

2024 Google ML Training Programme (Phase III)

Session 1.1

Introduction to Machine Learning

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Objective of Google ML Training Program

- Objectives of the Google ML training program are :
 - Equip participants with skill sets and knowledge base required to formulate, design, build, and develop suitable ML solutions to problems of engineering, science, social science, business, automation, healthcare, etc.;
 - Provide a pool of engineers with hands-on training in ML to help solve real-world problems using ML technology;
 - Promote TensorFlow framework as development platform for ML solutions and integration in cloud services
 - Provide foundation to participants towards acquisition of the Google ML Engineers Certificate;

Expected Outcome of the ML Program

- Outcomes of the Google ML training program include :
 - Ability to formulate ML solutions to real-world problems;
 - Examine the requirements of real-world problems to ensure success of ML application models;
 - Understand raw data and make decisions on whether ML solution will be necessary and the type of ML solution;
 - Design data preparation and processing synthesis for ML;
 - Understand ML model development, model training, retraining, testing, deployment, improvement, monitoring, and maintaining ML solutions.

Requirements for the ML Program

- Basic knowledge requirements for the ML training :
 - **Linear Algebra**
 - Matrices and Vectors are key Linear Algebra elements that are mostly used in ML model development.
 - **Calculus**
 - Integral Calculus and Differential Calculus are the key elements used in ML >> in calculating the likelihood of various events as well as in the learning process.
 - **Programming**
 - This is the foundation for the ML development >> most popular languages used are **Python**, **R**, **C**, and Java

What is Machine Learning

- Computational learning where algorithms are used to extract information from *raw data* (*very large data*) and represent it in a type of model.
- ML essentially learns from given raw data (experience) and make predictions or decisions based on the data learnt *without being programmed to do so*.
- We can view ML model as an *artifact* created by a *training process* and *learning algorithm* to find patterns in the data that map the input data attributes to the target outputs and produces an ML model that captures these patterns.

What is Machine Learning

- **Cont'd...**
- We refer to the ML **algorithm** as a **mathematical or logical program that turns the raw data into a model**.
- ML model emulates the human brain (machine) and how it learns from experience (past information) to solve problems
 - ML models are mostly developed and implemented using Artificial Neural Networks (ANN).
- Depth of learning in the ML defines the type of network:
 - **Shallow learning** >> Shallow networks
 - **Deep learning learning** >> Deep networks
- With ML, performance of algorithm improves with more data

Machine learning vrs Programming

- Conventional learning and Machine learning methods
 - Traditional learning uses structured data and rules.
 - We first create an algorithm by specifying all the rules
 - We present structured data to the rules
 - The rules operate on the data to produce outputs
 - ML uses complex unstructured (and structured) data and handles feature extraction automatically.
 - We present data to an algorithm (not rules)
 - We present expected outcomes, or it learns from answers
 - The algorithm learns the rules that map input to output
 - We present new data to the rules to give outputs

Machine Learning vrs Artificial Intelligence

- AI and ML are closely related and connected but the two are not the same >> ML is considered a subset or part of AI.
- AI is a concept that helps to design and create machines that can execute tasks "smartly" by mimicking human functions like learning and problem-solving using experience without being explicitly programmed >> AI therefore employs the ML and other related techniques to solve the problems.
- ML on the other hand is an application of AI that gives shape and meaning to the concept of creating intelligent machines.
- ML systems learn from data to identify patterns and trends to make decisions with minimal or no human interventions.

Machine Learning vrs Artificial Intelligence

- Cont'd.....
- One approach to train a machine to mimic the human way of reasoning is to use artificial neural network (ANN), which is a series of algorithms that are modelled after the human brain.
- Through AI, computers use **mathematical and logical function** to simulate the reasoning that human uses to learn from new information and make decisions.

