

# Machine learning

Presented by : Dr. Hanaa Bayomi



Lecture 1 : Introduction

# REFERENCES

- T. Mitchell, *Machine Learning*, McGraw-Hill
- Peter Flach, Machine Learning. The Art and Science of Algorithms that Make Sense of Data.
- John D. Kelleher, *Fundamental of Machine Learning for predictive Data Analytic.*

# Grading

Type	grades
▪ 3 Assignments	15
▪ Mid term Exam	15
▪ project	10
▪ Final exam	60
Total	100

# What is machine learning?

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## ➤ Definition:

Machine = computer, computer program (in this course)

Learning = improving performance on a given task, based on experience / examples

## ➤ In other words

- instead of the programmer writing explicit rules for how to solve a given problem, the programmer instructs the computer how to learn from examples
- in many cases the computer program can even become better at the task than the programmer is!

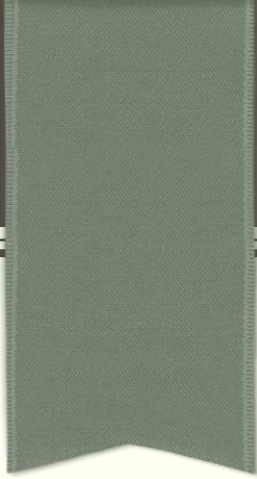
# INTRODUCTION

## Traditional Programming



## Machine Learning





# EXAMPLES

## Example 1 : Tic-Tac-Toe

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- ▶ How to program the computer to play tic-tac-toe?

		X
		O
		X

O		X

O		X
X		

O		X
	O	
X		

O		X
	O	
X	X	X

O		X
	O	O
X	X	X

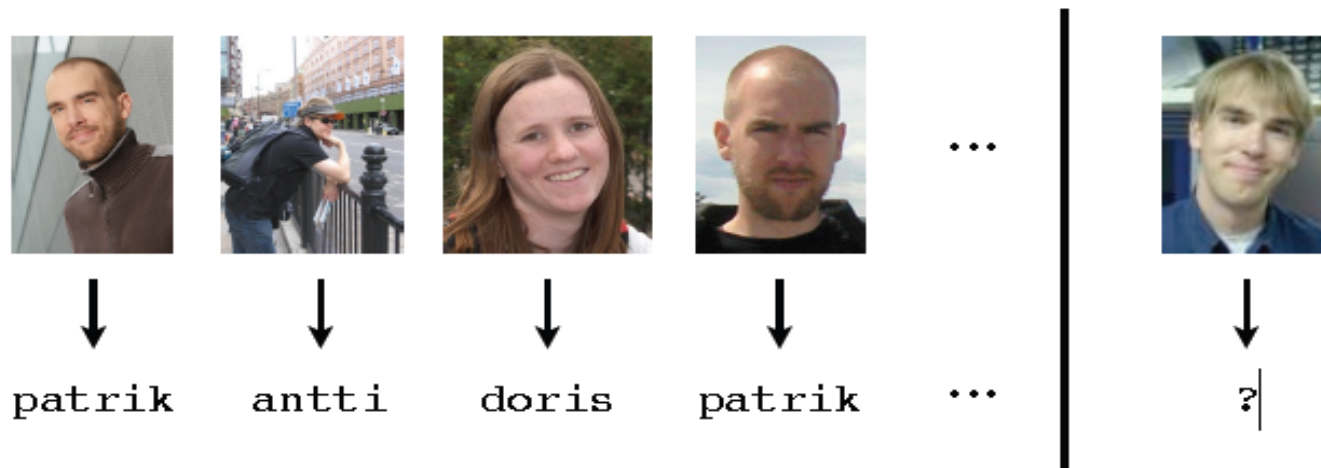
O		X
	O	O
X	X	X

- ▶ Option A: The programmer writes explicit rules, e.g. 'if the opponent has two in a row, and the third is free, stop it by placing your mark there', etc (lots of work, difficult, not at all scalable!)
- ▶ Option B: Go through the game tree, choose optimally (for non-trivial games, must be combined with some heuristics to restrict tree size)
- ▶ Option C: Let the computer try out various strategies by playing against itself and others, and noting which strategies lead to winning and which to losing (= 'machine learning')

## Example 2 : face recognition

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- ▶ Face recognition is hot (facebook, apple; security; ...)
- ▶ ~~Programmer writes rules: "If short dark hair, big nose, then it is Mikko"~~ (impossible! how do we judge the size of the nose?!)
- ▶ The computer is shown many (image, name) example pairs, and the computer learns which features of the images are predictive (difficult, but not impossible)

