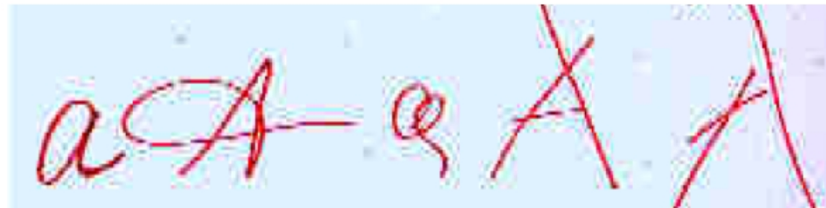# INTRODUCTION TO PATTERN RECOGNITION

WHAT IS A PATTERN?

- A pattern is an abstract object, such as a set of measurements describing a physical object

EXAMPLES OF PATTERNS

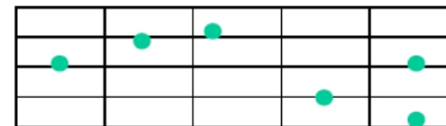
Handwritten Characters

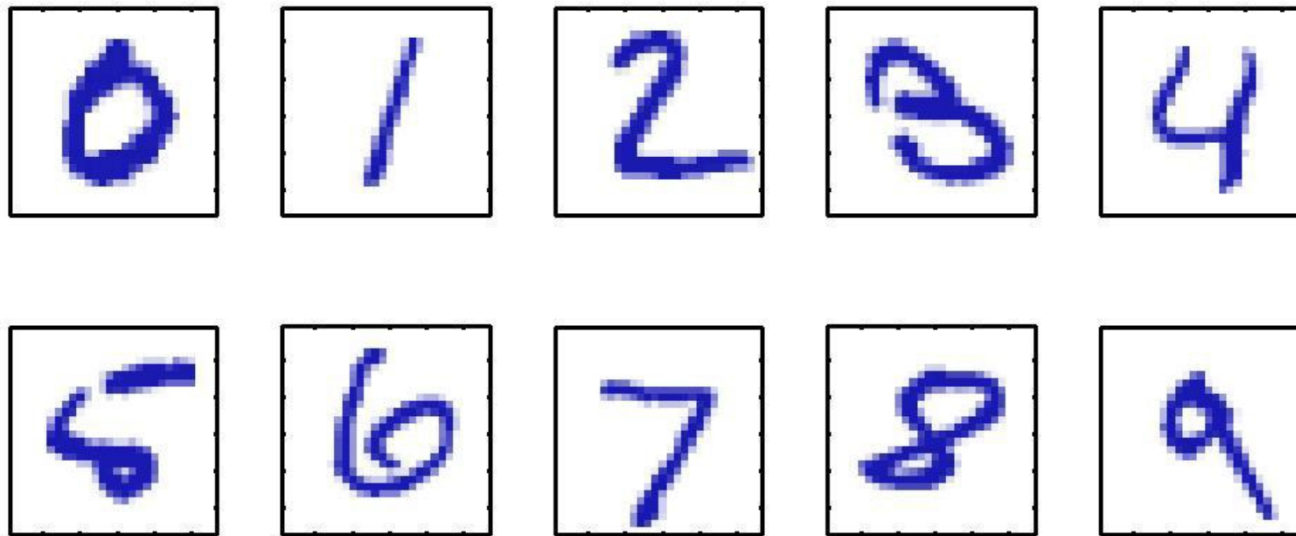UPC BarCode

Fingerprint

Animal Footprint

Postnet Bar Code

Data Trend

EXAMPLE PROBLEM:
# HANDWRITTEN DIGIT RECOGNITION

PATTERN RECOGNITION

- Typical application areas

  - Machine vision

  - Character recognition (OCR)

