

# Introduction to Machine Learning

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- 1, 2, 3, 4, 5, ?, ..., 24, 25, 26, 27, ?
- 1, 3, 5, 7, 9, ?, ..., 25, 27, 29, 31, ?
- 2, 3, 5, 7, 11, ?, ..., 29, 31, 37, 41, ?
- 1, 4, 9, 16, 25, ?, ..., 121, 144, 169, ?
- 1, 2, 4, 8, 16, 32, ?, ..., 1024, 2048, 4096, ?
- 1, 1, 2, 3, 5, 8, ?, ..., 55, 89, 144, 233, ?
- 1, 1, 2, 4, 7, 13, ?, 44, 81, 149, 274, 504, ?
- 3, 5, 12, 24, 41, ?, ..., 201, 248, 300, 357, ?
- 1, 6, 19, 42, 59, ?, ..., 95, 117, 156, 191, ?

- 1, 2, 3, 4, 5, 6, ..., 24, 25, 26, 27, 28
- 1, 3, 5, 7, 9, 11, ..., 25, 27, 29, 31, 33
- 2, 3, 5, 7, 11, 13, ..., 29, 31, 37, 41, 43
- 1, 4, 9, 16, 25, 36, ..., 121, 144, 169, 196
- 1, 2, 4, 8, 16, 32, 64, ..., 1024, 2048, 4096, 8192
- 1, 1, 2, 3, 5, 8, 13, ..., 55, 89, 144, 233, 377
- 1, 1, 2, 4, 7, 13, 24, 44, 81, 149, 274, 504, 927
- 3, 5, 12, 24, 41, 63, ....., 201, 248, 300, 357, 419  
(2, 7, 12, 17, 22, 27, 32, 37, 42, 47, 52, 57, 62)
- 1, 6, 19, 42, 59, ?, ..., 95, 117, 156, 191, ?
- **Pattern: Any regularity or structure in data or source of data**
- **Pattern Analysis: Automatic discovery of patterns in data**

