الجامعة السورية الخاصة
SYRIAN PRIVATE UNIVERSITY

مقرر مدخل إلى تعلم الآلة	كلية الهندسة المعلوماتية	المحاضرة الأولى

مقدمة إلى تعلم الآلة
Introduction to Machine Learning

د. رياض سنبل

Course Details

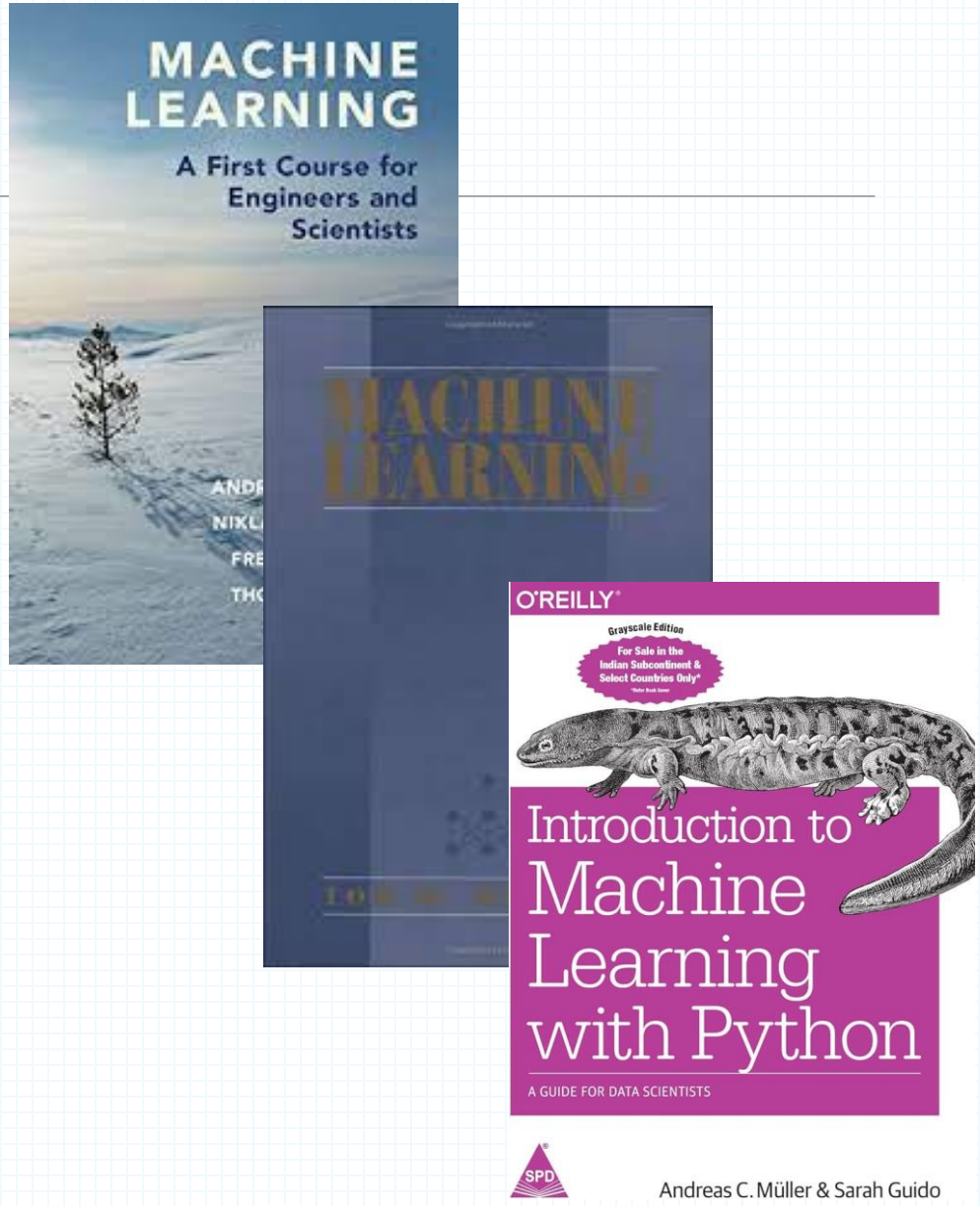
- **Course Title:** Introduction to Machine Learning
- **Credits:** 3 ECTS (2 Lectures & 2 Practical Sessions per week)
- **Course Staff:** Dr. Riad Sonbol, Eng. Aya Alassoad
- **Grading:**
  - 15% Test 1
  - 15% Test 2
  - 20% Practical Sessions, Assignments, etc.
  - 50% Final Exam

