

EE2211 Pre-Tutorial 1

Dr Feng LIN



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

- Wang Xinchao (Lec 1-3, Lec 10-12)
 - Jin Yueming (Lec 4-9)

- Python Tutor

- Liu Songhua (Week 1-2)

- Graduate Assistants (i.e., Graders)

- To be announced soon

- Support and Coordinators

- Celine Cheong

- Tutors

- Prof Mehul Motani
 - Babu Mahadev Prasad Hitesh
 - Fan Shaojing
 - Hou Linxin
 - Lin Feng
 - Mandar Anil Chitre
 - Neil Banerjee
 - Ngoc Nhu Thao Nguyen
 - Qingqing Ni
 - Shao Yurui
 - Sheral Crescent Tissera
 - Wang Si
 - Yu Juezhao
 - Yutong Du
 - Zhang Haoyu
 - Zhang Xiaoyang
 - Zhenyu Zhao
 - Zhu Zikun

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, Friday
 - Right after the lecture (i.e., 2 to 3 PM)
 - **1 Mid-term Quiz** (using ExamSoft)
 - Held offline on 15 March 2025 (Saturday of Week 8)
 - Content up to Week 6 (inclusive)
 - **1 Briefing Session on ExamSoft**
 - Tentative on Week 3, exact time to be confirmed with CIT Staff
 - **1 Final Exam** (using ExamSoft)
 - Held on 28-Apr-2025
 - **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

- Recordings of lectures are made available after lectures.
 - Still, you are strongly recommended to join the lecture for better interactions! ;-)

Responsibility of Team Members

- All members, together, strive to serve you well! However, we have a huge class of >700 students!!
- The lecturers will spare no effort in helping you, but it wouldn't be possible for us two to answer all questions from 700 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 $(\mathbf{x}_i, y_i), i = 1 \dots N$.
- \mathbf{x}_i is training sample / training example / feature vector

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

Feature space

Label space

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



Classification

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

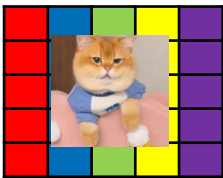
Size of label space = 10

Example 1

Dataset

$y_1 = 'cat'$

x_1



5×5

$y_2 = 'dog'$

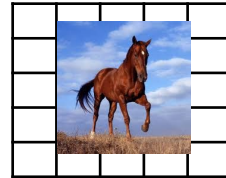
x_2



.....

$y_{100} = 'horse'$

x_{100}



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

x_1

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

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

'cat'

Testing
image



Predicted
label

Supervised Learning

Regression

- Given a dataset D (training set) which consists of a certain number N of data examples $(x_i, y_i), i = 1 \dots N$.
- 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

