Pattern Recognition

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1.Recognition

- Person has good perception ability. (Robustness)

- How about a computer? Is it has better perception ability than a person?

1.1 Why human focus on pattern recognition

- Why researchers want to increase machine awareness?
  - “Human >> Machine”
  - Recognition is easy to human.
  - Recognition is hard to machine.

- Scientific Approach
  - Desire for a machine that mimics the human brain
    - Example) Neural Network Research

1.1 Why human focus on pattern recognition

- Engineering Approach
  - Make life easier and more comfortably
  - For example)

Robot Vacuum Cleaner

Finger Print Recognition

Car Plate Recognition

Recycle Machine

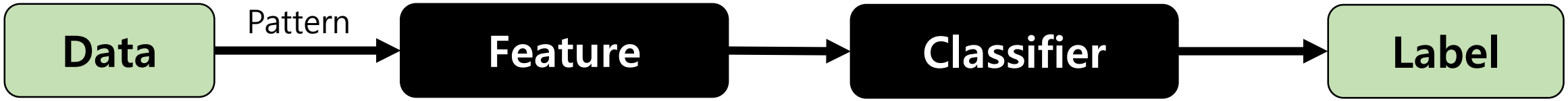
1.1 Why human focus on pattern “recognition”

- Anything Else?

https://www.youtube.com/watch?v=RBUdE-wJxtc

1.2 How to recognize something?

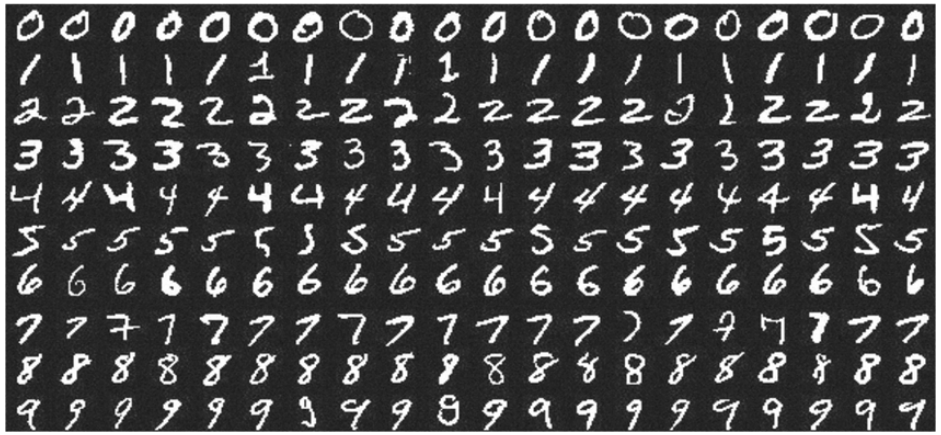
- Concept of Pattern Recognition



- Example
  - Feature
    - Face length(x1), Shape of noise(x2), size of eye(x3)
  - Classification
    - If (x1=short, x2=sharp, x3 = small), this person is
    - Classification is this kind of decision making

1.2 How to recognize something?

- Collect database (DB)
  - Definition
    - Sample
    - Train Set, Test Set
  - Requirement
    - We should collect high-quality data for making a high-quality recognition system.
    - We should collect large-scale data to cover general cases.
  - Example

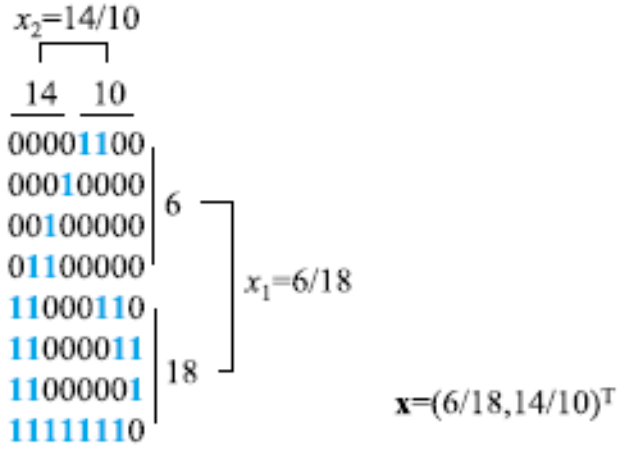


[MNIST Dataset]

training set of 60,000 examples, and a test set of 10,000 examples.

