

Machine Learning

Prepared by Dr. Yasser Abdelhamid

DS 620
Machine Learning

Lecture 1



OBJECTIVES

- ◉ Understanding why data scientists use machine learning
- ◉ Discussing the process for model building
- ◉ Using machine learning techniques
- ◉ Gaining hands-on experience with machine learning



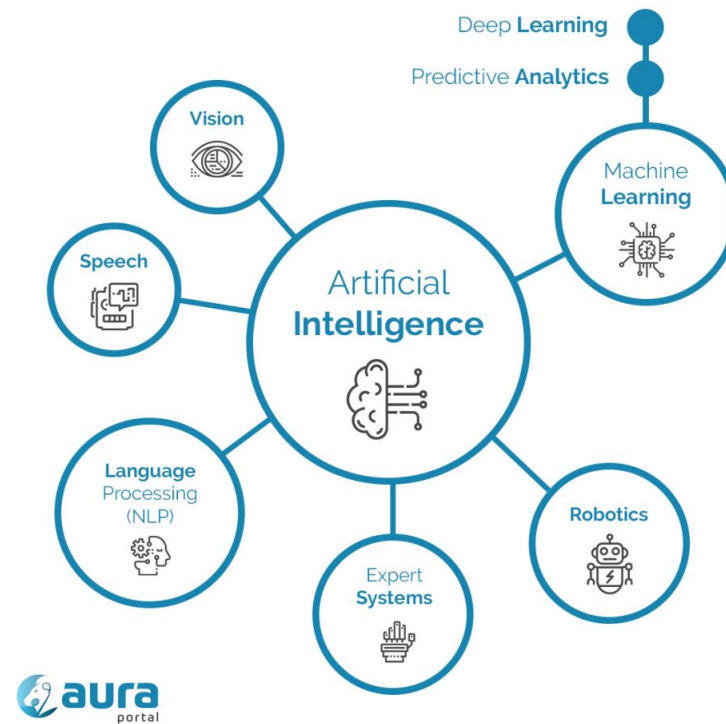
LECTURE OUTLINE

- ◉ Artificial Intelligence & Machine Learning
- ◉ Applications of Machine Learning
- ◉ Types of Machine Learning Systems
- ◉ Supervised vs Unsupervised ML systems
- ◉ Batch vs Online ML systems
- ◉ Instance-based vs Model-based ML systems



ARTIFICIAL INTELLIGENCE

The study of how to make computers do things that people are better at.