Outline of the course

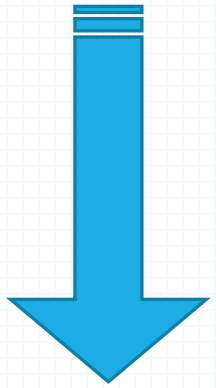
- **The course covers the following core topics:**
  1. An overview of machine learning systems, their methods, and applications.
  2. Learning using decision trees.
  3. Feature engineering.
  4. Training strategies and evaluation criteria.
  5. Selected machine learning algorithms: Naïve Bayes, KNN,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



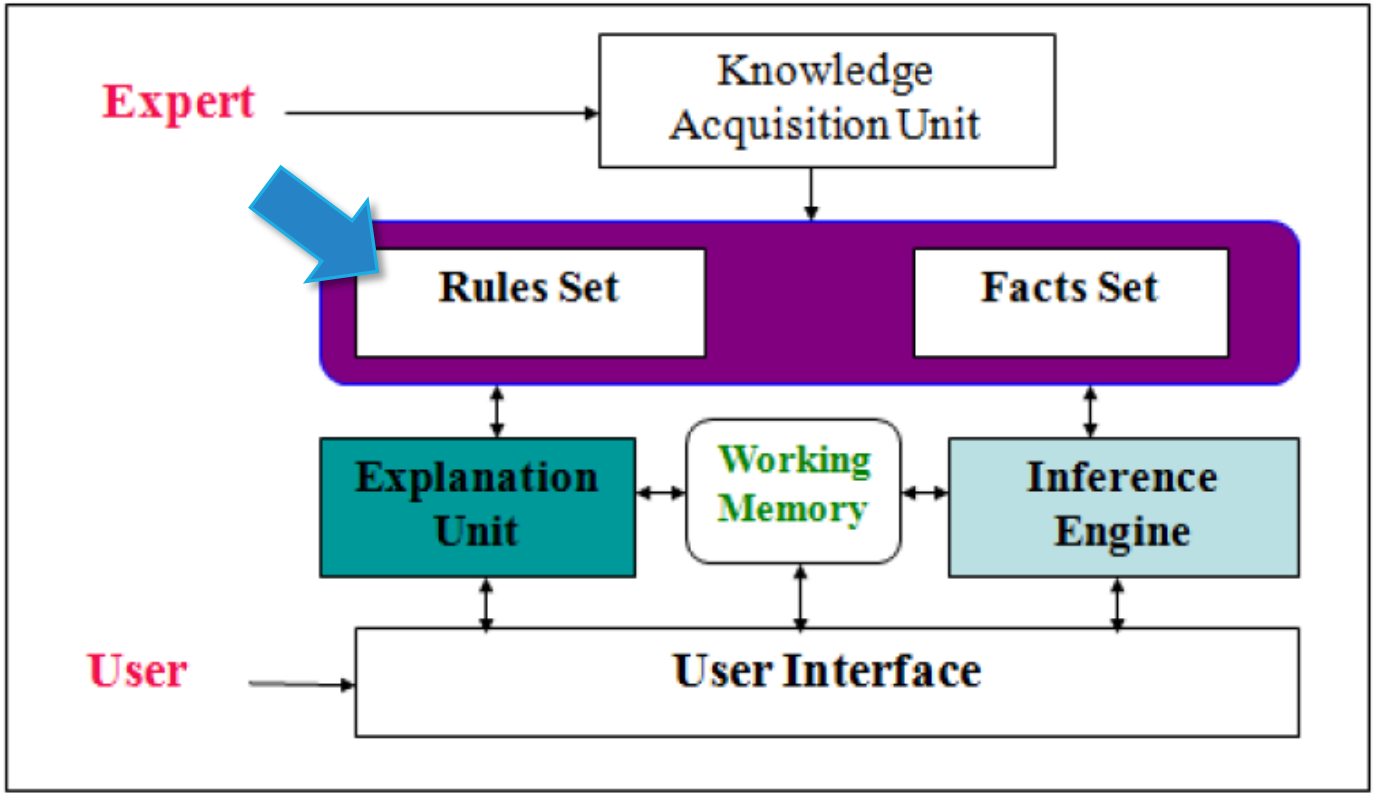
Why we need Machine Learning?



