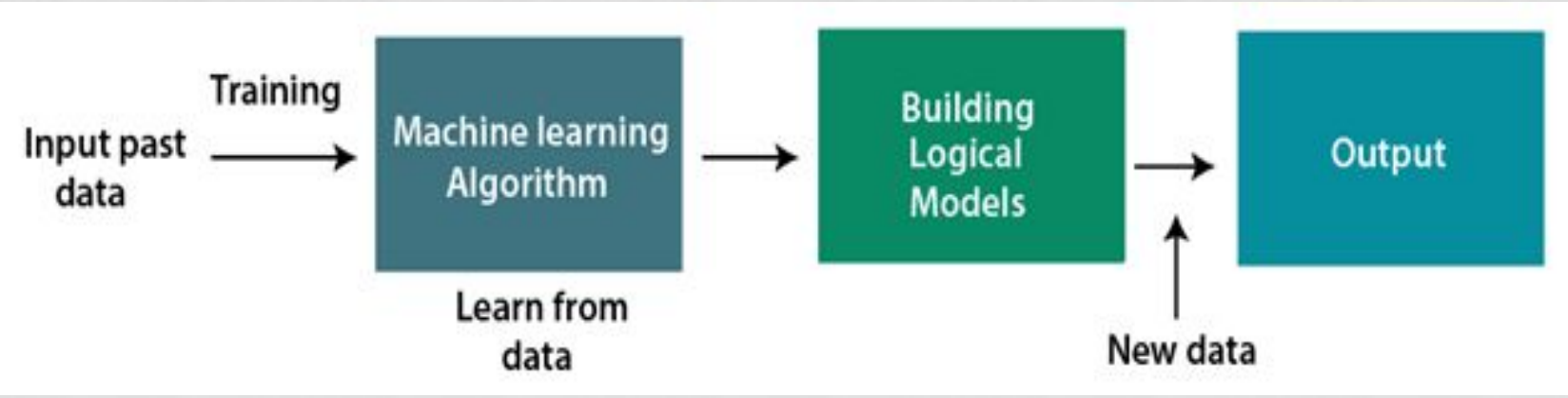
WHAT IS MACHINE LEARNING:

- “Machine learning is the field of study that enables a machine to automatically learn from data, improve performance from experiences, and predict things without being explicitly programmed.” (**Arthur Samuel 1959**)

HOW DOES MACHINE LEARNING WORK

- A Machine Learning system **learns from historical data which in known as training data, builds the prediction models, and whenever it receives new data, predicts the output for it.**
- The accuracy of predicted output depends upon the amount of data, as the huge amount of data helps to build a better model which predicts the output more accurately.



FEATURES OF MACHINE LEARNING

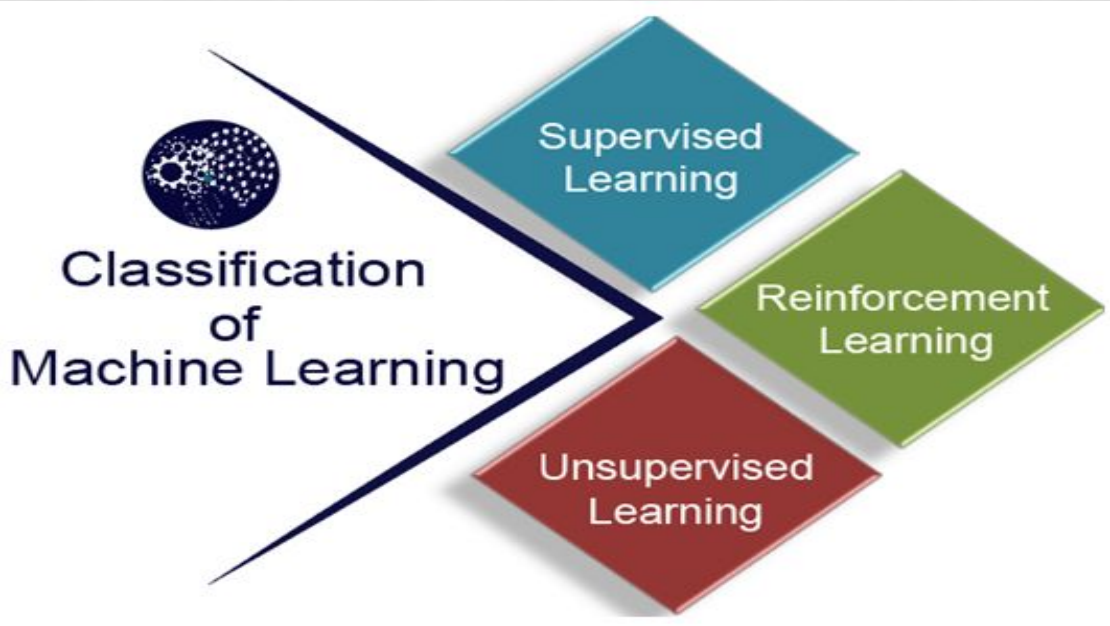
- Machine learning uses data to detect various patterns in a given dataset.
- It can learn from past data and improve automatically.
- It is a data-driven technology.
- Machine learning is much similar to data mining as it also deals with the huge amount of the data.

WHY MACHINE LEARNING

- Human has limitation in assessing the huge amount of data, manually.
- Using ML, algorithms can be trained on the huge amount of data that can:
  - explore the data
  - construct the models
  - predict the required output automatically.
  - can save both time and money.
- Decision making in various sector including finance
- Finding hidden patterns and extracting useful information from data.

CLASSIFICATION OF MACHINE LEARNING

- At a broad level, machine learning can be classified into three types:
  - **Supervised learning**
  - **Unsupervised learning**
  - **Reinforcement learning**



SUPERVISED LEARNING

- A type of machine learning method in which:
  - labeled data is provided to the machine learning system in order to train it,
  - The system creates a model using labeled data to understand the datasets and learn about each data,
  - On the basis of learning, Model predicts the output for an unlabeled data
- Basically discovers patterns in the data that relate data attributes with a target (class) attribute.
- Performance of model is measured on the basis of that how accurately new data is predicted

SUPERVISED LEARNING

- The two most common types of supervised learning are
- **Classification**
  - Prediction/Classification of the discrete values
  - outputs are discrete labels
  - Male or Female, True or False, Spam or Not Spam, etc.
- **Regression**
  - algorithms are used to predict the continuous values
  - outputs are real-valued.
  - price, salary, age, stock exchange market prediction

