



الجامعة السورية الخاصة  
SYRIAN PRIVATE UNIVERSITY

المحاضرة الأولى

كلية الهندسة المعلوماتية

مقرر مدخل إلى تعلم الآلة

# مقدمة إلى تعلم الآلة Introduction to Machine Learning

د. رياض سنبل

# Course Details

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- **Course Code:** CIEC.6.03
- **Course Title:** Introduction to Machine Learning
- **Credits:** 3 ECTS (2 Lectures & 2 Practical Sessions per week)
- **Course Staff:** Dr. Riad Sonbol, Eng. Anas Abdulaziz
- **Grading:**
  - 15% Test 1
  - 15% Test 2
  - 20% Practical Sessions, Assignments, etc.
  - 50% Final Exam

# Outline of the course

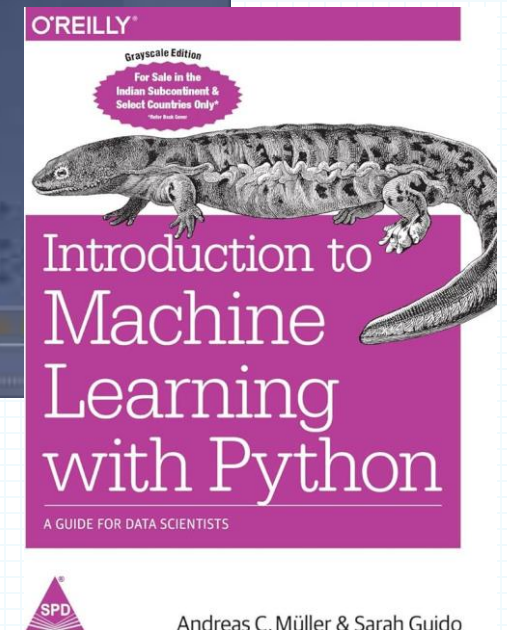
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- **The course covers the following core topics:**
  1. An overview of machine learning systems, their methods, and applications.
  2. Learning using decision trees.
  3. Feature engineering.
  4. Training strategies and evaluation criteria.
  5. Selected machine learning algorithms: Naïve Bayes, KNN, SVM.

# Outline of the course

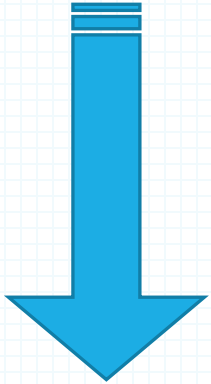
- **Textbooks:**

- *Lindholm, A., Wahlström, N., Lindsten, F. and Schön, T.B., 2022. Machine learning: a first course for engineers and scientists. Cambridge University Press.*
- *Mitchell, T.M., 1997. Machine learning. McGraw Hill.*
- *Müller, A.C. and Guido, S., 2016. Introduction to machine learning with Python: a guide for data scientists. " O'Reilly Media, Inc."*