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

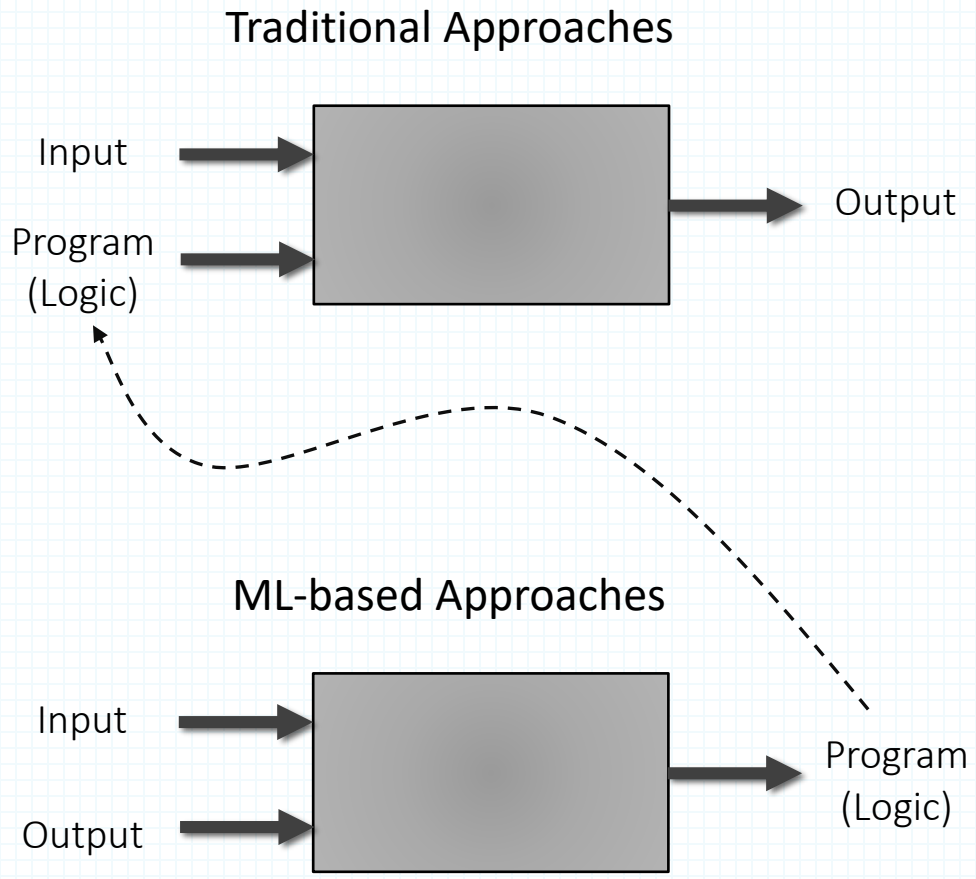
Expert Systems (النظم الخبيرة): A quick revision

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



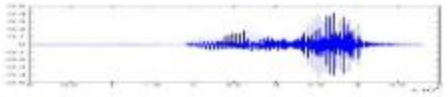
What is Machine Learning?