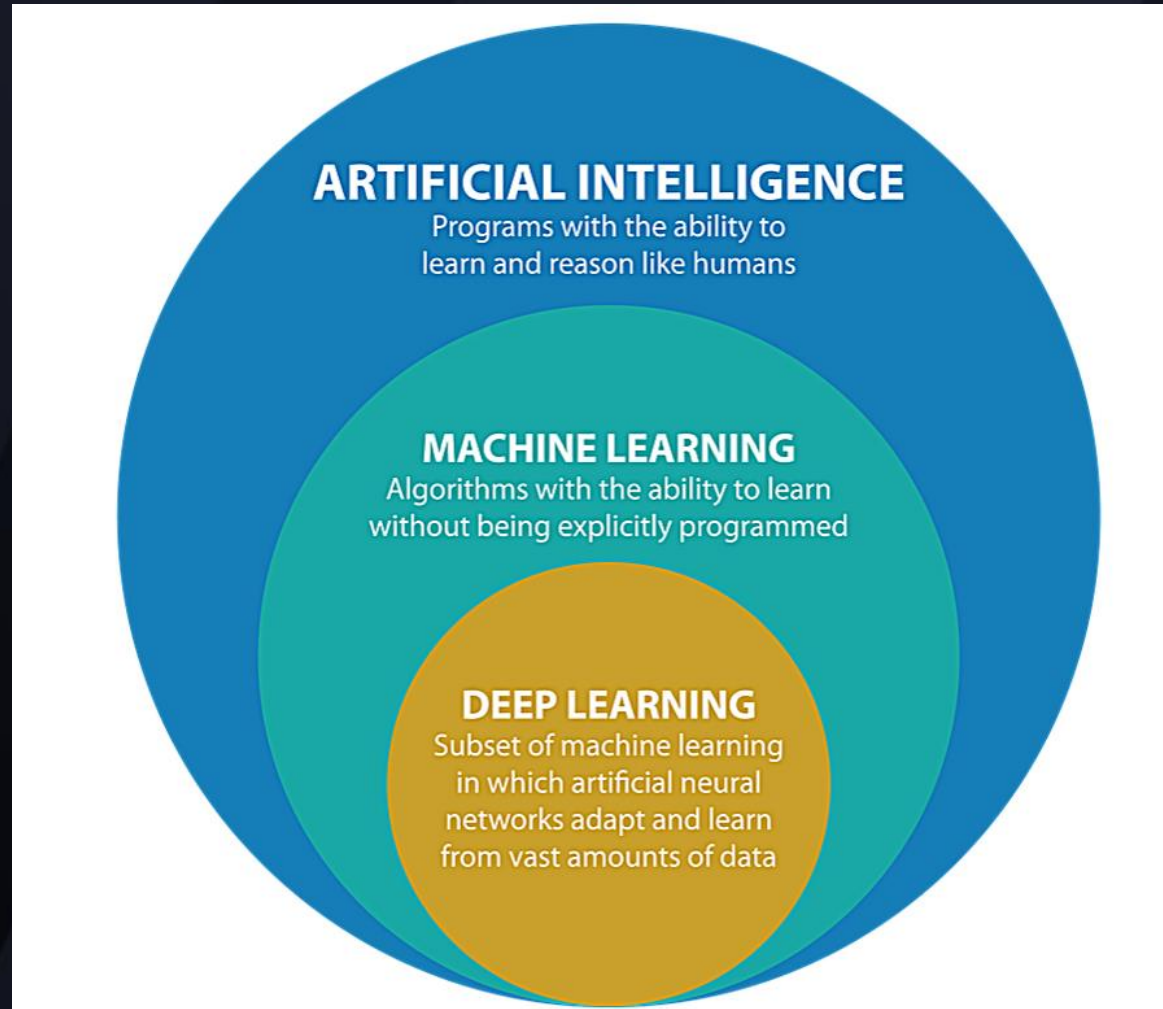


MACHINE LEARNING

- ❖ Machine Learning is the science (and art) of programming computers so they can learn from data.
- ❖ Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed. (Arthur Samuel, 1959)
- ❖ A computer program is said to learn from experience E with respect to some task T and some performance measure P , if its performance on T , as measured by P , improves with experience E . (Tom Mitchell, 1997)



ARTIFICIAL INTELLIGENCE, MACHINE LEARNING, AND DEEP LEARNING



MACHINE LEARNING IS GOOD FOR...

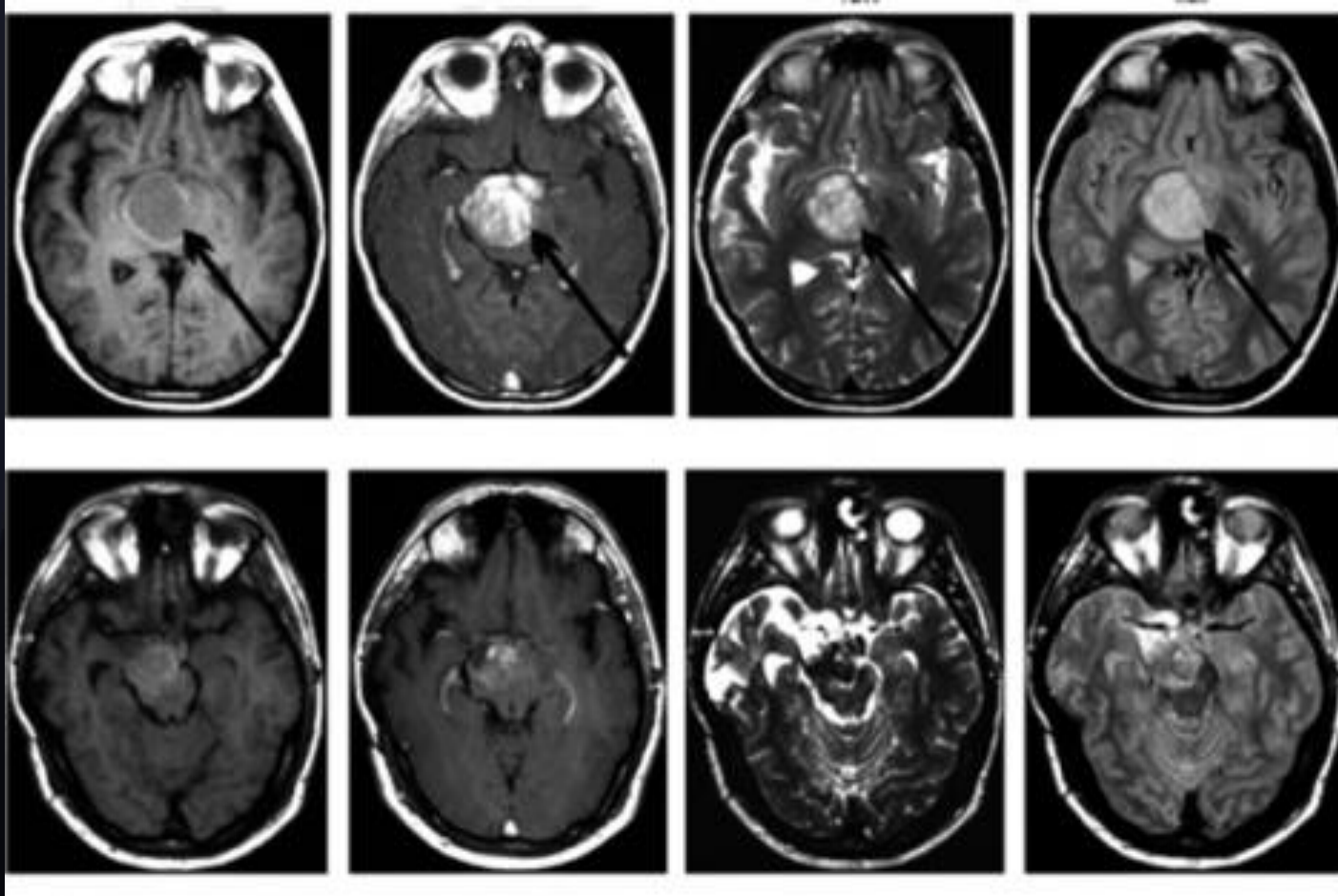
- ❖ Problems for which existing solutions require a lot of fine-tuning or long lists of rules.
- ❖ Complex problems for which using a traditional approach yields no good solution.
- ❖ Fluctuating environments: a Machine Learning system can adapt to new data.
- ❖ Getting insights about complex problems and large amounts of data. (Data Mining)