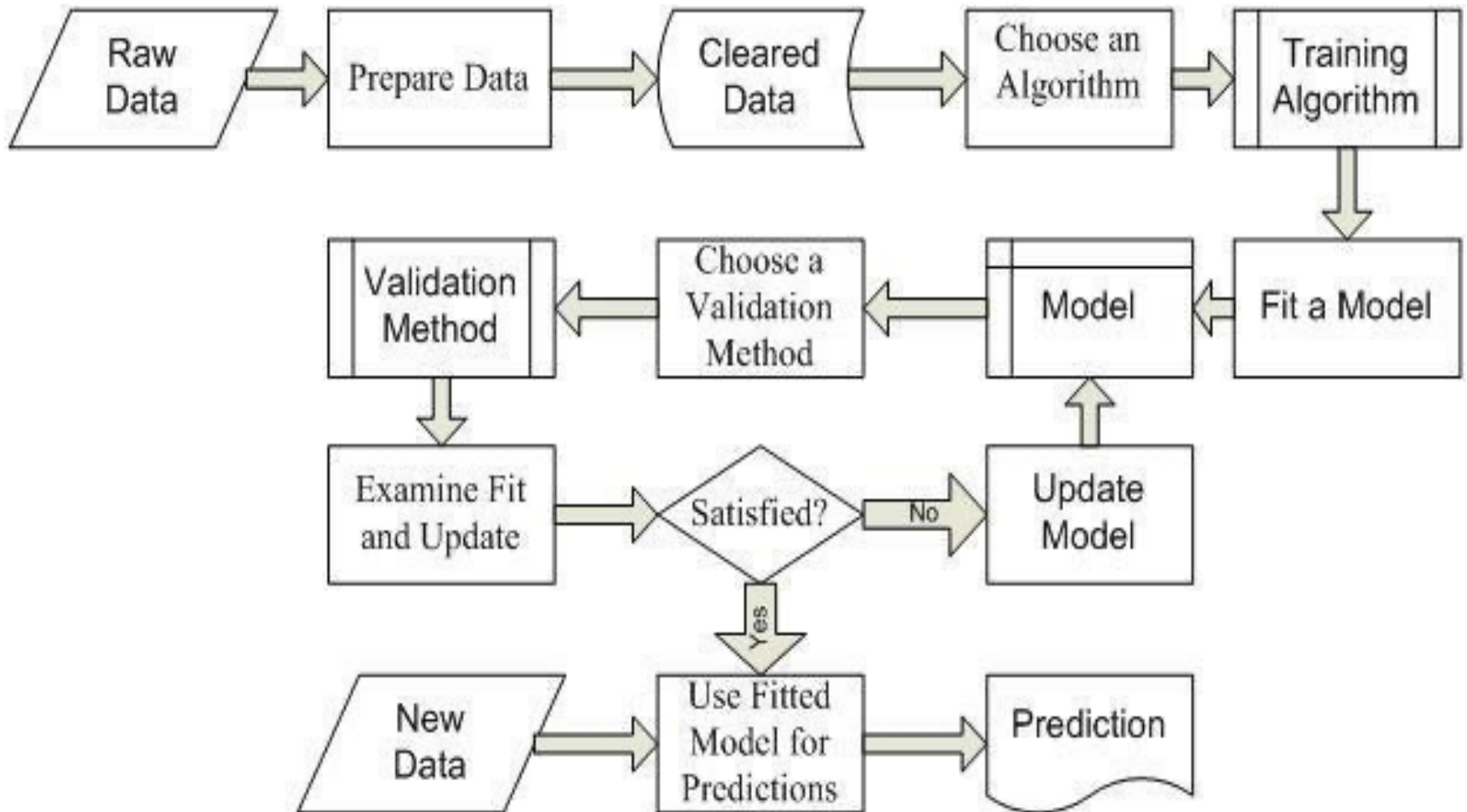
The Need for ML

- ML is a key driving force behind many innovations and technologies in engineering, science, social science, finance, and other spheres >> there is high demand for ML engineers
- ML can produce accurate results and analysis by developing efficient and fast algorithms and data-driven models to process real-time data >> attraction for industry
- ML is at forefront of technology and every industry is seeking for its implementation in diverse application domains >> opens doors for broad scope of opportunities
- Help future-proofing of career to maintain competitiveness in the job market as automation and transform shape economy