  - Computer aided diagnosis

  - Speech recognition

  - Face recognition

  - Biometrics

  - Image Data Base retrieval

  - Data mining

  - Bionformatics

- The task: Assign unknown objects – patterns – into the correct class. This is known as classification.
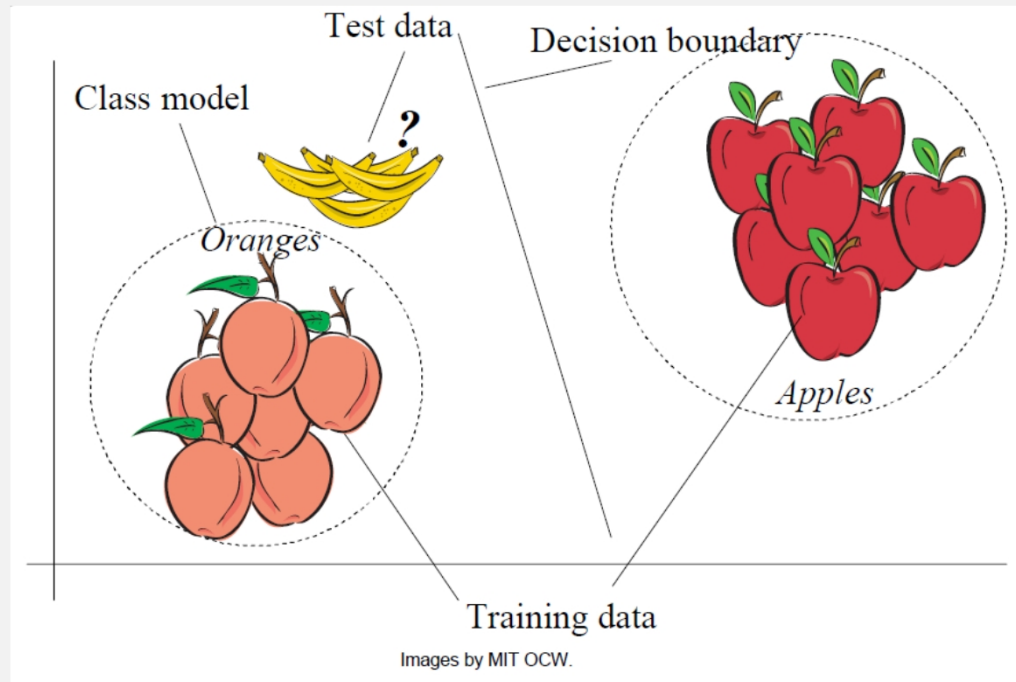
OBJECT DETECTION \ RECOGNITION

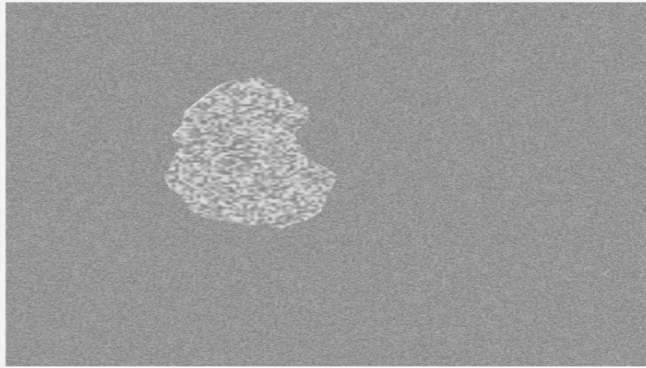- Find objects in the image, determine what they are Eg: Face detection and recognition:

Photograph by MIT OCW.
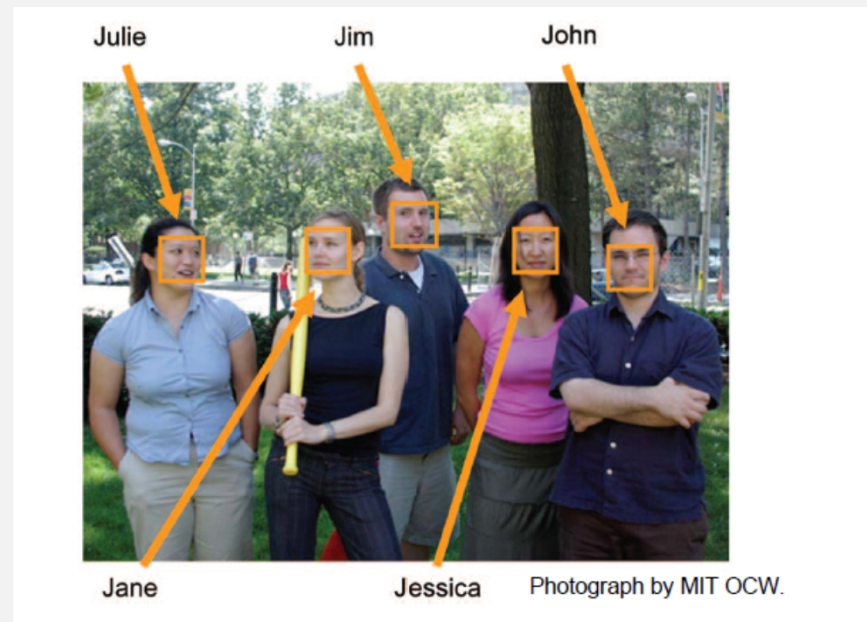
ROLE OF MACHINE LEARNING

- "Big Four" Problems of Machine Learning
- • Classification
- • Density Estimation
- • Clustering
- • Regression

CLASSIFICATION

Images by MIT OCW.

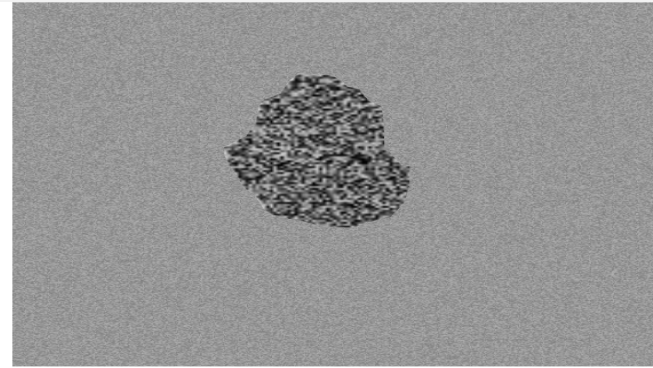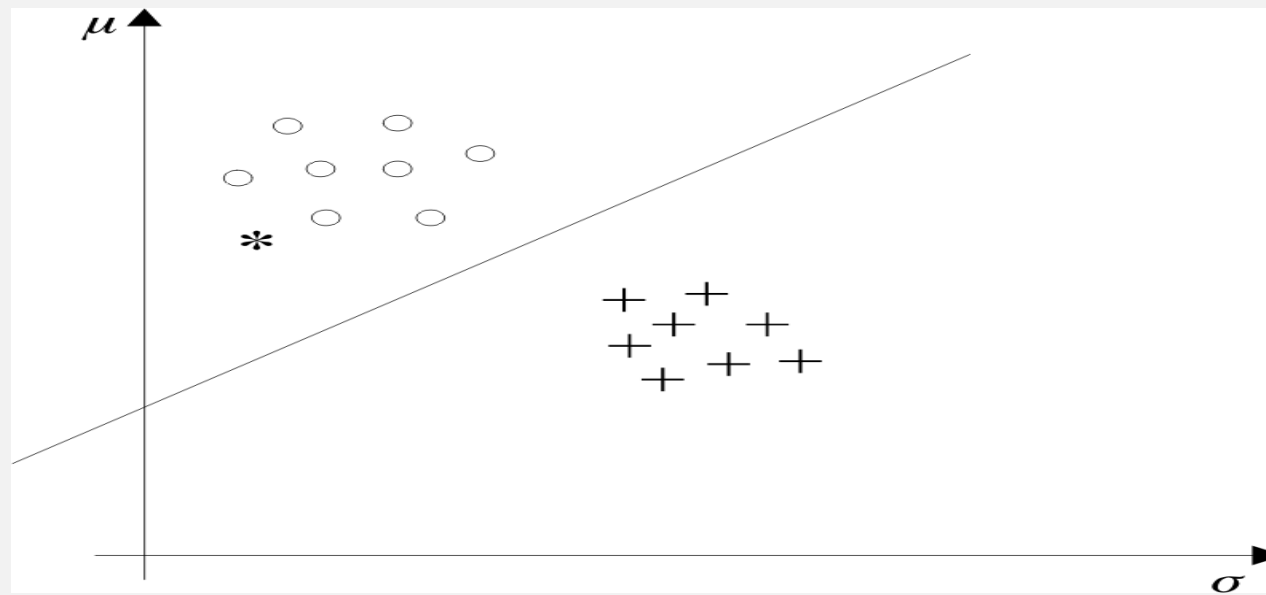An example:

(a)   (b)

- Supervised – unsupervised pattern recognition:
  The two major directions

  - **Supervised**: Patterns whose class is known a-priori are used for training.

  - **Unsupervised**: The number of classes is (in general) unknown and no training patterns are available.

FEATURES

- Features: These are measurable quantities obtained from the patterns, and the classification task is based on their respective values.

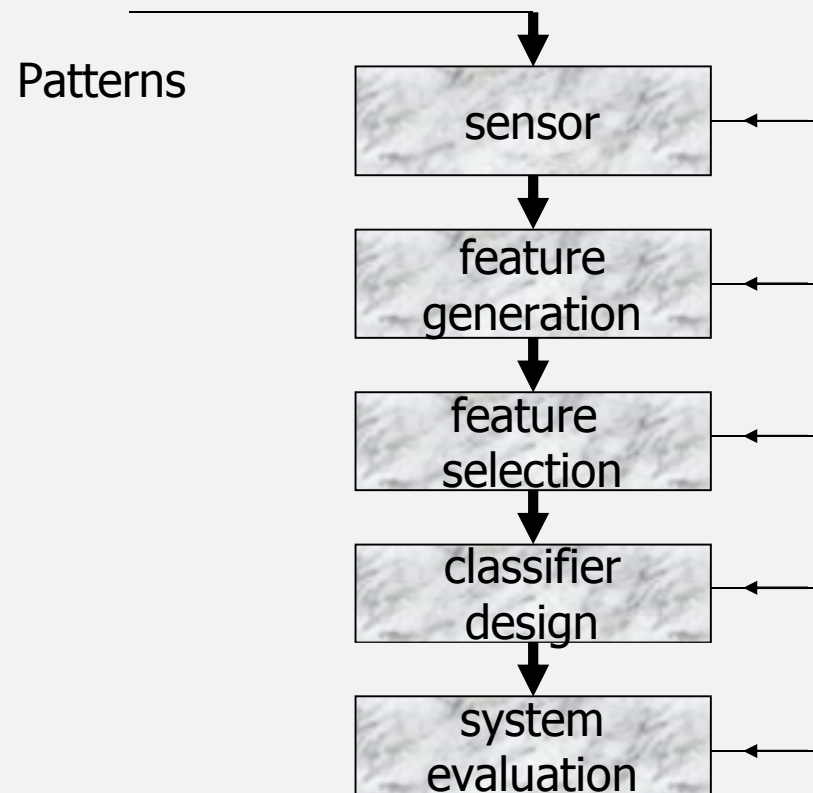- Feature vectors: A number of features

$$x_1, \ldots, x_l,$$

constitute the feature vector

$$\underline{x} = [x_1, \ldots, x_l]^T \in R^l$$

Feature vectors are treated as random vectors.