# Why we need Machine Learning?

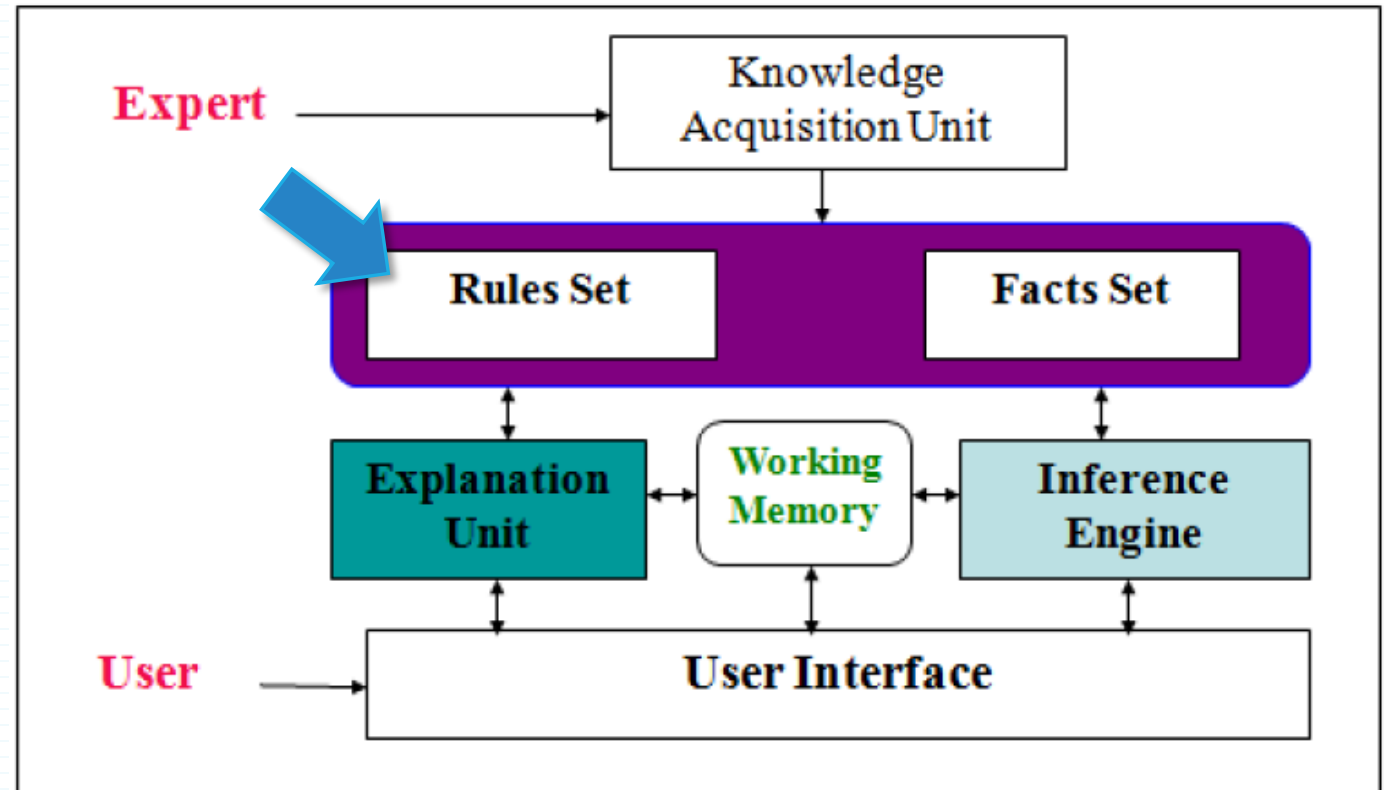
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- Traditional Algorithms
- Heuristics, A\* algorithms, approximate algorithms
- Expert Systems
- Machine Learning