# Image Classification

**Tiger**



**Giraffe**



**Horse**



**Bear**





# Scene Image Classification

**Tall  
building**

**Inside  
city**

**Street**

**Highway**

**Coast**

**Open  
country**

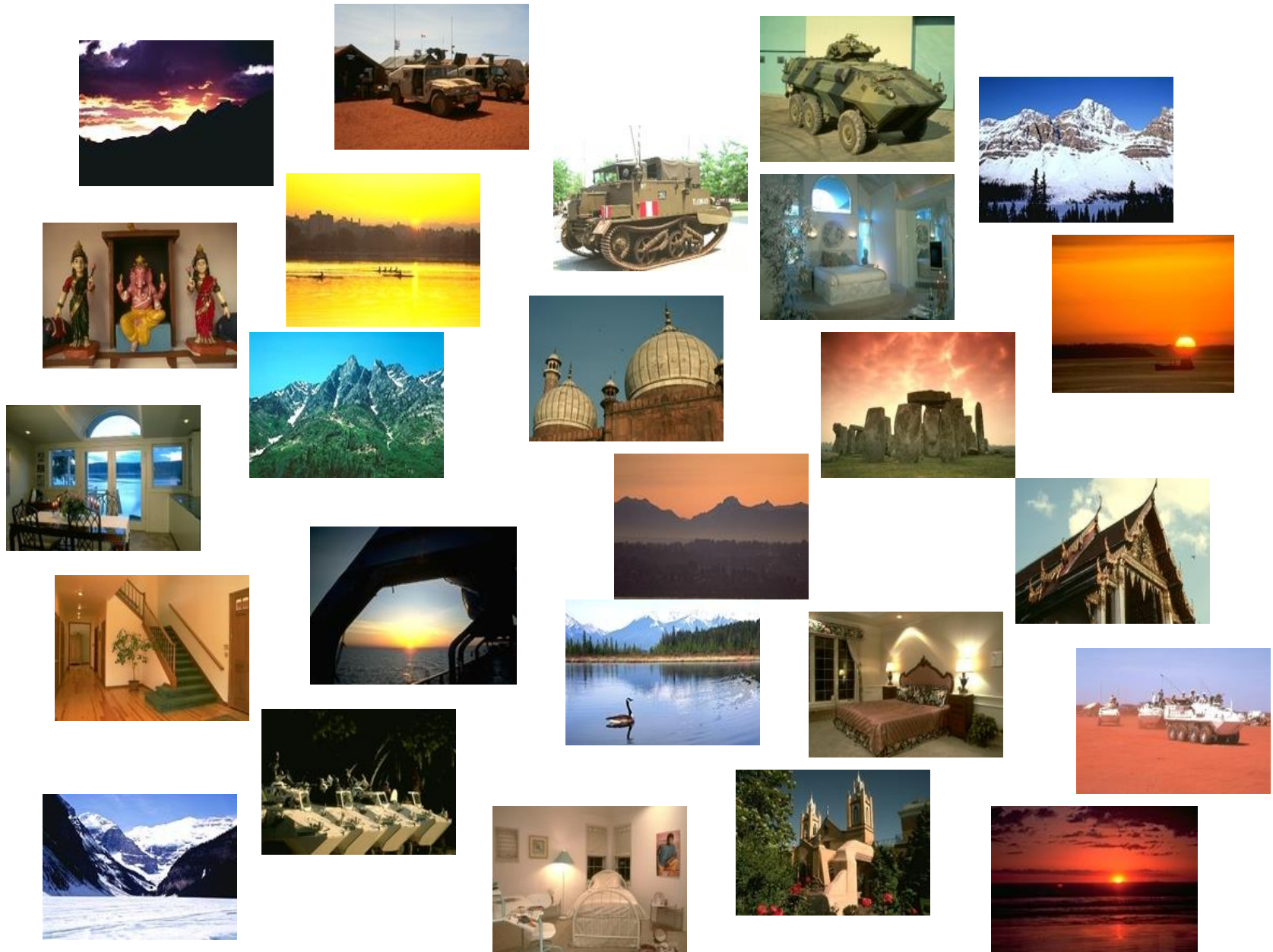
**Mountain**

**Forest**





# Scene Image Clustering



# Scene Image Clustering

**Residential Interiors**



**Mountains**



