EE2211 Pre-Tutorial 1

Dr Feng LIN

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Instructor

Feng LIN (Frank)

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Location:

- E1A-04-01
- Level 6, #06-02, T-Lab Building

Attendance of Today's Tutorial

About Me

Undergraduate: Control Engineering at Beihang University

Master: System Engineering at Beihang University

Doctorate: Electrical and Computer Engineering at National University of Singapore

Research Interests

- Flight Control Systems and Robust Control
- Vision-aided Control and Vision-aided Inertial Navigation
- Autonomous Unmanned Aerial Vehicles

Welcome to EE2211!

- Team
  - Lecturers
    - Xinchao Wang (Lec 1-3, Lec 10-12)
    - Helen Zhou (Lec 4-9)
  - Python Tutor
    - Zhu Zikun (Week 1-2)
  - Graduate Assistants (TBA)
  - Support and Coordinators
    - Celine Cheong
  - Tutors
    - Christopher Moy Shin Lee Lan C
    - Fan Shaojing
    - Goh Shu Ting
    - Lin Feng
    - Liu Xingyu
    - Ngoc Nhu Thao Nguyen
    - Nguyen Duc Thang
    - Peiqin Liu
    - Qingqing Ni
    - Shao Yurui
    - Sheral Crescent Tissera
    - Shi Fan
    - Tham Chen Khong
    - Theivendiram Pranavan
    - Wang Si
    - Xu Yuecong
    - Yu Juezhao
    - Yutong Du
    - Zhang Haoyu
    - Zhang Xiaoyang

Logistics

- Schedule
  - **12 Weeks Lectures**, starting from Week 1
  - **12 Weeks Tutorials**, starting from Week 2
  - **2 Programming Tutorials** (optional and highly recommended)
    - Week 1 – 2
    - Right after the lecture (i.e., 4 to 5 PM)
  - **1 Mid-term Quiz** (using ExamSoft)
    - Tentatively held offline on 11 Oct 2024 (Saturday of Week 8)
    - Content up to Week 6 (inclusive)
  - **1 Final Exam** (using ExamSoft)
    - Held on 25-Nov-2024
  - **3 Assignments**
    - Assignment 1: released on Week 4, due on Week 6 (tentatively)
    - Assignment 2: released on Week 6, due on Week 9 (tentatively)
    - Assignment 3: released on Week 9, due on Week 13 (tentatively)

Logistics

- 3 Assignments (36%) + Tutorial Attendance (4%)
- 1 Mid-term (30%)
- 1 Final Exam (30%)

- Held online:
  – Lectures

- Held offline (in classrooms):
  – Tutorials

- Videos of lectures are made available after lectures.

Responsibility of Team Members

- All members, together, strive to serve you well! However, we have a huge class of >500 students!!
- The lecturers will spare no effort in helping you, but it wouldn't be possible for us two to answer all questions from 500 students on time…
- Therefore, to get the most prompt and high-quality answers to your questions, when you have:
  - Logistic-related Questions, go to Lecturers
  - Lecture-related Questions, go to Lecturers
  - Fundamental Python Questions (Week 1-2), go to GAs
  - Tutorial-related Questions, go to Tutors
  - Assignment-related Questions, go to GAs
- We will also actively use **Canvas Discussion** to answer questions so that everyone benefits! Feel free to post questions there!

Agenda of Tutorial

- Recap
- Self-learning (Download code from Github)
- Tutorial 1

Recap

- Definition of Machine Learning
- Three Types of Machine Learning
  - ❖Supervised
  - ❖Unsupervised
  - ❖Reinforcement
- Inductive and Deductive Reasoning

Machine Learning

What is machine learning

Learning is any process by which a system improves performance from experience.

- Herbert Simon

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**.

- Tom Mitchell

Machine Learning: field of study that gives computers the ability to learn without being explicitly programmed.