CLASSIFICATION SYSTEM

❖ The classifier consists of a set of functions, whose values, computed at $\underline{x}$, determine the class to which the corresponding pattern belongs

Patterns

```
sensor
   ↓
feature
generation
   ↓
feature
selection
   ↓
classifier
design
   ↓
system
evaluation
```

ADDRESS INTERPRETATION PROBLEM

- Pattern recognition tasks

- object recognition (address vs non-address)

- two-class discrimination

- few class recognition (digits)

- Many classes, but cataloged (postal directory)

CLASSFICATION
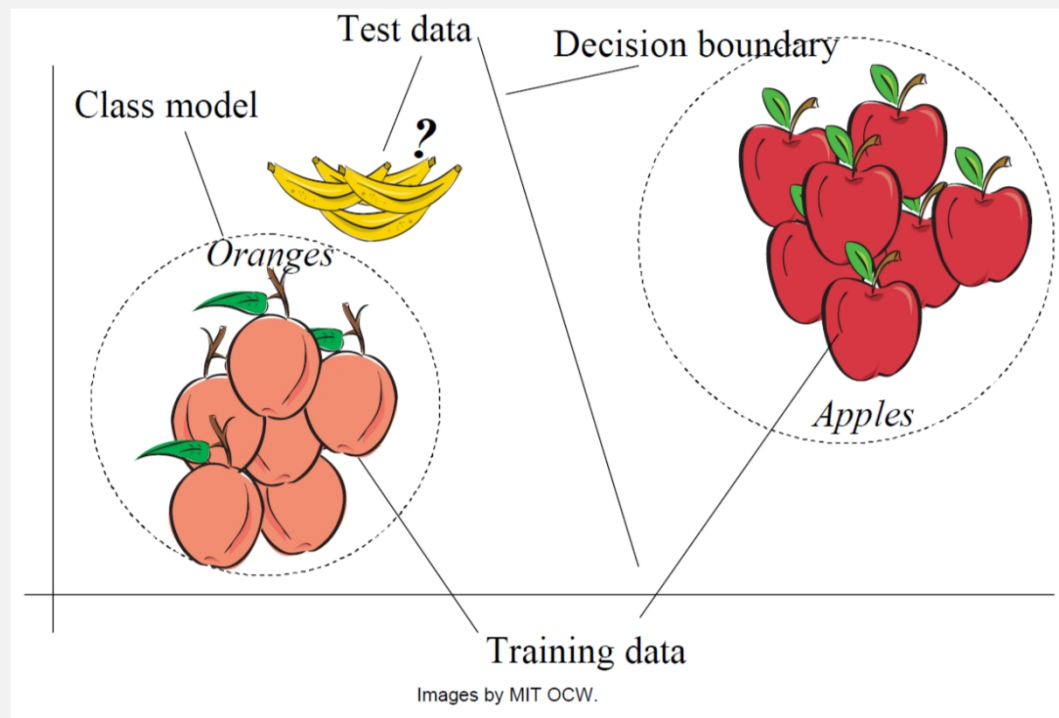
Images by MIT OCW.
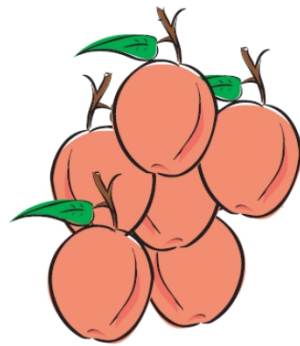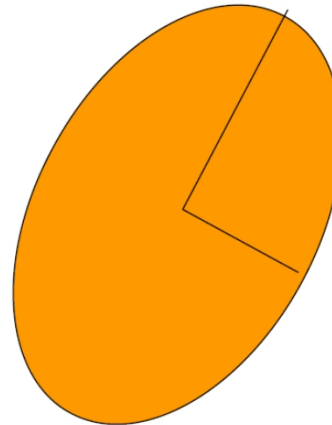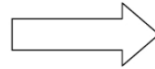
DENSITY ESTIMATION

Image by MIT OCW.

Individual samples → Generating density

μ, Σ

CLUSTERING

Images by MIT OCW.