**Military Vehicles**



**Sacred Places**

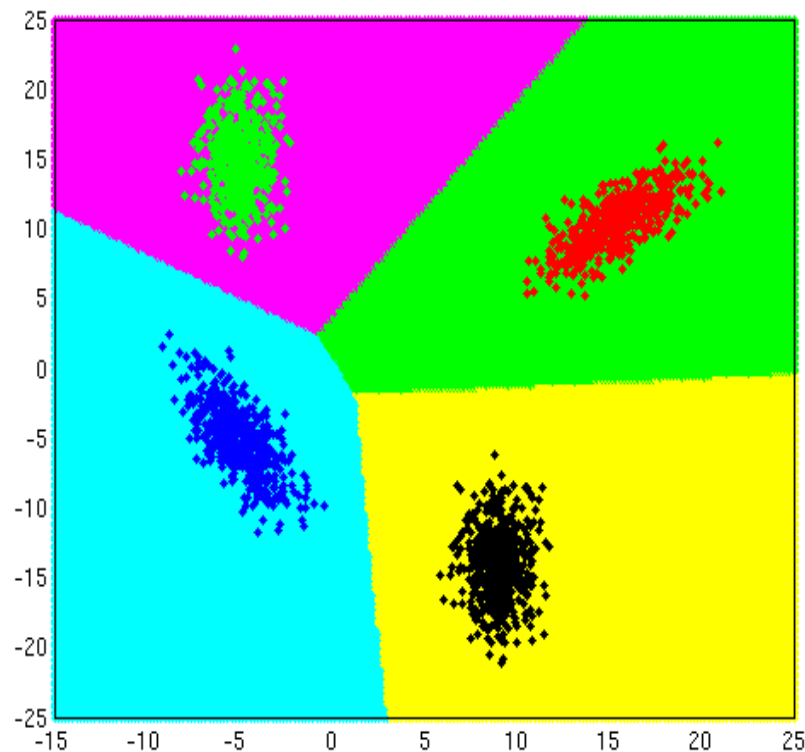
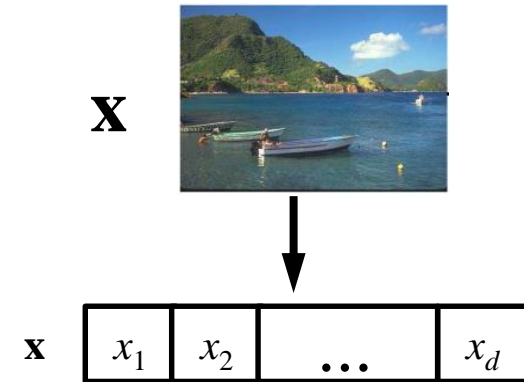
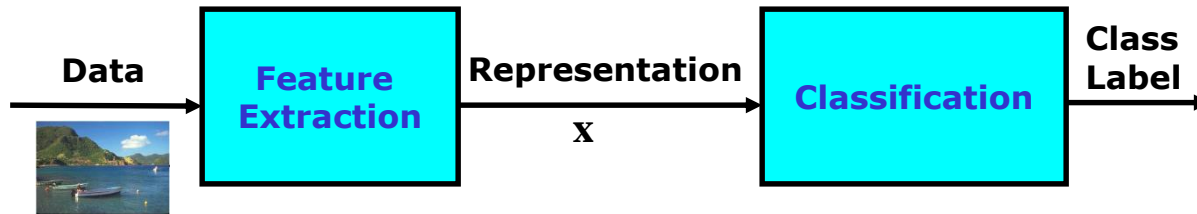


**Sunsets & Sunrises**



# Pattern Analysis Tasks

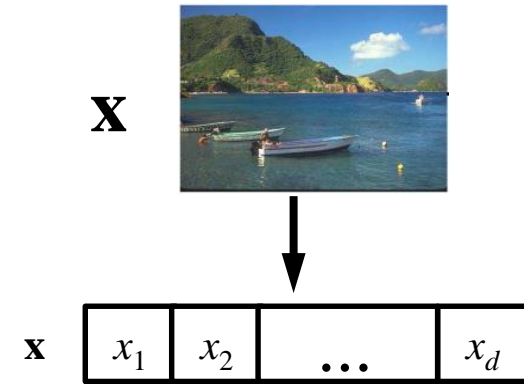
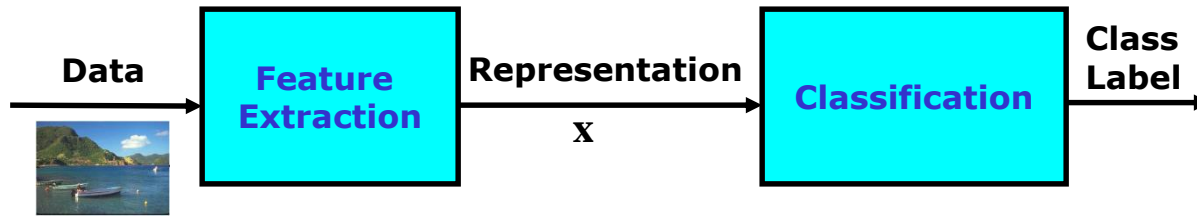
- **Pattern Classification:**
  - **Supervised learning**



