

Introduction

Human Perception

Human have developed highly sophisticated skills for sensing their environment and taking actions according to what they observed 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.

Pattern Recognition

A pattern is an entity, vaguely defined, that could be given a name e.g.

- Fingerprint image
- Handwritten word
- Human face
- Speech signal
- DNA Sequence

Pattern recognition is the study of how machines can observe the environment, learn to distinguish patterns of interest, make sound and reasonable decisions about the categories of the patterns.

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

10.2 Pattern Recognition Applications

Problem Domain	Application	Input Pattern	Pattern Class
Document Image Analysis	Optical Character Recognition	Document image	Characters, Words
Remote Sensing	Forecasting Crop Yield	Multispectral image	Land use categories
Industrial Automation	Fruit Sorting	Images from conveyer	Grade of quality
Natural Language Processing	Information Extraction	Sentences	Parts of Speech
Document Classification	Junk Mail Filtering	Email	Junk/non-Junk
Multimedia Database Retrieval	Internet Search	Video clip	Video genres
Bioinformatics	Sequence Analysis	DNA sequence	Known types of genes

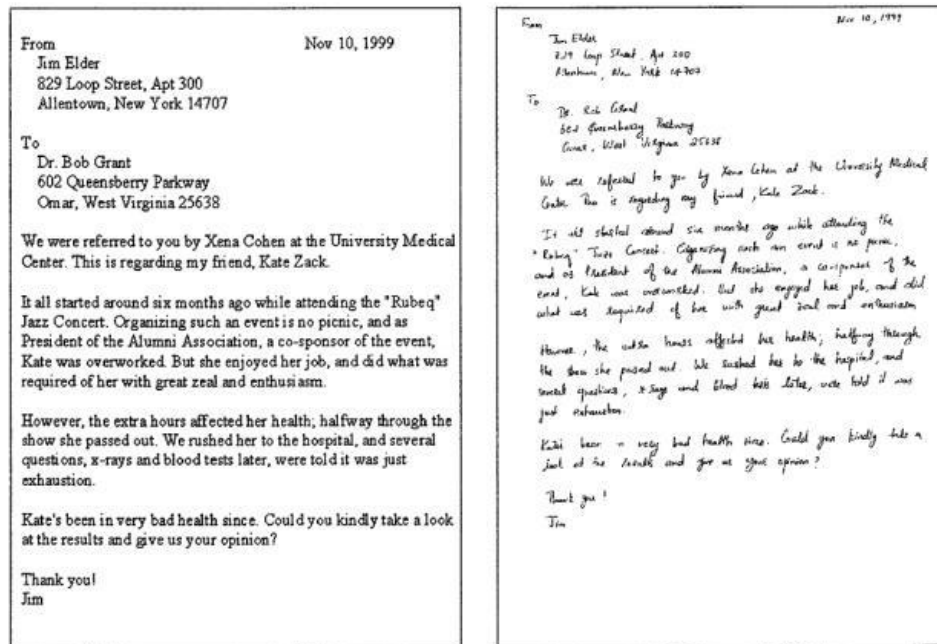


Figure 8.1: English Handwriting Recognition

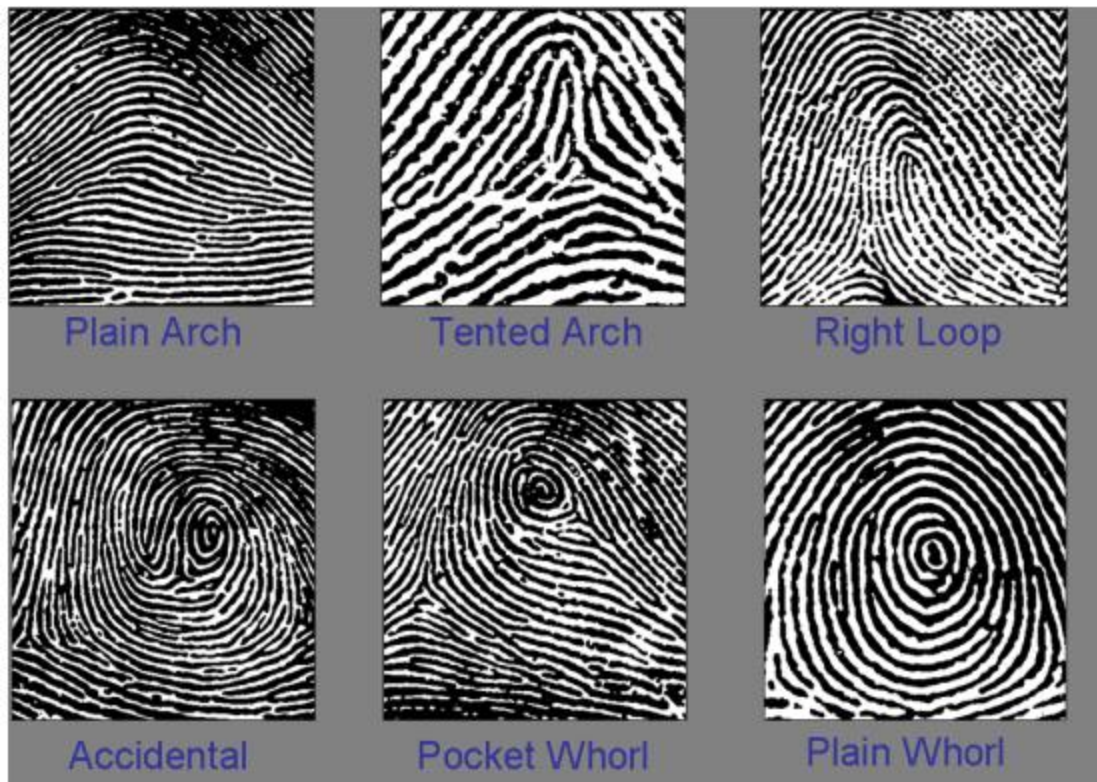


Figure 8.2: Fingerprint Recognition

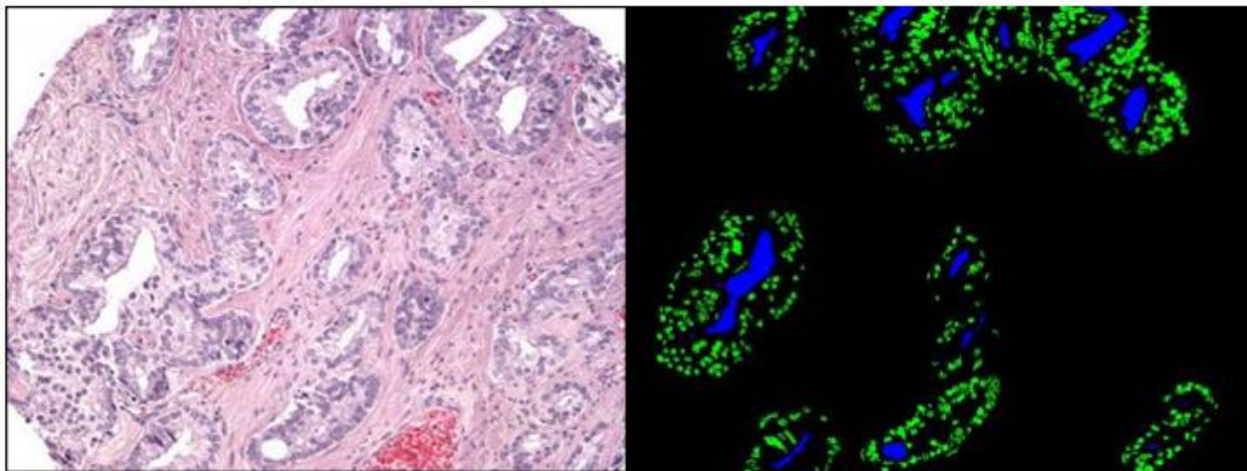


Figure 8.3: Cancer Detection and Grading Using Microscopic Tissue Data

10.3 Pattern Recognition System

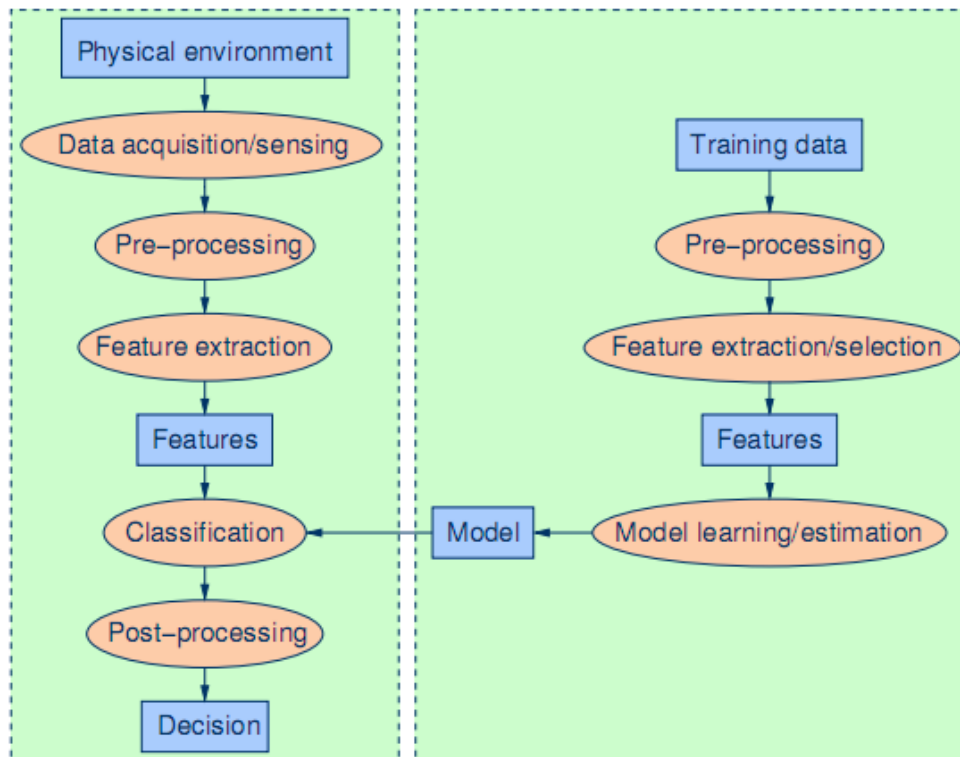


Figure 8.4: Process diagram of Pattern Recognition System

Data acquisition and Sensing:

- ✓ Measurement of physical variables.
- ✓ Important issues: Bandwidth, resolution, sensitivity, distortion, SNR, latency etc.

Pre-Processing:

- ✓ Removal of noise
- ✓ Isolation of patterns of interests from the background.

Feature Extraction:

- ✓ Finding a new representation in terms of features

Model learning and Estimation:

- ✓ Learning a mapping between features and pattern groups and categories.

Classification:

- ✓ Using features and learned models to assign a pattern to a category.

Post-Processing:

- ✓ Evaluation of confidence in decisions.
- ✓ Exploitation of context to improve performance.
- ✓ Combination of experts.

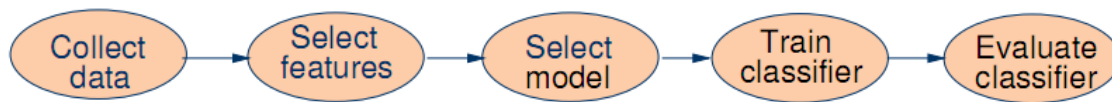
10.4 The Design Cycle

Figure 8.5: The Design Cycle for Pattern Recognition

Data Collection

- ✓ Collecting training and testing data.
- ✓ How can we know when we have adequately large and representative set of samples?

Feature Selection

- ✓ Domain dependence and prior information.
- ✓ Computational cost and feasibility.
- ✓ Robust features
- ✓ Discriminative features
 - Similar values for similar patterns.
 - Different values for different patterns.

Model Selection

- ✓ Domain dependence and prior information.
- ✓ Definition of design criteria.
- ✓ Computational complexity.

- ✓ Types of models: templates, theoretic or statistical, neural etc.

Training

- ✓ How can we learn the rule from data?
- ✓ Supervised learning: A teacher provides a category label of cost of each pattern in the training set.
- ✓ Unsupervised learning: The system form clusters or natural grouping of the input patterns.
- ✓ Reinforcement learning: No desired category is given but the teacher provides feedback to the system such as the decision is right or wrong.

Evaluation

- ✓ How can we estimate the performance with training samples?
- ✓ How can we predict the performance with future data?