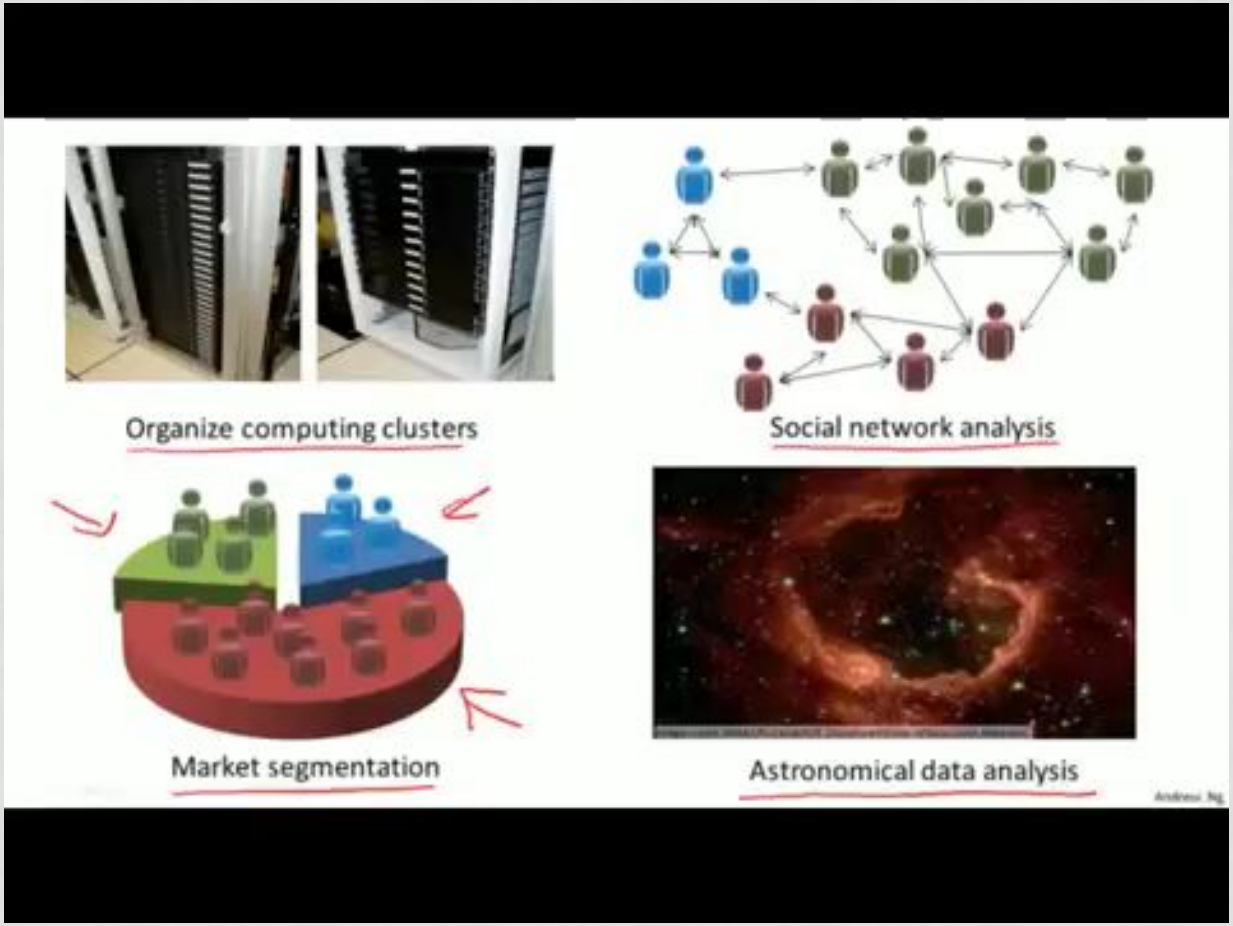
UNSUPERVISED LEARNING

- In unsupervised learning or clustering there is no explicit supervision, and the system forms clusters or "natural groupings" of the input patterns.
- The data have no target attribute. i.e. input data set is unlabeled
- we don't have a predetermined result. The machine tries to find useful insights from the huge amount of data

UNSUPERVISED LEARNING

- The two most important examples are
- **Dimension reduction**
  - Principle component Analysis(PCA)
    - Singular Value Decomposition(SVD), for matrix factorization in PCA
  - Independent computing analysis (ICA)
    - a technique to separate the mixture of signals into their different sources
- **Clustering**.
  - K- MEANS
  - density-based clustering
    - unsupervised learning methods that identify distinctive groups/clusters in the data
  - Hierarchical Clustering

UNSUPERVISED LEARNING

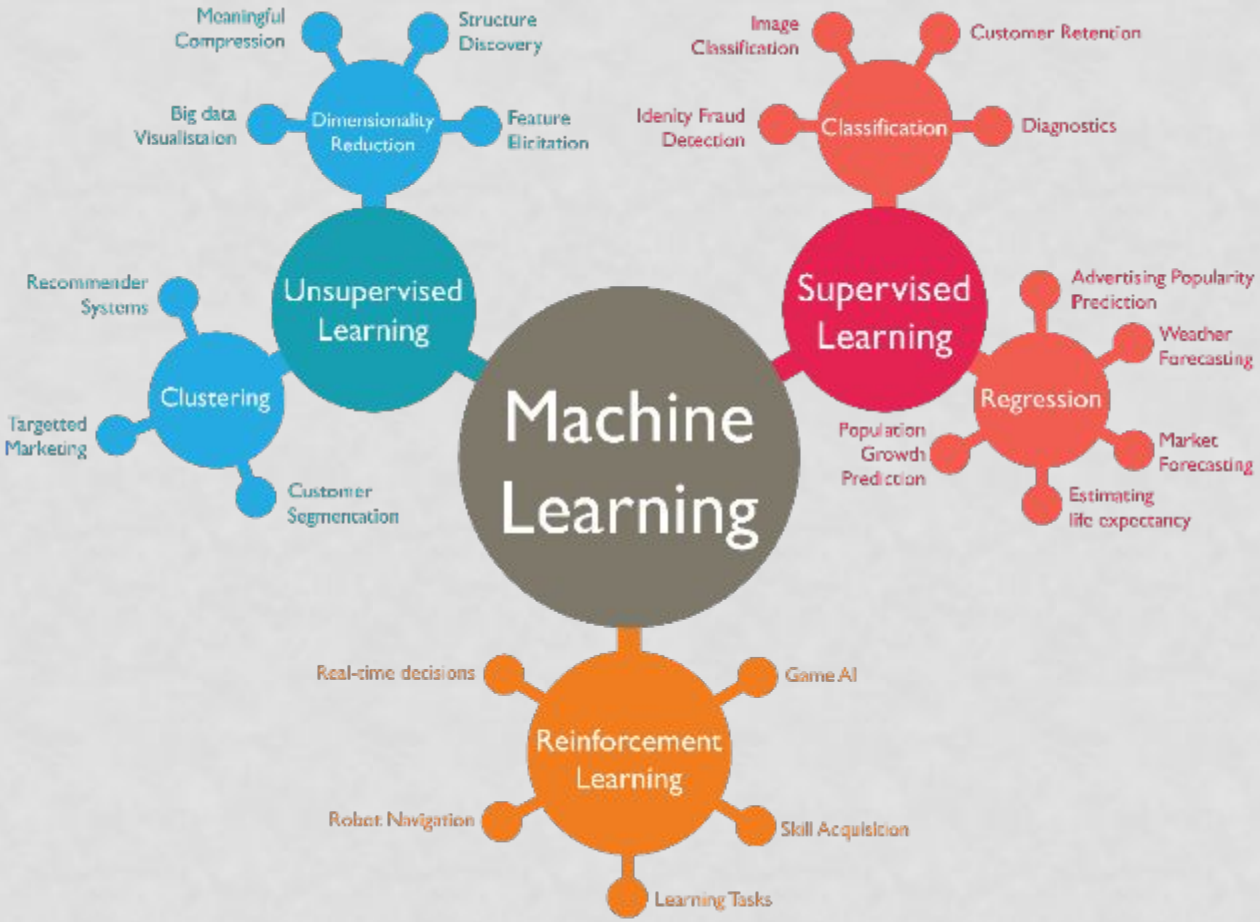


REINFORCEMENT LEARNING

- Reinforcement Learning is a type of Machine Learning, and thereby also a branch of Artificial Intelligence.
- A feedback-based learning method, in which a learning agent gets a reward for each right action and gets a penalty for each wrong action
- The agent learns automatically with these feedbacks and improves its performance to get the most reward points.