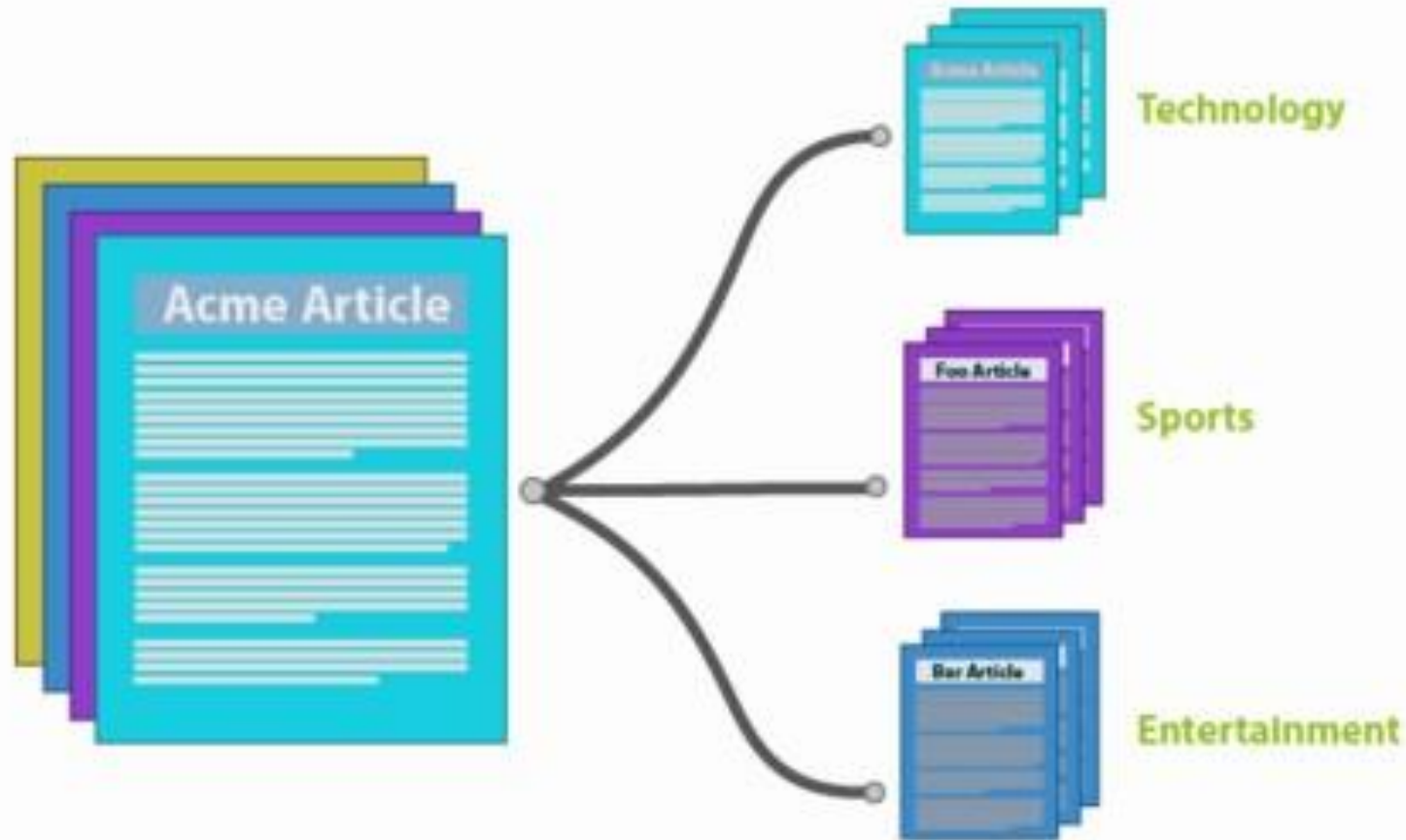
ANALYSING IMAGES OF PRODUCTS ON A PRODUCTION LINE TO AUTOMATICALLY CLASSIFY THEM.



DETECTING TUMORS IN BRAIN SCANS.



AUTOMATICALLY CLASSIFYING NEWS ARTICLES.



SUMMARIZING LONG DOCUMENTS AUTOMATICALLY.

Executive Summary

- Mission of the Company (e.g. Purpose, Unique Selling Points)
- Summary of Market Opportunity (e.g. problem solved/market size/etc.)
- Summary of key aspects of the Company (people, finance)
- Summary of Vision of the Company (5 years horizon)

Company

- Who you are
- Where are you located
- Is it a spin-out or a start-up?
- What stage is your spin-out process? Are you supported by the technology transfer office?
- What you plan to sell
- To whom
- Company structure/ownership (if applicable)
- Any relevant history

Product and Services

- Unique Selling Proposition — what is different about this product or service and what problem does it solve
- Intellectual Property Position — ownership, how it will be protected (patent, trade secret, design right, copyright etc), freedom to operate (results of a patent search)
- Sustainable competitive advantage — what will stop the competition catching up
- List of minimum performance requirements expected by the market place
- Current stage of development and product/service development roadmap

