



## Course Overview

Introduction to Computer

Yu-Ting Wu

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## Course Information

- **Meeting time:** 09:10 - 12:00, Tuesday
- **Classroom:** 電1F-06
- **Instructor:** 吳昱霆 ([Yu-Ting Wu](#))
- **Teaching assistants:** [曾念馨](#)
- **Course webpage:**
  - <https://kevincosner.github.io/courses/IC2022/>
- **Grading:**

• Assignment: 25%	• Midterm: 35%
• Participation: 5%	• Final exam: 35%

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## HW Late Policy

- One day 90%
- Two days 80%
- Three days 70%
- Four days 60%
- Five days+ 50%
- E.g., assume the deadline for the HW is 12/24 23:59 and you submit your HW on 12/25, you will get a 10% penalty
- You should **NOT** share your homework with any **living creatures (if caught, you will get zero)**

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## Textbook

- **Computer Science: An Overview (13<sup>th</sup> edition)**
  - Glenn Brookshear and Dennis Brylow



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## Introduction

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## Algorithms

- A set of steps that defines how a task is performed



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## Algorithms (cont.)

- A set of steps that defines how a task is performed
  - Example: recipes for cooking

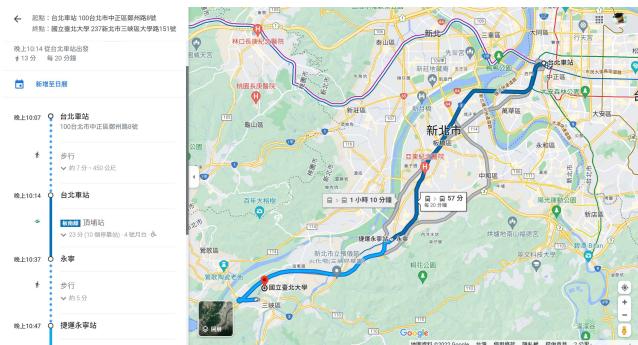


10 Ingredients	3 Method Steps
① 40g butter	Step 1
② 3 green shallots, thinly sliced	Melt the <b>butter</b> in a large, heavy-based saucepan over medium heat until foaming. Add the <b>shallot</b> and <b>garlic</b> . Cook, stirring, for 2 minutes or until softened.
③ 2 garlic cloves, crushed	
④ 400g can cherry tomatoes	
⑤ 500ml (2 cups) Massel Stock	
⑥ Chicken Style	
⑦ 1 tbsp sweet chilli sauce	Step 2
⑧ 350g dried spaghetti pasta	Add the <b>tomatoes</b> , stock, <b>sweet chilli sauce</b> and 250ml (1 cup) water to the pan. Season with salt. Add the <b>spaghetti</b> , and increase heat to high. Cook, stirring often so the pasta cooks evenly, for 12 minutes or until the pasta is al dente.
⑨ 300g peeled green prawns, deveined, tails removed	
⑩ Extra virgin olive oil, to drizzle	Step 3
⑪ Chopped fresh continental parsley leaves, to serve	Add <b>prawns</b> to pan and use tongs to toss until combined. Cover and cook for 3 minutes or until prawns change colour. Drizzle over <b>oil</b> , and sprinkle
⑫ Select all ingredients	

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## Algorithms (cont.)

- A set of steps that defines how a task is performed
  - Example: route planning



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## Algorithms (cont.)

- A set of steps that defines how a task is performed
  - Example: finding the greatest common divisor of two positive integers

**Description:** This algorithm assumes that its input consists of two positive integers and proceeds to compute the greatest common divisor of these two values.

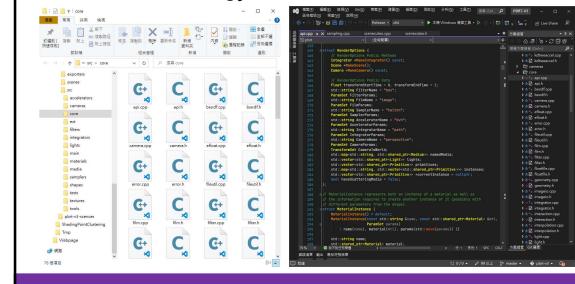
### Procedure:

- Step 1. Assign M and N the value of the larger and smaller of the two input values, respectively.
- Step 2. Divide M by N, and call the remainder R.
- Step 3. If R is not 0, then assign M the value of N, assign N the value of R, and return to step 2; otherwise, the greatest common divisor is the value currently assigned to N.

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## Programs

- A **representation** of an algorithm
  - Usually displayed on computer screens for the convenience of humans
  - Usually **encoded** in a manner compatible with the technology of the machine



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## Programming

- The process of developing a program and encoding it into a machine



what others think you do

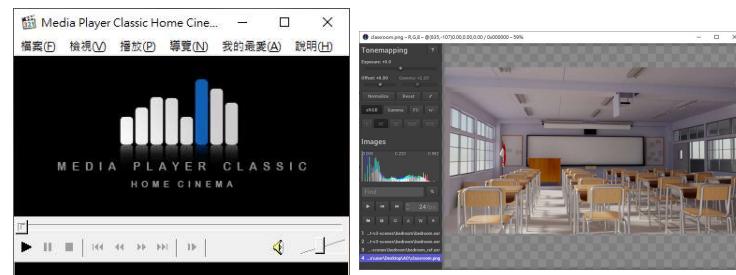


what you actually do

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## Software

- Programs (and their algorithms)
  - Examples: image viewers, video players, editors, browsers, communication software ... etc.