SOME OTHE TYPES OF ML

- **Semi-supervised learning**
  - In which only a subset of the training data is labeled.
- **Time-series forecasting**
  - Such as in financial markets
- **Anomaly detection**
  - Such as used for fault-detection in factories and in surveillance


Machine Learning
Unsupervised Learning
Meaningful Compression
Structure Discovery
Dimensionality Reduction
Big data Visualisaion
Feature Elicitation
Clustering
Recommender Systems
Targetted Marketing
Customer Segmentation
Supervised Learning
Image Classification
Customer Retention
Classification
Identity Fraud Detection
Diagnostics
Regression
Advertising Popularity Prediction
Weather Forecasting
Population Growth Prediction
Market Forecasting
Estimating life expectancy
Reinforcement Learning
Real-time decisions
Game AI
Robot Navigation
Skill Acquisition
Learning Tasks

APPLICATIONS OF ML

- Face Recognition
- Character recognition
- Finger print recognition
- Object recognition
- Medical imaging
- Document classification
- And many more…

PATTERN RECOGNITION

- Pattern recognition is the use of machine learning algorithms to identify patterns.
- It classifies data based on statistical information or knowledge gained from patterns and their representation.

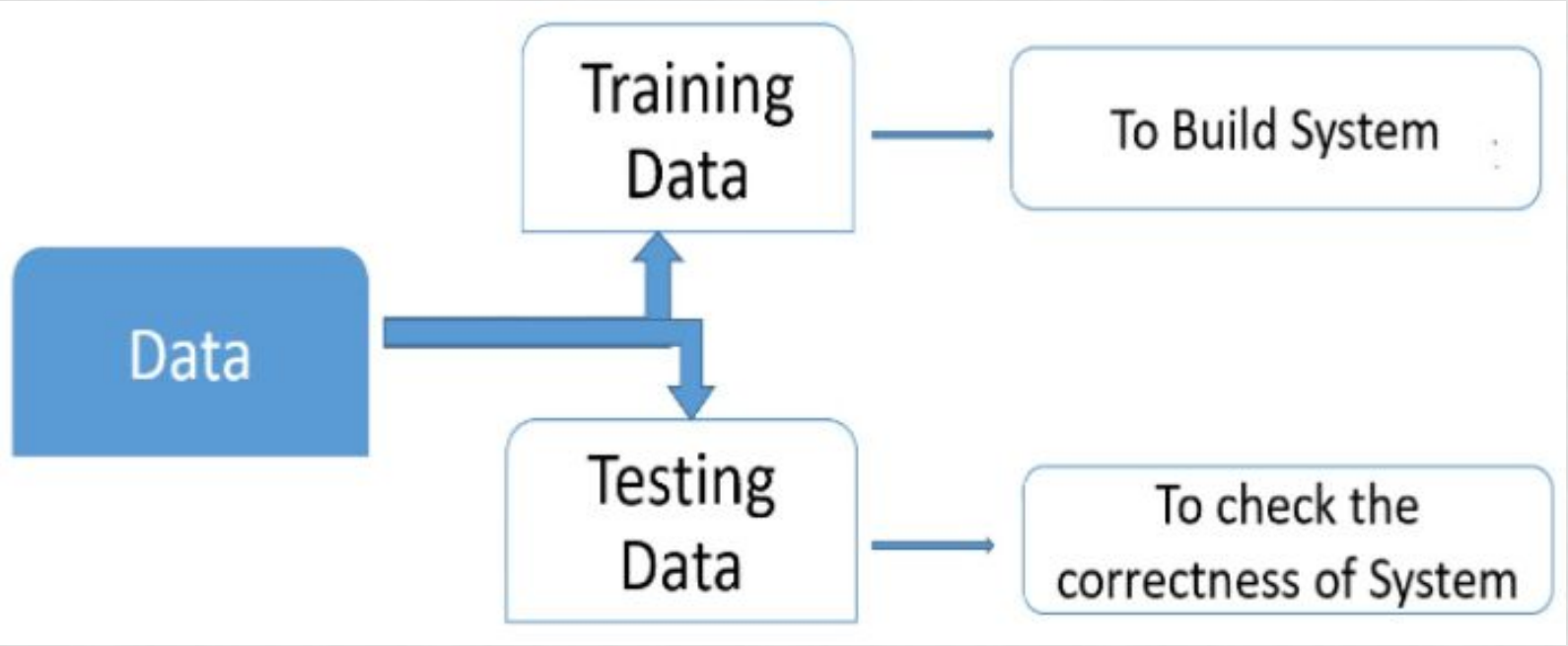
- In case of labelled data, labeled training data is used to train pattern recognition systems. A label is attached to a specific input value that is used to produce a pattern-based output.
- In the absence of labeled data, computer algorithms may be employed to find unknown patterns.

FEATURES OF PATTERN RECOGNITION

- Pattern recognition has the following features:
  - completely rely on data and derives any outcome or model from data itself
  - It has great precision in recognizing patterns.
  - It can recognize unfamiliar objects.
  - It can recognize shapes and objects accurately from various angles.
  - It can recover patterns in instances of missing data.
  - A pattern recognition system can discover patterns that are partly hidden.