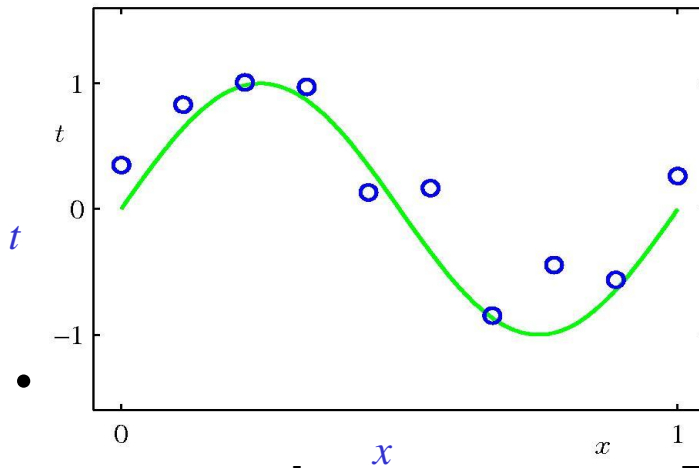


# Pattern Analysis Tasks

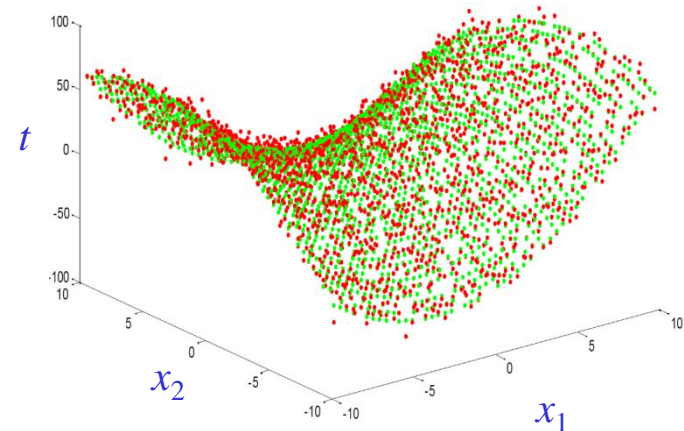
- **Pattern Classification:**
  - Supervised learning



