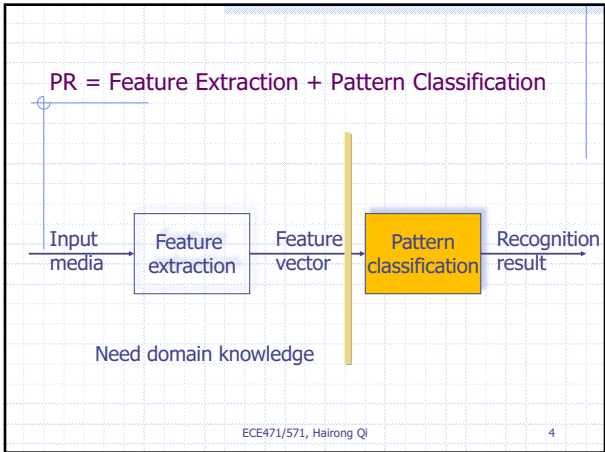# ECE471-571 – Lecture 1

Introduction

Statistics are used much like a drunk uses a lamppost: for support, not illumination

-- Vin Scully

Terminology

- ◆ Feature
- ◆ Sample
- ◆ Dimension
- ◆ Pattern classification (PC)
- ◆ Pattern recognition (PR)

PR = Feature Extraction + Pattern Classification

Input media → Feature extraction → Feature vector → Pattern classification → Recognition result

Need domain knowledge

4

An Example

- ◆ fglass.dat
  - forensic testing of glass collected by German on 214 fragments of glass
  - Data file has 10 columns
    - RI – refractive index
    - Na – weight of sodium oxide(s)
    - ...
    - Type

RI	Na	Mg	Al	Si	K	Ca	Ba	Fe	type
1.52101	13.64	4.49	1.10	71.78	0.06	8.75	0.00	0.00	1
1.51761	13.89	3.60	1.36	72.73	0.48	7.83	0.00	0.00	1

5

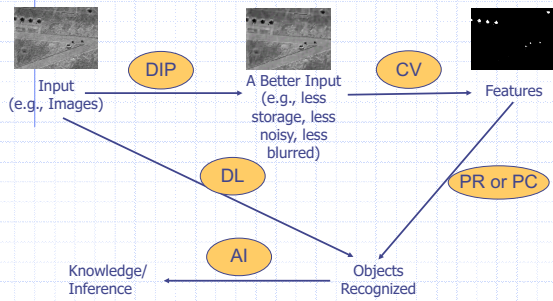
On the Different Courses at UT

- ◆ Machine Learning (ML) (CS425/528)
- ◆ Pattern Recognition (PR) (ECE471/571)
- ◆ Data Mining (DM) (Big Data) (CS526)
- ◆ Deep Learning (DL) (ECE599/592)
- ◆ From Google Trends
- ◆ Digital Image Processing (DIP) (ECE472/572)
- ◆ Computer Vision (CV) (ECE573)

Mar. 2015, Tombone's Computer Vision Blog:
http://www.computervisionblog.com/2015/03/deep-learning-vs-machine-learning-vs.html

Sept. 2017: https://www.alibabacloud.com/blog/Deep-Learning-vs-Machine-Learning-vs-Pattern-Recognition-207110

6

A Graphical Illustration

Input (e.g., Images) → DIP → A Better Input (e.g., less storage, less noisy, less blurred) → CV → Features

DL

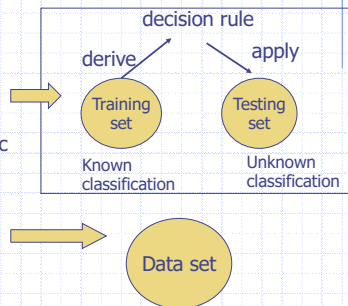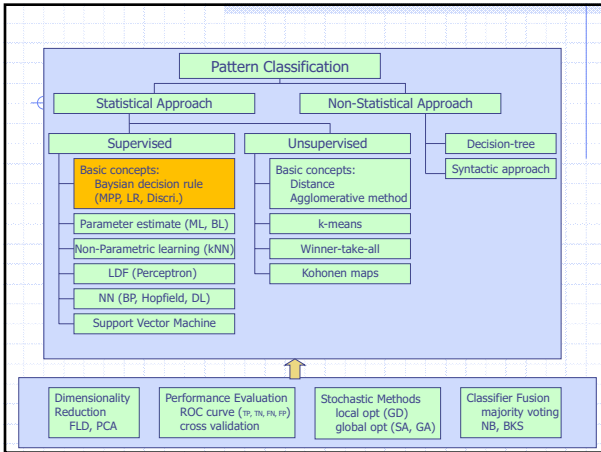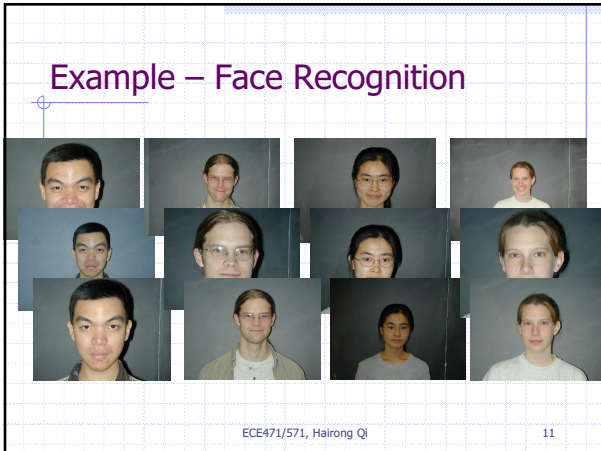PR or PC