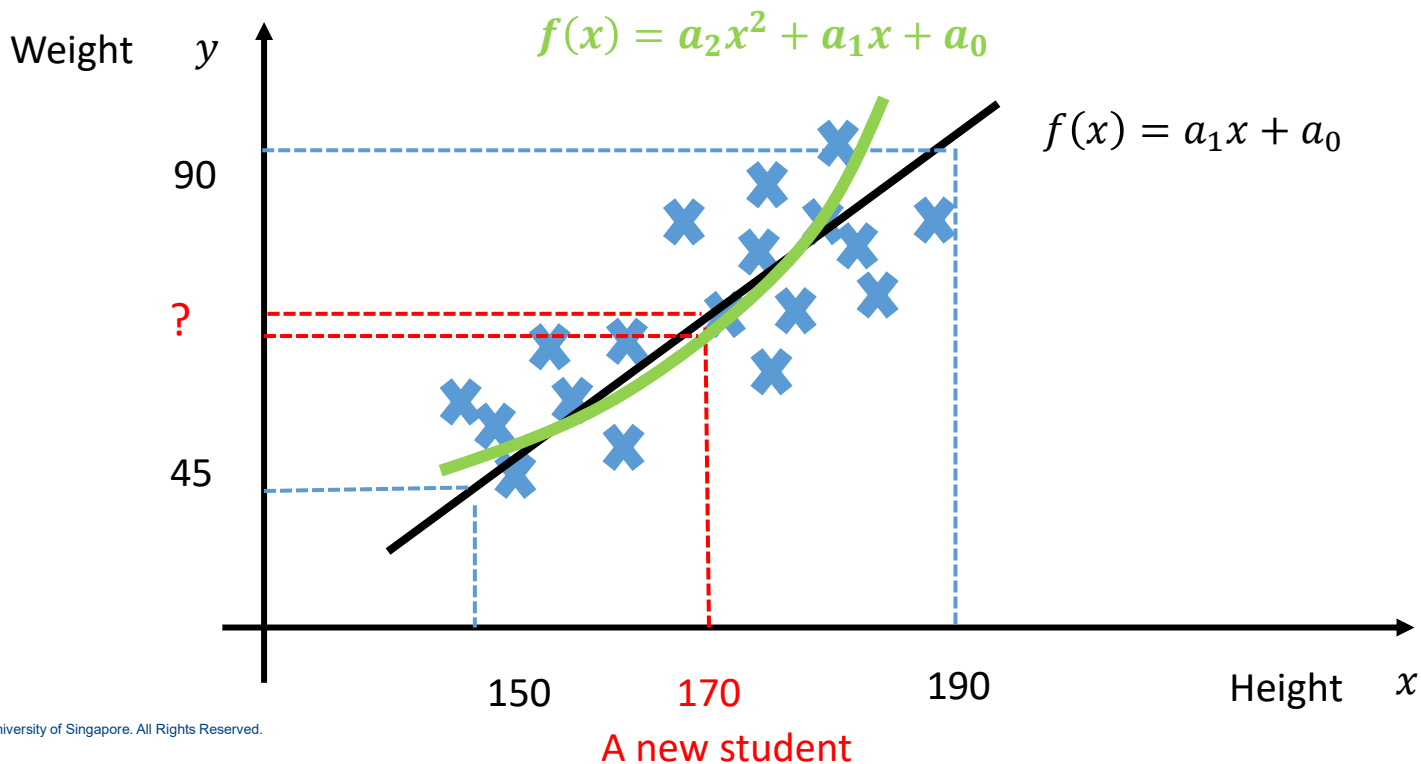


Regression

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

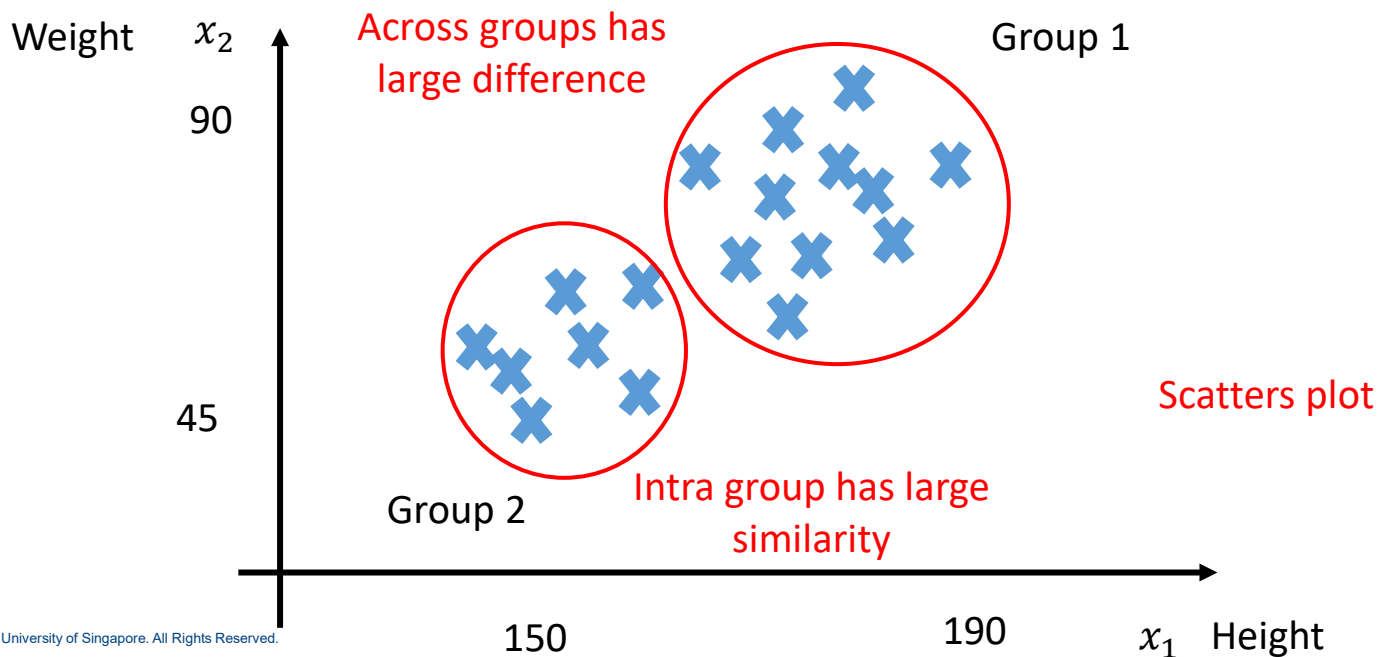
Clustering

Example:

$$x_i = \begin{bmatrix} x_{i1} \\ x_{i2} \end{bmatrix}$$

Height of i^{th} student in EE2211

Weight of i^{th} student in EE2211

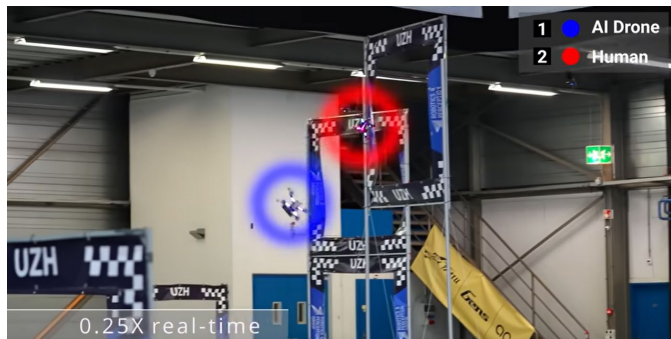


Comparison

	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	<ul style="list-style-type: none">• Training samples• Discrete labels	<ul style="list-style-type: none">• 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