Market Opportunity

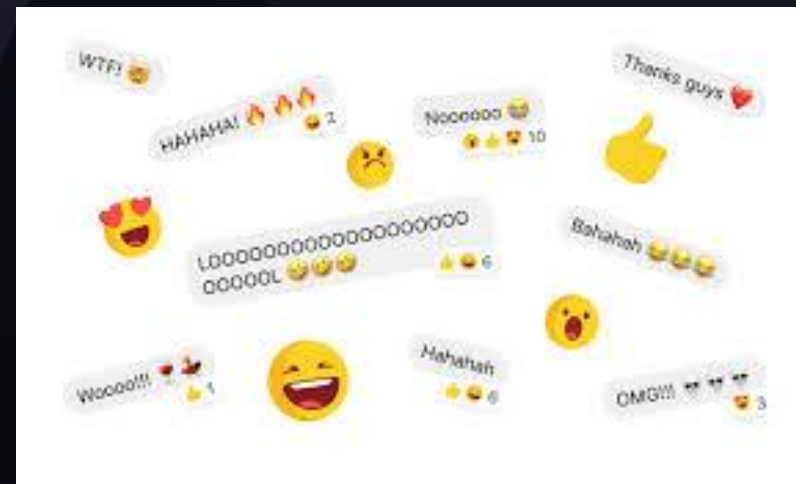
- Estimated size of market and targeted market segments
- Target market share
- Geographical market segment (UK? World-wide?)
- Drivers for change to this product or service - why the status quo is not sustainable
- Key potential customers identified and initial feedback from these on the product or service
- Competitors

Marketing/Sales

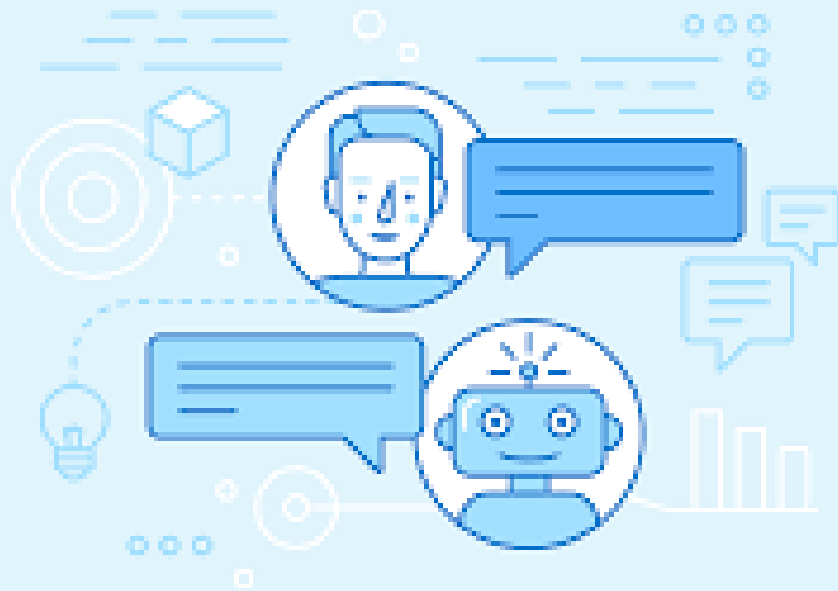
- Route to market
- Barriers to entry
- Pricing: price and profit margin
- Comparison of target price of this product or service with competition, with reasons for any expected differences
- Projected sales volumes and value over first 5 years of operation