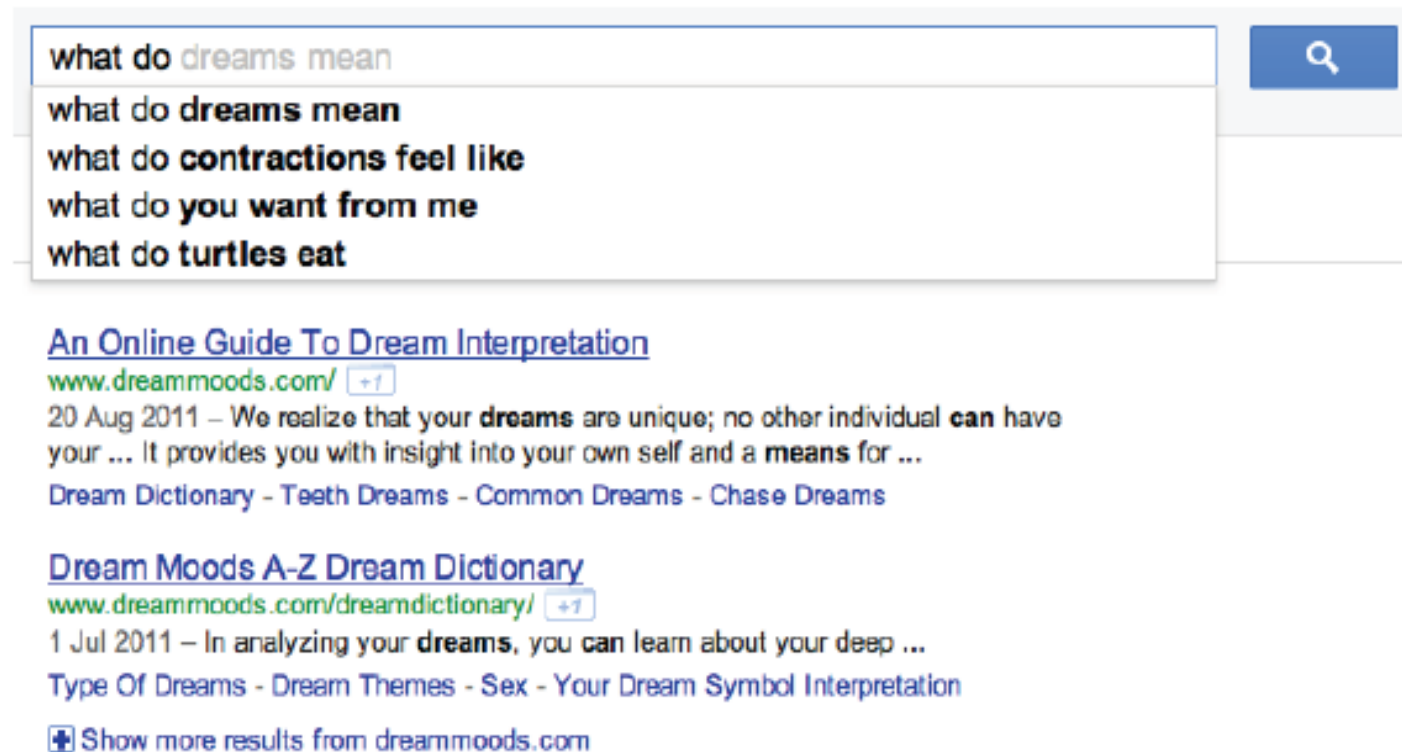




## Example 3: Prediction of search queries

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- ▶ The programmer provides a standard dictionary (words and expressions change!)
- ▶ Previous search queries are used as examples!



## Example 4: Ranking search results

- ▶ Various criteria for ranking results
- ▶ What do users click on after a given search? Search engines can learn what users are looking for by collecting queries and the resulting clicks.

nokia

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**Nokia 5700 XpressMusic – Wikipedia** ☆

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[fi.wikipedia.org/wiki/Nokia\\_5700\\_XpressMusic](#) - Välimuistissa - Samankaltaisia

[+](#) Näytä lisää tuloksia kohteesta wikipedia.org

**Nokia (nokia) on Twitter** ☆ - [ Käännä tämä sivu ]

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## Example 5

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- ▶ Self-driving cars:
  - ▶ Sensors (radars, cameras) superior to humans
  - ▶ How to make the computer react appropriately to the sensor data?

SMARTER THAN YOU THINK

### Google Cars Drive Themselves, in Traffic



Ramin Rohman for The New York Times

## Example 6

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- ▶ Machine translation:
  - ▶ Traditional approach: Dictionary and explicit grammar
  - ▶ More recently, *statistical* machine translation based on example data is increasingly being used

Google kääntäjä

Kielestä: suomi ▼ ↕ Kielelle: englanti ▼ Käännä

Tietojenkäsittelytieteen opinnot antavat erinomaisen pohjan työskentelylle kaikkialla, missä kehitetään tai sovelletaan tietotekniikkaa.

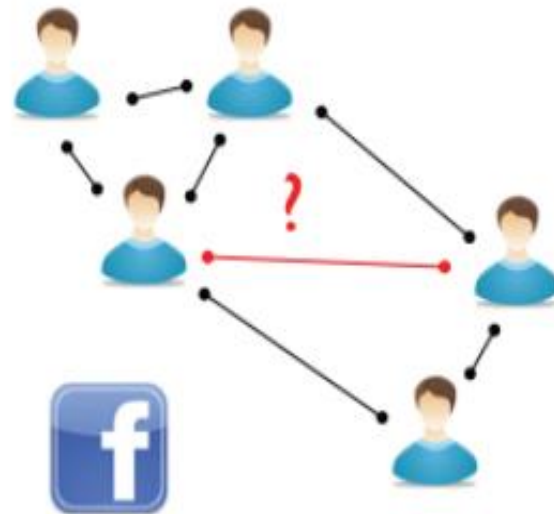
Käännös (suomi > englanti)

Computer studies provide an excellent foundation for the work, wherever applicable, or to develop information technology.

## Example 7

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- Prediction of friends in Facebook, or prediction of who you'd like to follow on Twitter.



# Problem setup

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- ▶ One definition of machine learning: A computer program improves its performance on a given task with experience (i.e. examples, data).





# 1- Task

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▶ **Task:** What is the problem that the program is solving?

- Machine learning allows us to tackle tasks that are too difficult to solve with fixed programs written and designed by human beings.
- Machine learning is interesting because developing our understanding of machine learning entails developing our understanding of the principles that underlie intelligence.

# 1- Task (Cont.)

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Some of the most common machine learning tasks include the following:

**1- Classification** : In this type of task, the computer program is asked to specify which of  $k$  categories some input belongs to.

-Classification Algorithms attempt to map inputs into one of a set of classes (Colors, Good and Bad Credit Risks)

**2- Regression** : In this type of task, the computer program is asked to predict a numerical value given some input.

-Regression Algorithms attempt to map inputs into continuous output (Integers, Real Numbers, Vectors, etc.)



## 1- Task (Cont.)

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Some of the most common machine learning tasks include the following:

**3- Transcription:** In this type of task, the machine learning system is asked to observe a relatively unstructured representation of some kind of data and transcribe it into discrete, textual form.

E.g.: optical character recognition (OCR), where the computer program is shown a photograph containing an image of text and is asked to return this text in the form of a sequence of characters.

**4- Machine translation:** In a machine translation task, the input already consists of a sequence of symbols in some language, and the computer program must convert this into a sequence of symbols in another language.

## 2- Experience

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- ▶ **Experience:** What is the data (examples) that the program is using to improve its performance?
- **Experience** is a dataset.
- **A dataset** is a collection of many examples.
- **An example** is a collection of **features** that have been quantitatively measured from some object or event that we want the machine learning system to process.

### 3- performance level

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- ▶ **Performance measure:** How is the performance of the program (when solving the given task) evaluated?

In order to evaluate the abilities of a machine learning algorithm, we must design a quantitative measure of its performance. Usually this performance measure  $P$  is specific to the task  $T$  being carried out by the system.

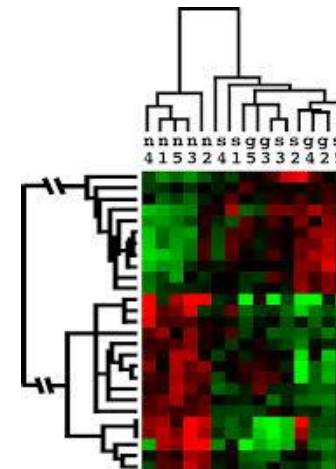
- Accuracy : Accuracy is just the proportion of examples for which the model *produces the correct output*.
- Error Rate : the proportion of examples for which the model *produces an incorrect output*.