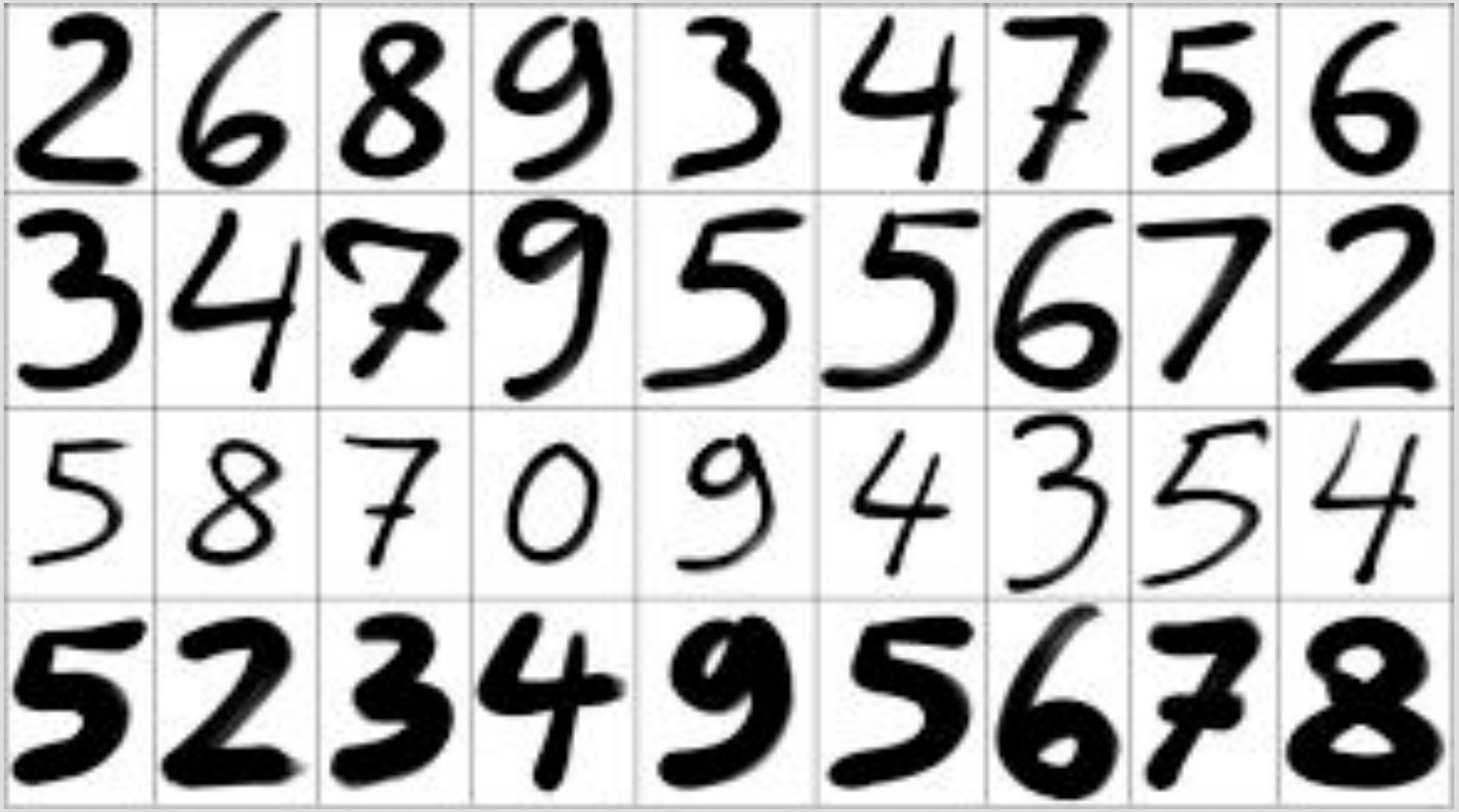
HOW PATTERN RECOGNITION WORKS

- A system gets trained and becomes adaptable to give result in an accurate manner
- A section of the dataset is used for training the system while the rest is used for testing it.

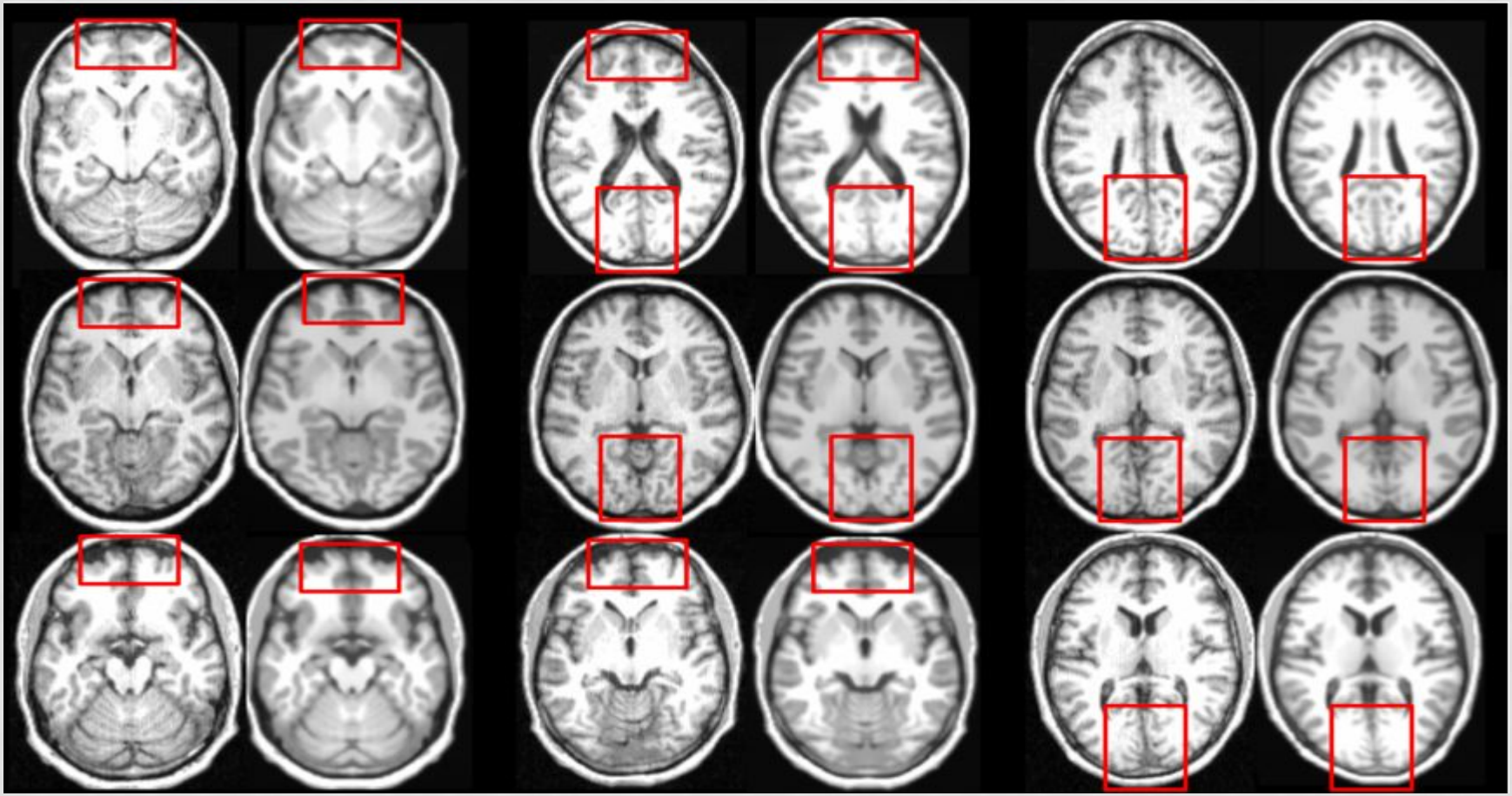


- Training Data
  - The training set contains images or data used for training or building the model.
  - Training rules are used to provide the criteria for output decisions.
  - All the relevant information is extracted from the data and results are obtained.
  - Generally, 80-85% of the data of the dataset is taken for training data.
- Testing Data
  - Testing data is used to test the system.
  - It is the set of data which is used to verify whether the system is producing the correct output after being trained or not.
  - Generally, 20% of the data of the dataset is used for testing.
  - Testing data is used to measure the accuracy of the system.