Benefits and Challenges of ML

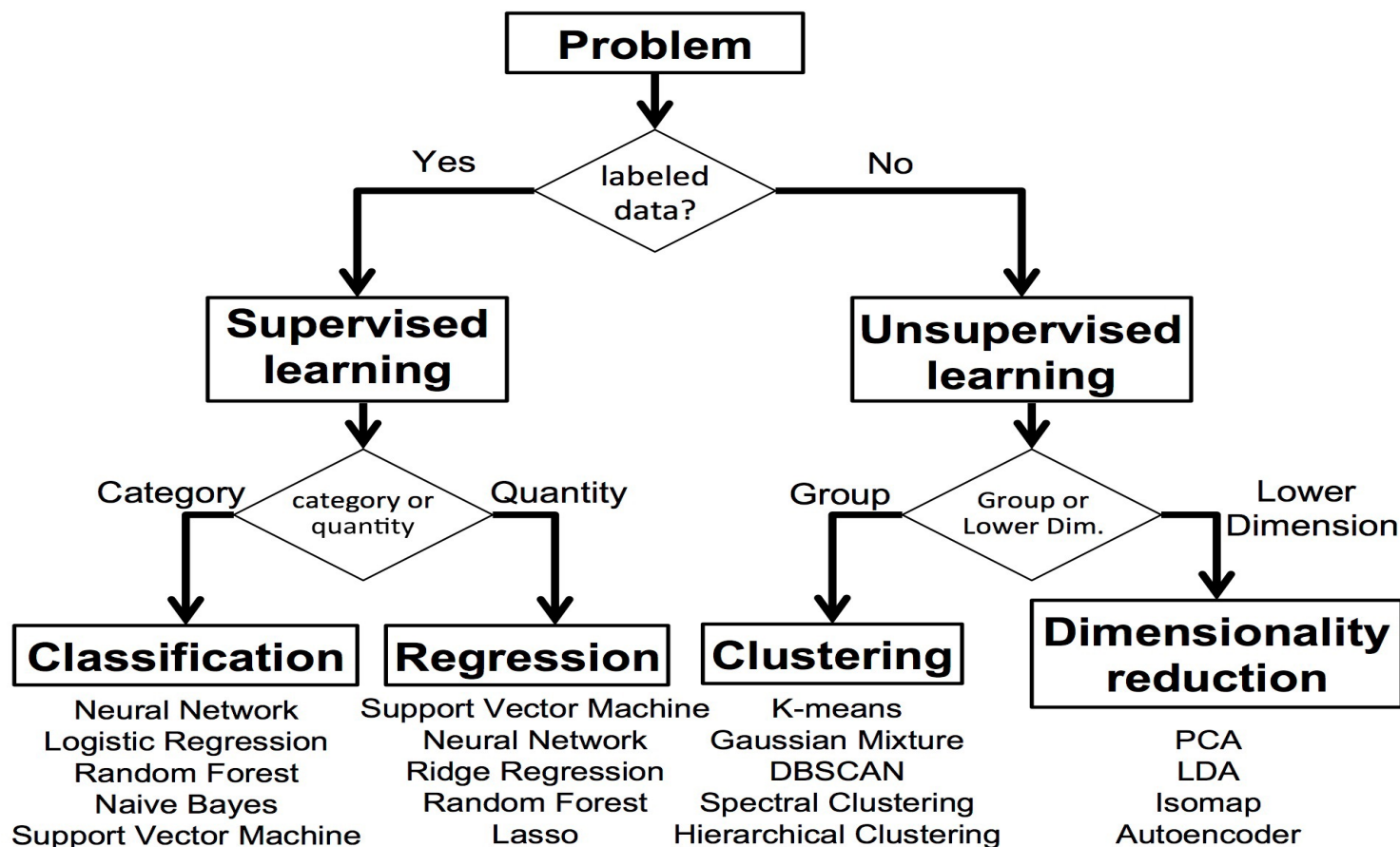
- ML has many advantages because it can help enterprises understand patterns and trends in data collected and learn the associations in the data to help tailor product development
- Some enterprises use ML as the key driver in their business models >> Uber uses ML to match drivers with users while Google uses ML to help users surf the ride advert in search
- A disadvantage of ML is that it can be expensive >> require software infrastructure that can be expensive as well as data
- Another problem is the ML bias >> model trained on dataset that contains errors can lead to inaccurate model of the world which can fail or at worst be discriminatory.