# WHEN DO WE USE MACHINE LEARNING?

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ML is used when:

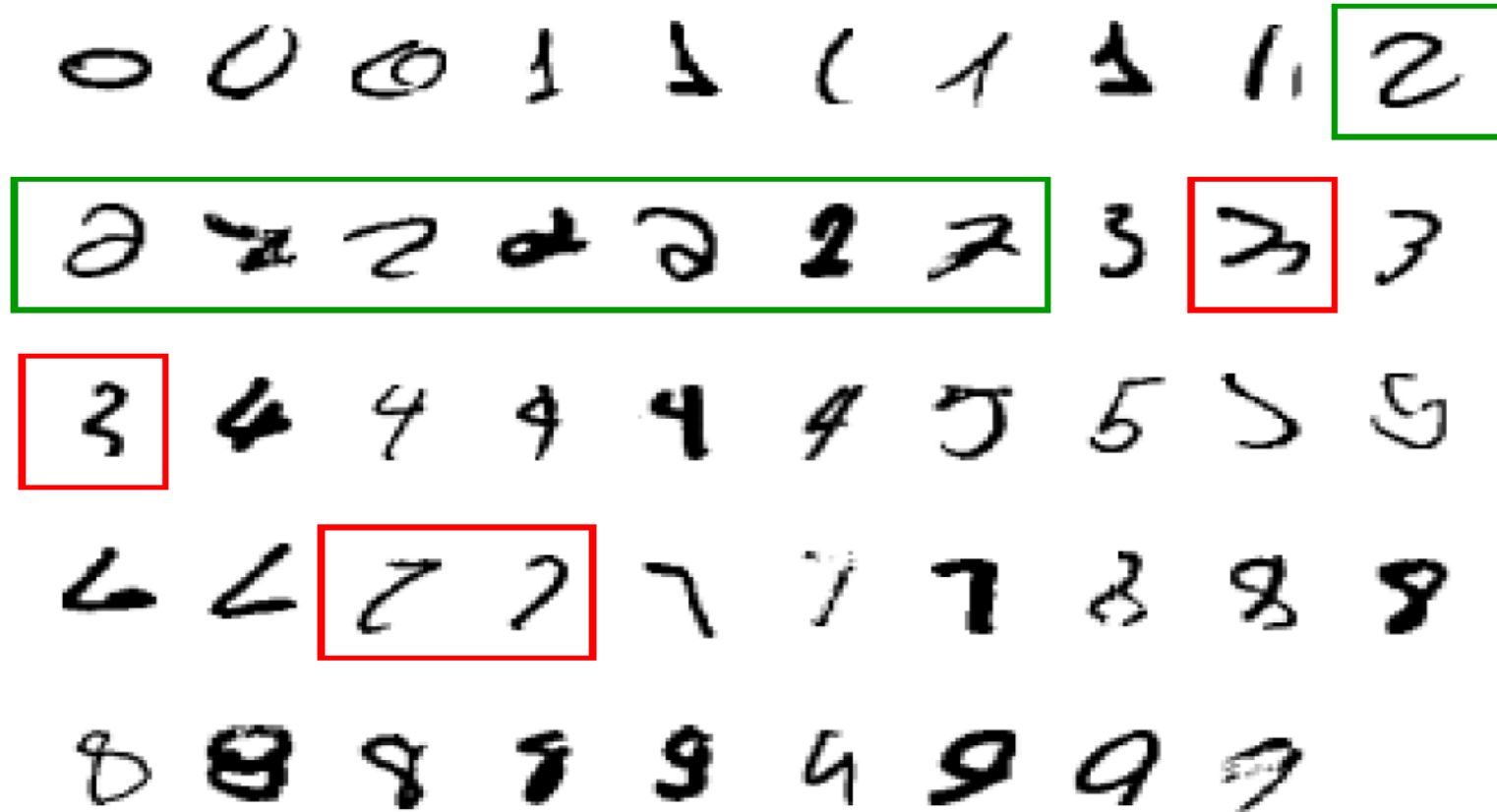
- ❑• Human expertise does not exist (navigating on Mars)
- ❑• Humans can't explain their expertise (speech recognition)
- ❑• Models must be customized (personalized medicine)
- ❑• Models are based on huge amounts of data (genomics)



# WHEN DO WE USE MACHINE LEARNING?

A classic example of a task that requires machine learning:

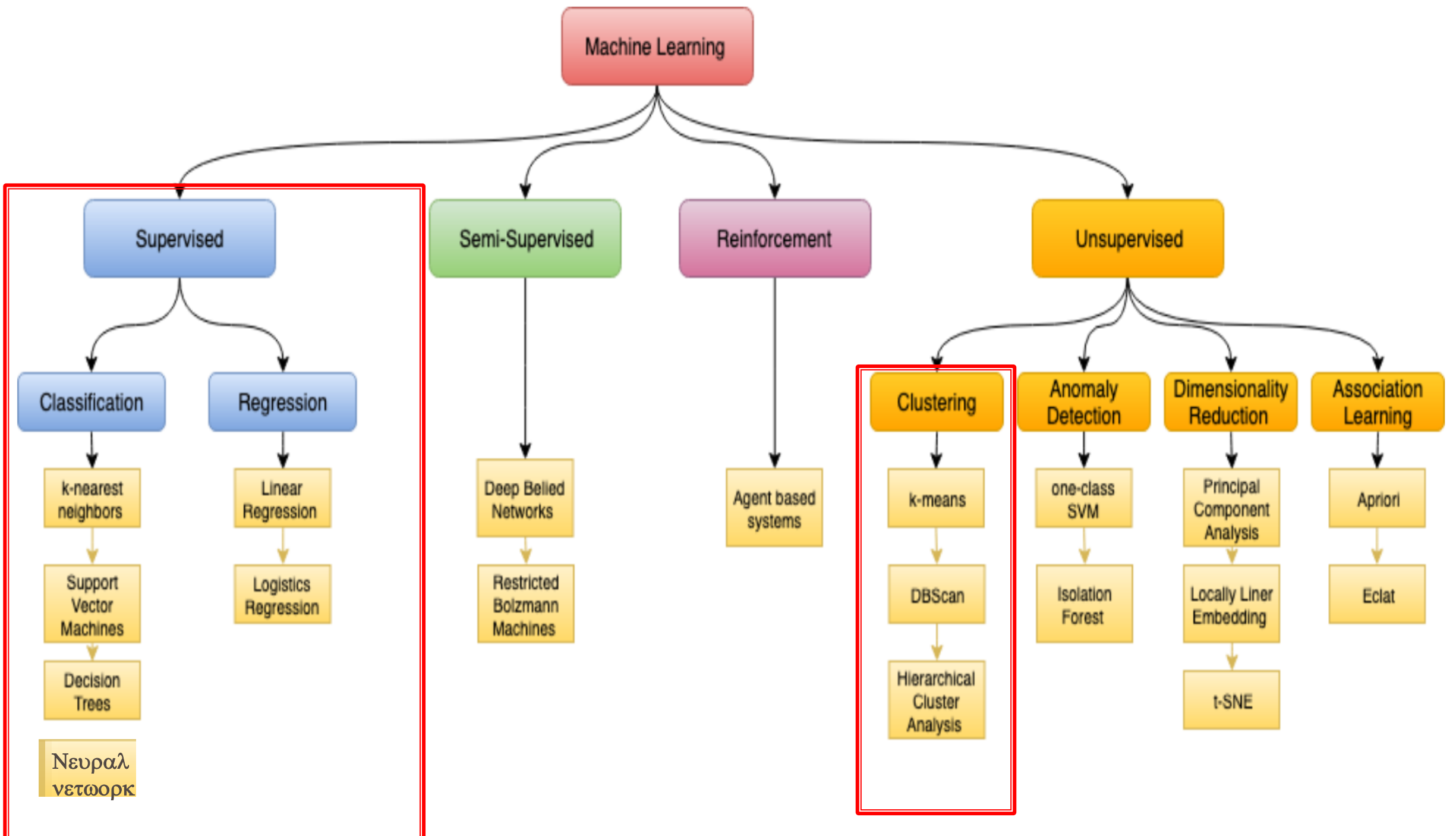
It is very hard to say what makes a 2

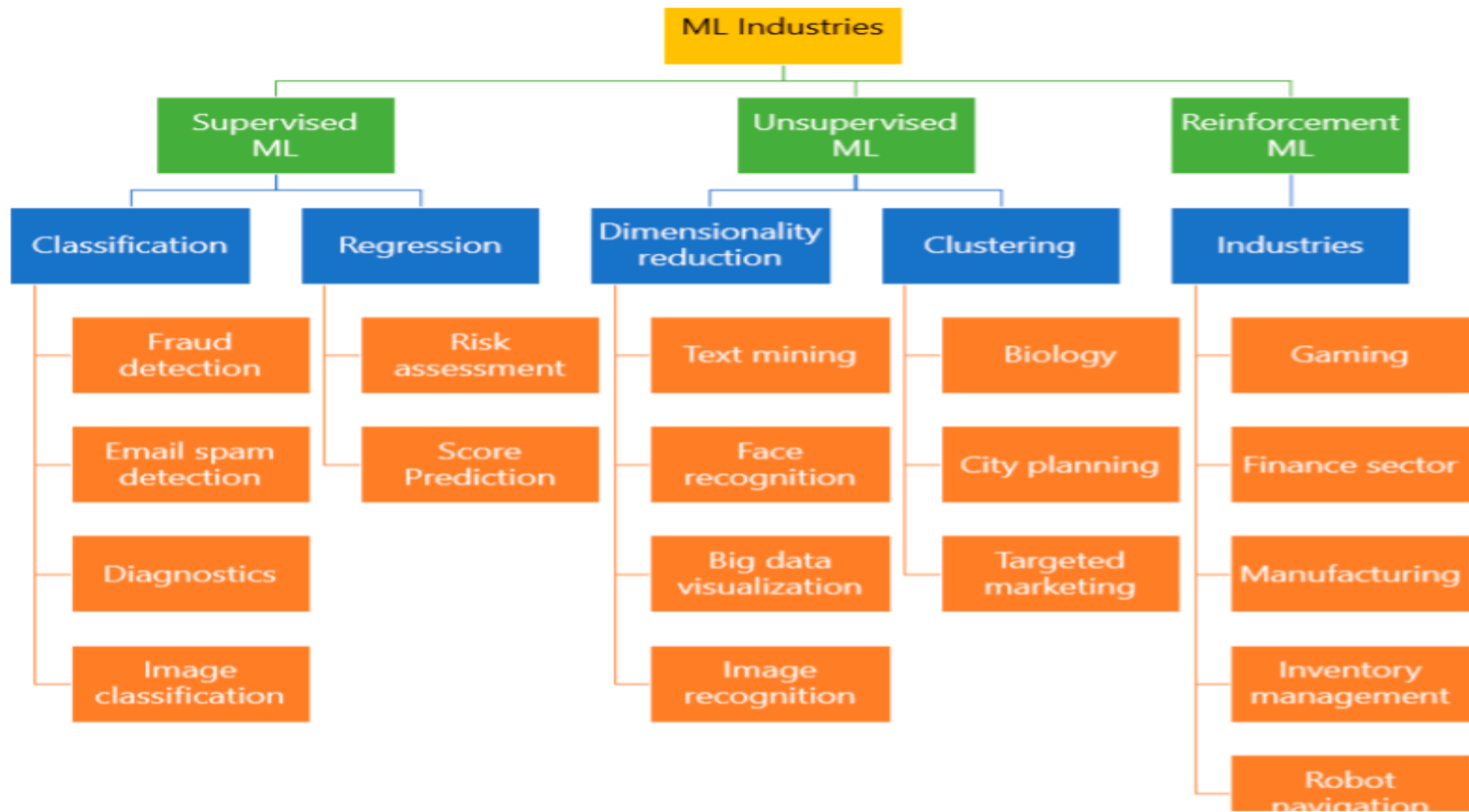


# Some more examples of tasks that are best solved by using a learning algorithm

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- ☐ Recognizing patterns:
  - ☐ Facial identities or facial expressions
  - ☐ Handwritten or spoken words
  - ☐ Medical images
- ☐ Generating patterns:
  - Generating images or motion sequences
- ☐ Recognizing anomalies:
  - ☐ Unusual credit card transactions
  - ☐ Unusual patterns of sensor readings in a nuclear power plant
- ☐ Prediction:
  - Future stock prices or currency exchange rates