- **Regression (Function Approximation):**
  - Supervised learning



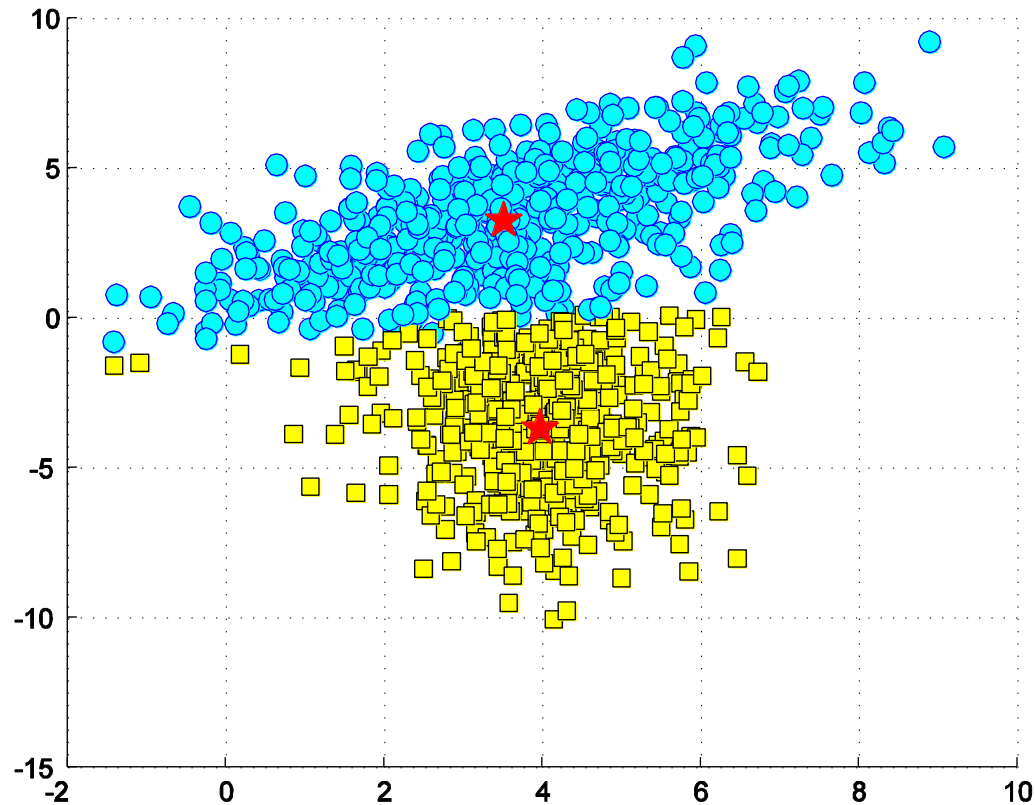
$$t = f(x)$$



$$t = f(\mathbf{x})$$

$$\mathbf{x} = [x_1, x_2]^T$$

# Pattern Analysis Tasks



- **Pattern Clustering**
  - Unsupervised learning

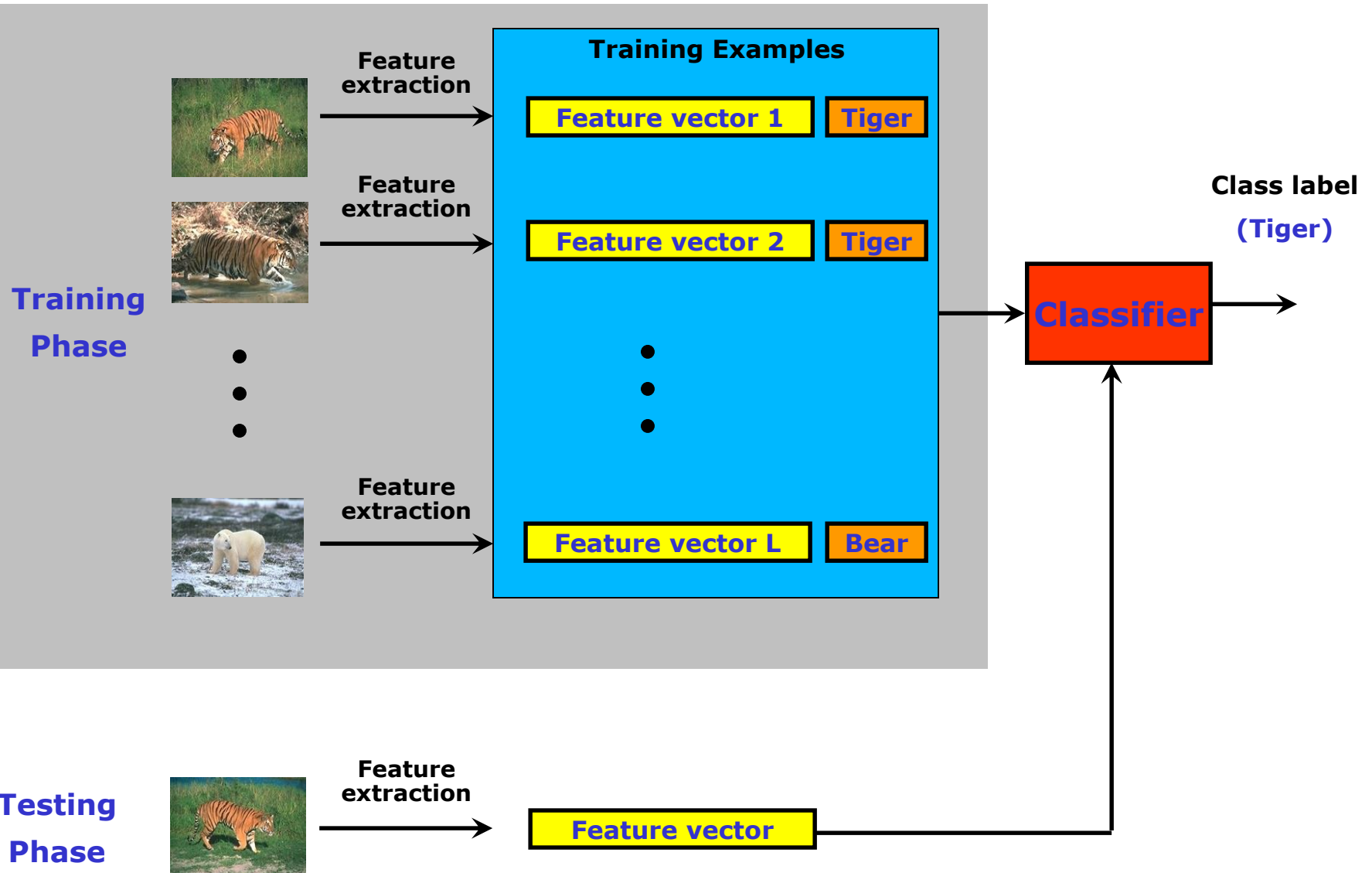
# Machine Learning for Pattern Recognition

