UCS2H36 PRINCIPLES OF PATTERN RECOGNITION

Unit I

Introduction to Pattern Recognition

Machine perception, pattern recognition systems - sensing, segmentation, grouping, feature extraction - classification - post-processing, The design cycle - learning and adaptation, basics of probability, random processes and linear algebra : Probability : independence of events, conditional and joint probability

* Pattern

→ a set of data that is representative of some characteristic, structure or phenomenon that can be consistently observed & measured.

→ The data can be in the form of visual features, textual phrases

→ The goal in pattern recognition is to identify these patterns so that machines can categorize, predict or interpret new data based on learned patterns.

* Machine Perception

→ Build a machine that can recognize patterns. Can be

(i) speech recognition
(ii) OCR
(iii) finger print identification

→ Basic steps include preprocessing with segmentation, feature extraction, and then the use of a classifier

* Pattern Recognition Systems

Sensing

→ use of a transducer (camera or microphone)

→ The pattern recognition system depends on the bandwidth, the resolution, sensitivity distortion of the transducer.

Segmentation

→ Segmentation involves dividing an image, signal or dataset into distinct parts or sections. The goal is based on trying to break down a complex input into smaller, more manageable regions that may represent meaningful objects / parts of objects.

Image Segmentation - divide picture into different regions that might represent the background, foreground or specific objects.

Text Segmentation - Breaking text into sentences words or phrases

Speech segmentation - Dividing audio data into segments that might represent distinct phenomes or words.

→ Segmentation usually creates non-overlapping regions, where each part represents a unique segment of the data.

Grouping

→ The process of identifying and connecting similar or related segments across the data.

→ Grouping helps establish relationships on the basis of similarity, proximity or continuity.

→ This is crucial for recognizing patterns that span multiple segments or for identifying objects made up of multiple parts.

→ Grouping can be done for portions of images, cluster grouping in data and word grouping in text.

Difference between Segmentation and Grouping?

→ Segmentation is about dividing data into distinct parts without necessarily connecting them, enabling initial simplification of data.

→ Grouping is about finding connections or associations between the segmented parts to understand the overall structure or context.

* Pattern Recognition System Components

(i) Sensing

(ii) Segmentation

(iii) Feature Extraction

(iv) Classification

(v) Post-processing + decision-making

Segmentation & Grouping from previous page

Feature Extraction → extract discriminative features

→ Features can be invariant w.r.t translation, rotation and scale

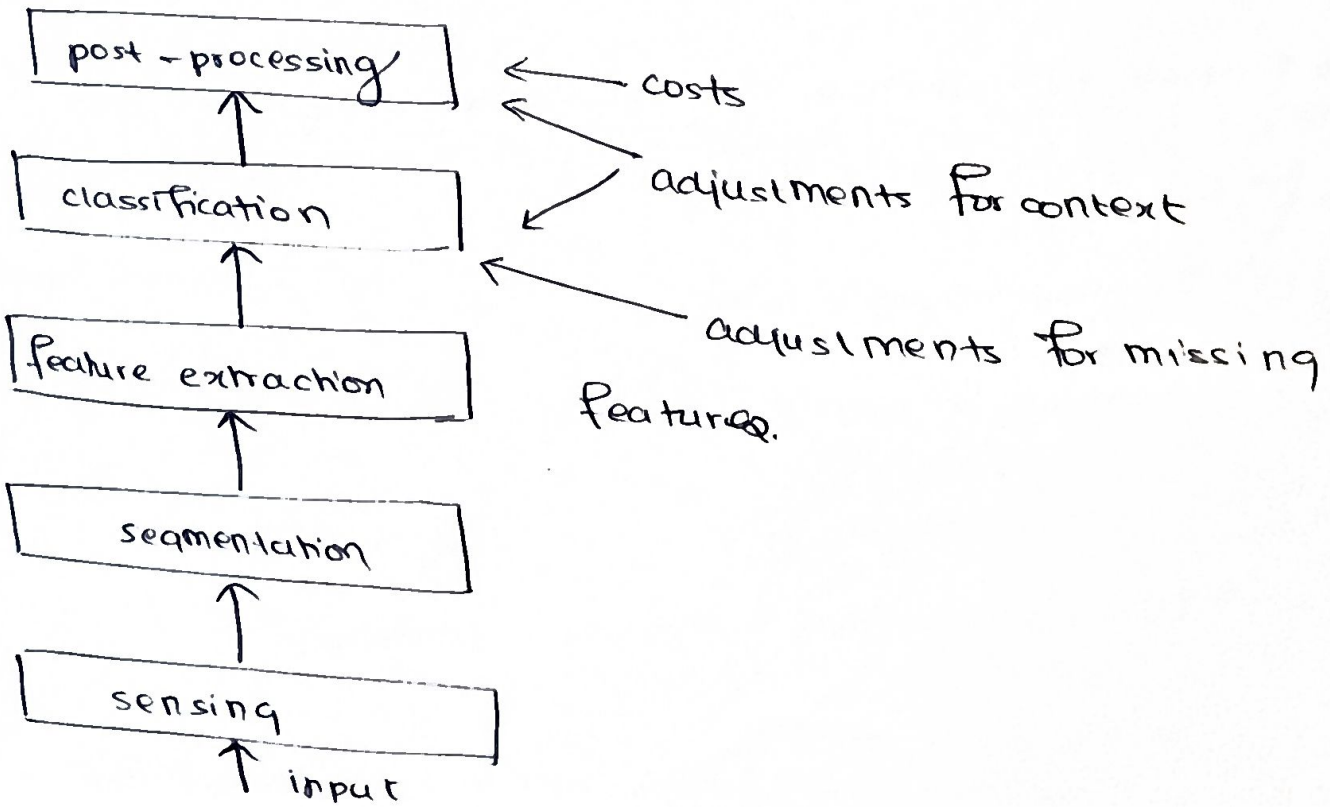
Classification → use a feature vector provided by a feature extractor to assign the object to a category.

