

UNSUPERVISED MACHINE LEARNING

IBRAHIM RADWAN

OUTLINE

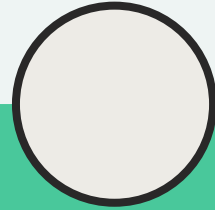
- What is Machine Learning?
- Types of Machine Learning
- Why Unsupervised Machine Learning?
- Contents of the Subject
- Resources
- Tools
- Assessments

WHAT IS MACHINE LEARNING?



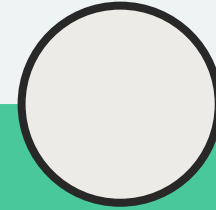
- Machine learning is a subset of AI that focuses on developing algorithms and models that enable computers to learn from and make predictions or decisions based on data.
- It's a key driver of AI applications, including natural language processing, image recognition, and recommendation systems.

CASE STUDIES



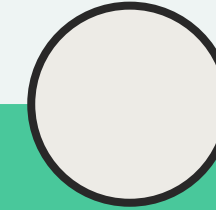
HEALTHCARE

**Predicting Disease
Outcomes**



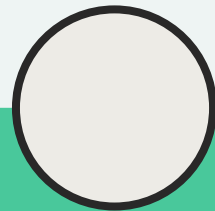
FINANCE

**Algorithmic
Securities Trading**



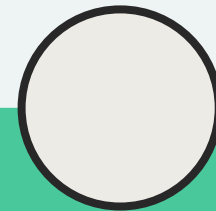
RETAIL

**Personalized
Recommendations &
Cart Management**



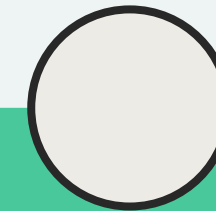
MANUFACTURING

**Predictive Tools
Maintenance**



TRANSPORTATION

**Autonomous
Vehicles (Hybrid)**



ENERGY

**Energy Consumption
Optimization**

REAL WORLD APPLICATIONS

2025

Radiologists and healthcare professionals employed deep learning algorithms to analyze medical images such as X-rays, MRIs, and CT scans.

2030

An educational platform uses AI to provide personalized learning experiences for students as well as assessments suited to learnings.

2035

A smart grid system utilized AI to optimize energy consumption in urban areas. The system adjusted energy distribution to reduce waste and costs.

2040

By using natural language processing, the chatbot understood and responded to customer queries reducing response times.

TYPES OF MACHINE LEARNING

Supervised Learning

- The machine “learns” from the training data set {(Input Data, Labels)}
- It requires upfront human intervention to **label** the data appropriately
- For example, weather condition prediction, object detection, etc.

Unsupervised Learning

- The machine “discovers” the inherent structure of **unlabelled** data {(Input Data)}
- It requires some human intervention for validating output variables
- For example, discovering online shoppers’ habits, etc.

Reinforcement Learning

- RL involves learning through experience
- In RL, an agent learns to achieve a goal in an uncertain, potentially complex environment by **performing actions and receiving feedback** through rewards or penalties
- RL mimics the try-and-error learning process
- For example, chess game

WHY UNSUPERVISED MACHINE LEARNING?



- **Unsupervised learning** is where we have only input data $\{(\mathbf{x})\}$, and correspond output variable $\{(\mathbf{y})\}$
- The goal is to model the underlying structure or distribution of the data to learn more about the data
- It is unsupervised, as there is no correct answer to guide the learning process of how to discover the structure of the data
- Unsupervised learning techniques can be further grouped into:
 - *Clustering*: it is where we try to discover the inherent grouping in the data, such as grouping customers based on shopping habits
 - *Association*: It is where the focus is on building mining rules to describe data structures, such as people that buy X products tend to buy Y products

WHY UNSUPERVISED MACHINE LEARNING?



- **A Scenario:** Imagine arriving on Earth with no cooking knowledge, given 100 days, a stove, and a fridge full of food, but without instructions on cooking.
- **Exploration Process:** Over time, random trial and error may lead you to discover how to use the kitchen tools and eventually make an edible meal.
- **Challenges of Random Exploration:** The lack of structured information leads to noisy, irrelevant data and a long, inefficient learning process.
- **Role of Unsupervised Learning:** By reviewing data from the 100 days, unsupervised learning (e.g., clustering) can identify patterns on the days, where you successfully made meals.
- **Potential Insight:** Clustering can help recognise what worked on certain days, allowing you to learn from those patterns.
- **Limitations of Clustering:** Unsupervised learning may still group irrelevant or unhelpful data together, making it not a perfect solution.
- **Benefit of Using Unsupervised Learning:** Despite limitations, it helps identify useful patterns in otherwise chaotic data, making the process more efficient.

CONTENTS OF THE UNIT

Clustering

Dimensionality Reduction

Association Rules

AutoEncoder

RESOURCE PAGE

Recommended Books

- Hands On Unsupervised Learning With Python, Giuseppe Bonaccorso, ([Link to Download](#))
- Applied Unsupervised Learning with Python, Benjamin Johnston, Aaron Jones, and Christopher Kruger ([Link to Download](#))

Practical Activities:

- <https://github.com/aapatel09/handson-unsupervised-learning>
- <https://github.com/TrainingByPackt/Applied-Unsupervised-Learning-with-Python>

TOOLS

The following tools are required to be installed on your computer, if possible:

- VSCode (<https://code.visualstudio.com/download>)
- Python (can be installed as an extension from VSCode)
- Jupyter Notebook (can be installed as an extension from VSCode)
- Git (<https://git-scm.com/downloads>)
- Create an account on [www.GitHub.com](https://www.github.com)

ASSESSMENT

Type: Project-based

Group Size: Individual or 3–5 members

GitHub Repo: Upload all code & documentation organised into separate files

Tasks:

- Clustering
- Dimensionality Reduction
- Association Rules
- Autoencoders

Requirements:

- Document all steps clearly
- Explain methods & results
- Organize everything in GitHub

Evaluation: Based on correct implementation, clarity, and insights

Q&A