- Arthur Samuel

Type of Machine Learning

- Supervised Learning
  - ❖Classification
  - ❖Regression
- Unsupervised
- Reinforcement

Supervised Learning

Classification

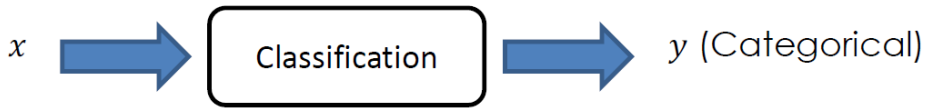
- Given a dataset D (training set) which consists of a certain number N of data examples $(\mathrm{x}_i, y_i), i = 1 \ldots N$.
- x_i is training sample / training example / feature vector

$$\mathrm{x}_i = \begin{bmatrix} x_{i1} \\ x_{i2} \\ \vdots \\ x_{id} \end{bmatrix} \in \mathbb{R}^d$$, d-dimentional Euclidean Space

Feature space

Label space

- The label y_i can only take on finitely many values, so $y_i \in \{1,2, \ldots, c\}$, where c is the number of classes.
- Learn a function to predict categorical y given x



Classification

$y_i \in \{cat, dog, frog, \ldots, horse\}$

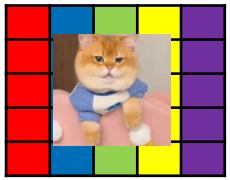
Size of label space = 10

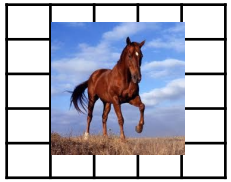
Example 1

Dataset

$y_1 =' cat'$ $y_2 =' dog'$ $y_{100} =' horse'$

x_1 x_2 ..... x_{100}





5×5

$x_1 \in \mathbb{R}^{25}$

Learn an image classifier $f(x)$ to predicts which animal is given a new image.

$f(x_{new}) = y_{new}$ $'cat'$

Testing image

Predicted label

Supervised Learning

Regression

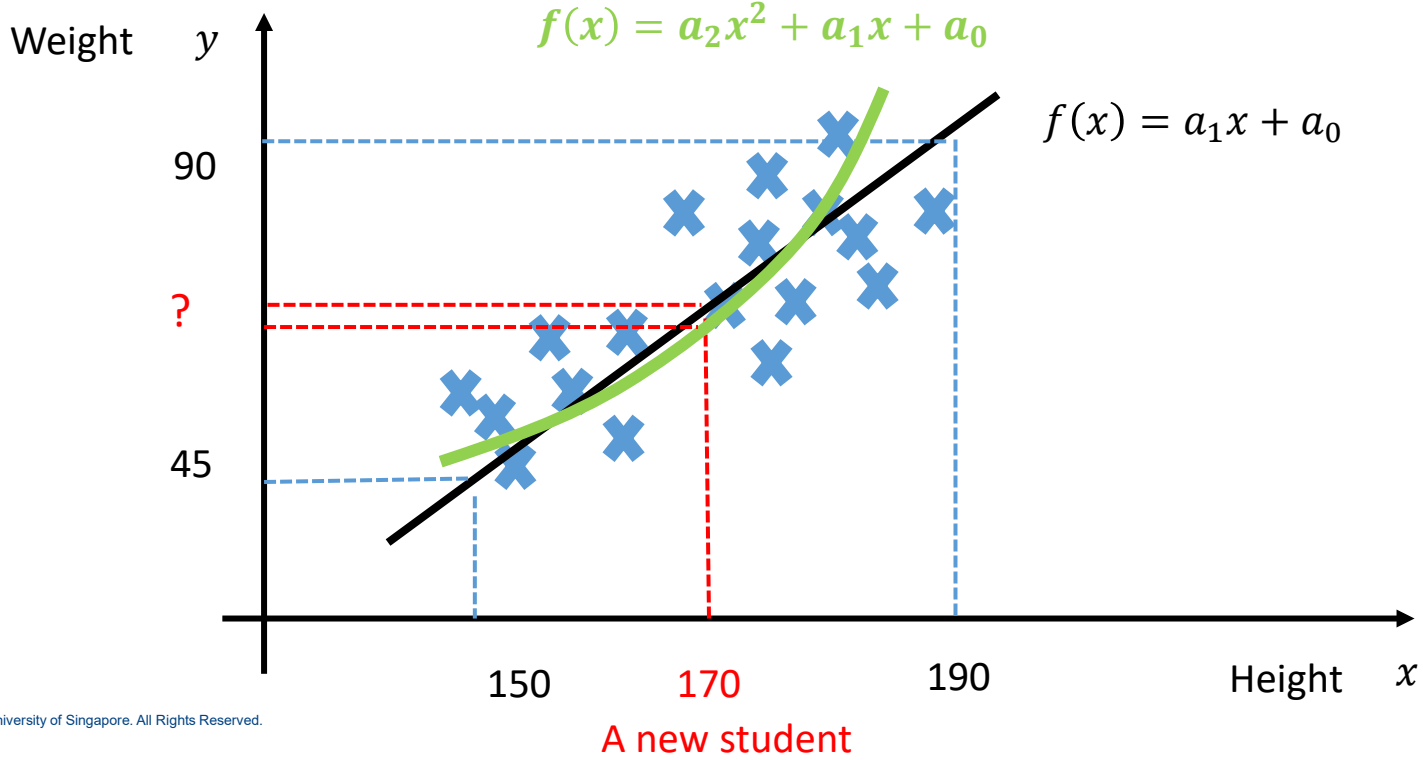
- Given a dataset D (training set) which consists of a certain number N of data examples $(\mathrm{x}_i, y_i), i = 1 \ldots N$.
- x_i is training sample / training example / feature vector
- But y_i is continuous number, which is normally called target variable or outcome variable.
- Learn a function to predict real-valued y given x