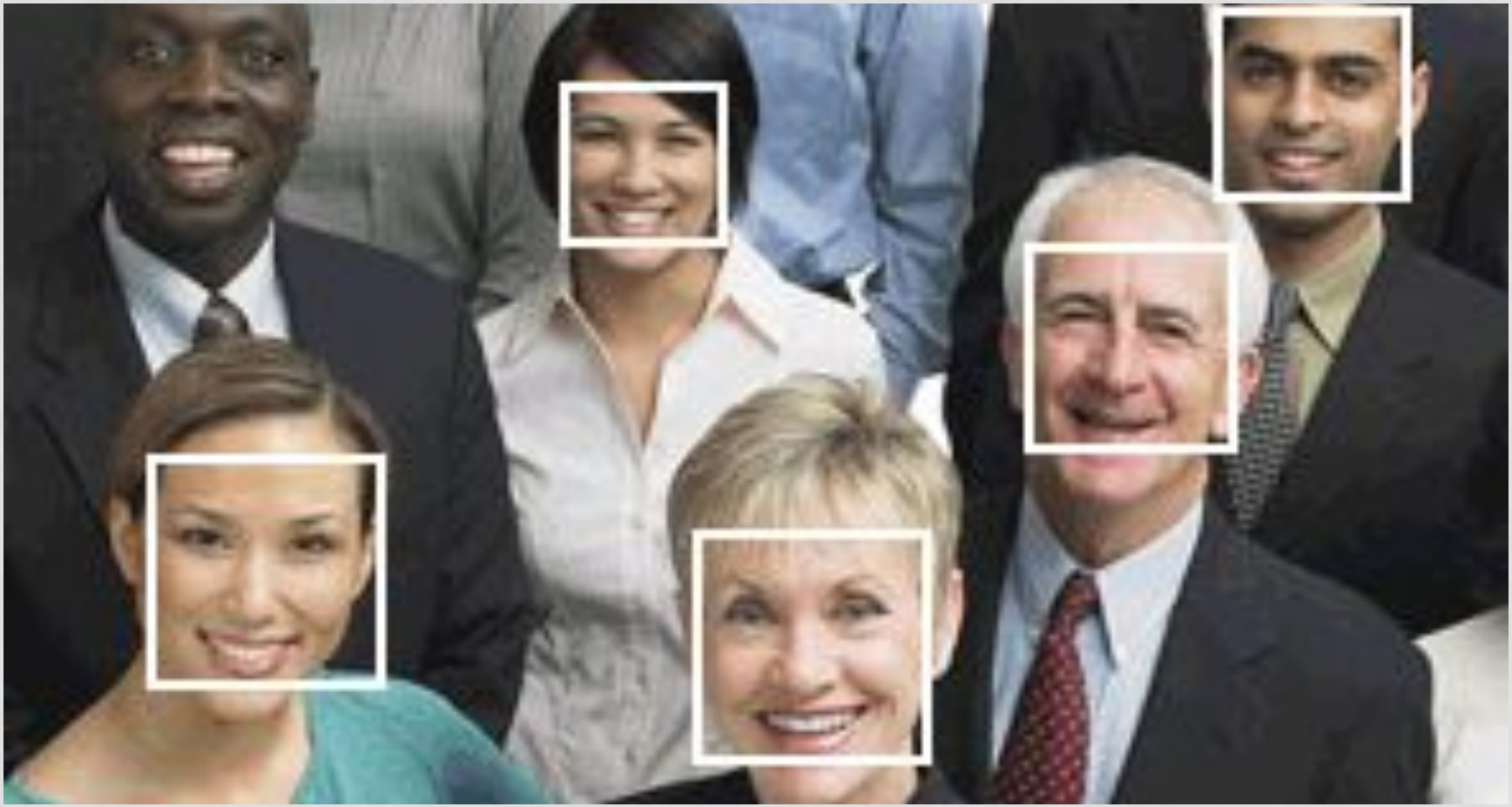
EXAMPLE



EXAMPLE



SEGMENTATION

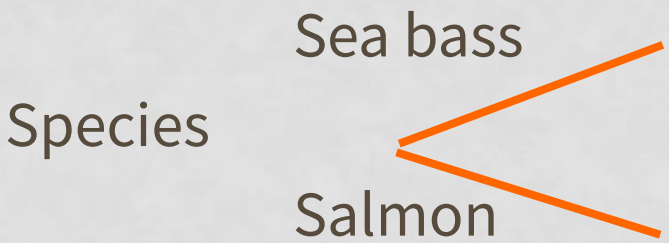


MACHINE PERCEPTION

- 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”



- Problem Analysis

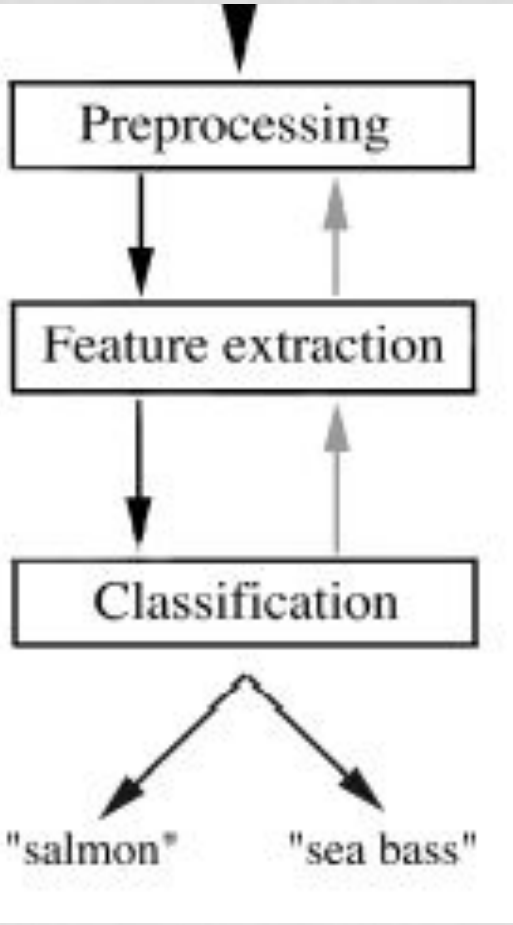
  - Set up a camera and take some sample images to extract features

    - Length
    - Lightness
    - Width
    - Number and shape of fins
    - Position of the mouth, etc…

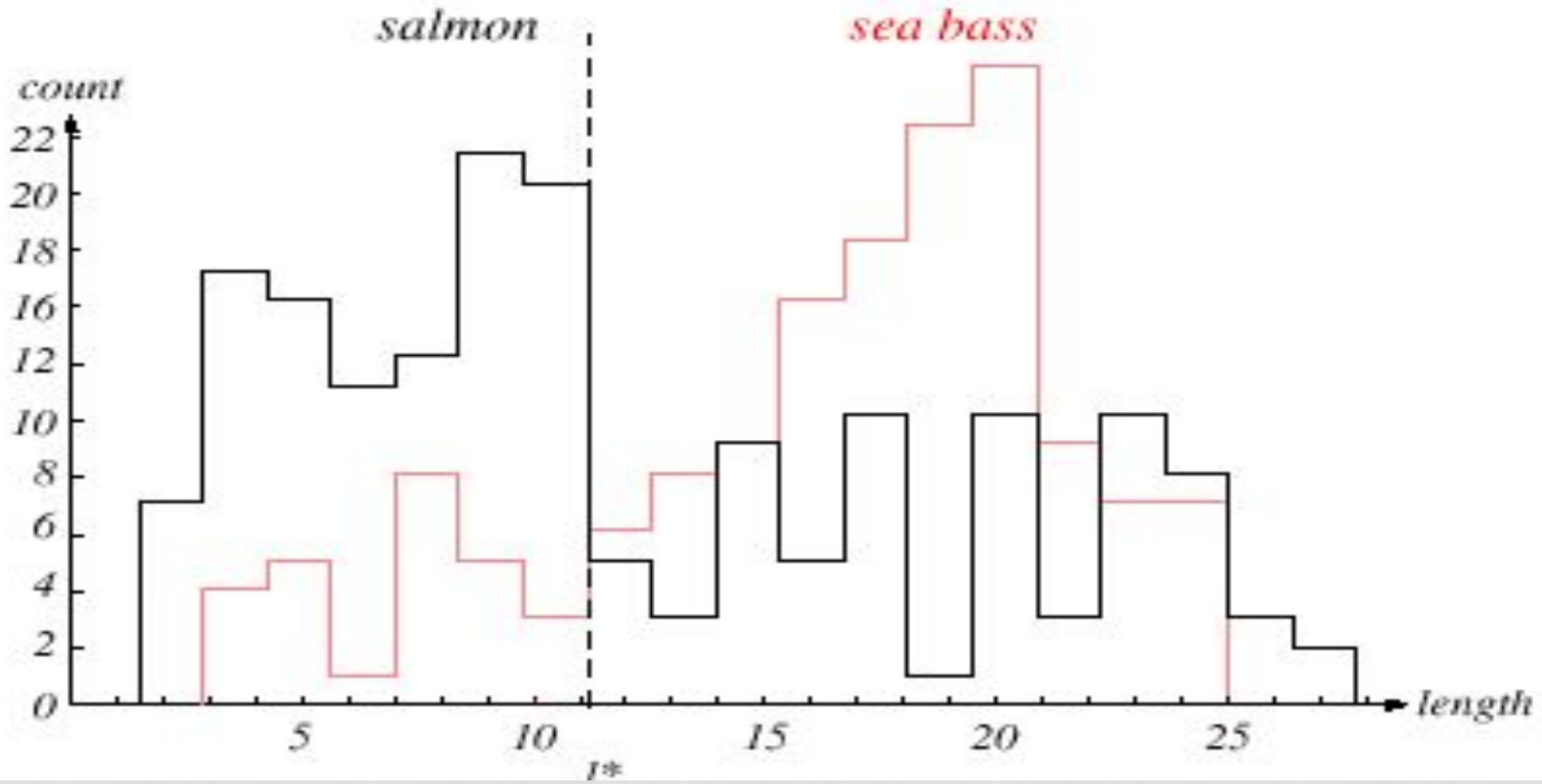
    - This is the set of all suggested features to explore for use in our classifier!