1.2 How to recognize something?

- Feature
  - If we consider overall pixel in each image (8x8),
    - 64 features
    - 64 dimensions' feature vector $X=(X_1,...X_{64})$
    - **Does this feature has discriminative power?**
  - Definition: Feature
    - the ratio of black pixel
  - Important problem
    - Discriminative power
    - Curse of dimensionality



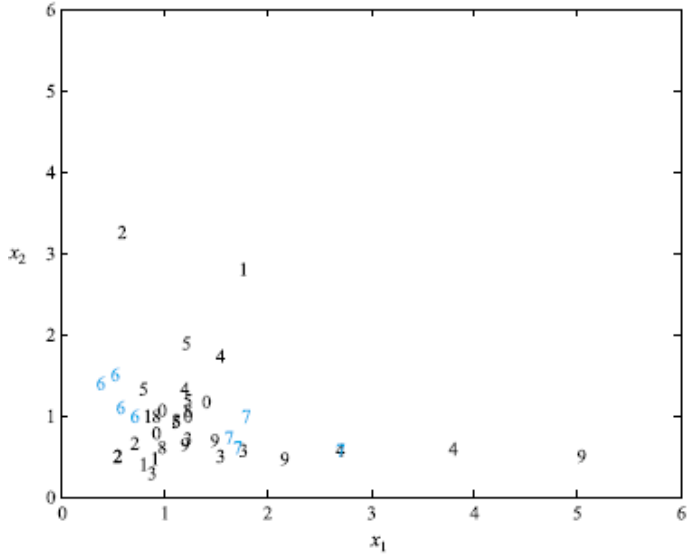
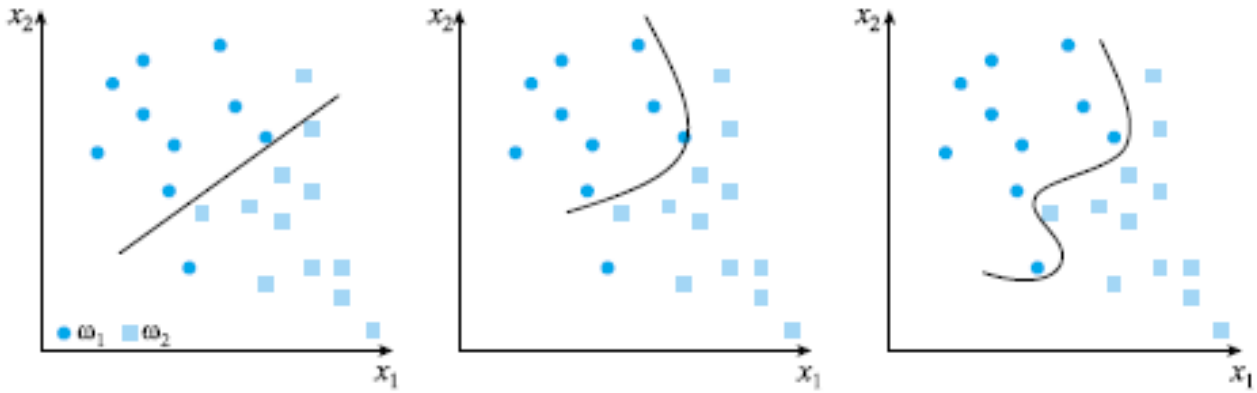


Fig. Distribution of input data

1.2 How to recognize something?

- Classification
  - Two stage approach
    - First stage: model selection
    - Second stage: learning



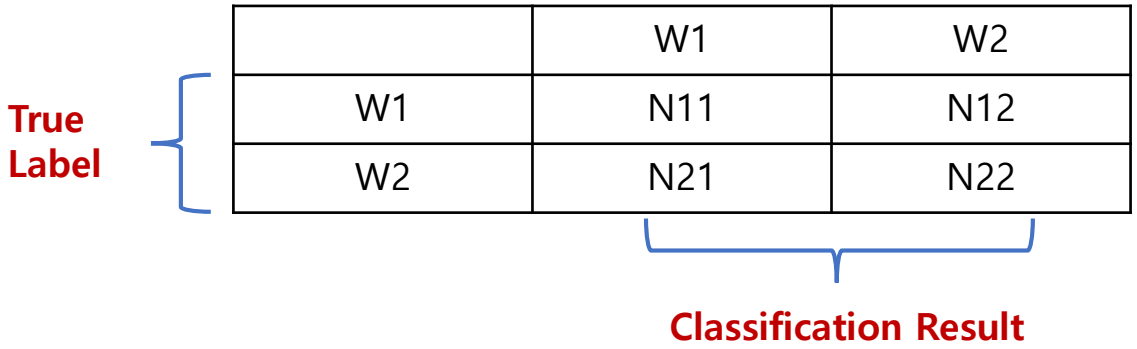
  - Linear classification and nonlinear classification
    - Linear classification: decision line, decision plane, decision hyperplane
    - Nonlinear classification: decision curve, decision surface, decision hypersurface