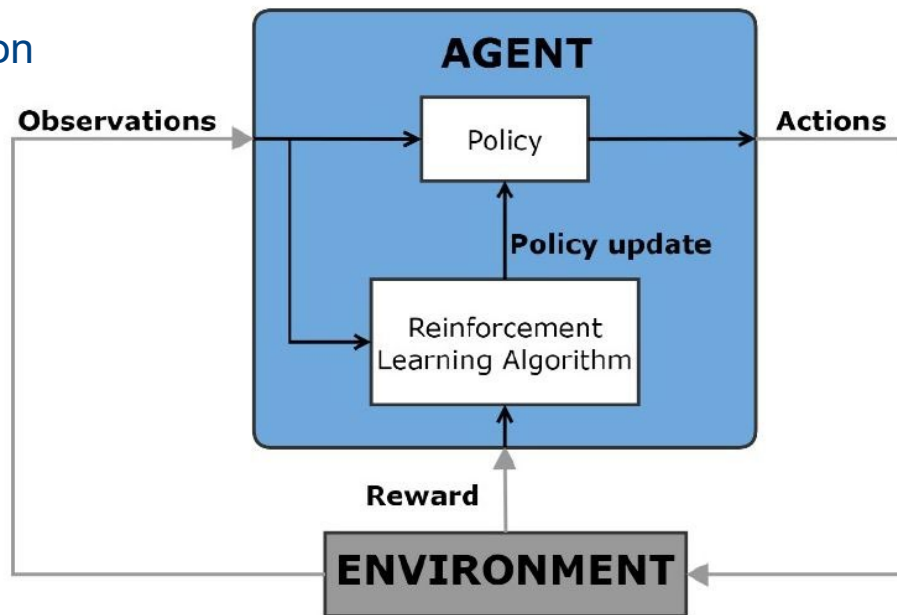
Type of Machine Learning

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



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

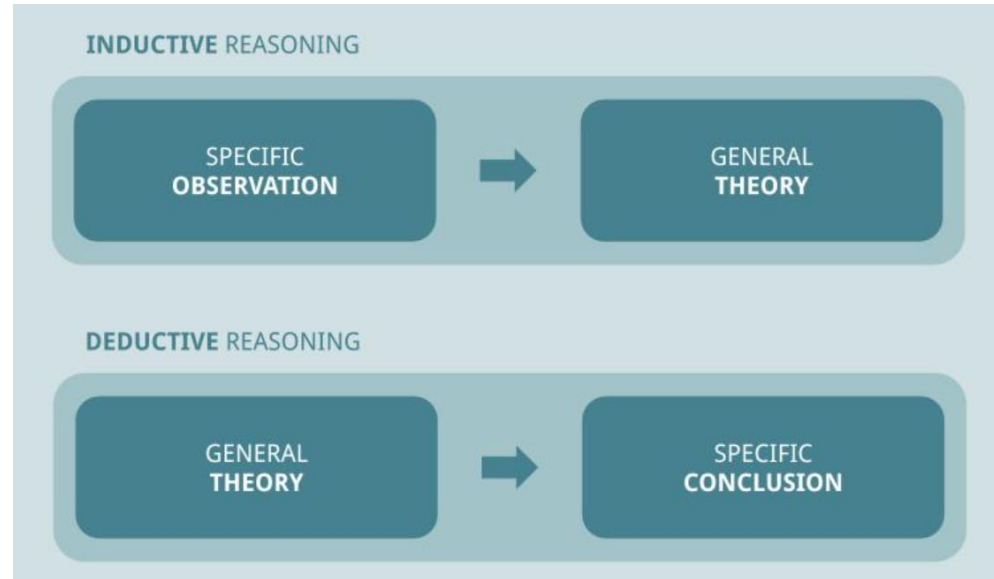
<https://www.youtube.com/watch?v=fBiataDpGlo>



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

Three Types of in ML

Supervised Learning

Unsupervised Learning

Reinforcement Learning

Two Types of Supervised Learning

Classification, Regression

One Type of Unsupervised Learning

Clustering

Inductive and Deductive

Inductive: Probable

Deductive: Rule-based

Example of a Classifier Model

Nearest Neighbor Classifier



THANK YOU