Post processing → Exploit context-input-dependent information other than from the target pattern itself to improve performance.

Costs → Penalties associated with incorrect classifications or decisions

Adjustments for Context → Modifications based on surrounding information or conditions that influence the classification.

Adjustments for Missing Features → Techniques to handle incomplete data by estimating / compensating for missing info. before classification



Example → Pattern recognition to separate sea bass from salmon on a conveyor belt

1. Sensing - → A camera is set up on a conveyer belt to capture images of the incoming fish

→ capture raw images of fish as input

2. Segmentation - → System isolates each fish from the background & other objects on the conveyer belt..

→ Focus on the fish rather than irrelevant details

3. Feature Extraction → Specific features of the fish, such as length, lightness, width, fin shape

→ Provides measurable characteristics to differentiate between fish species

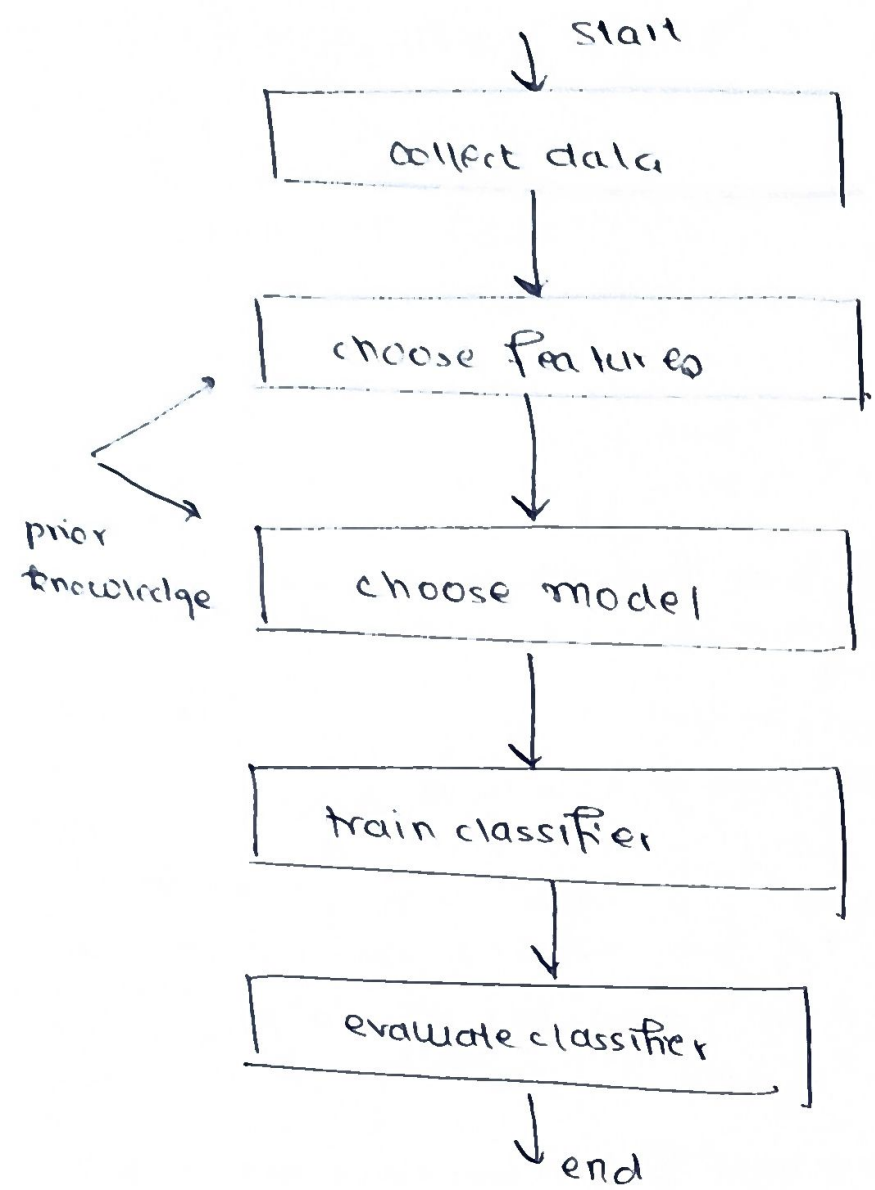
4. Classification - Based on the extracted features, apply a model.

The model may use specific features to adjust the decision boundaries to minimize misclassification cost

5. Post-Processing - adjust results based on contextual factors

6. Decision - The final decision is made and the fish is sorted accordingly.

→ Design Cycle of Pattern Recognition



(i) Data Collection - choose an adequately large and representative set of examples for training & testing the system

(ii) Feature Selection - depends on the characteristics of the problem domain. Should be simple to extract, invariant to irrelevant transformation, insensitive to noise

(iii) Model Choice - domain & problem specific

(iv) Training - use data features to determine the classifier and its features

(v) Evaluation - measure the error rate & switch features & parameters.

(vi) Evaluate computational complexity - analyse trade-off between computational ease and performance.

- evaluate how each algorithm scales as a function of the number of features, patterns and categories

* Learning and Adaptation

→ supervised learning - associated with labels / human annotations in the training dataset

→ unsupervised learning - the system forms clusters or 'natural groupings' of the input patterns