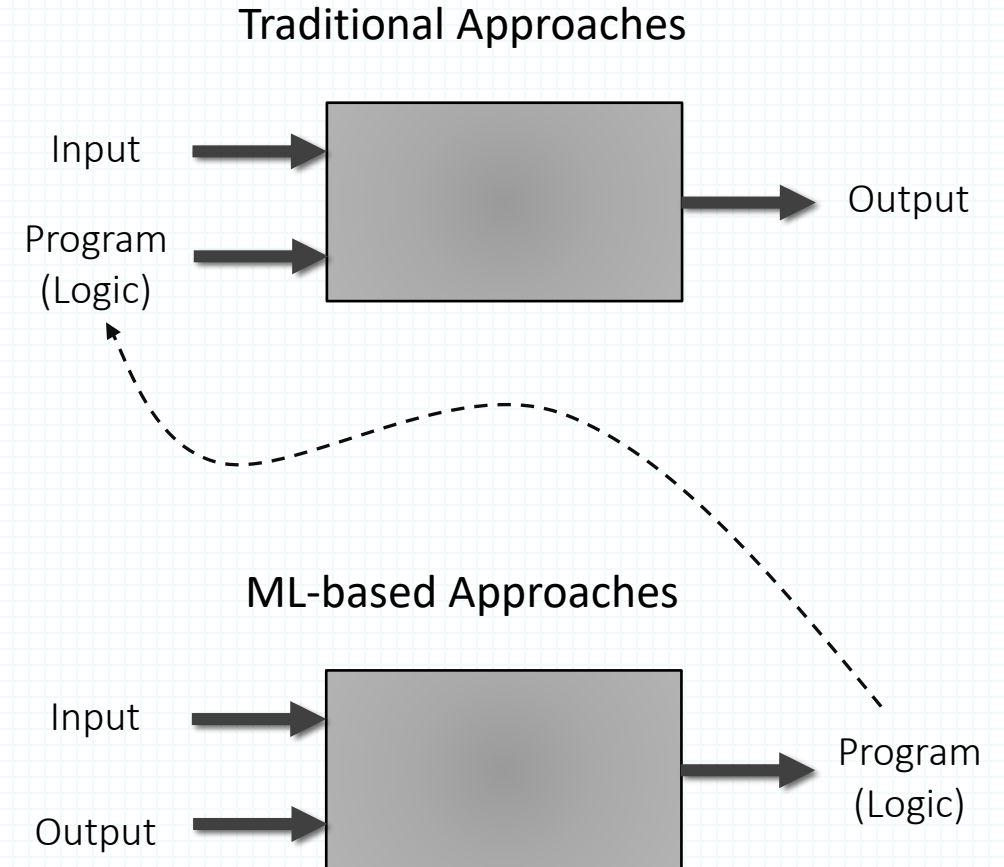
# Expert Systems (النظم الخبيرة): A quick revision

- An expert system generally consists of four components:
  - **Knowledge base (Rules)**
  - Search or inference system,
  - Knowledge acquisition system,
  - User interface or communication system.



# What is Machine Learning?

- Machine Learning is a type of Artificial Intelligence that provides computers with the ability to learn
- Getting computers to program themselves



# Machine Learning $\approx$ Looking for a Function

- Speech Recognition

$$f(\text{audio waveform}) = \text{"How are you"}$$

- Image Recognition

$$f(\text{cat image}) = \text{"Cat"}$$

- Playing Go

$$f(\text{Go board state}) = \text{"5-5" (next move)}$$

- Dialogue System

$$f(\text{"Hi" (what the user said)}) = \text{"Hello" (system response)}$$

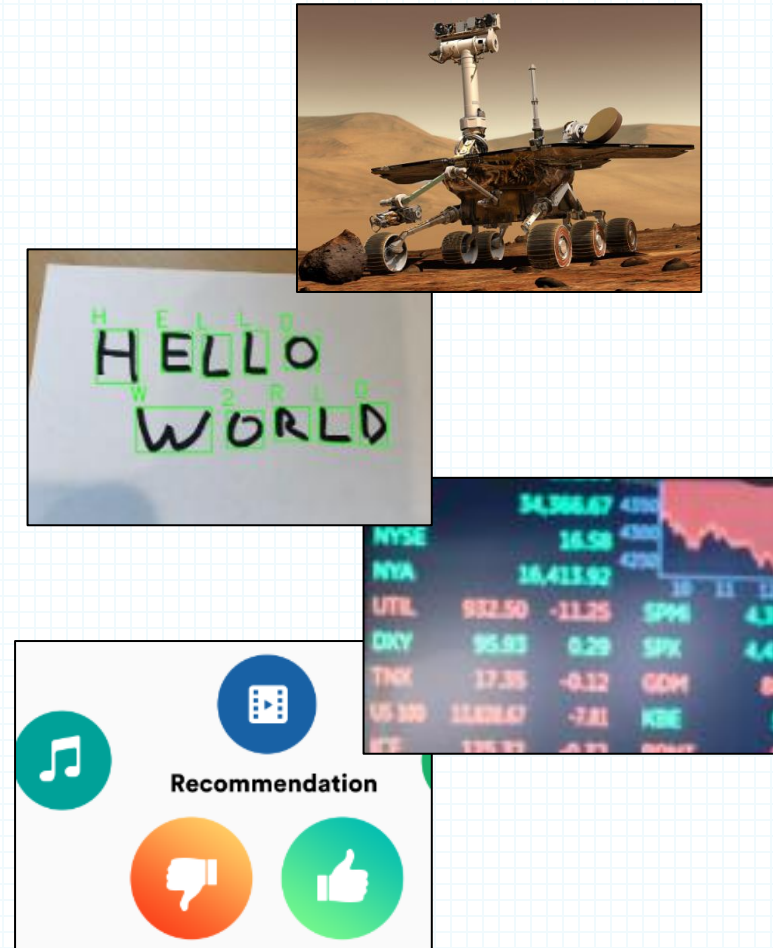
# When Do We Use Machine Learning?

