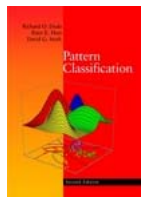
Chapter 1: Introduction to Pattern Recognition

- Machine Perception
- An example
- Pattern Recognition Systems
- The Design Cycle
- Learning and Adaptation
- Conclusion

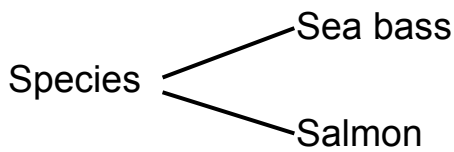


Machine Perception

- Build a machine that can recognize patterns:
  - Speech recognition
  - Fingerprint identification
  - OCR (Optical Character Recognition)
  - DNA sequence identification

An Example

"Sorting incoming Fish on a conveyor according to species using optical sensing"



2

❖Problem Analysis

- ❖Set up a camera and take some sample images to extract features
  - ❖Length
  - ❖Lightness
  - ❖Width
  - ❖Number and shape of fins
  - ❖Position of the mouth, etc…

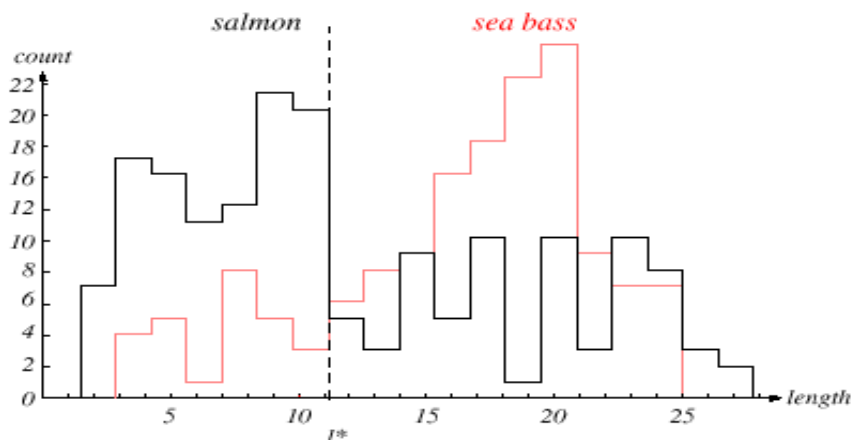
  This is the set of all suggested features to explore for use in our classifier!

2

- Preprocessing
  - Use a segmentation operation to isolate fishes from one another and from the background
- Information from a single fish is sent to a feature extractor whose purpose is to reduce the data by measuring certain features
- The features are passed to a classifier

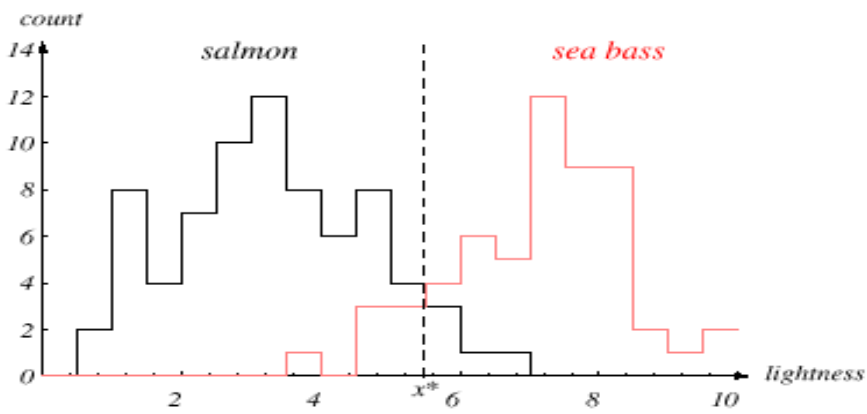
❖Classification

Select the length of the fish as a possible feature for discrimination



The length is a poor feature alone!

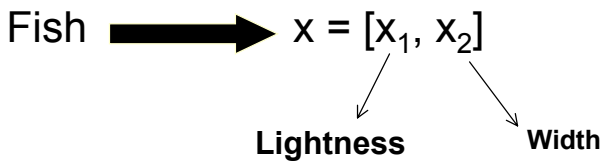
Select the lightness as a possible feature.