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## Hardware

- Machinery (equipment)



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## Terminology Review

- **Algorithm**
  - A set of steps that defines how a task is performed
- **Program**
  - A representation of an algorithm
- **Programming**
  - The process of developing a program
- **Software**
  - Programs (and their algorithms)
- **Hardware**
  - Machinery (equipment)

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## Gödel's Incompleteness Theorems

*"Some problems cannot be solved by algorithms"*



Kurt Friedrich Gödel (1906 – 1978)

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## The History of Computing

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## Early Computing Devices

- **Abacus**

- Use positions of beads to represent numbers
- Used in ancient China, early Greek and Roman



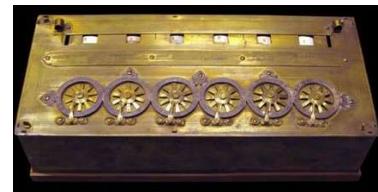
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## Early Computing Devices (cont.)

- **Gear-based machines (1600s – 1800s)**

- Use positions of gears to represent numbers
  - Blaise Pascal (1642)
  - Thomas Morland (1666)
  - Wilhelm Leibniz (1673)



Pascal's calculator



Leibniz's calculator

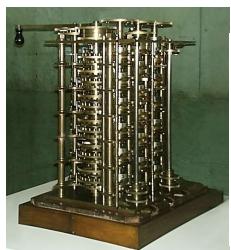
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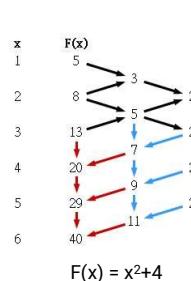
## Early Computing Devices (cont.)

- **Gear-based machines (1600s – 1800s)**

- Use positions of gears to represent numbers
  - Difference engine: Charles Babbage (1820)



Difference engine



Charles Babbage

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## Early Computing Devices (cont.)

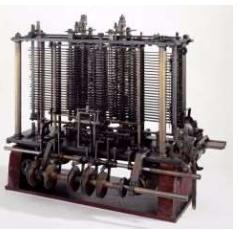
- **Gear-based machines (1600s – 1800s)**

- Use positions of gears to represent numbers
  - Analytical engine: Charles Babbage (1834)

- The idea of a general-purpose computer comprises of
  - Input (punch card)
  - Processor
  - Control unit
  - Storage
  - Output



Ada Lovelace



Analytical Engine

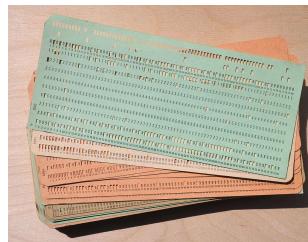
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## Early Data Storage

- Punched cards**

- Popular from 1720s to 1970s



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## Early Data Storage (cont.)

- Punched cards**

- First used in Jacquard Loom (1801) to store patterns for weaving cloth
- Storage of programs in Babbage's Analytical Engine



Jacquard Loom



Analytical Engine

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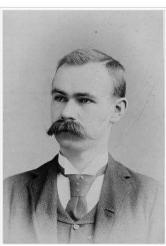
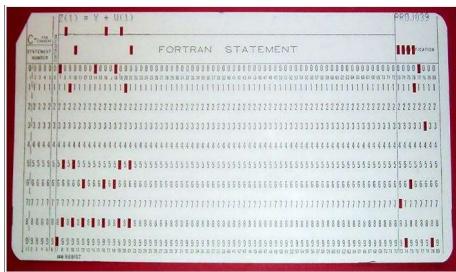
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## Early Data Storage (cont.)

- Punched cards**

- Used by Herman Hollerith (1890) to speed up the tabulation process in the 1890 U.S. census
- Shorten the time from 8 years to 3 years



Herman Hollerith

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## 1<sup>st</sup> Generation Computer

- 1940 – 1958**

- Mechanical relays**

- 1940: George Stibitz at Bell Laboratories
- 1944: Mark I: Howard Aiken and IBM at Harvard

- Vacuum tubes (totally electronics)**

- 1937 – 1941: Atanasoff-Berry at Iowa State
- 1940s: Colossus: secret German code-breaker
- 1940s: ENIAC: Mauchly & Eckert at U. of Penn.

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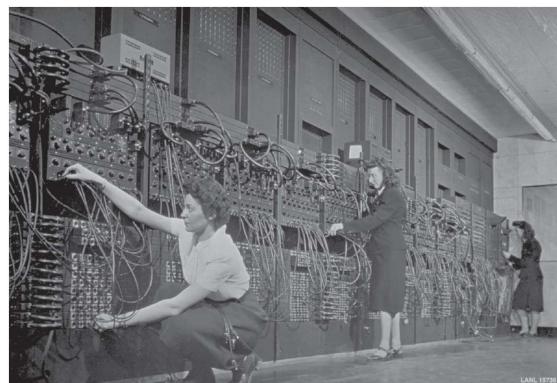
## 1<sup>st</sup> Generation Computer (cont.)



