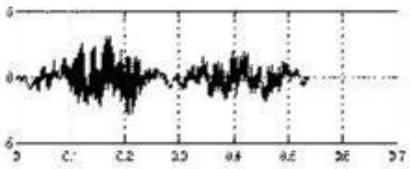
PATTERN RECOGNITION

WHAT IS A PATTERN?

- A pattern is an abstract object, or a set of measurements describing a physical object.



WHAT IS A PATTERN CLASS?

- A **pattern class** (or category) is a set of patterns sharing common attributes.

- A collection of “similar” (not necessarily identical) objects.

- During **recognition** given objects are assigned to prescribed classes.

WHAT IS PATTERN RECOGNITION?

- Theory, Algorithms, Systems to put Patterns into Categories
- Relate Perceived Pattern to Previously Perceived Patterns
- Learn to distinguish patterns of interest from their background

HUMAN PERCEPTION

- Humans have developed highly sophisticated skills for sensing their environment and taking actions according to what they observe, e.g.,
  - Recognizing a face.
  - Understanding spoken words.
  - Reading handwriting.
  - Distinguishing fresh food from its smell.

- We would like to give similar capabilities to machines.

EXAMPLES OF APPLICATIONS

Optical Character Recognition (OCR)	• **Handwritten**: sorting letters by postal code. • **Printed texts**: reading machines for blind people, digitalization of text documents.
Biometrics	• **Face recognition, verification, retrieval.** • **Finger prints recognition.** • **Speech recognition.**
Diagnostic systems	• **Medical diagnosis**: X-Ray, EKG (**ElectroCardioGraph**) analysis.
Military applications	• **Automated Target Recognition** (ATR). • **Image segmentation and analysis** (recognition from aerial or satelite photographs).

HUMAN AND MACHINE PERCEPTION

- We are often influenced by the knowledge of how patterns are modeled and recognized in nature when we develop pattern recognition algorithms.

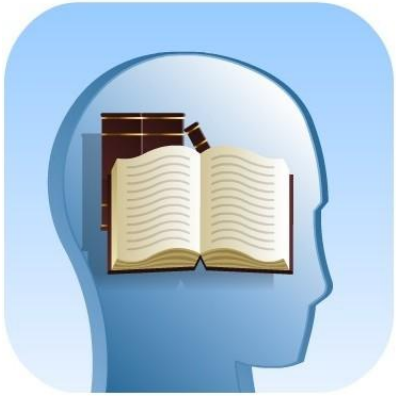
- Research on machine perception also helps us gain deeper understanding and appreciation for pattern recognition systems in nature.

- Yet, we also apply many techniques that are purely numerical and do not have any correspondence in natural systems.

PATTERN RECOGNITION

- Two Phase : ***Learning*** and ***Detection***.
- Time to learn is higher.
  - *Driving a car*
- Difficult to learn but once learnt it becomes ***natural***.
- Can use AI learning methodologies such as:
  - Neural Network.
  - Machine Learning.

LEARNING



- How can machine learn the rule from data?

  - **Supervised learning**: a teacher provides a category label or cost for each pattern in the training set.

  - **Unsupervised learning**: the system forms clusters or natural groupings of the input patterns.

CASE STUDY (CONT.)

- What can cause problems during sensing?
  - Lighting conditions.
  - Position of fish on the conveyor belt.
  - Camera noise.
  - etc…
- What are the steps in the process?
  1. *Capture image.*
  2. *Isolate fish*
  3. *Take measurements*
  4. *Make decision*

PATTERN RECOGNITION SS PROCE

- ***Data acquisition and sensing:***
  - Measurements of physical variables.
  - Important issues: bandwidth, resolution , etc.
- ***Pre-processing:***
  - Removal of noise in data.
  - Isolation of patterns of interest from the background.
- ***Feature extraction:***
  - Finding a new representation in terms of features.
- ***Classification***
  - Using features and learned models to assign a pattern to a category.
- ***Post-processing***
  - Evaluation of confidence in decisions.

CASE STUDY

- Fish Classification:
  - Sea Bass / Salmon.

Salmon

- **Problem**: Sorting incoming fish on a conveyor belt according to species.

- Assume that we have only two kinds of fish:
  - Sea bass.
  - Salmon.

Sea-bass

HOW TO SEPARATE SEA BASS FROM SALMON?

- Possible features to be used:
  - Length
  - Lightness
  - Width
  - Number and shape of fins
  - Position of the mouth
  - Etc …

- Assume a fisherman told us that a “sea bass” is generally longer than a “salmon”.
- Even though “sea bass” is longer than “salmon” on the average, there are many examples of fish where this observation does not hold.

THANKS FOR ATTENTION