1.2 How to recognize something?

- Evaluation
  - In terms of miss-rate
    - Correct Recognition Rate = C/N
    - Rejection Rate = R/N
    - Error Rate = E/N

    where, c = the number of correct answer, r = the number of reject answer,
    e = the number of wrong answer, N = C+R+E

  - Confusion Matrix



  - In terms of risk
    - Misclassifying a cancer patient as normal is more dangerous than misclassifying a normal person as a cancer patient.

1.2 How to recognize something?

- Evaluation
  - Detection Metric

    FPR(False Positive Rate) = $n_{21}/(n_{21}+n_{22})$

    FNR(False Negative Rate) = $n_{12}/(n_{12}+n_{11})$

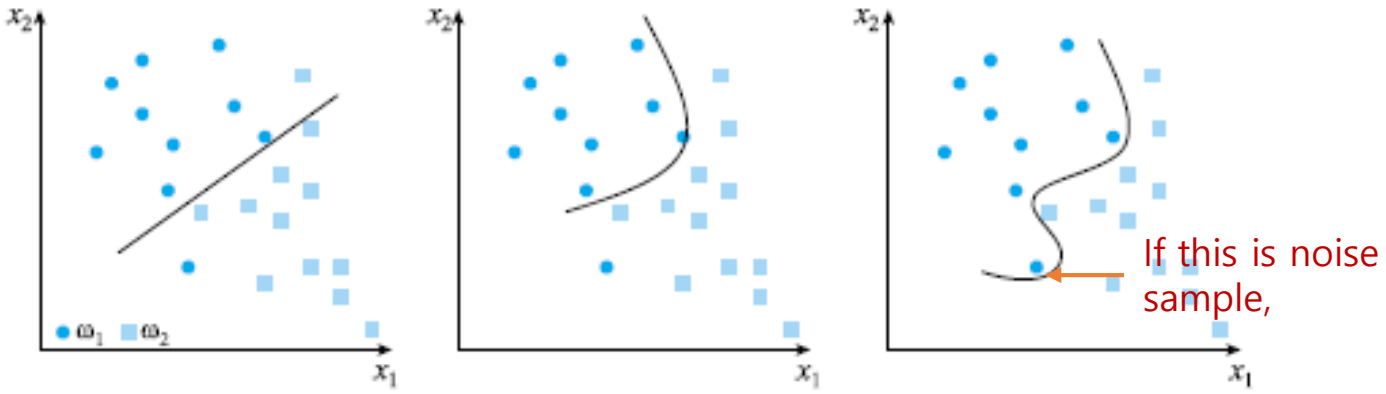
  - Indexing Metric

    Precision = $n_{11}/(n_{11}+n_{21})$

    Recall = $n_{11}/(n_{11}+n_{22})$

1.2 How to recognize something?

- Evaluation
  - Generalization
    - Measuring the performance using test set
    - Test set: new sample (this sample never used in training)
    - Avoiding overfitting
      - **[Question] 3rd order decision curve is optimal?**



