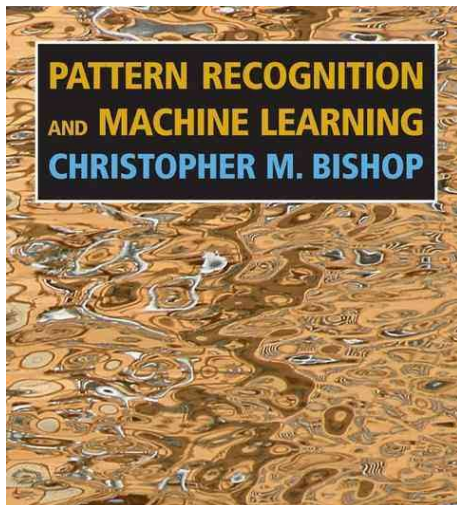# Lecture1: Introduction

Chen Lin, Associate Professor

Xiamen University

September 1, 2018

Course Information

- Textbook: "Pattern Recognition and Machine Learning" by C. Bishop
  https://www.microsoft.com/en-us/research/people/cmbishop/

Course Schedule

| Lecture	Title	Reading Materials	Weak
1	Introduction	pp. 1-3	1
2	Linear Regression	pp. 4-11	2-3
3	Probability Theory	pp. 12-20	3
4	Probablistic Linear Regression	pp.24-29, 137-144, 147-152, 78-84, 93-97	4-6
5	Bayesian Linear Regression	pp. 21-24, 152-158, 144-147, (85-93,97-105)	7-(8)
6	Classification	pp. 38-48, 179-209	9-12
7	Other Introductory Concepts	pp.33-38, 48-58	13
8	SVM	pp.325-338	14-(15)
9	EM	pp. 423-455	15(16)

Outline

1. What is PR/ML/AI?

2. Machine Learning Tasks

3. Statistical Machine Learning Framework

Quiz(1)

Which of the following is true?
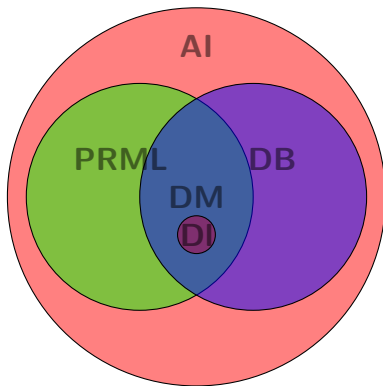
(a) A
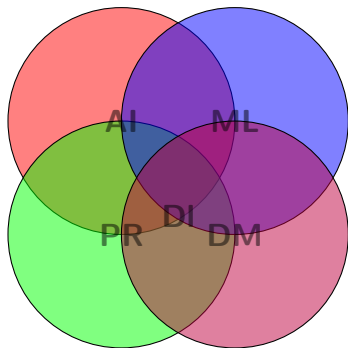
(b) B

Patterns in Data

Figure: The Universe
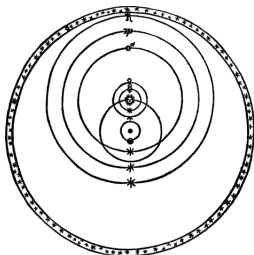
Kepler's Laws of Planetary Motion

Figure: Astronomical observations of Tycho Brahe

Kepler noticed that an imaginary line drawn from a planet to the Sun swept out an equal area of space in equal times, regardless of where the planet was in its orbit. The discovered pattern became Kepler's second law and led to the realization of what became Keplers first law.[1]

[1] https://earthobservatory.nasa.gov/Features/OrbitsHistory/page2.php

Pattern Recognition
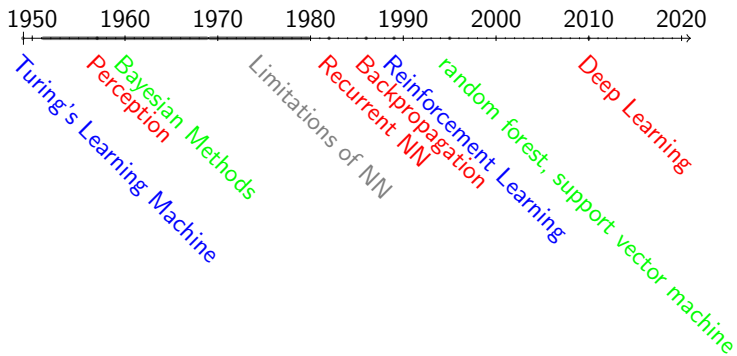
Pattern Recognition focuses on

- the recognition of patterns and regularities in data
- through the use of computer algorithms,
- with the use of patterns to take actions.

Pattern Recognition and Machine Learning are often used interchangeably.

Machine Learning

Definition

A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E.

Timeline from 1950 to 2020:

- Turing's Learning Machine
- Perception
- Bayesian Methods
- Limitations of NN
- Recurrent NN
- Backpropagation
- Reinforcement Learning
- random forest, support vector machine
- Deep Learning

Artificial Intelligence

Definition

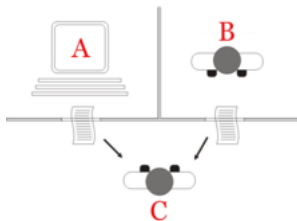Artificial intelligence is the simulation of human intelligence processes by machines.

Figure: Turing test is a human would judge natural language conversations between a human and a machine designed to generate human-like responses

- AI is a broader concept, covering philosophical and ethical issues.
- ML is a particular approach to AI, there are more AI methods (i.e.

1. What is PR/ML/AI?

2. Machine Learning Tasks

3. Statistical Machine Learning Framework

Paradigms of Machine Learning

Types of problems and tasks include:

- Supervised Learning: training data comprises examples of input with their corresponding target values.
  - classification
  - regression
- Unsupervised Learning: (training data) consists of input examples without corresponding target values.
  - clustering
  - density estimation
  - visualization
- Reinforcement Learning: optimal output to be obtained through a process of trial and error.

Quiz(2)

Name a few APPs on your cellphone that adopt machine learning methods and categorize them.

A Classification Example

Figure: Hand-written digits recognition

1. Input 28×28 pixel image $\rightarrow (x \in R^{784}, t)$
2. Feature extraction $x \rightarrow x'$ e.g. scaled to a box of a fixed size
3. Train model $y(x', w)$, $w = \arg \min Loss_D(w)$ on training set
4. Model selection of y on validation set
5. Prediction on test set i.e. ability of generalization

Our goal is to obtain good generalization.

Quiz(3)

The goal of an advertising campaign is to maximize the revenue from displaying ads. As a media buyer you need to bid for displaying ads. Design a machine learning algorithm for tackling the optimal ad buying problem. Detail your solutions in the following aspects.

1. What is your training set?
2. Is feature selection necessary?
3. List some possible forms of loss function.
4. How do you choose from candidate models of similar predictive or explanatory power?