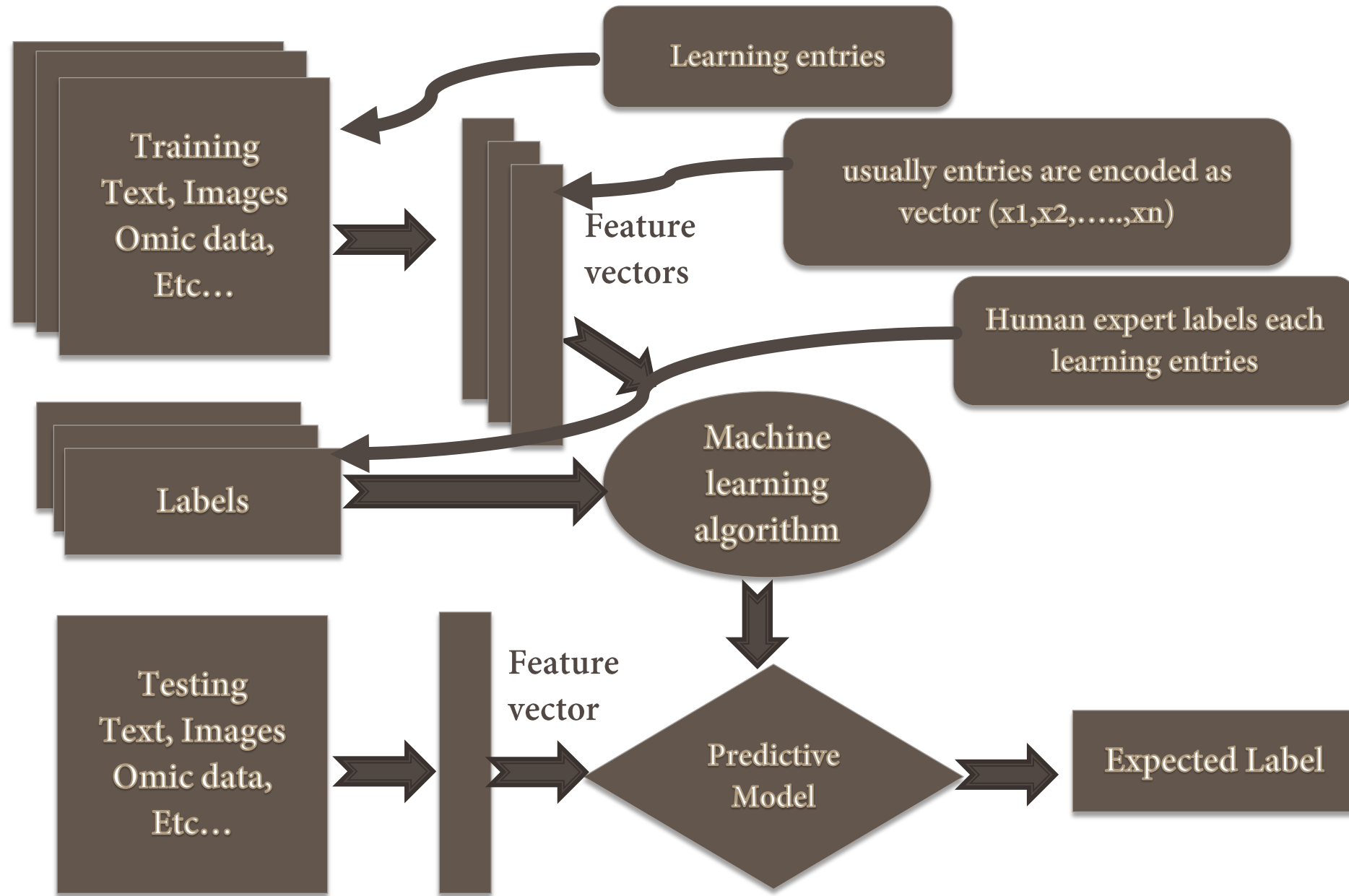


# Supervised Learning

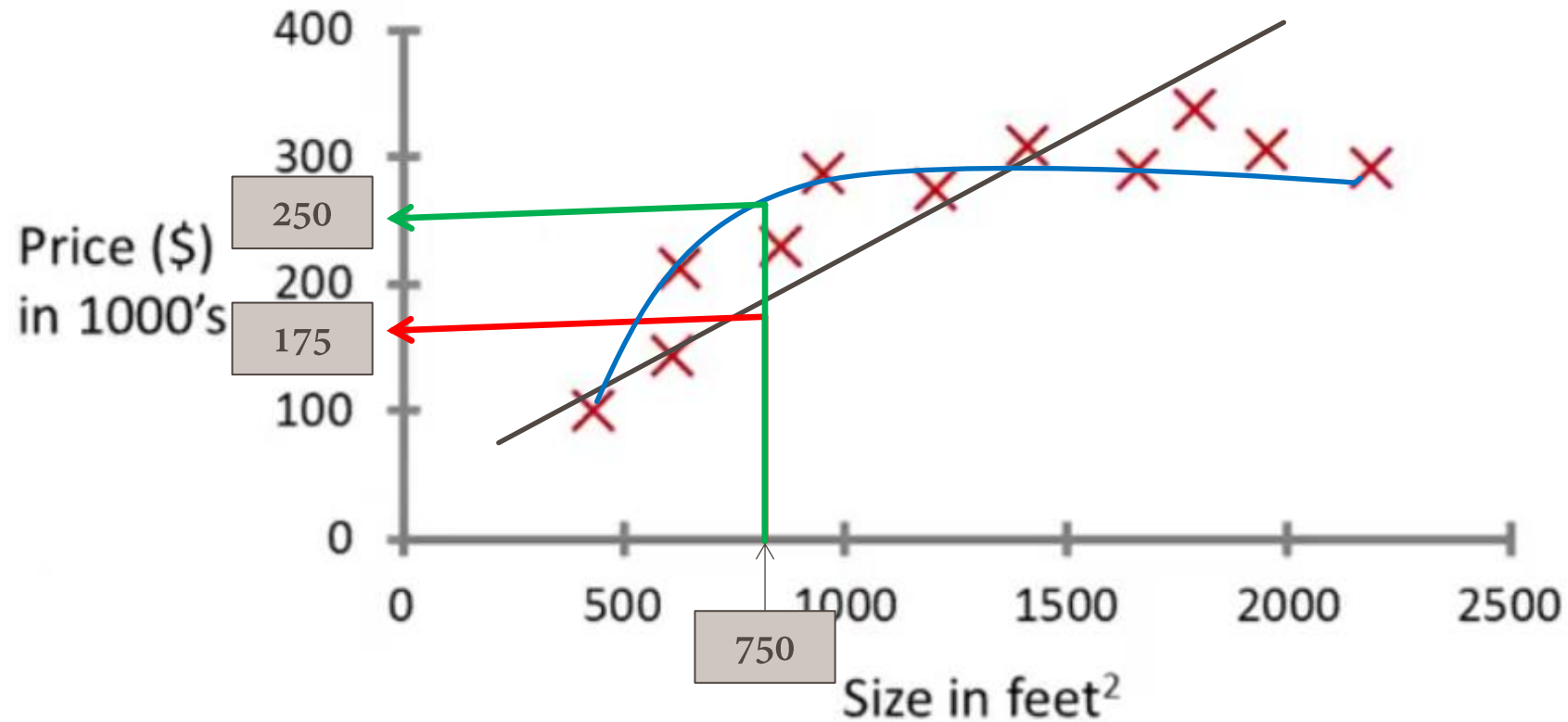
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- ❑ In supervised learning, we are given a data set and already know what our correct output should look like, having the idea that there is a relationship between the input and the output.
- ❑ Supervised learning problems are categorized into "regression" and "classification" problems.
- ❑ In a regression problem, we are trying to predict results within a continuous output, meaning that we are trying to map input variables to some continuous function.
- ❑ In a classification problem, we are instead trying to predict results in a discrete output. In other words, we are trying to map input variables into discrete categories.