ML Model Workflow Process

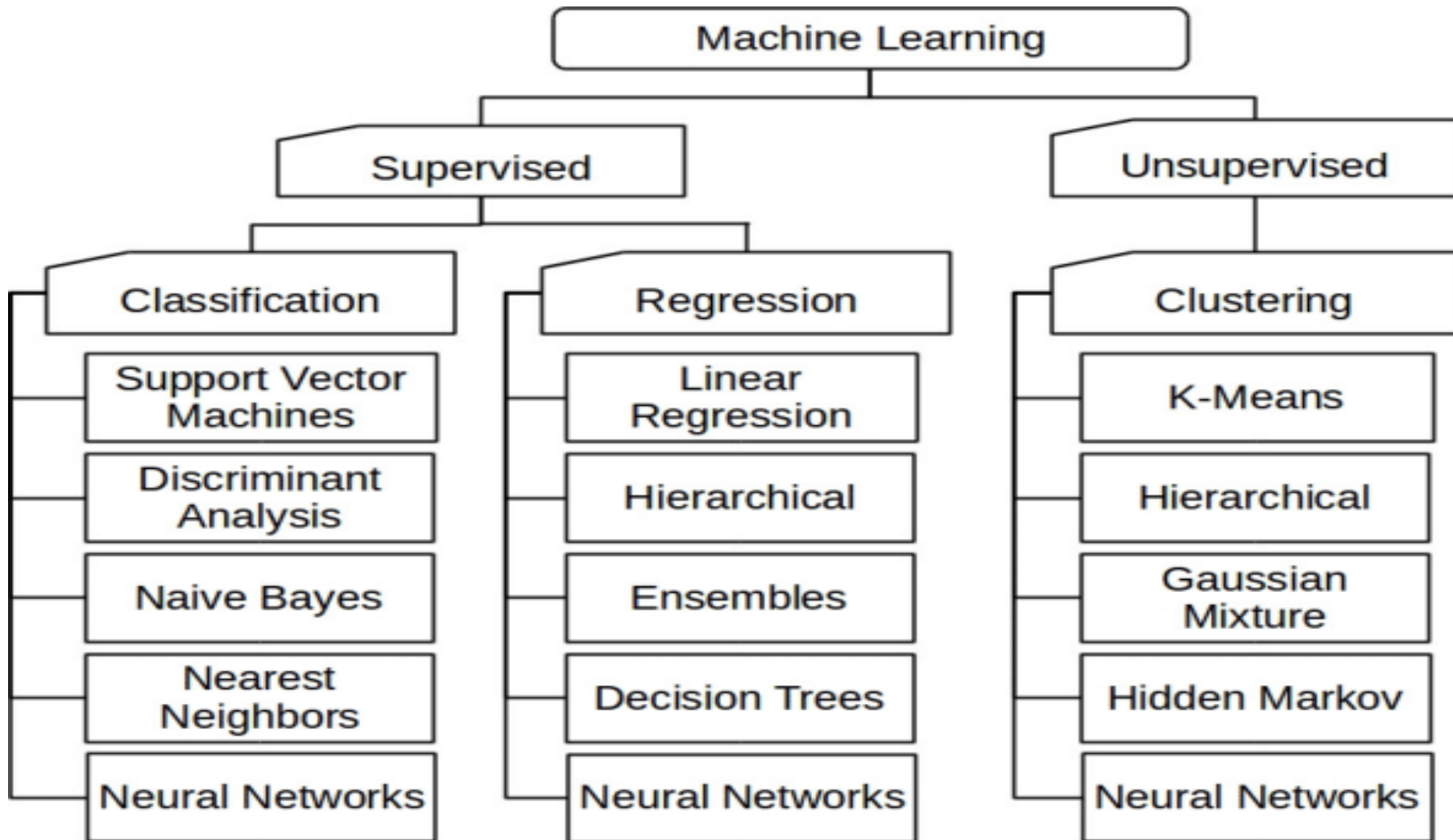


Selecting ML Model for Learning

- Selecting ML model to solve a task depends on the problem, data type, ML style, ML task, depth of learning, etc...



Types of ML Algorithms



Key Issues in ML Model Development

- To solve any problem using machine learning, the first task is to decide whether the problem is a candidate for ML solution.
- Other key issues for the machine learning development are:
 - **Modelling :**
 - How to formulate application problems as ML problem ?
 - How to represent the data?
 - Learning protocols (the source of data and labels)
 - **Representation (function that best separates data):**
 - What functions should we learn (the hypothesis spaces) ?
 - How to map the raw input data to an instance space?
 - Are there any rigorous way to find these?
 - What are the general approach?

Key Issues in ML Model Development

- Cont'd.....
 - Algorithms :
 - What are good algorithms?
 - How do we define success?
 - Generalization vrs. over fitting
 - The computational problem

Application areas and scope of ML

- ML is used in a wide range of applications including :
 - **Web search**: ranking page based on what you are most likely to click on.
 - **Computational biology**: rational design drugs in the computer based on past experiments.
 - **Financial** : decide who to send what credit card offers to. Evaluation of risk on credit offers. Decide where to invest.
 - **E-commerce**: Predicting customer churn. Whether or not a transaction is fraudulent.
 - **Healthcare** : medical diagnosis for disease identification detection or prediction and risk satisfaction.