AI

Knowledge/ Inference ← Objects Recognized

7

Conferences

◆ Computer Vision and Pattern Recognition (CVPR)

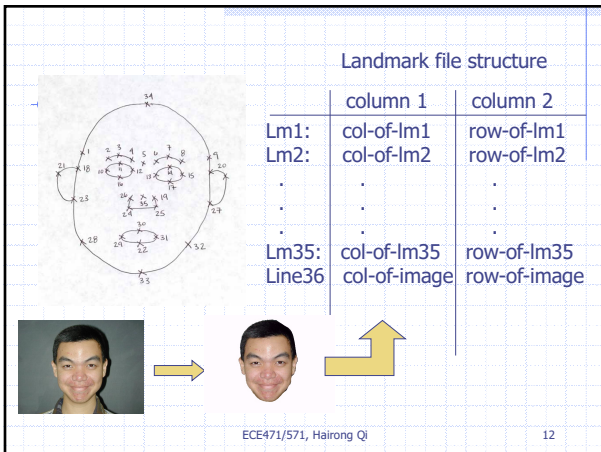◆ International Conference on Pattern Recognition (ICPR)

ECE471/571, Hairong Qi   8

Different Approaches - Overview

◆ Supervised classification
  ▪ Parametric
  ▪ Non-parametric
◆ Unsupervised classification
  ▪ clustering

decision rule

derive → Training set   apply → Testing set

Known classification   Unknown classification

Data set

ECE471/571, Hairong Qi   9

3

Slide 1 — Pattern Classification diagram

Pattern Classification

Statistical Approach — Non-Statistical Approach

Supervised — Unsupervised — Decision-tree

Syntactic approach

Basic concepts:
Baysian decision rule
(MPP, LR, Discri.)

Parameter estimate (ML, BL)

Non-Parametric learning (kNN)

LDF (Perceptron)

NN (BP, Hopfield, DL)

Support Vector Machine

Basic concepts:
Distance
Agglomerative method

k-means

Winner-take-all

Kohonen maps

| Dimensionality Reduction FLD, PCA | Performance Evaluation ROC curve (TP, TN, FN, FP) cross validation | Stochastic Methods local opt (GD) global opt (SA, GA) | Classifier Fusion majority voting NB, BKS |

Slide 2

Example – Face Recognition

Slide 3

Landmark file structure

	column 1	column 2
Lm1:	col-of-lm1	row-of-lm1
Lm2:	col-of-lm2	row-of-lm2
.	.	.
.	.	.
Lm35:	col-of-lm35	row-of-lm35
Line36	col-of-image	row-of-image

4

Example - Network Intrusion Detection

◆ KDD Cup 99
◆ Features
  - basic features of an individual TCP connection, such as its duration, protocol type, number of bytes transferred and the flag indicating the normal or error status of the connection
  - domain knowledge
  - 2-sec window statistics
  - 100-connection window statistics

Example - Gene Analysis for Tumor Classification

◆ Early detection of cancer
◆ Tumor classification
  - Observation of abnormal consequences of tumor development
  - Physical examination (X-rays)
  - Molecular marker detection
◆ Tumor gene expression profiles: molecular fingerprint
◆ Challenge: high dimensionality (in the order of thousands)
  - 16,063 known human genes and expressed sequence tags

Example - Color Image Compression
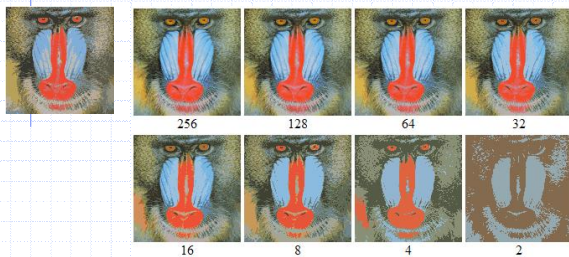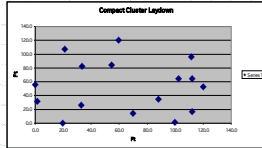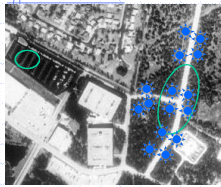
Example - Automatic Target Recognition

Ford 250   Harley Motocycle   Ford 350   Suzuki Vitara
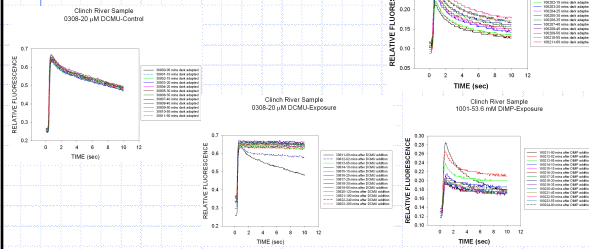
Example – Bio/chemical Agent Detection in Drinking Water

- x-axis: time (seconds)
- y-axis: relative fluorescence induction

Assignment and Tests

- Programming and Reporting
  - 4 Regular projects
    - C/C++/Python (major)
    - Matlab or C/C++/Python (non-major)
  - 1 Final project (C/C++/Python or Matlab)
    - With milestone deliverables
    - With final presentation
- 4~5 Homework (C/C++/Python or Matlab)
- 2 Tests

ECE471/571, Hairong Qi   18