# SUPERVISED LEARNING PARADIGM



# Housing price prediction



Supervised Learning

“right answers” or “Labeled data” given

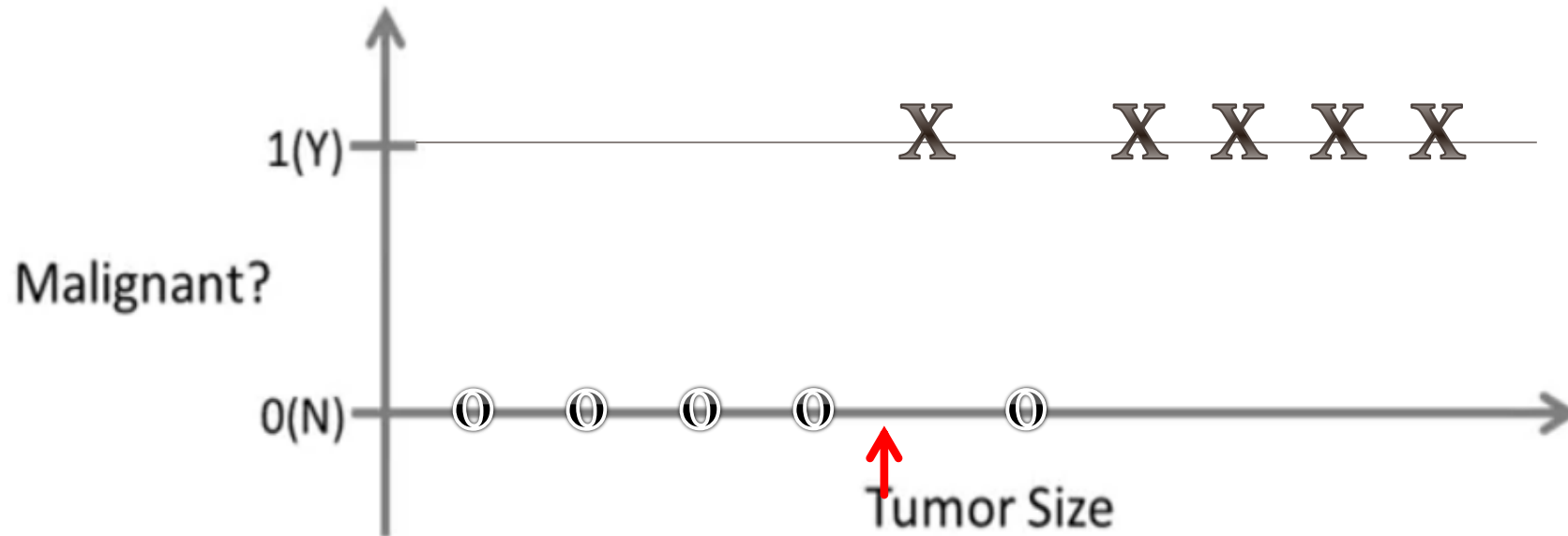
Regression:

Predict continuous valued output (price)

# Lung Cancer

## (Malignant or benign)

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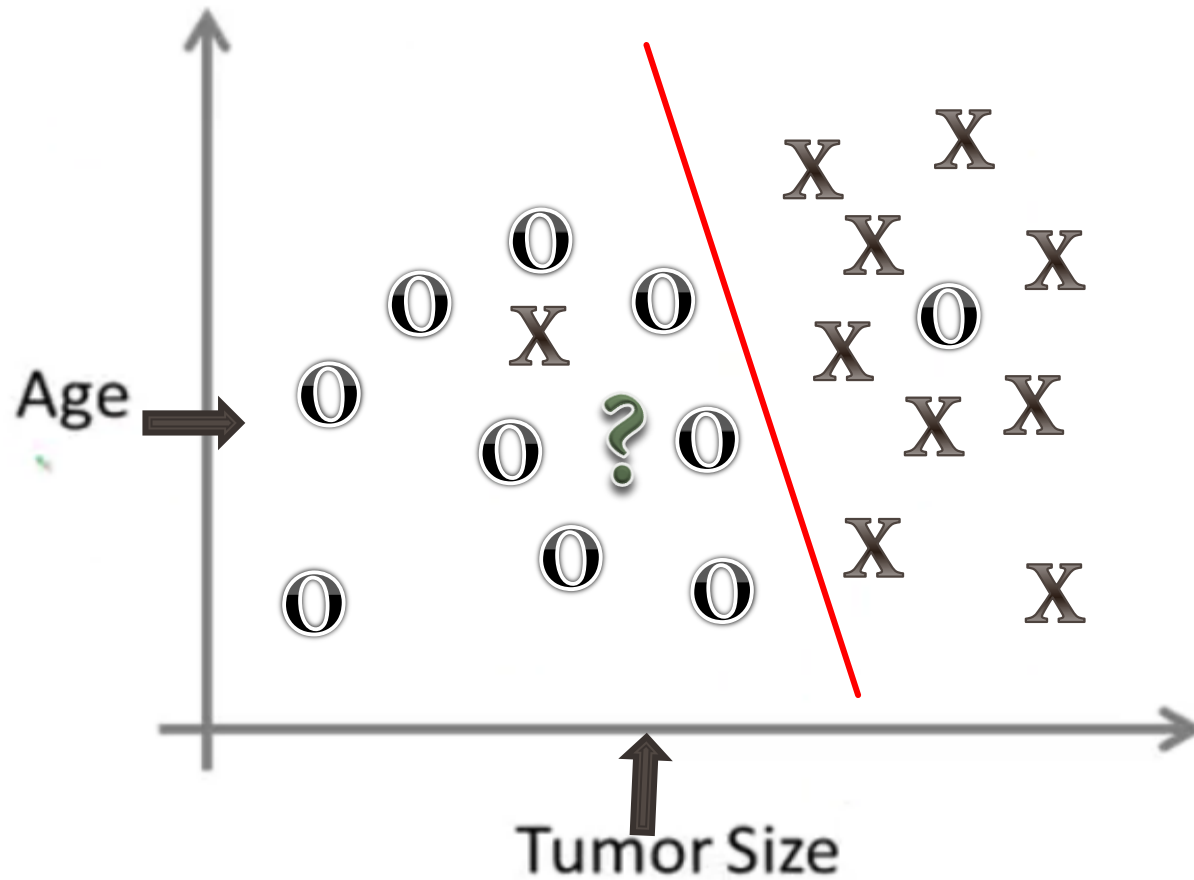
Classification

Discrete valued output (0 or 1)

# Lung Cancer

(Malignant or benign)