Regression

x_i: Height of i^{th} student in EE2211

y_i: Weight of i^{th} student in EE2211

Example:



Type of Machine Learning

- Supervised Learning
  - ❖Classification
  - ❖Regression
- Unsupervised Learning
  - ❖Clustering
- Reinforcement

Clustering

- Given a dataset $D = \{x_i : 1 \leq i \leq \mathrm{N}\}$, which only consists of a certain number N of feature vectors
- The label y_i is NOT available.
- Output hidden structure behind

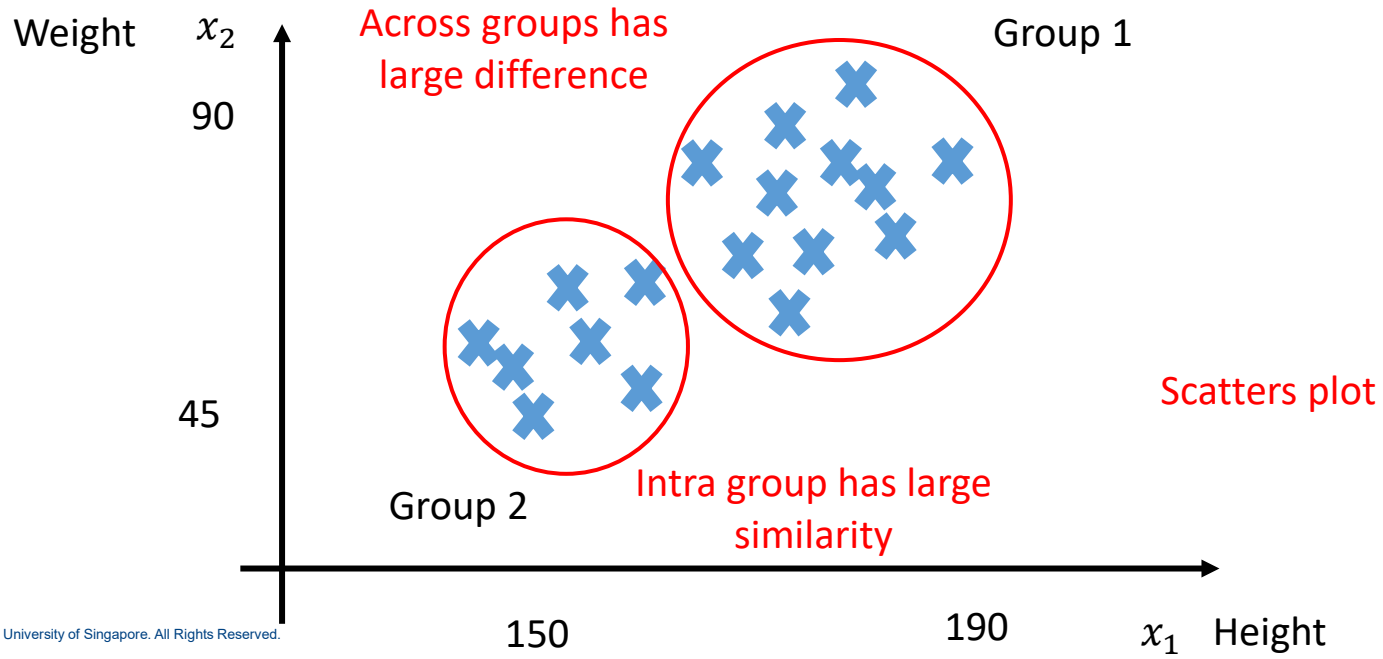
Clustering

Example:

$$\mathrm{x}_i = \begin{bmatrix} x_{i1} \\ x_{i2} \end{bmatrix}$$

Height of i^{th} student in EE2211

Weight of i^{th} student in EE2211

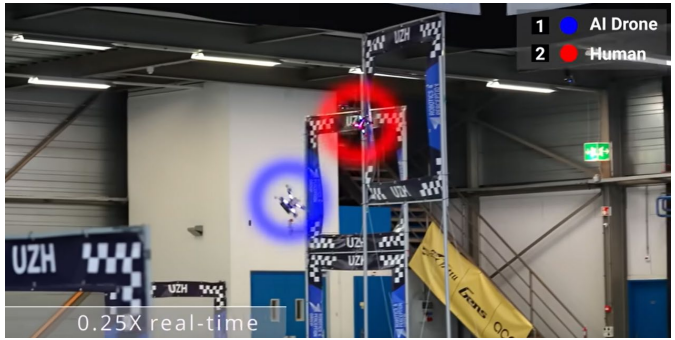


Comparison

	Supervised Learning		Unsupervised Learning
	Classification	**Regression**	**Clustering**
Purpose	Categorize data into predefined classes or labels	Predict continuous numeric values.	Group similar data points without predefined labels.
Input	• Training samples • Discrete labels	• Training samples • Continuous target values	Samples only
Output	A rule/function that maps inputs to discrete labels	A rule/function that maps inputs to continuous values	Underlying patterns in data