Preprocessing and Features Extraction

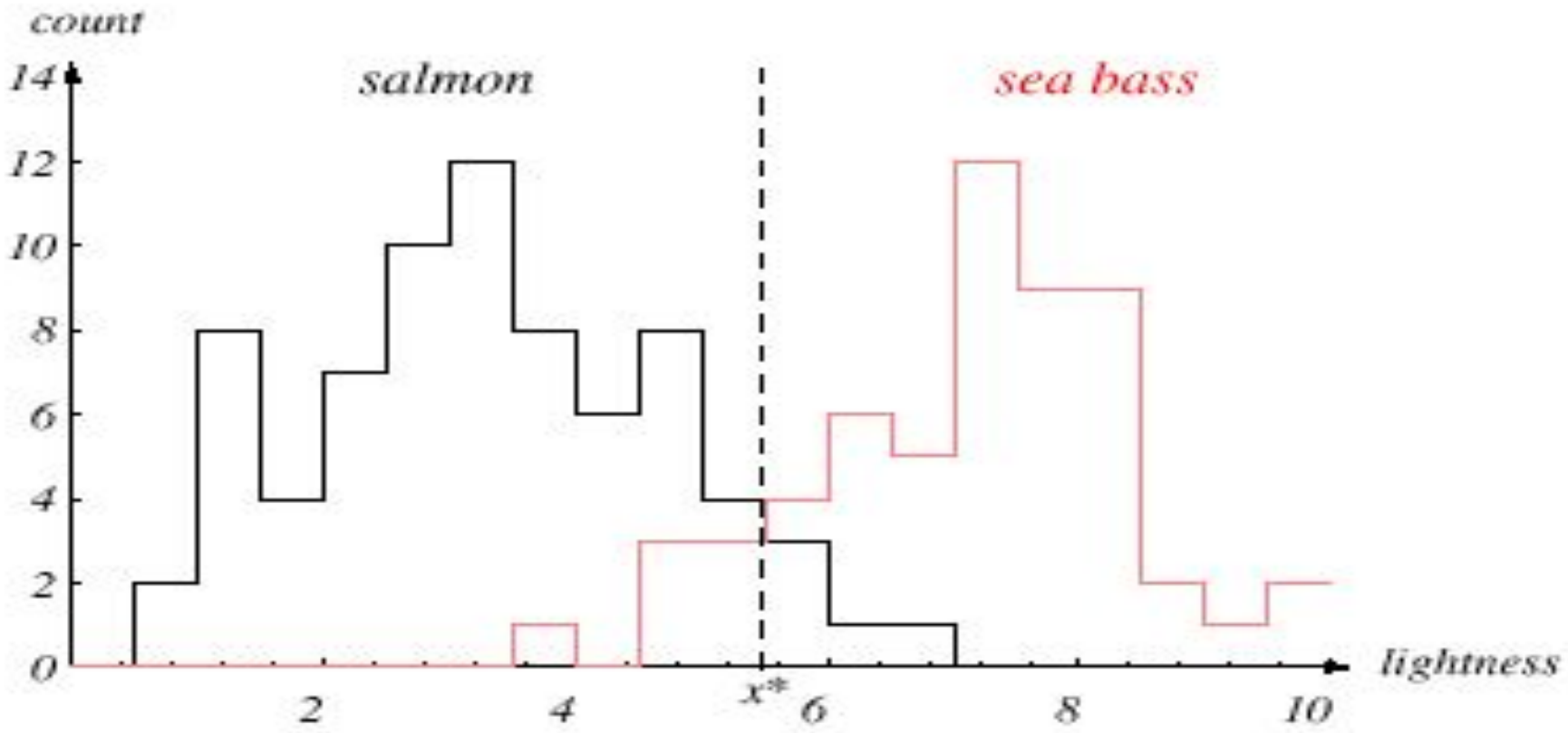
- Use a segmentation operation to isolate fishes from one another and from the background
- Information from a single fish is sent to a feature extractor whose purpose is to reduce the data by measuring certain features
- The features are passed to a classifier.


Preprocessing
Feature extraction
Classification
"salmon"
"sea bass"

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

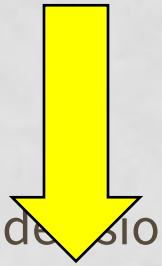

salmon
sea bass
count
22
20
18
16
12
10
8
6
4
2
0
5
10
15
20
25
length
x*

- The length is a poor feature alone!
- Select the lightness as a possible feature.


count
14
12
10
8
6
4
2
0
salmon
sea bass
2
4
x*
6
8
10
lightness

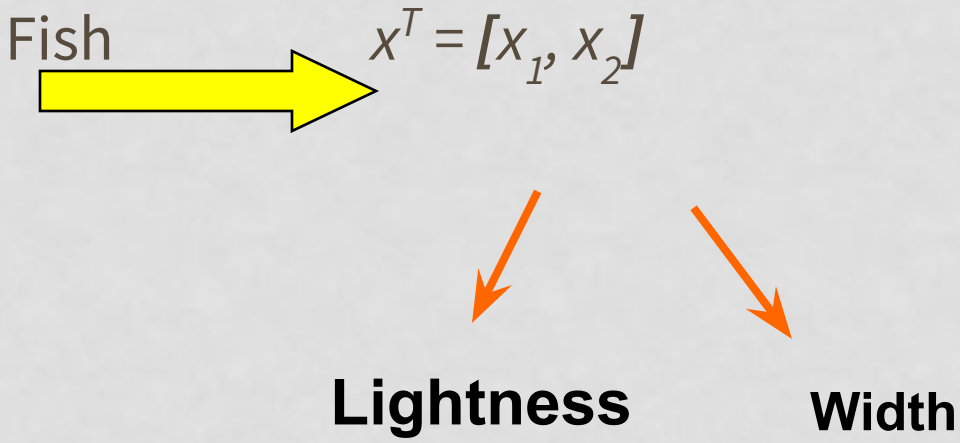
- Threshold decision boundary and cost relationship

  - 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!)