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



Machine Learning ≈ Looking for a Function

- Speech Recognition

$f($  $) =$ “How are you”

- Image Recognition

$f($  $) =$ “Cat”

- Playing Go

$f($  $) =$ “5-5” (next move)

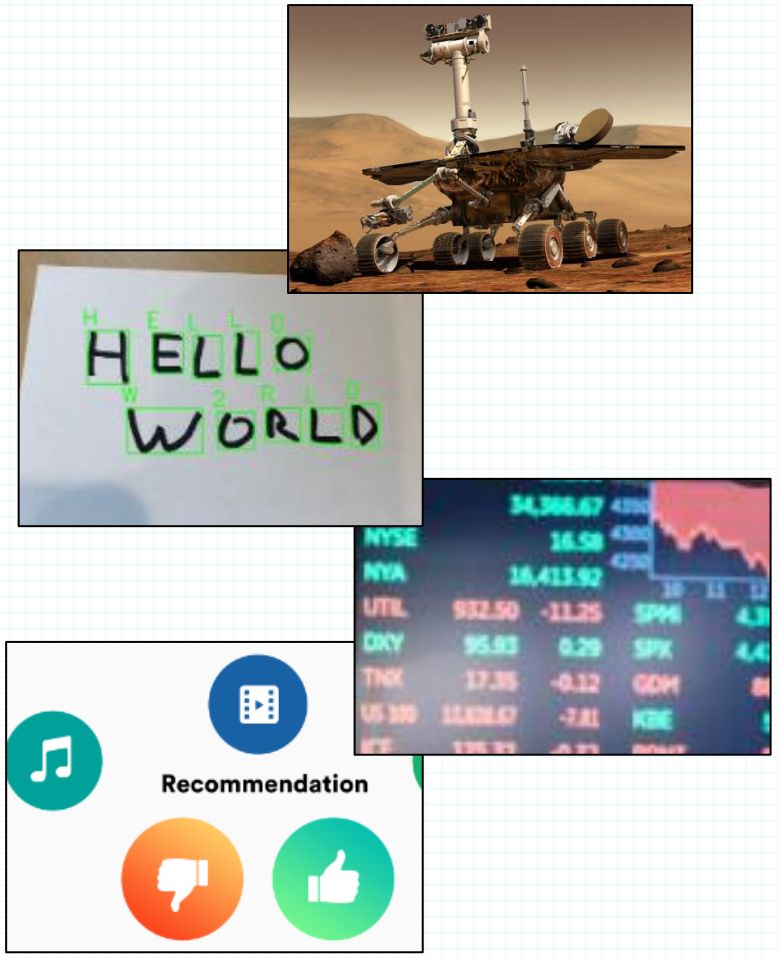
- Dialogue System

$f($ “Hi” $) =$ “Hello”

(what the user said) (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.



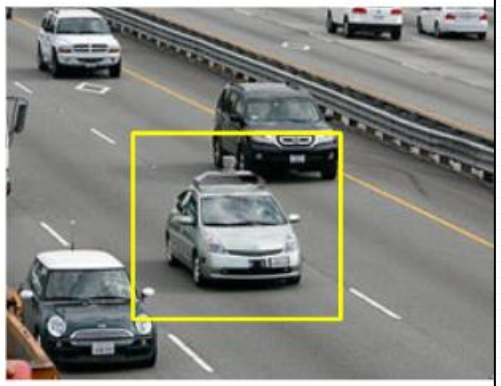
Common ML Applications

- 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]