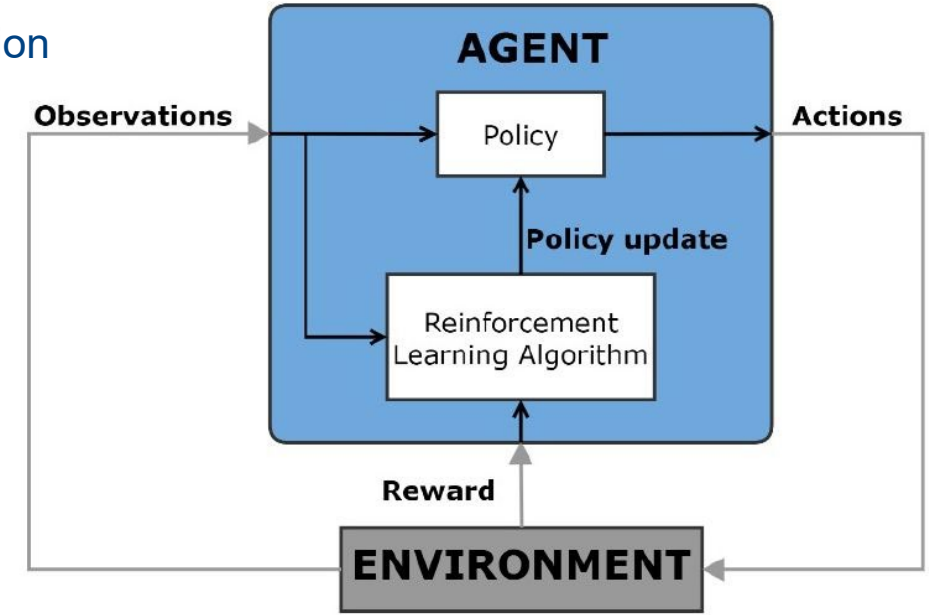
Type of Machine Learning

- **Reinforcement Learning**
  - ❖Improve sequence of state or action
  - ❖Get better delayed rewards



Champion-level Drone Racing using Deep Reinforcement Learning (Nature, 2023)

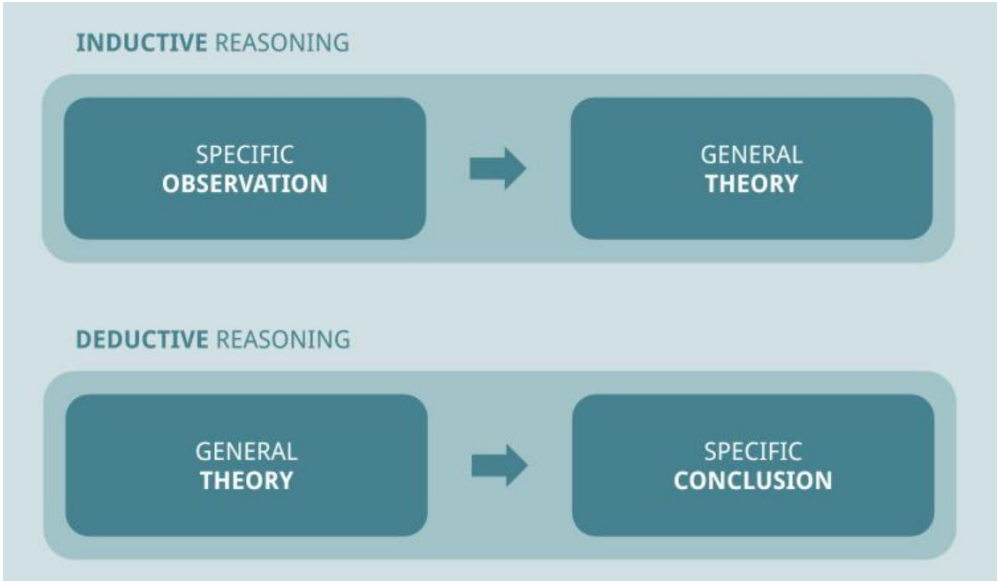
https://www.youtube.com/watch?v=fBiataDpGIo



Adopted from https://www.mathworks.com/discovery/optimal-control.html

Inductive and Deductive Reasoning

- **Inductive Reasoning**
  - ❖To reach probable conclusions
  - ❖Not all information need, cause uncertainty
- **Deductive Reasoning**
  - ❖To reach logical conclusions deterministically



https://vitalflux.com/deductive-inductive-reasoning-examples-differences/

Summary

Three Components in ML Definition

Task T, Performance P, Experience E

Two Types of Supervised Learning

Classification, Regression

Three Types of in ML

Supervised Learning
Unsupervised Learning
Reinforcement Learning

One Type of Unsupervised Learning

Clustering

Inductive and Deductive

Inductive: Probable
Deductive: Rule-based

Example of a Classifier Model

Nearest Neighbor Classifier

THANK YOU