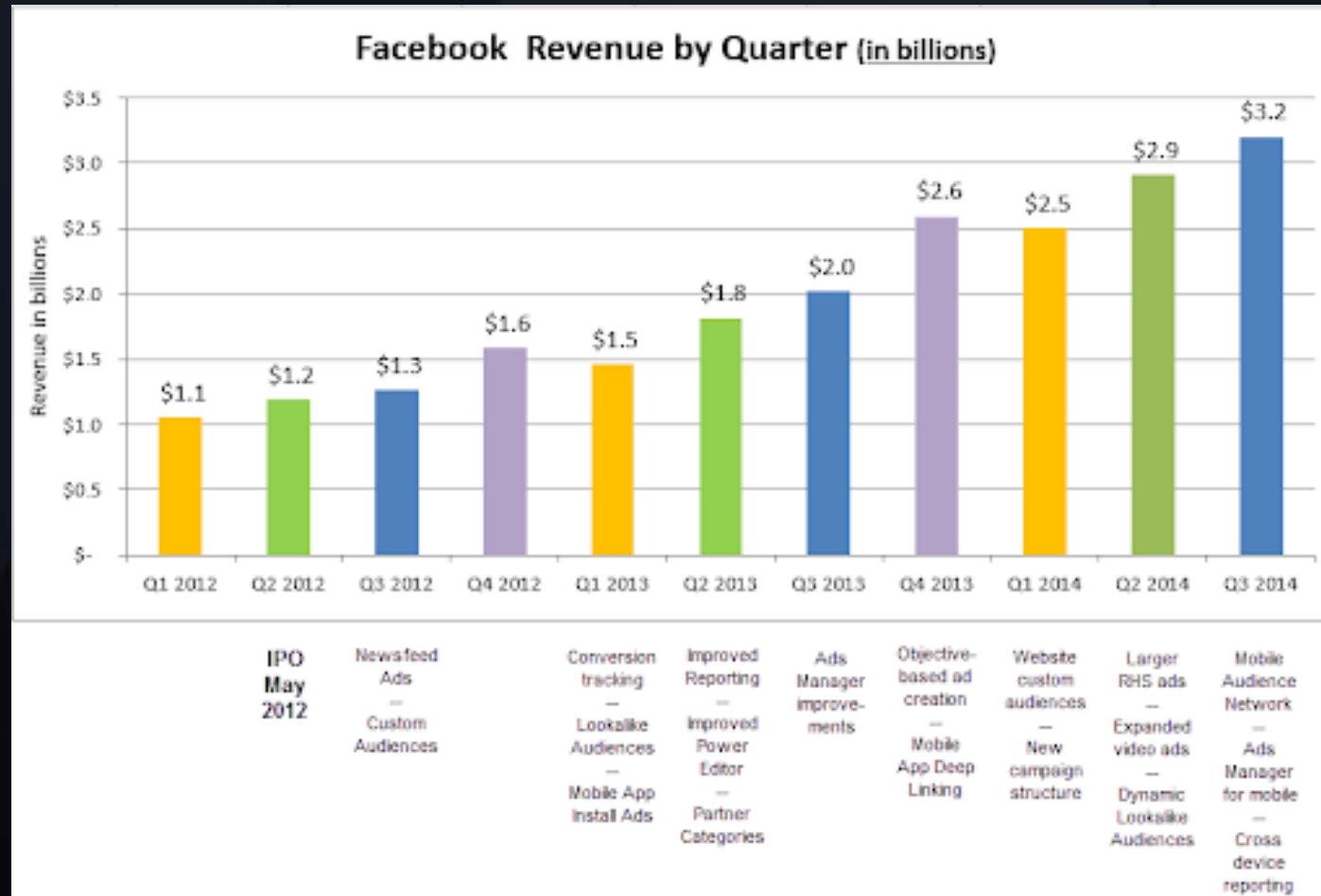
AUTOMATICALLY FLAGGING OFFENSIVE COMMENTS ON DISCUSSION FORUMS.



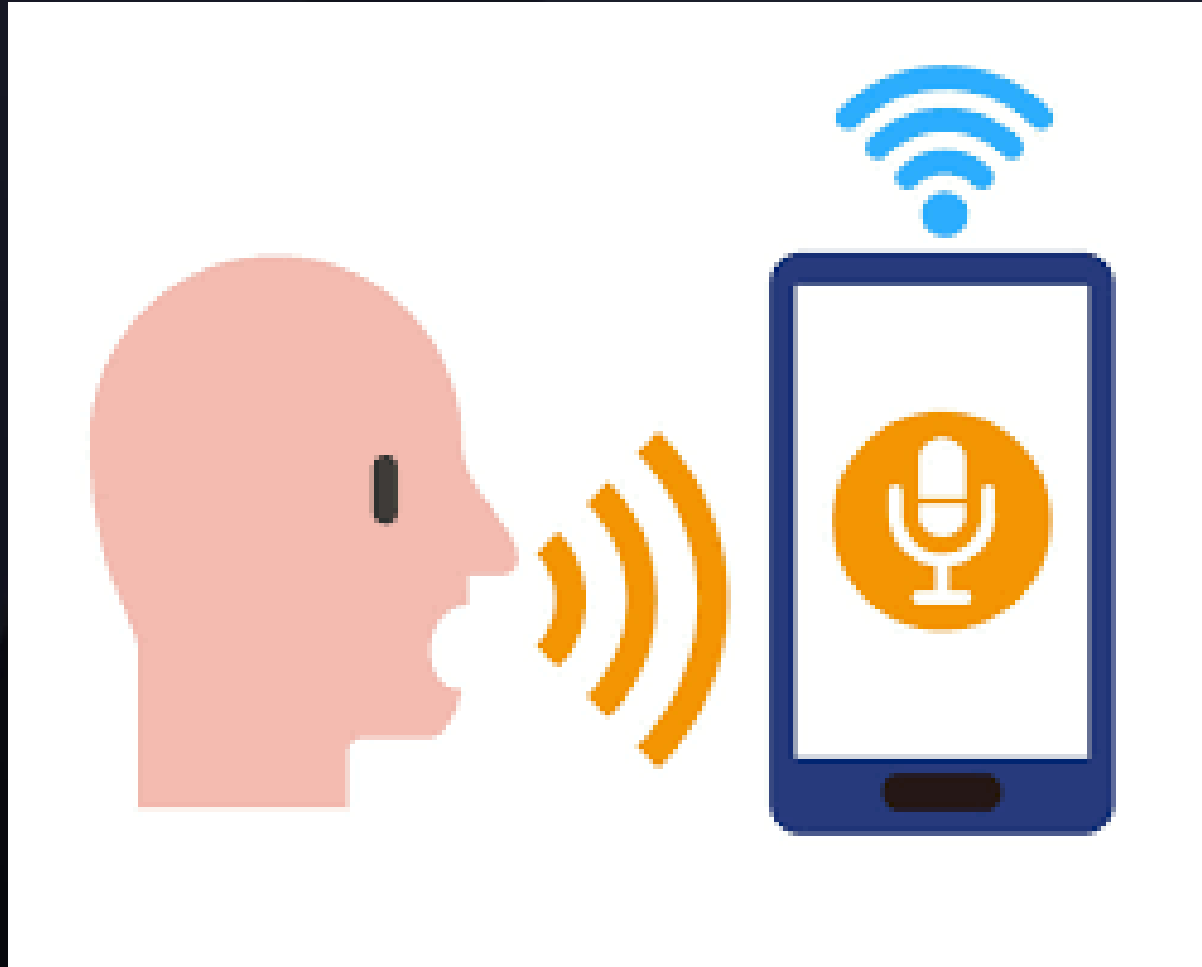
CREATING A CHATBOT OR A PERSONAL ASSISTANT.