Application areas and scope of ML

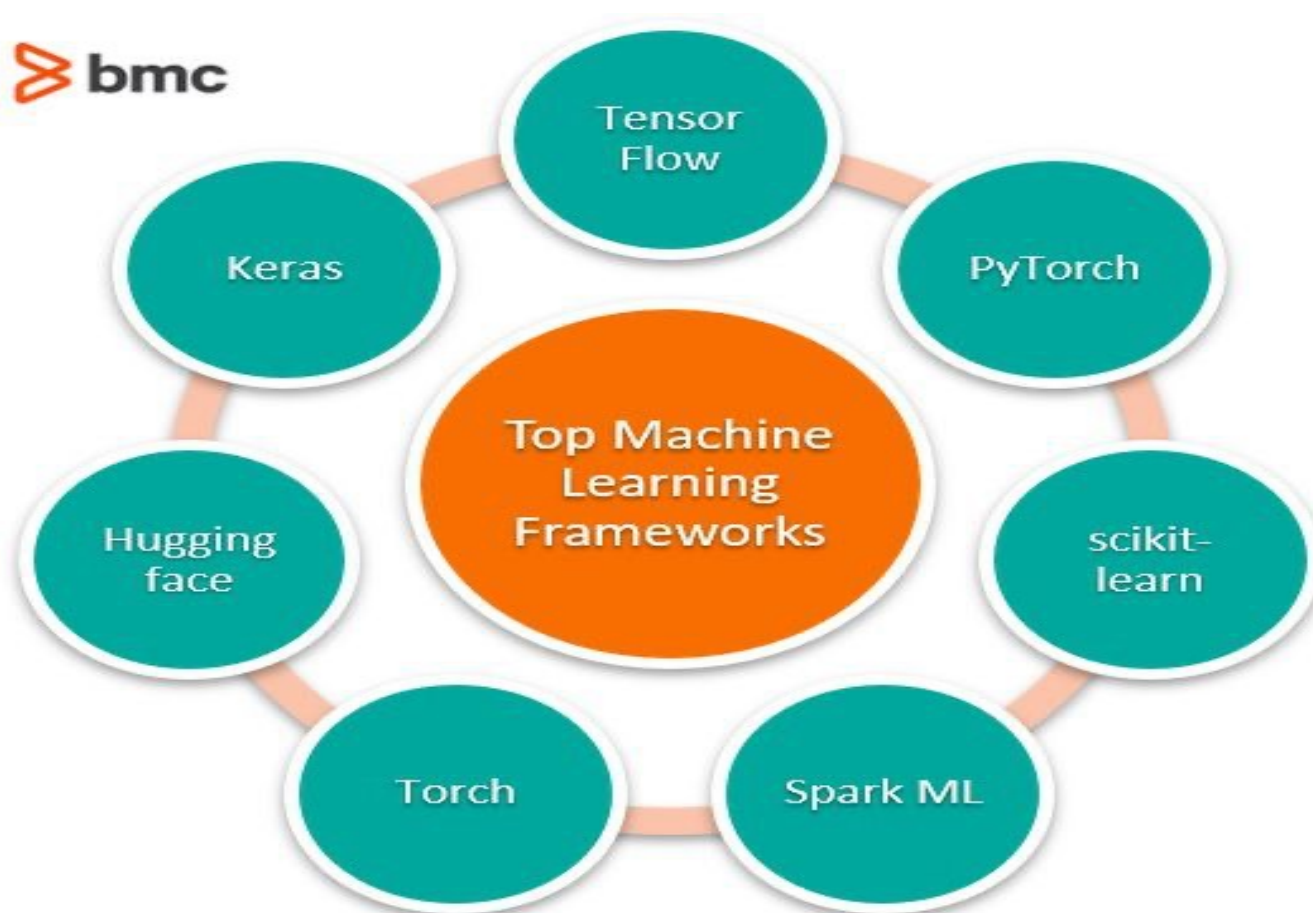
- **Cont'd....**
 - **Space exploration:** space probes and radio astronomy.
 - **Robotics:** how to handle uncertainty in new environments
 - **Autonomous service:** Self-driving car, UAV, drones, etc
 - **Manufacturing :** Predictive maintenance and monitoring
 - **Social networks:** Data on relationships and preferences.
 - **Travel and hospitality :** Dynamic pricing
 - **Customer relationship management:**
 - **Human resource information system:**
 - **Entertainment:**
 - **Business intelligence, Fake news detection, etc..**

ML Model Development Frameworks

- Wide variety of tools for implementing ML models for deployments (embedded hardware or chip such as microchip or mobile/web/cloud service) but commonly used platforms for development :
 - C, C++, Java, or .Net
 - Modern languages and tools that focus specifically on machine learning implementation are:
 - Python >> NumPy, SciPy, Matplotlib,
 - Matlab >> toolboxes for classification, regression, etc
 - R >> libraries for classification, regression, etc
 - SAS >> statistical package for data analysis, etc

ML Model Development Frameworks

- Cont'd.....
- Open-source development framework and tools



Practical ML Application Example 1

- We now explore the Google online ML model development to capture live data acquisition from objects for training and development of models for export to cloud for an application.
- Go to the following link below and for new project, select any of the three project sources for live data acquisition >> image project, audio project or pose project
 - <https://teachablemachine.withgoogle.com/>
- Default is 2-classes but you can add more classes depending on the desired number of output classes for your network
- You can acquire say, 200 samples of data by varying degrees for each class >> for example, if it is apple, you can acquire different views of it to get say, 200 samples.

Practical ML Application Example 1

- **Cont'd...**
- After data acquisition, we proceed to train the network with the data >> select the epoch, learning rate, batch size, data for training and data for testing, and model parameters.
- After the model development, check the model performance for training and testing accuracy >> confusion matrix, error performance measure, etc., (go to “under the hood” on the training menu).
- We can export the developed model to TensorFlow for Native TensorFlow with Python or TensorFlow Lite for Mobile or edgetpu or embedded application, and TensorFlow.js for browser (web, mobile or cloud based) application/project.