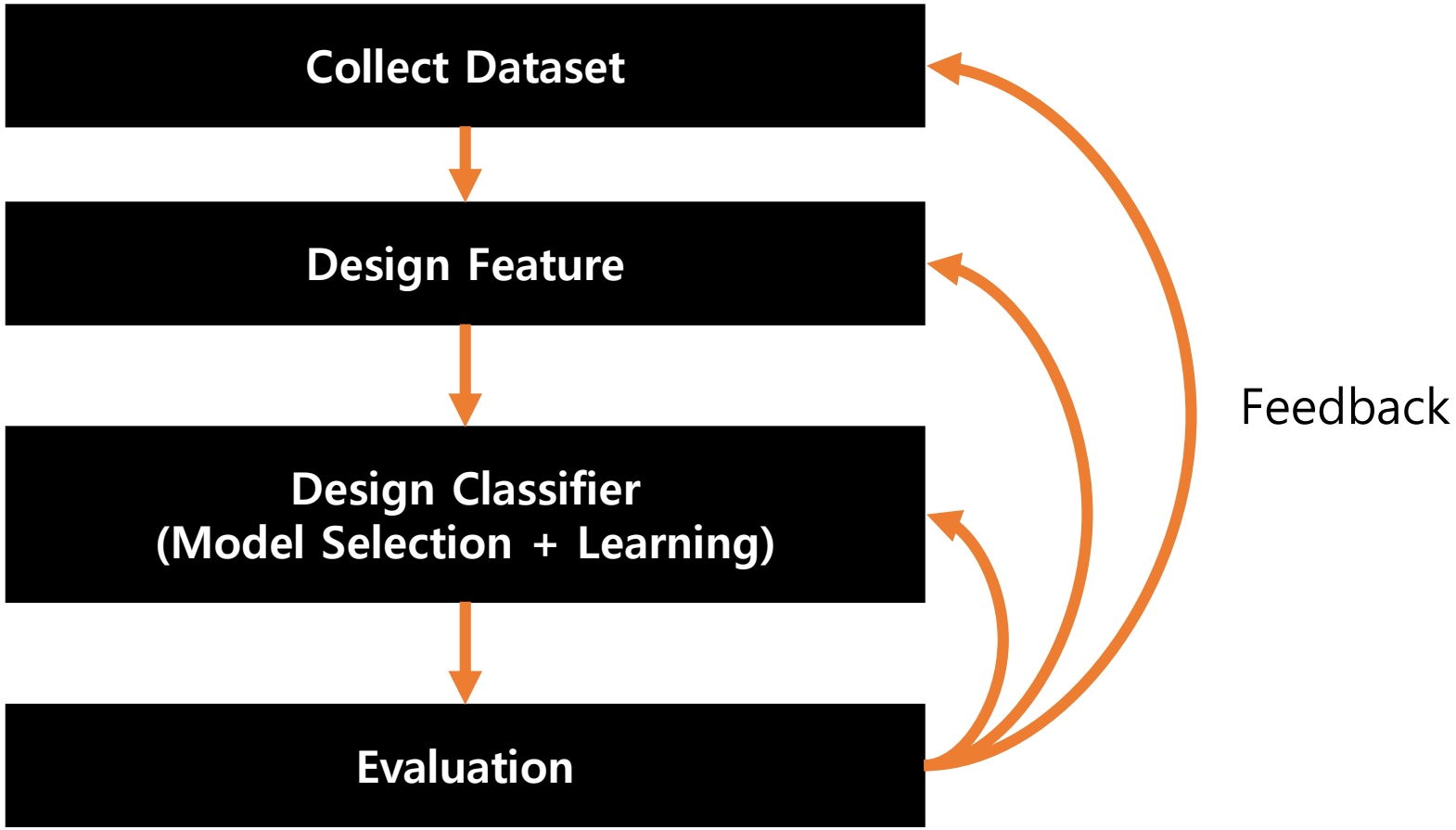
1st order 2nd order 3rd order

1.2 How to recognize something?

- For Model selection
  - There is enough dataset
    - We can split the dataset as follow: Train set/Test set/ **Validation set**
    - From the validation accuracy, we predict the general performance.
  - There is no enough dataset,
    - We can use “Resampling” (CH.12)
      - K-Cross validation
      - Bootstrap