FORECASTING YOUR COMPANY'S REVENUE NEXT YEAR, BASED ON MANY PERFORMANCE METRICS.



MAKING YOUR APP REACT TO VOICE COMMANDS.



DETECTING CREDIT CARD FRAUD.



SEGMENTING CLIENTS BASED ON THEIR PURCHASES TO DESIGN DIFFERENT MARKETING STRATEGY FOR EACH SEGMENT.



RECOMMENDING A PRODUCT, BASED ON PAST PURCHASES.

Customers who viewed this item also viewed these products



Dualit Food XL1500
Processor

\$560

 Add to cart



Kenwood kMix Manual
Espresso Machine



\$250

 Select options



Weber One Touch Gold
Premium Charcoal
Grill-57cm

\$225

 Add to cart



NoMU Salt Pepper and
Spice Grinders

\$3

 View options



TYPES OF MACHINE LEARNING SYSTEMS

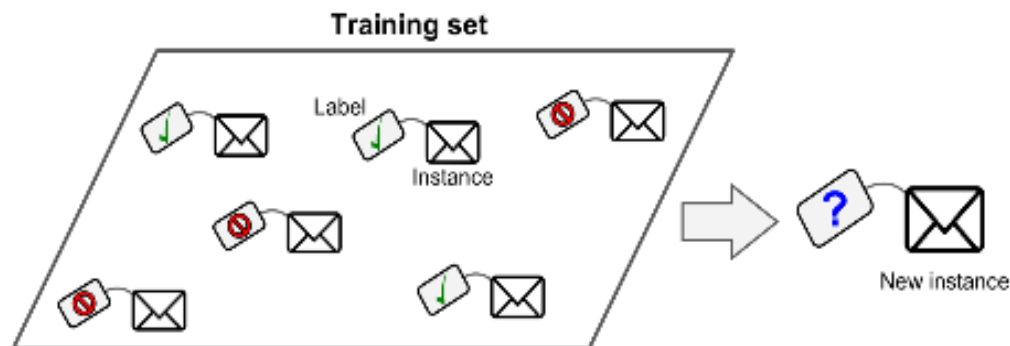
- ❖ Supervised, unsupervised, semi-supervised, and Reinforcement Learning.
- ❖ Online versus batch learning.
- ❖ Instance-based versus model-based learning.



SUPERVISED/UNSUPERVISED LEARNING

❖ Supervised learning

- In supervised learning, the training set you feed to the algorithm includes the desired solutions, called **labels**.
 - Classification
 - Prediction
 - Regression (Prediction of a numeric value)
 - Logistic Regression (probability of belonging to a given class).



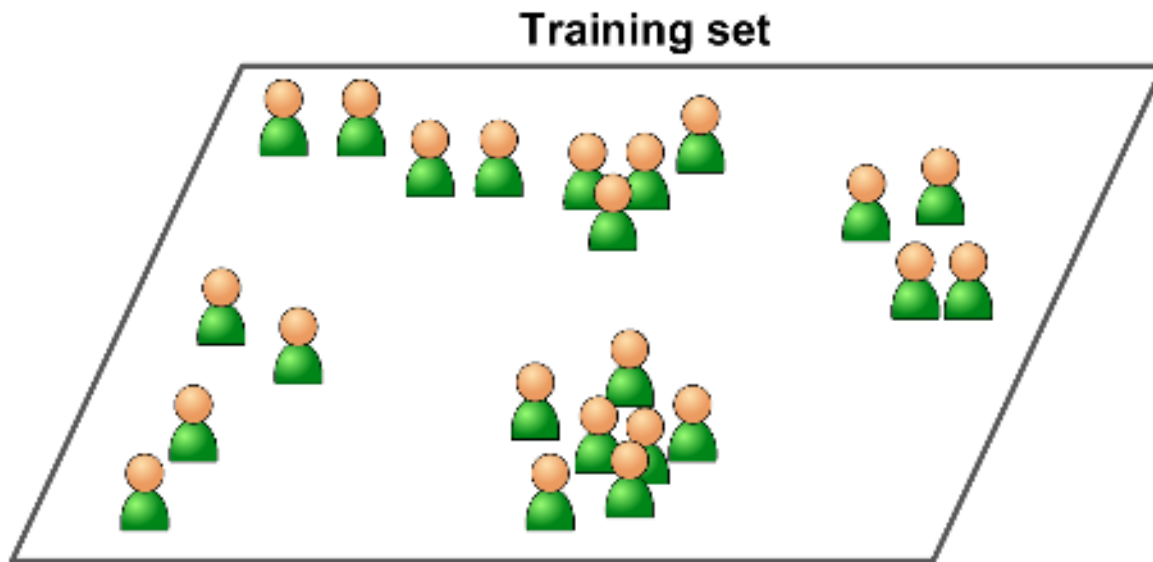
EXAMPLES OF SUPERVISED LEARNING ALGORITHMS

- ❖ k-Nearest Neighbours
- ❖ Linear Regression
- ❖ Logistic Regression
- ❖ Support Vector Machines (SVMs)
- ❖ Decision Trees and Random Forests
- ❖ Neural networks