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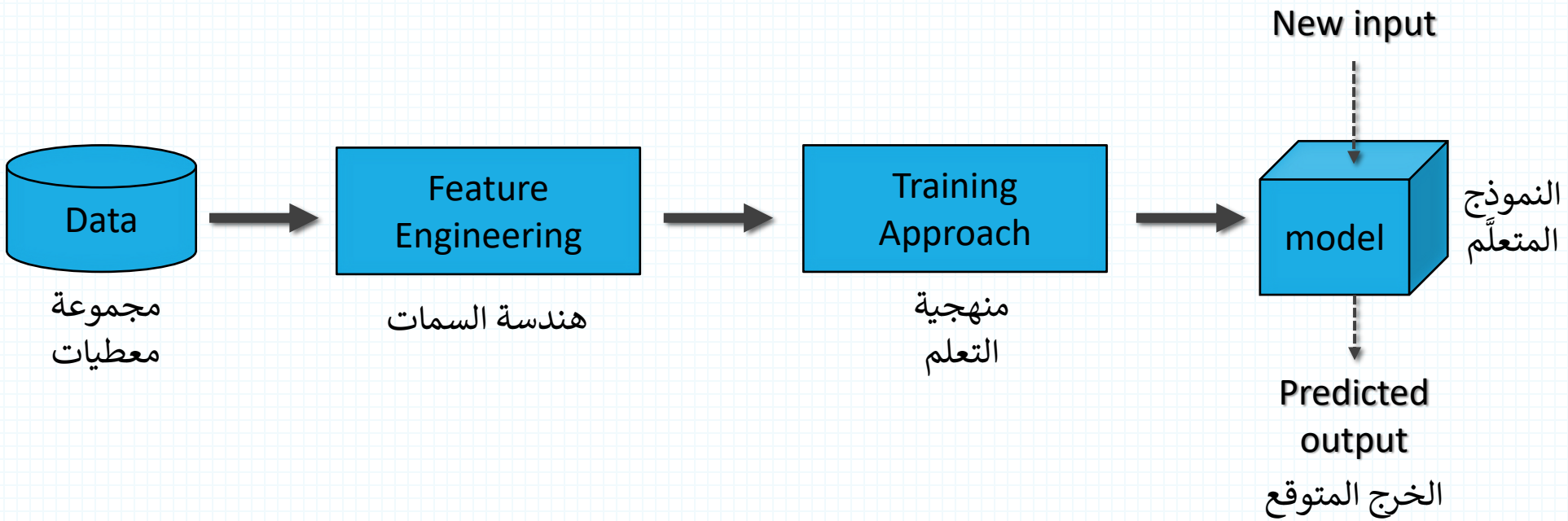
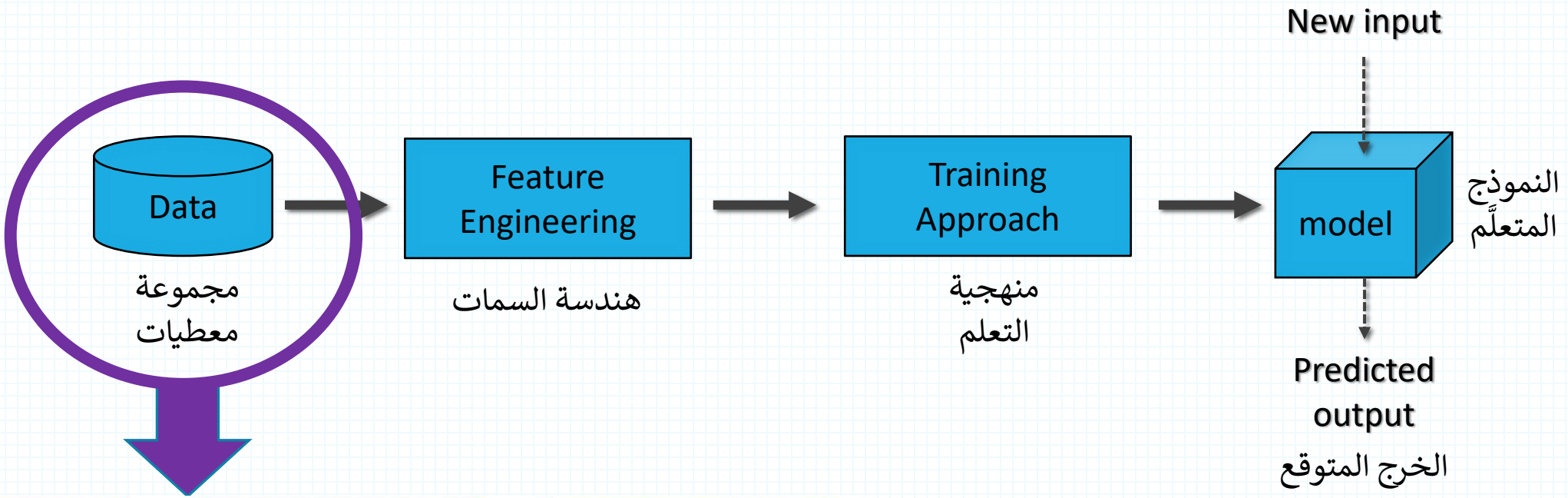
Types of Learning

- **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.