- **ML is used when:**

- Human **expertise does not exist** (navigating on Mars),
- Humans are **unable to explain** their expertise (speech recognition, OCR)
- Solution **changes in time** (routing on a computer network, stock market)
- Solution needs to be **adapted to particular cases** (recommendation systems)

- **Learning is not always useful:**

- There is no need to “learn” to calculate payroll.



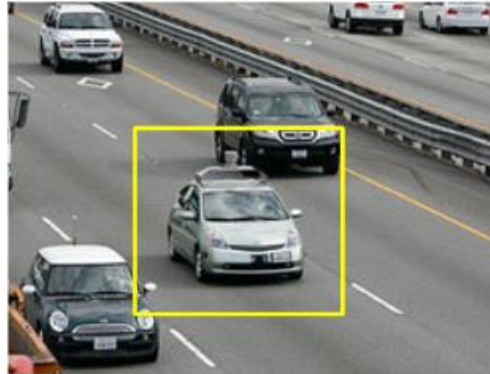
# Common ML Applications

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- Recognizing patterns:
  - Facial identities or facial expressions.
  - Handwritten or spoken words.
  - Medical images.
  - Sentiment Analysis.
- Generating patterns:
  - Generating images or motion sequences.
  - Articles generation.
- Recognizing anomalies:
  - Unusual credit card transactions
- Prediction:
  - Future stock prices or currency exchange rates
- Web search
- Computational biology
- Finance
- E-commerce
- Space exploration
- Robotics
- Information extraction
- Social networks
- Debugging

# More advanced Applications

## Autonomous Cars



- Nevada made it legal for autonomous cars to drive on roads in June 2011
- As of 2013, four states (Nevada, Florida, California, and Michigan) have legalized autonomous cars

Penn's Autonomous Car →  
(Ben Franklin Racing Team)

## Scene Labeling via Deep Learning



[Farabet et al. ICML 2012, PAMI 2013]

# Types of Learning

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- **Supervised (inductive) learning (التعلم المشرف عليه):** Training data **includes** desired outputs
  - Regression: predict numerical values
  - Classification: predict categorical values, i.e., labels
- **Unsupervised learning (التعلم غير المشرف عليه):** Training data does **not include** desired outputs
  - Clustering: group data according to "distance"
  - Association: find frequent co-occurrences
  - Link prediction: discover relationships in data
  - Data reduction: project features to fewer features
- **Semi-supervised learning**
  - Training data **includes a few** desired outputs
- **Reinforcement learning (التعلم المعزز)**
  - Learn to act based on **feedback/reward**.

# Supervised Learning Techniques

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- **Numerical classifier functions**

- Linear classifier, perceptron, logistic regression, support vector machines (SVM), neural networks

- **Parametric (probabilistic) functions**

- Naïve Bayes, Gaussian discriminant analysis (GDA), hidden Markov models (HMM), probabilistic graphical models

- **Non-parametric (instance-based) functions**

- $k$ -nearest neighbors, kernel regression, kernel density estimation, local regression

- **Symbolic functions**

- Decision trees, classification and regression trees (CART)

- **Aggregation (ensemble) learning**

- Bagging, boosting (Adaboost), random forest

# Traditional ML Pipeline