UNSUPERVISED LEARNING

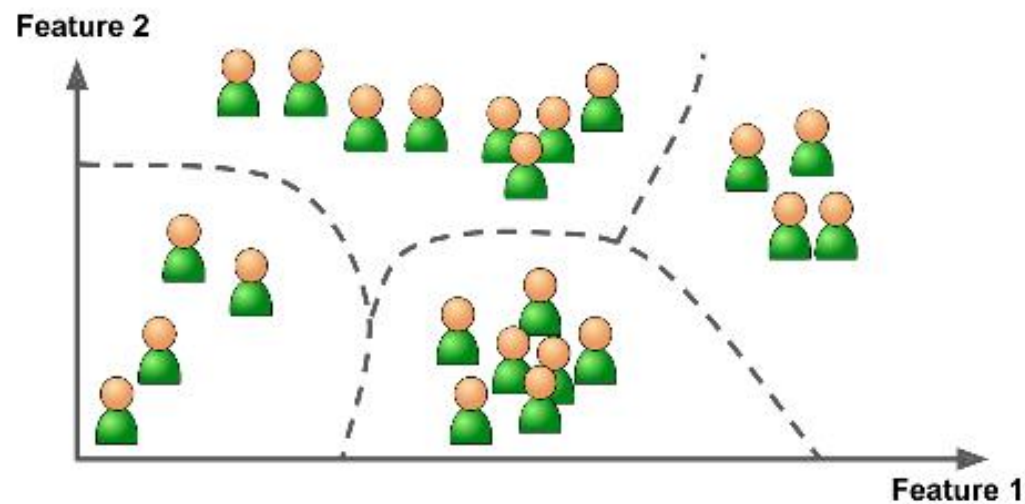
- ❖ In unsupervised learning, the training data is unlabelled. The system tries to learn without a teacher.



UNSUPERVISED LEARNING ALGORITHMS

❖ Clustering

- K-Means
- DBSCAN
- Hierarchical Cluster Analysis (HCA)



UNSUPERVISED LEARNING ALGORITHMS (CONT.)

❖ Anomaly detection and novelty detection

- One-class SVM
- Isolation Forest



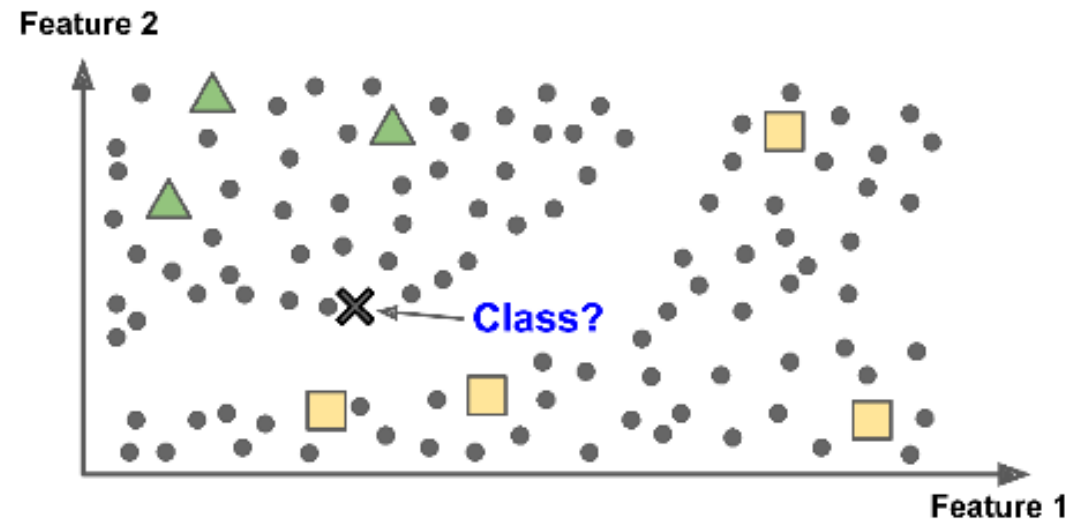
VISUALIZATION AND DIMENSIONALITY REDUCTION UNSUPERVISED LEARNING ALGORITHMS

- ❖ Visualization refers to the process of representing and presenting the patterns, structures, or relationships discovered in unlabeled data in a visual format.
- ❖ Dimensionality reduction refers to the process of reducing the number of input features or variables in a dataset while preserving the essential information or structure of the data. It aims to overcome the curse of dimensionality, where high-dimensional data can lead to computational challenges, increased complexity, and decreased model performance.
 - Principal Component Analysis (PCA)
 - Kernel PCA
 - Locally Linear Embedding (LLE)
 - t-Distributed Stochastic Neighbour Embedding (t-SNE)



SEMI-SUPERVISED LEARNING

- ❖ Can deal with data that's partially labelled.
- ❖ Most semi-supervised learning algorithms are combinations of unsupervised and supervised algorithms.



REINFORCEMENT LEARNING

- ❖ An agent, can observe the environment, select and perform actions, and get rewards in return (or penalties in the form of negative rewards).
- ❖ It learns by itself what is the best strategy, called a **policy**, to get the most reward over time.
- ❖ A policy defines what action the agent should choose when it is in a given situation.