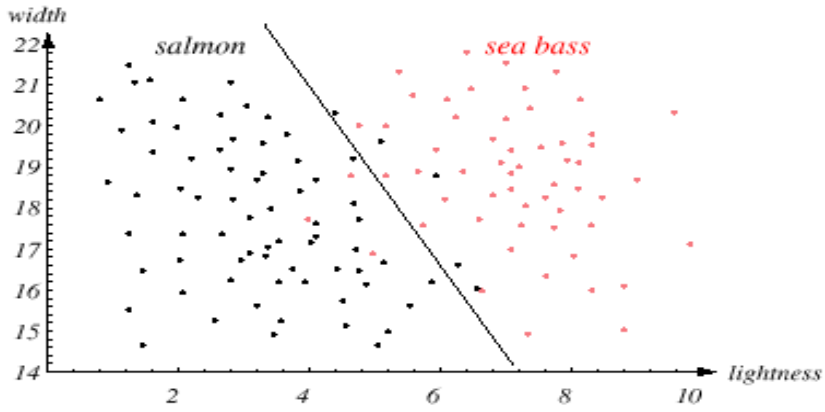


- Threshold decision boundary and cost relationship
  - Move our decision boundary toward smaller values of lightness in order to minimize the cost (reduce the number of sea bass that are classified salmon!)

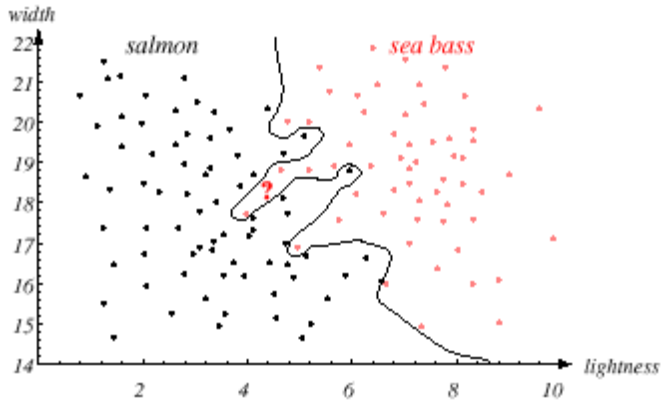
Task of decision theory

- Adopt the lightness and add the width of the fish



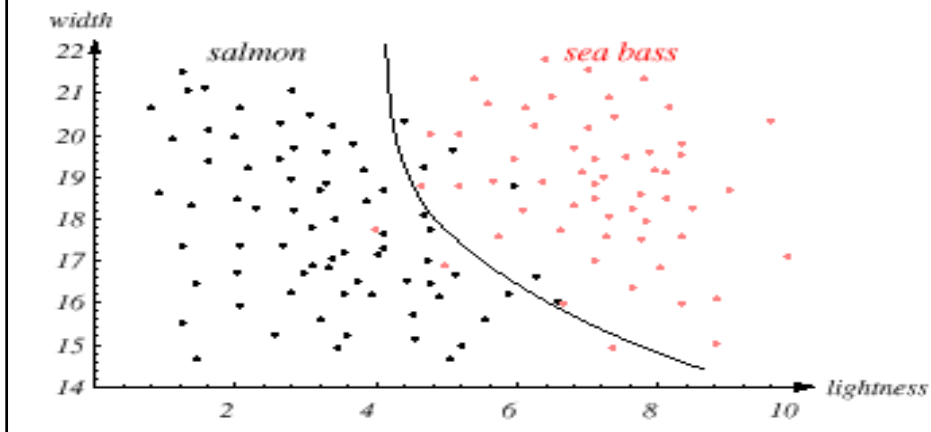


- We might add other features that are not correlated with the ones we already have. A precaution should be taken not to reduce the performance by adding such "noisy features"
- Ideally, the best decision boundary should be the one which provides an optimal performance such as in the following figure:



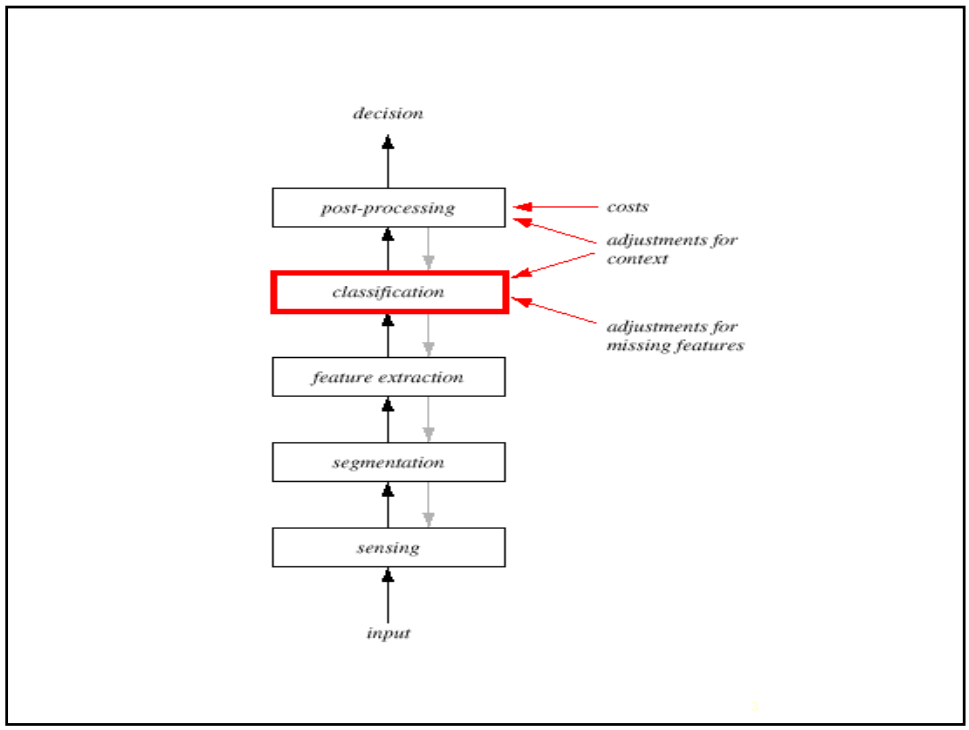
❖However, our satisfaction is premature because the central aim of designing a classifier is to correctly classify novel input

Issue of generalization!



Pattern Recognition Systems

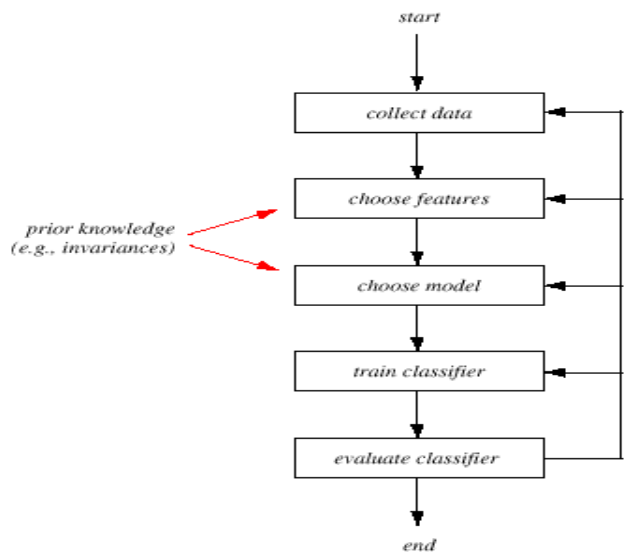
- Sensing
  - Use of a transducer (camera or microphone)
  - PR system depends of the bandwidth, the resolution sensitivity distortion of the transducer
- Segmentation and grouping
  - Patterns should be well separated and should not overlap



- Feature extraction
  - Discriminative features
  - Invariant features with respect to 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

The Design Cycle

- Data collection
- Feature Choice
- Model Choice
- Training
- Evaluation
- Computational Complexity



❖Data Collection

How do we know when we have collected an adequately large and representative set of examples for training and testing the system?

❖Feature Choice

Depends on the characteristics of the problem domain. Simple to extract, invariant to irrelevant transformation insensitive to noise.

❖Model Choice

Unsatisfied with the performance of our fish classifier and want to jump to another class of model

❖Training

Use data to determine the classifier. Many different procedures for training classifiers and choosing models

❖Evaluation

Measure the error rate (or performance and switch from one set of features to another one

❖Computational Complexity

What is the trade off between computational ease and performance?

(How an algorithm scales as a function of the number of features, patterns or categories?)

Learning and Adaptation

- 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

Conclusion

- Reader seems to be overwhelmed by the number, complexity and magnitude of the sub-problems of Pattern Recognition
- Many of these sub-problems can indeed be solved
- Many fascinating unsolved problems still remain