Traditional ML Pipeline



Traditional ML Pipeline



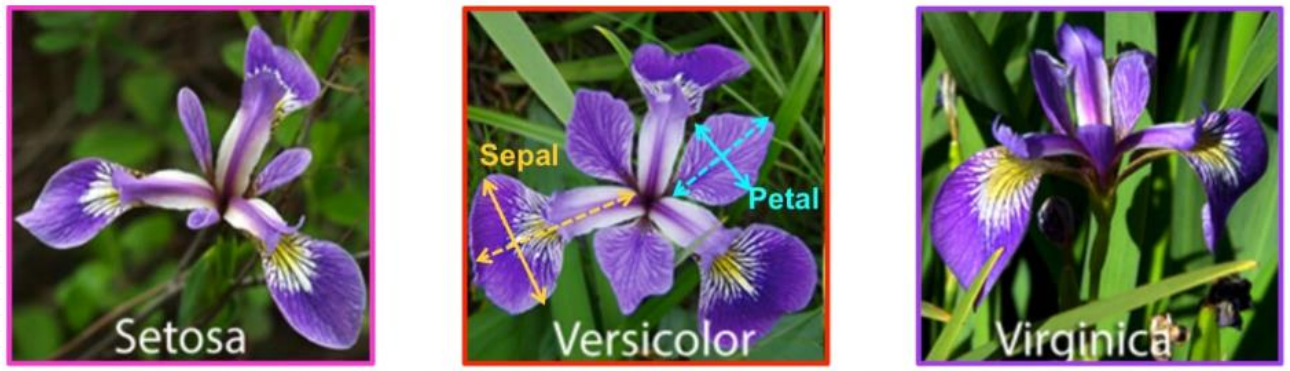
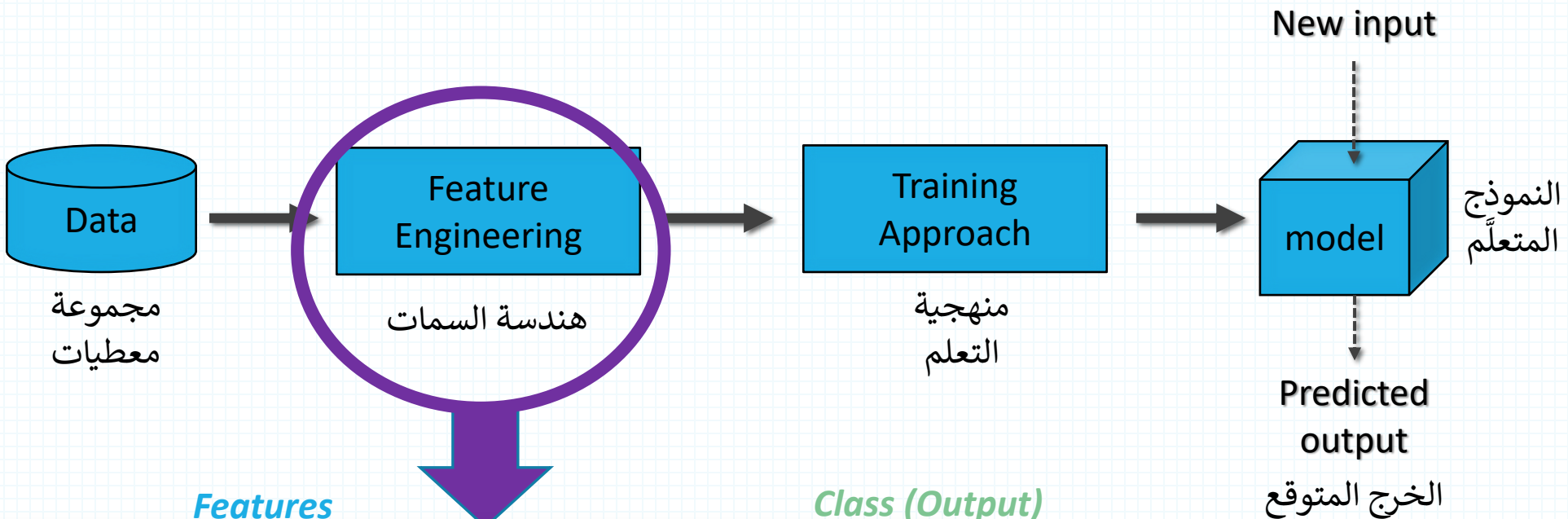