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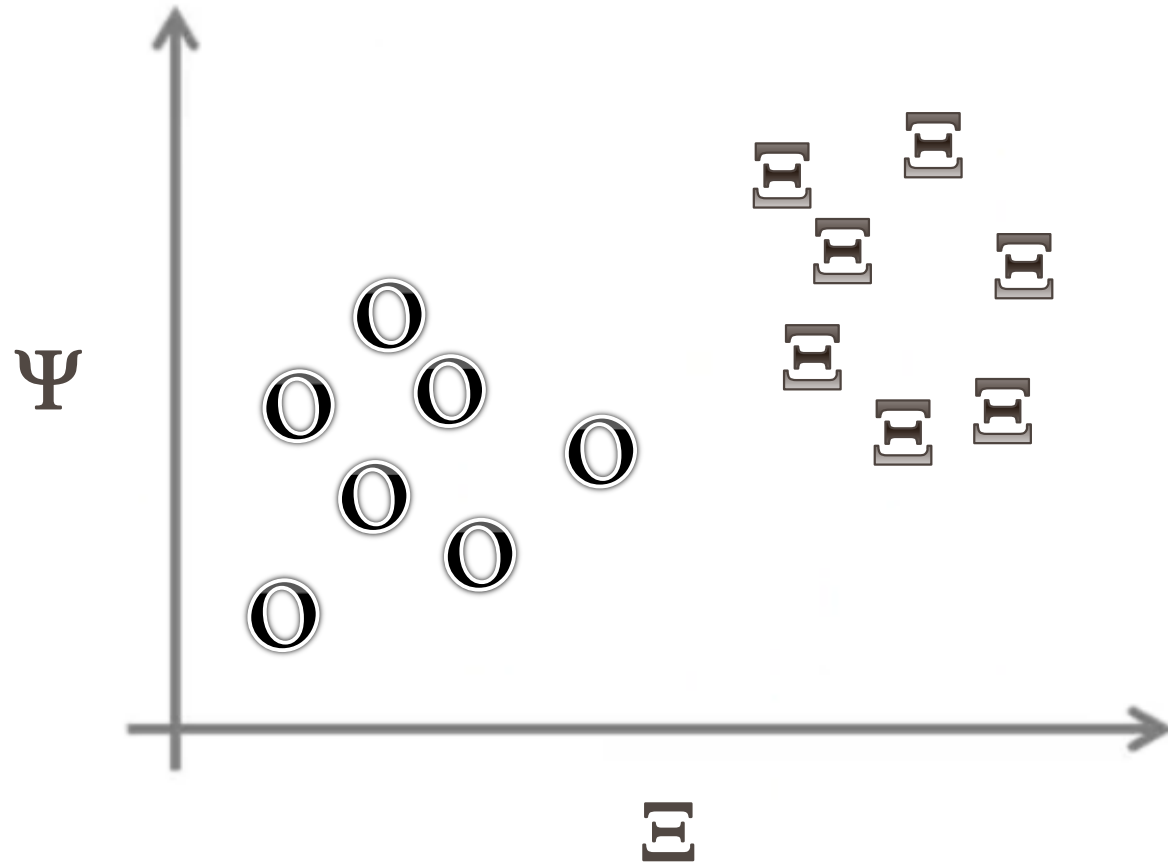
# UNSUPERVISED LEARNING

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- ❑ Unsupervised learning, on the other hand, allows us to approach problems with little or no idea what our results should look like.
- ❑ We can derive structure from data where we don't necessarily know the effect of the variables.
- ❑ We can derive this structure by clustering the data based on relationships among the variables in the data.
- ❑ With unsupervised learning there is no feedback based on the prediction results, i.e., there is no teacher to correct you.