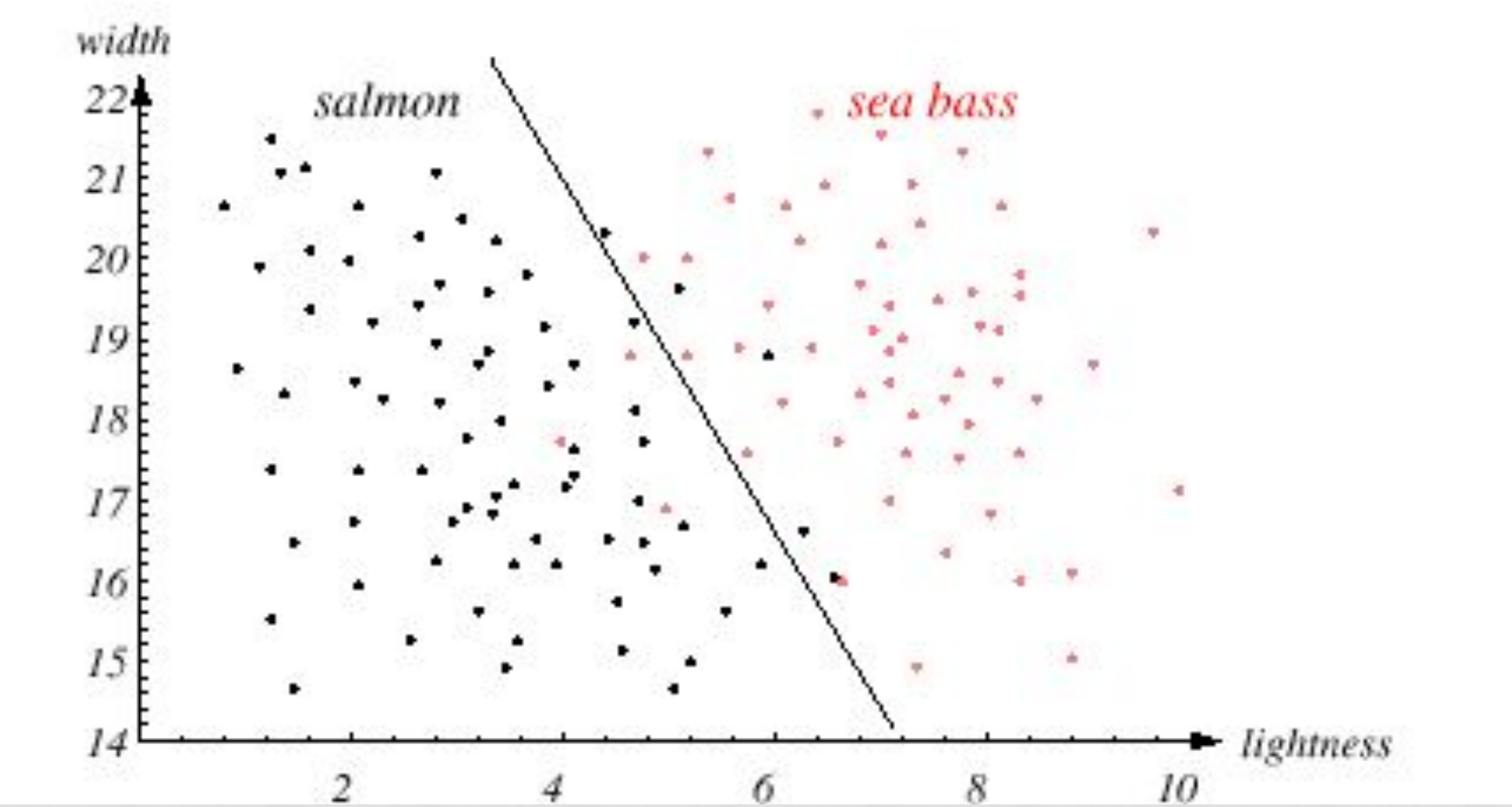


Task of decision theory

- Adopt the lightness and add the width of the fish



Rule for separating the fish

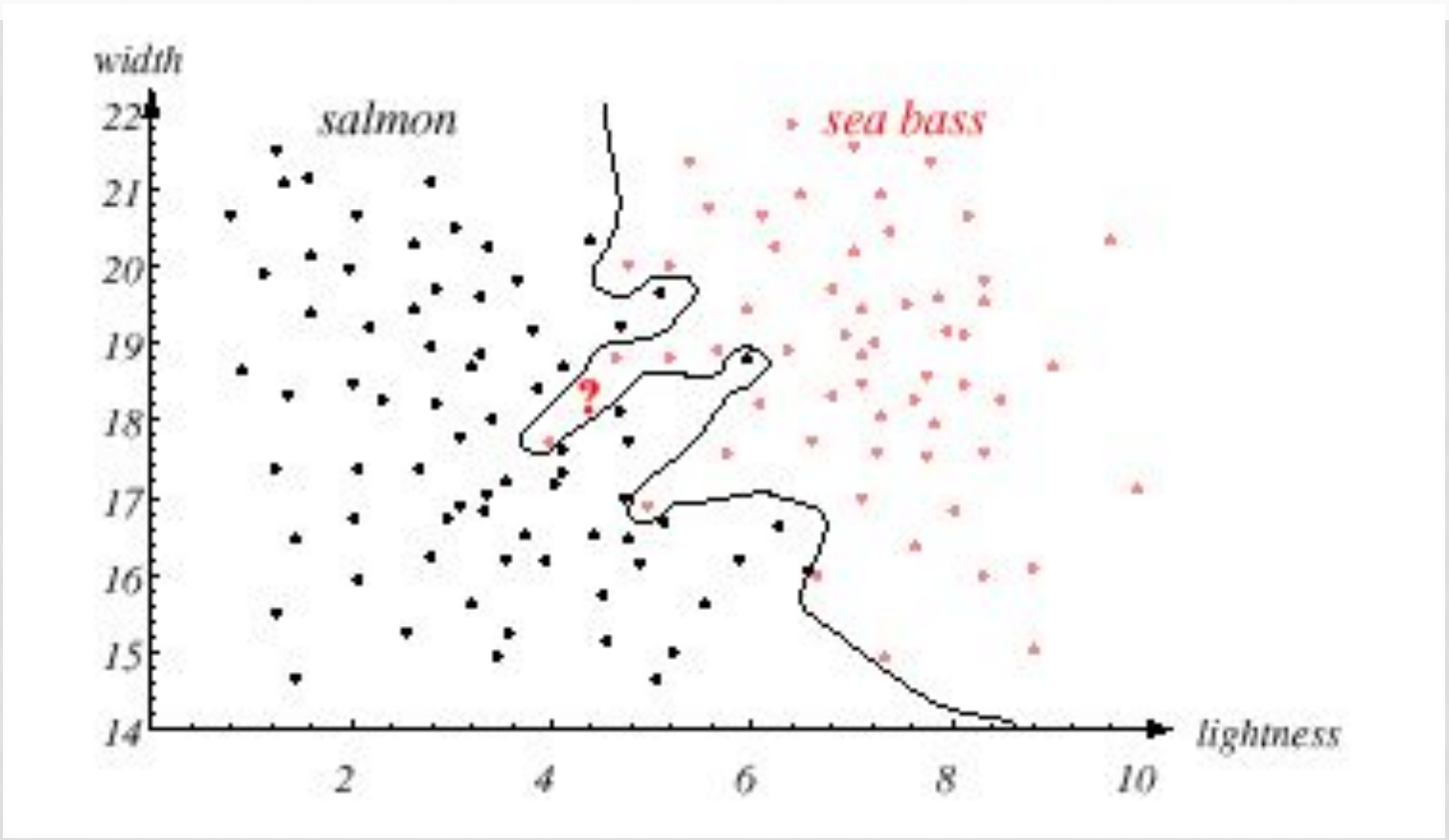


ADD MORE FEATURE?