- **Learning:** Acquiring new knowledge or modifying the existing knowledge
- **Knowledge:** Familiarity with information present in data
- **Learning by machines for pattern analysis:** Acquisition of knowledge from data to discover patterns in data
- **Data-driven techniques to learning by machines:** Learning from examples (Training of models)
- **Generalization ability of learning machines:** Performance of trained models on new (test) data
- **Target of learning techniques:** Good generalization ability



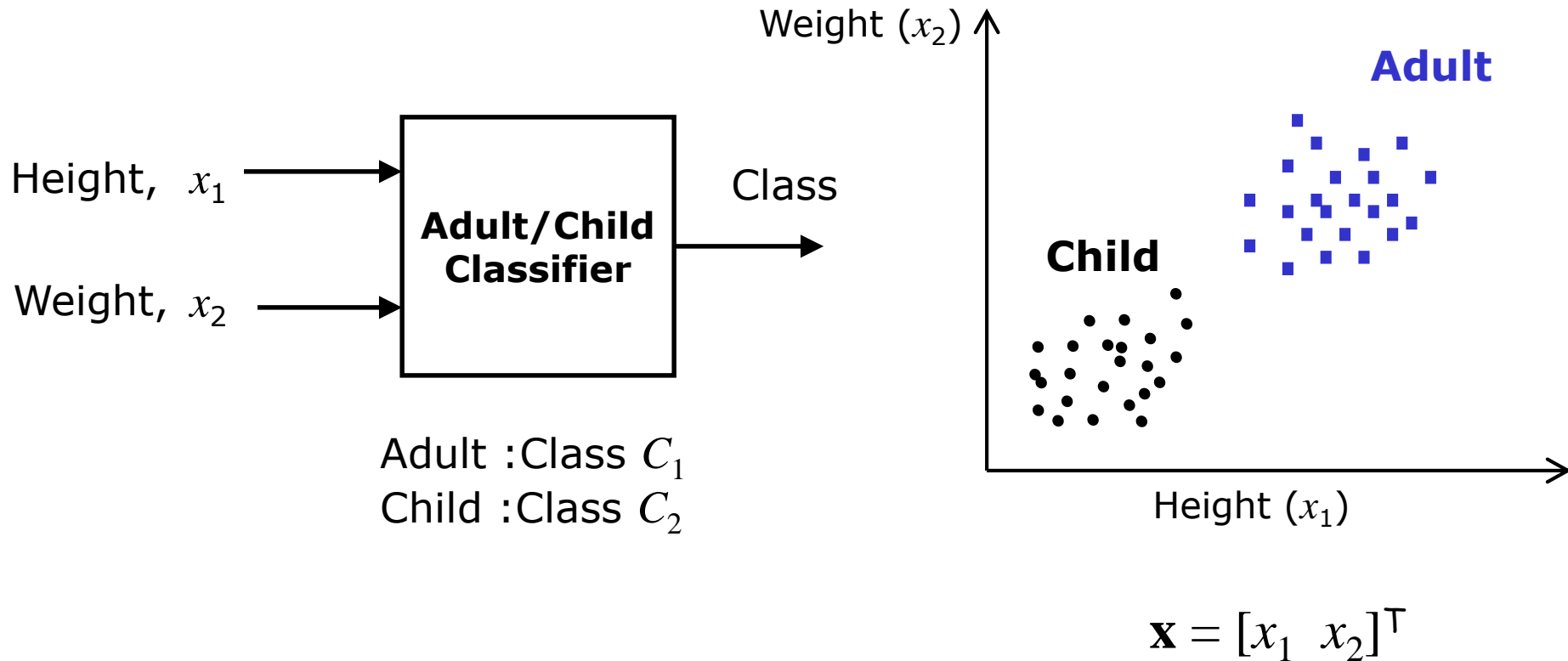
# Static Pattern Classification

**Static pattern:** An example is represented by a vector of features

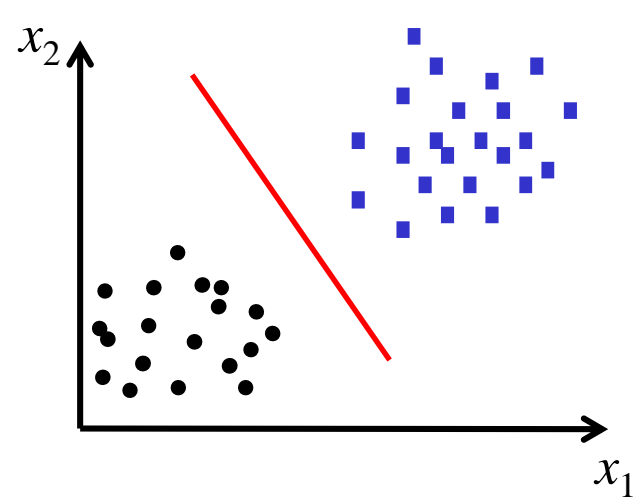


# 2-class pattern classification

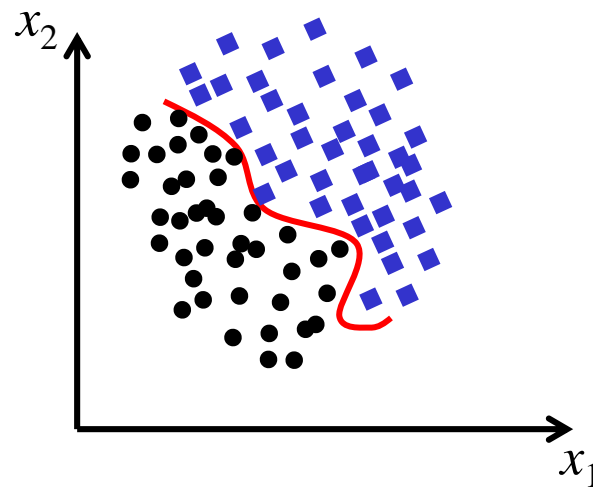
- **Example:** Classifying a person as child or adult



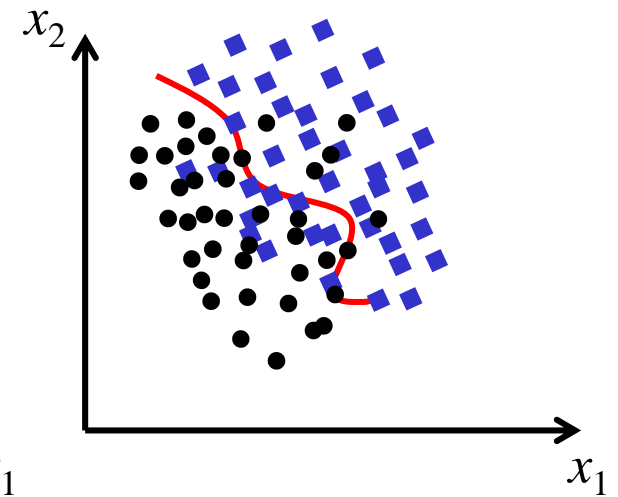
# Pattern Classification Problems



**Linearly  
separable  
classes**



**Nonlinearly  
separable  
classes**



**Overlapping  
classes**