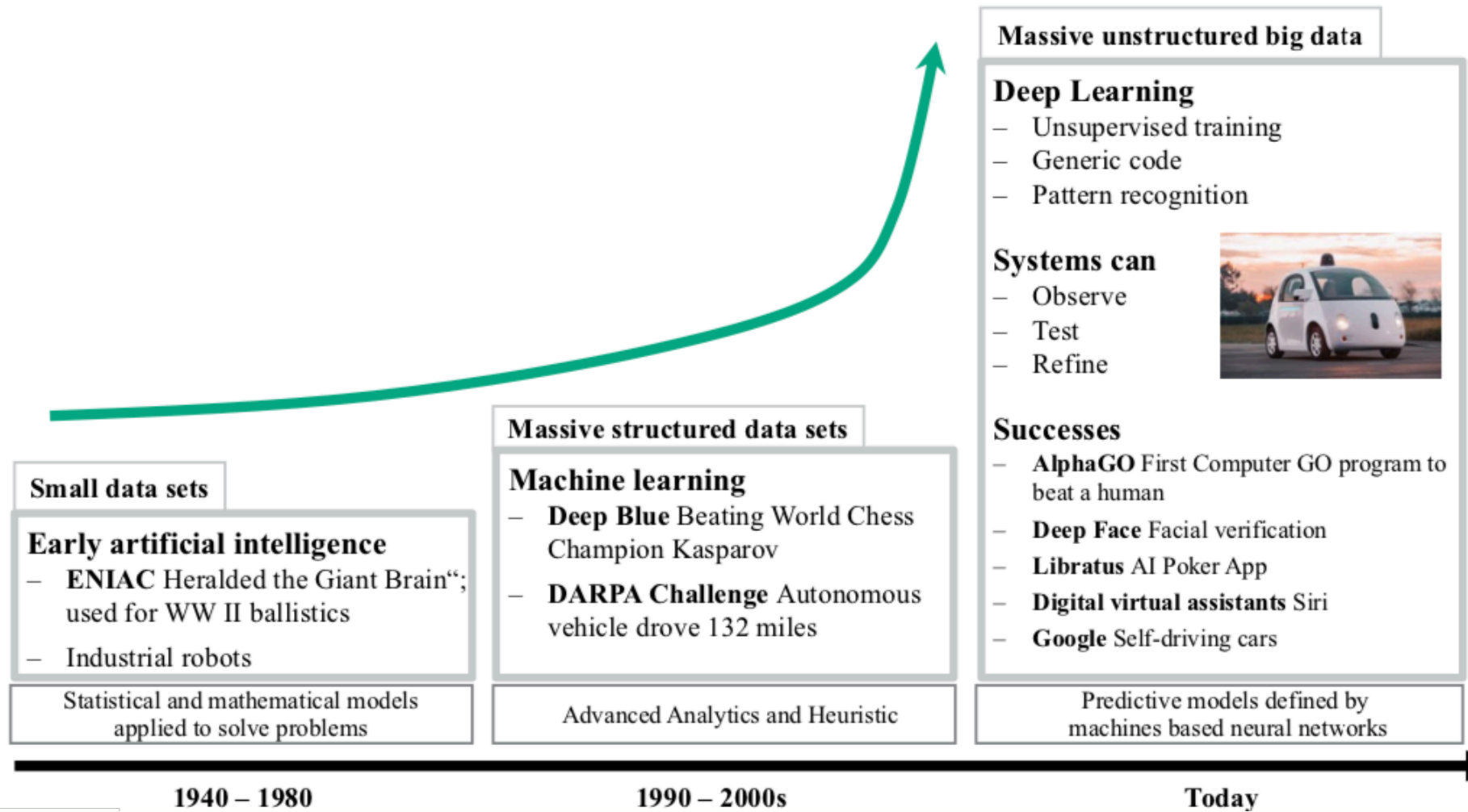


5. M.L. Algorithms: Summary



Designed By:
Priyanshu Jain

5. The Evolution of AI





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