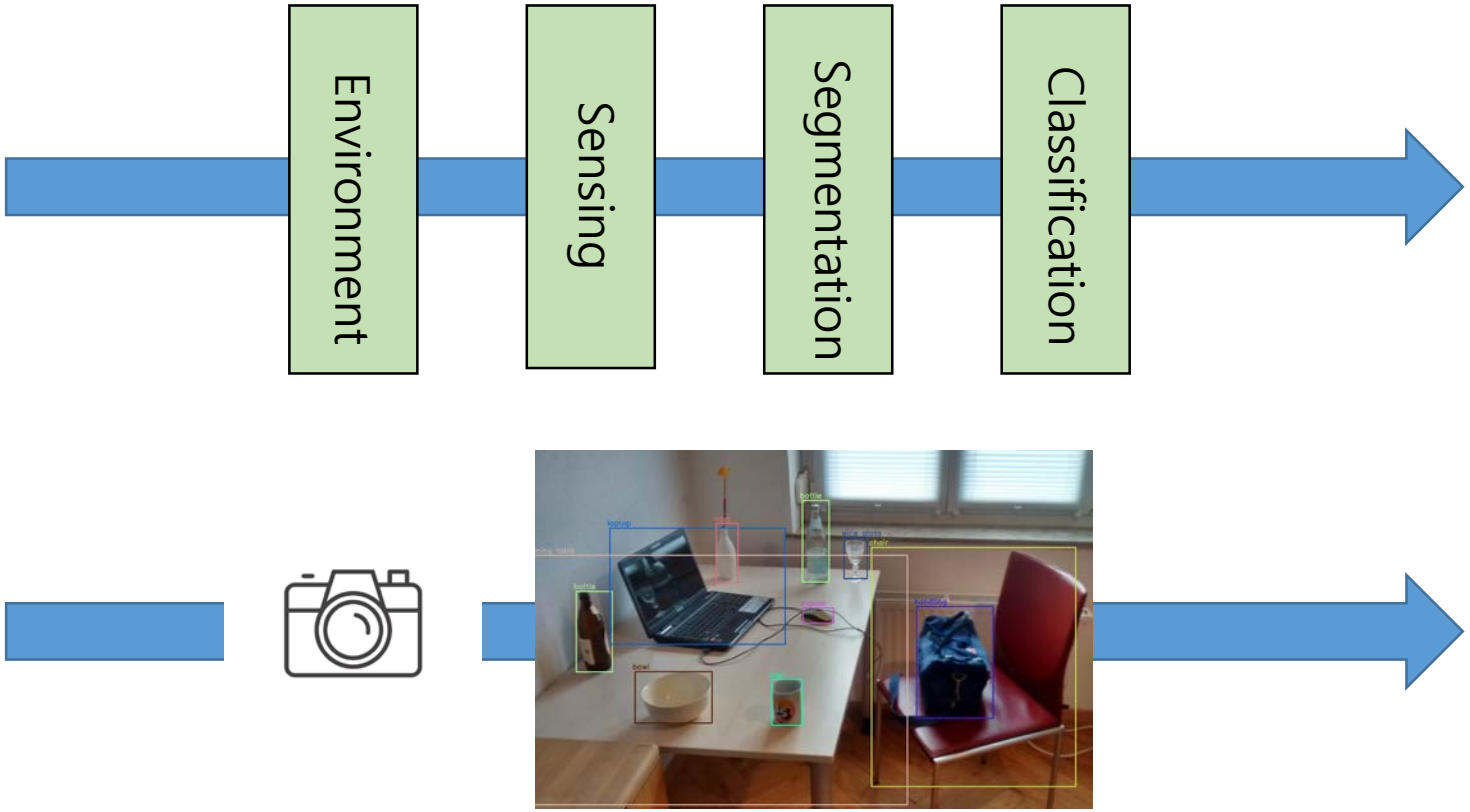
1.3 System Architecture for Pattern Recognition

- Development Cycles



1.3 System Architecture for Pattern Recognition

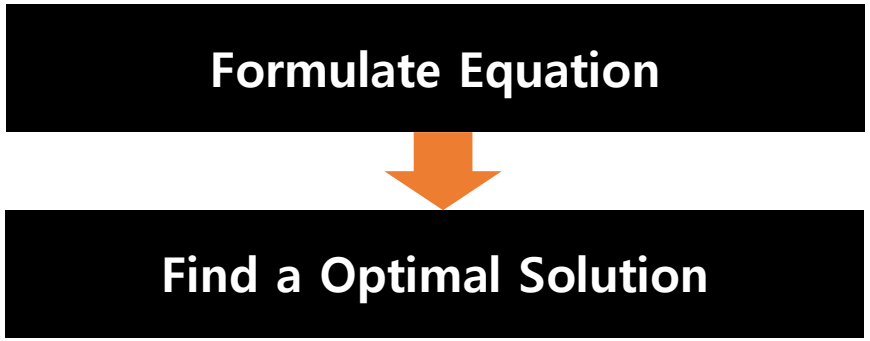
- Process of Pattern Recognition System
  - Need to Detection/Segmentation module
  - Can be choose multiple classifier



1.4 Mathematics

- Pattern Recognition meets mathematics
  - Probability & statistics
  - Linear algebra
  - Information theory
  - Optimization

- Traditional solution in Pattern Recognition



1.5 Resource

- About Computer Vision
  - Conference: CVPR, ICCV, ECCV, BMVC
  - Journal: TPAMI, IJCV

- **Arxiv.org**
  - https://arxiv.org/list/cs.CV/recent