Image Source: http://suruchifialoke.com/2016-10-13-machine-learning-tutorial-iris-classification/

Traditional ML Pipeline

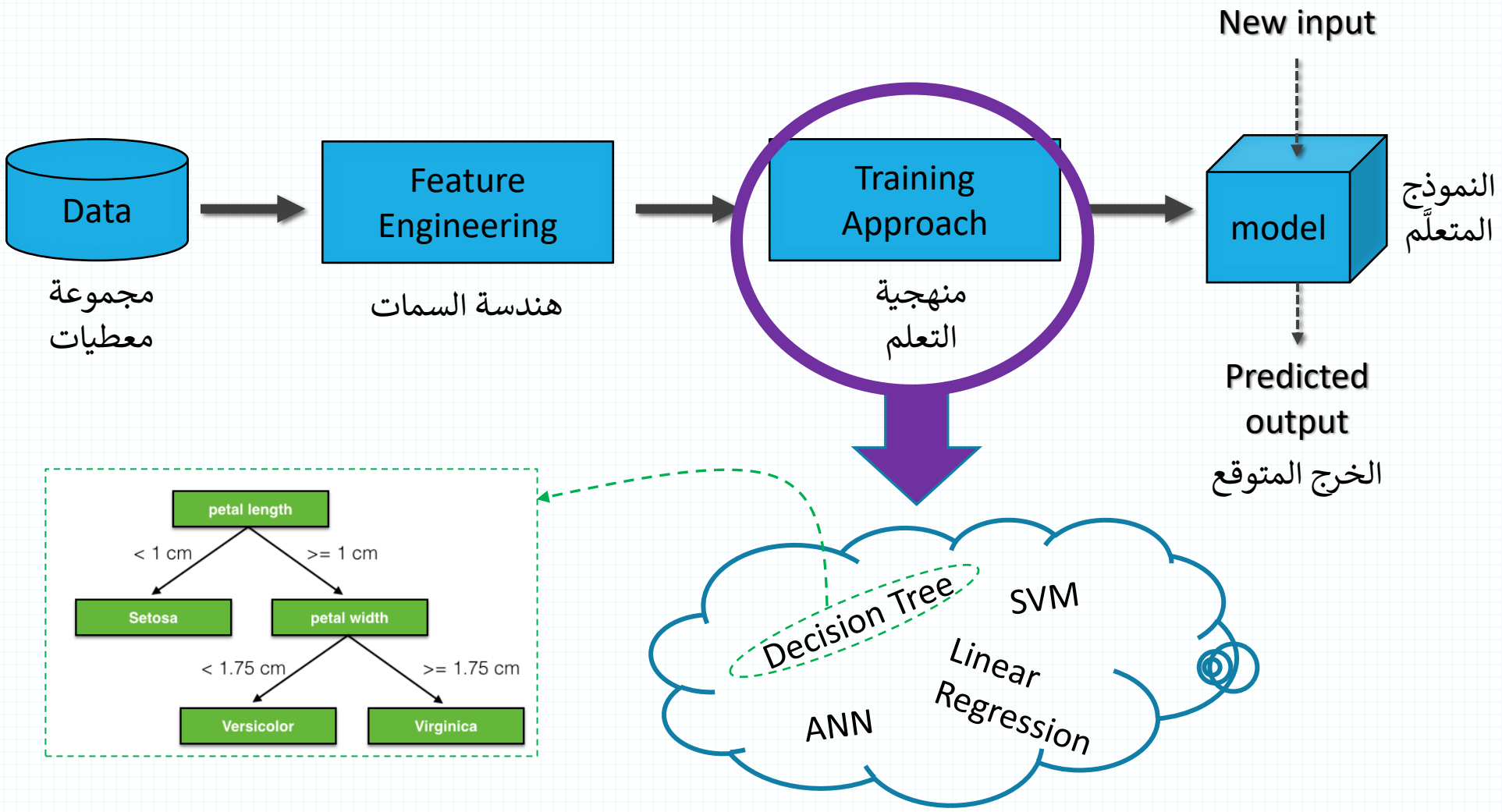


Features ***Class (Output)***

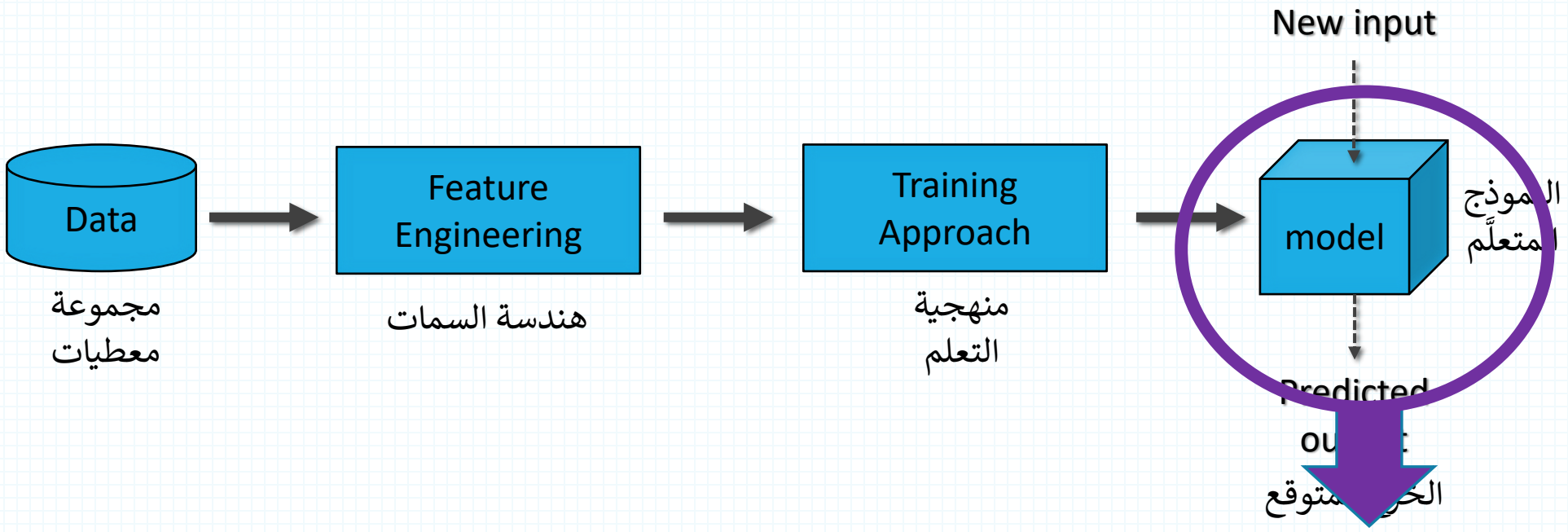
```
1  sepal_length,sepal_width,petal_length, petal width,class
2  5.1,3.5,1.4,0.2,Iris-setosa
3  4.9,3.0,1.4,0.2,Iris-setosa
4  4.7,3.2,1.3,0.2,Iris-setosa
5  4.6,3.1,1.5,0.2,Iris-setosa
6  5.0,3.6,1.4,0.2,Iris-setosa
7  5.4,3.9,1.7,0.4,Iris-setosa
8  4.6,3.4,1.4,0.3,Iris-setosa
```

Instance

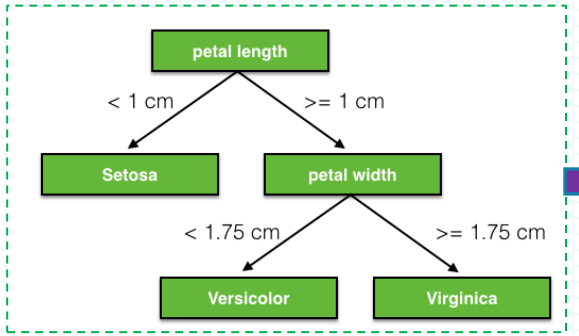
Traditional ML Pipeline



Traditional ML Pipeline



Sepal Length: 5.1 ,
Sepal Width=3.5,
Petal Length = 0.8,
Petal Width = 0.2,
Class = ???



Class = Setosa

Traditional ML Pipeline