BATCH AND ONLINE LEARNING

- ❖ Another criterion used to classify Machine Learning systems is whether or not the system can learn incrementally from a stream of incoming data.



BATCH LEARNING

- ❖ In batch learning, the system is incapable of learning incrementally: it must be trained using all the available data.
 - Not suitable for huge and rapidly changing data.



ONLINE LEARNING

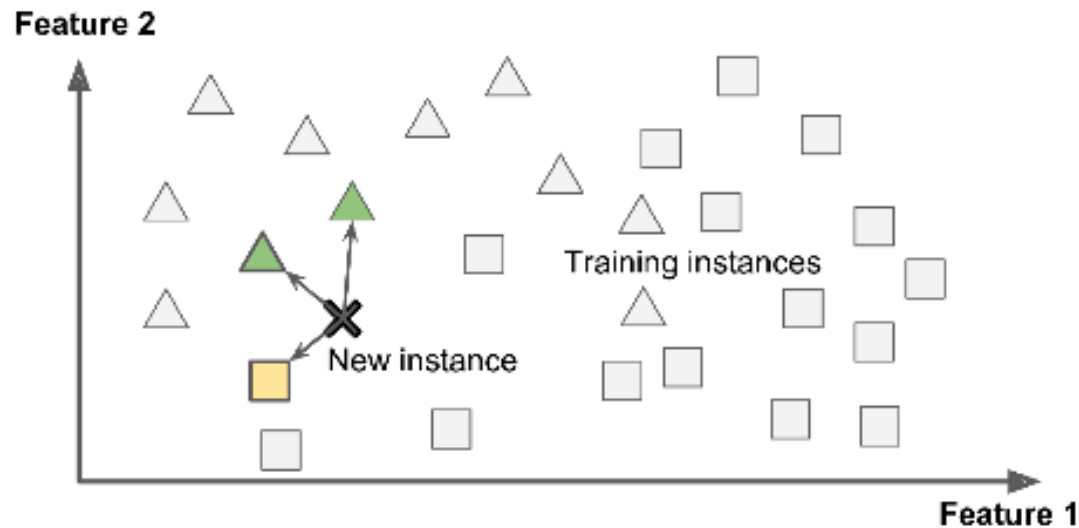
- ❖ In online learning, you train the system incrementally by feeding it data instances sequentially, either individually or in small groups called **mini-batches**.
- ❖ Great for systems that receive data as a continuous flow (e.g., stock prices) and need to adapt to change rapidly or autonomously.
- ❖ Can also be used to train systems on huge datasets that cannot fit in one machine's main memory (**out-of-core** learning).



INSTANCE-BASED VERSUS MODEL-BASED LEARNING

❖ Instance-based learning

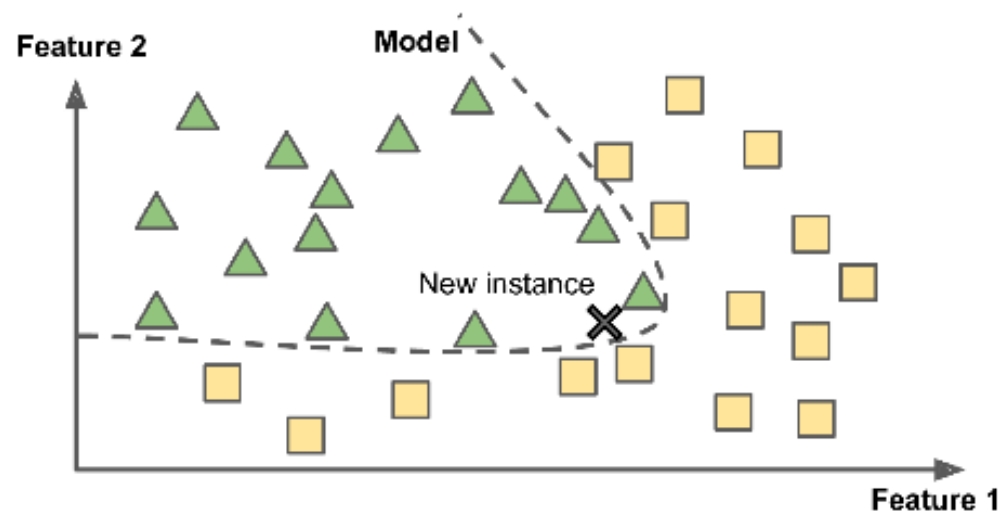
- The system generalizes to new cases by using a similarity measure to compare them to the learned examples



INSTANCE-BASED VERSUS MODEL-BASED LEARNING

❖ Model-based learning

- The system generalizes from a set of examples by building a model of these examples and then using that model to make predictions.



SUMMARY

- ❖ Artificial Intelligence
- ❖ Machine Learning
- ❖ What applications Machine Learning is suitable for
- ❖ Examples of machine learning applications
- ❖ Types of Machine Learning Systems
- ❖ Supervised vs Unsupervised ML systems
- ❖ Batch vs Online ML systems
- ❖ Instance-based vs Model-based ML systems





مجموعة جامعة
الجميع الذكية
للتعليم القابضة

MIDOCEAN
UNIVERSITY
BY EVERYONE'S SMART UNIVERSITY



Thank You