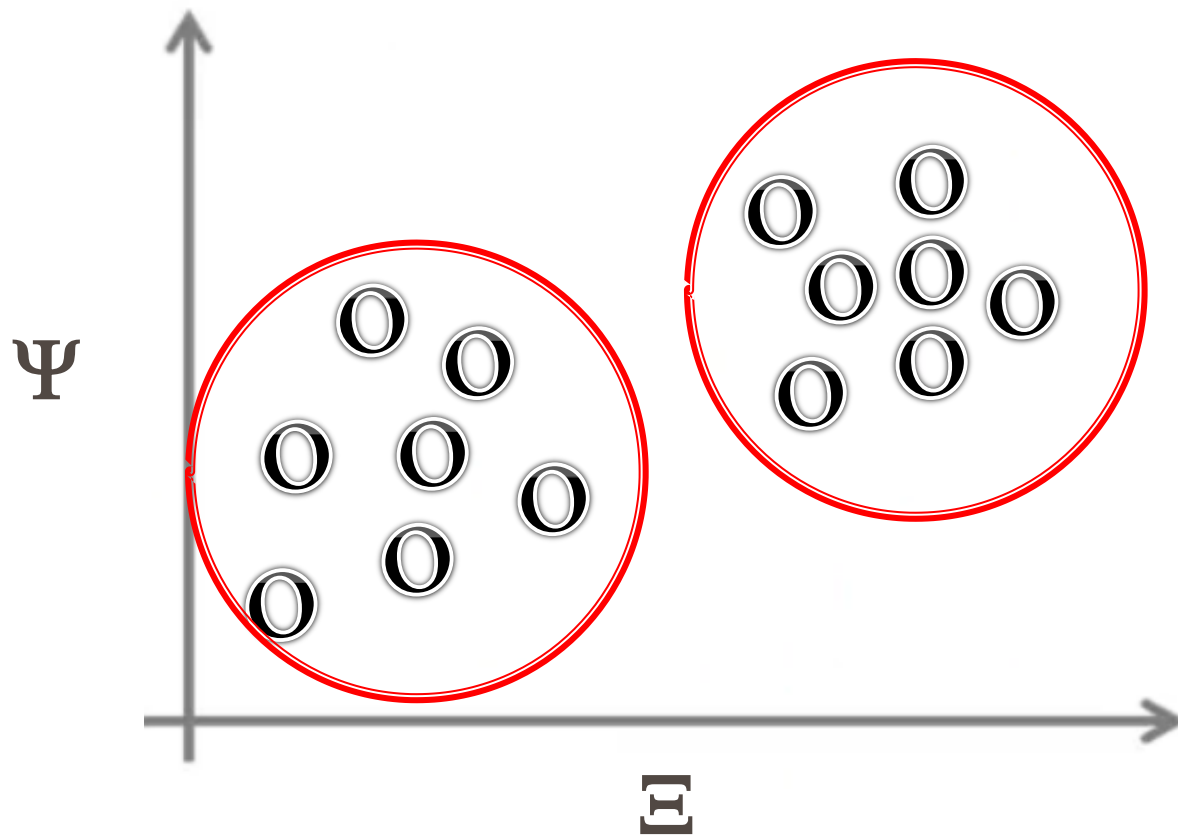
# SUPERVISED

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# Unsupervised

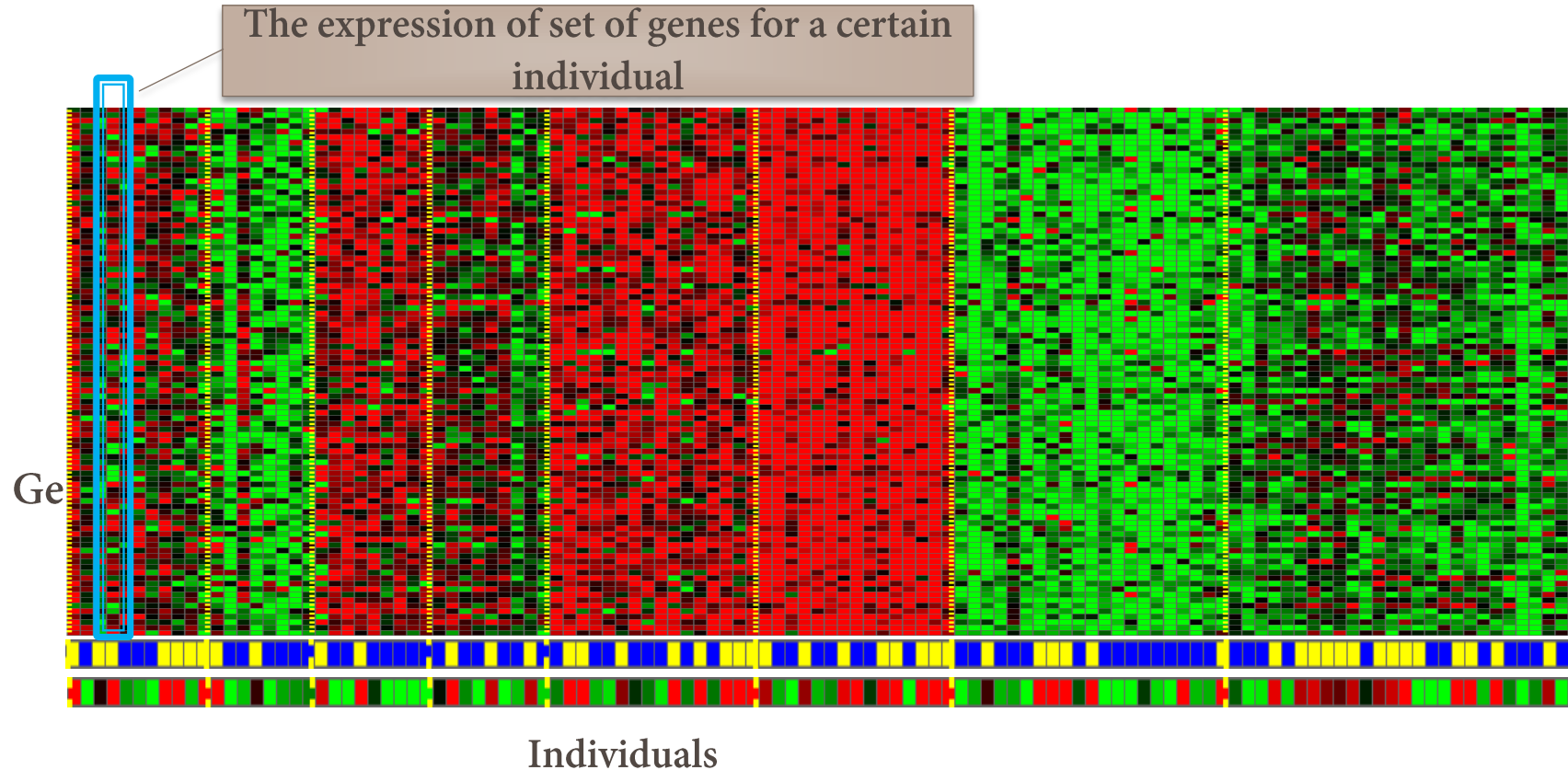
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Unsupervised learning is where you only have input data and no corresponding output variables.



# Unsupervised Learning applications

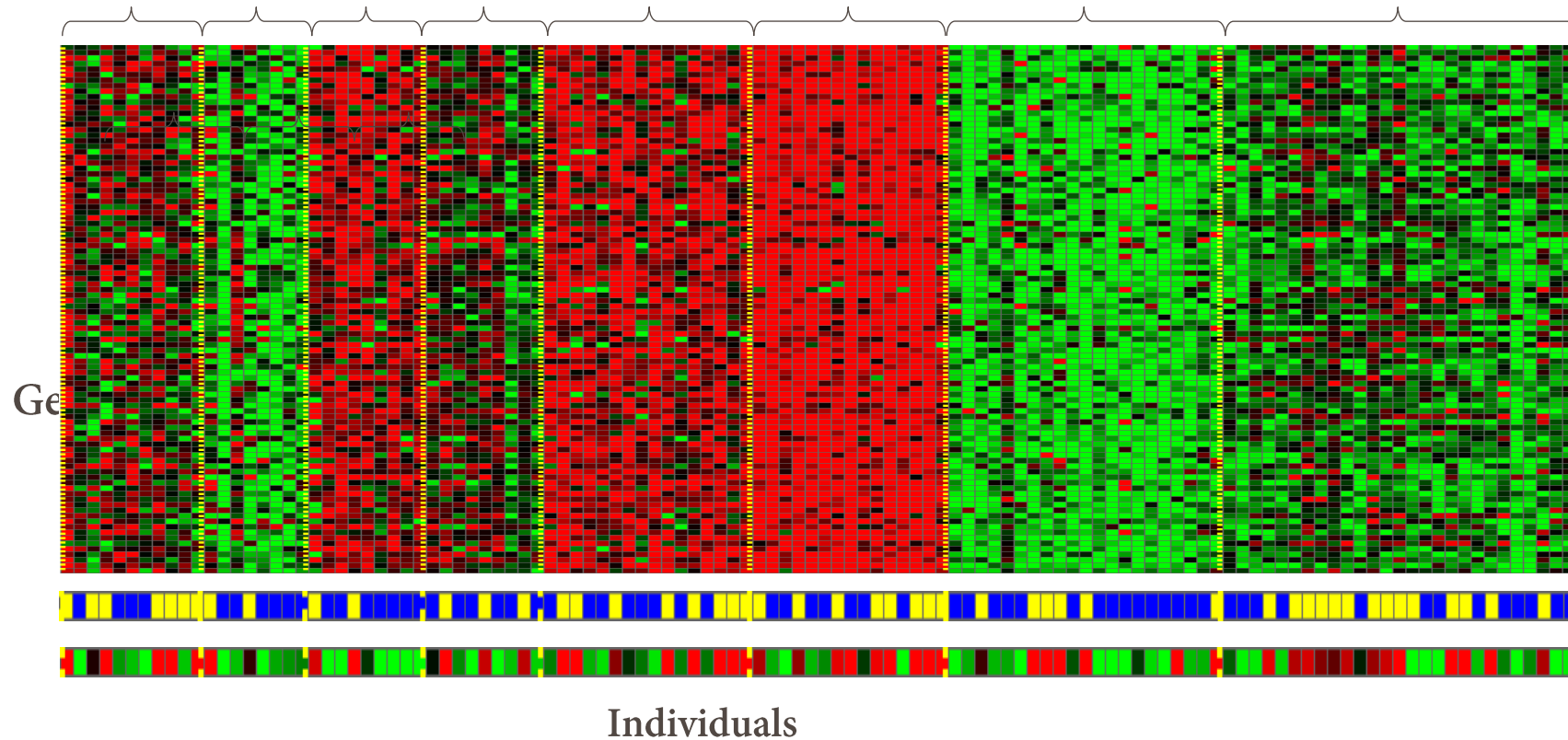


We need to cluster the individuals based of the similarity of their genes.



# Unsupervised Learning applications

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## Microarray data

- Have a group of individuals
- On each measure expression of a gene
- Run algorithm to cluster individuals into types of people

# UNSUPERVISED

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Julia Klabows  
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BP's costs for the Deepwater Horizon disaster have hit \$10bn. Photograph: AP/WideWorld

# Learning Types

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	Supervised	Unsupervised
Discrete	<b>Classification</b>	<b>Clustering</b>
Continuous	<b>Regression</b>	<b>Dimensionality reduction</b>

# Machine Learning types

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- Semi-supervised learning
  - mix of Supervised and Unsupervised learning
  - usually small part of data is labelled
- Reinforcement learning **Learning by interaction**
  - Model learns from a series of actions by maximizing a reward function
  - The reward function can either be maximized by penalizing bad actions and/or rewarding good actions
  - Example - training of self-driving car using feedback from the environment