- Some features might be redundant.
  - Those features which don't improve accuracy significantly but increase computational cost (CC).
- Add color of fish eye?
  - Correlation
  - Computational cost
  - **Due to correlation between features CC increases.** So use features with least correlation
- Might we ever have too many features?
  - possibly even degrade the performance

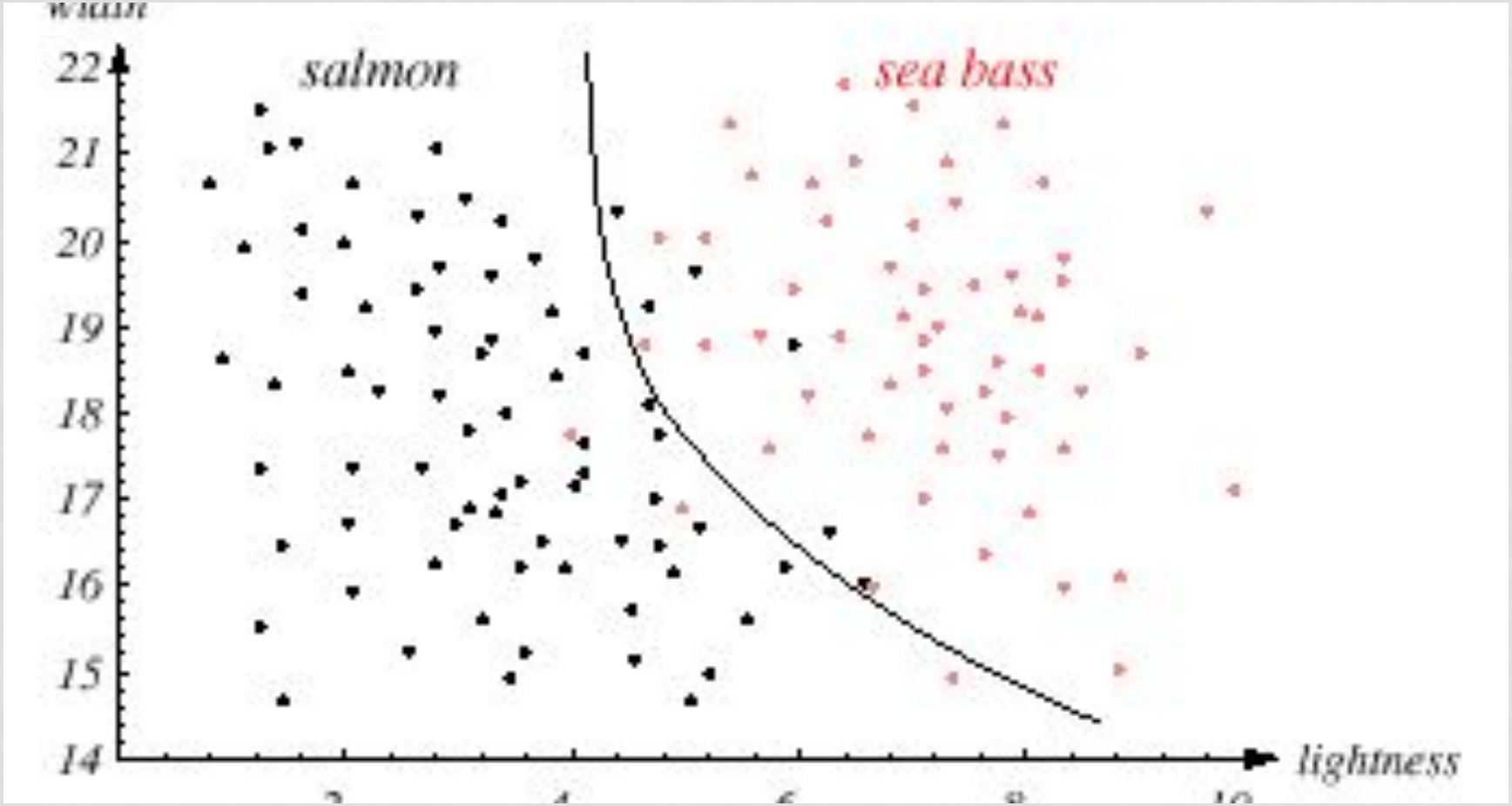
- We might add other features that are not correlated with the ones we already have. A precaution should be taken not to reduce the performance by adding such“noisy features”

- Ideally, the **best decision boundary should be the one which provides an optimal performance** such as in the following figure:


width
salmon
sea bass
?
lightness
22
21
20
19
18
17
16
15
14
2
4
6
8
10

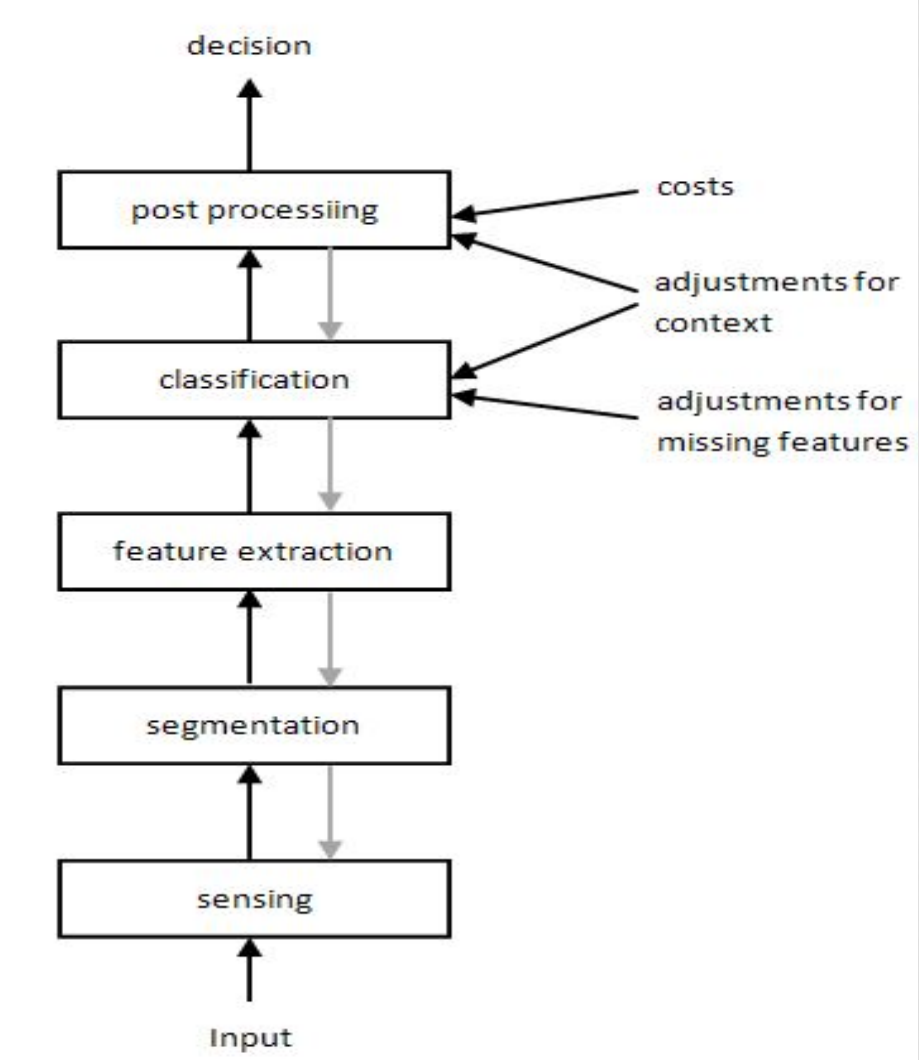
- However, our satisfaction is premature because the central aim of designing a classifier is to correctly classify novel input

Issue of generalization!


salmon
sea bass
22
21
20
19
18
17
16
15
14
lightness

- Our decisions are fundamentally task or cost specific.
- We wish to favor a small number of features, which might lead to simpler decision regions, and a classifier easier to train
- Robust
- Noise

PR PROCESS : MAIN PHASES



PR PROCESS : MAIN PHASES

- **Sensing:** In this phase, the pattern recognition system converts the input data into analogous data.
- **Segmentation:** This phase ensures that the sensed objects are isolated.
- **Feature extraction:** This phase computes the features or properties of the objects and sends them for further classification.
- **Classification:** In this phase, the sensed objects are categorized or placed in groups or cases.
- **Post-processing:** Here, further considerations are made before a decision is made.

SYSTEM PERFORMANCE

- Error rate(Prob. of misclassification)
- Speed
- Cost
- Robustness
- Reject option
- Return on investment