Mark I

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## 1<sup>st</sup> Generation Computer (cont.)



Electronic Numerical Integrator And Computer (ENIAC)

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## 2<sup>nd</sup> Generation Computer

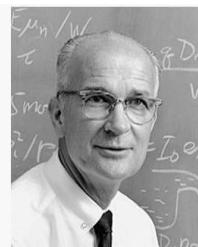
- 1959 – 1963
- **Transistor**
  - Developed by J. Bardeen, H. W. Brattain, and W. Shockley



John Bardeen



Walter Brattain

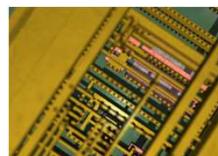


William Shockley

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## 3<sup>rd</sup> Generation Computer

- 1965 – 1970
- **Integrated Circuit (IC)**
  - Complete circuits constructed as single units
  - 1964: IBM SYSTEM-360
  - Decrease the size of computers, make desktop and mobile computers possible



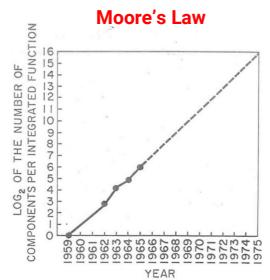
IBM SYSTEM-360

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## 4<sup>th</sup> Generation Computer

- From 1971
- **Very-Large-Scale Integration (VLSI)**
  - IC can be encased in toy-sized blocks of plastic called **chips**
  - **Moore's Law**



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## Personal (Desktop) Computers

- Origins: hobbyists built homemade computers from a combination of chips
- Steve Jobs and Stephen Wozniak built **Apple Computer** in 1976 for manufacturing and marketing their products
- **IBM** introduced the PC in 1981
  - The underlying software was developed by a newly formed company known as **Microsoft**
  - Accepted by the business community
  - Became the standard hardware design for most desktop computers

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## Internet

- The ability to connect individual computers in a world-wide system
- **World Wide Web** (or shortened to **Web**)
  - First proposed by Tim Berners-Lee
  - Documents stored on computers throughout the Internet can be linked together producing a maze of linked information
- **Search engines** make the information on the Web accessible
  - Sift through the Web, categorize the findings, assist users to find particular topics

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## Miniaturization of Computing Machines

- Tiny computers are embedded within a wide variety of electronic appliances and devices
  - **Global Positioning Systems (GPS)**
  - Engine monitors
  - Voice command system
- **Smartphones**



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## Topics We Plan to Cover

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## Topics We Plan to Cover

- Chap01: Data storage
- Chap02: Data manipulation
- Chap03: Operating systems
- Chap04: Networking and the internet
- Chap05: Algorithms
- Chap06: Programming language
- Chap08: Data abstractions
- Chap09: Database systems
- Chap10: Computer graphics
- Chap11: Artificial intelligence
- Chap12: Theory of computation

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## Chap 1: Data Storage

Basics of Data Encoding and Storage

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## Data Storage and Representation



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## Related Courses in NTPU

- 數位電子電路 (1<sup>st</sup> year)
- 數位訊號處理 (江振宇老師, 4<sup>th</sup> year)
- 數位系統設計 (陳永源老師, 1<sup>st</sup> year)

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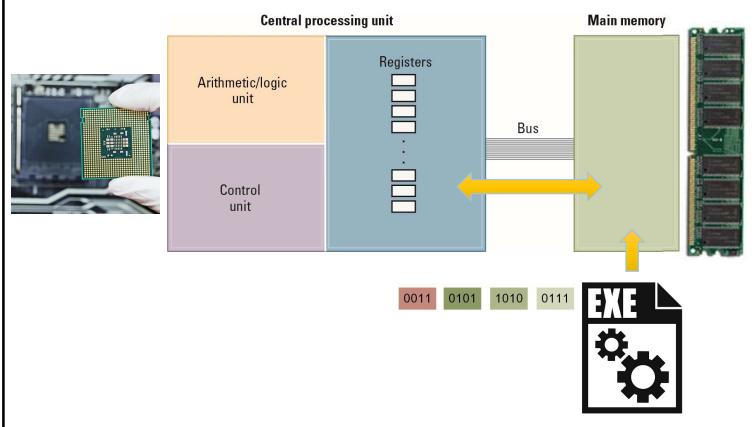
## Chap 2: Data Manipulation

Basic Internal Operation of a Computer

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## Data Manipulation



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## Related Courses in NPTU

- 計算機結構 (陳志昌老師, 3<sup>rd</sup> year)

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## Chap 3: Operating Systems

A Special Software that Controls the Overall Operations of a Computer

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## Operating Systems

```

graph TD
    user --> app[application programs<br/>(compilers, web browsers, development kits, etc.)]
    user --> os[operating system]
    user --> hw[computer hardware<br/>(CPU, memory, I/O devices, etc.)]
    app <--> os
    os <--> hw
    
```

The diagram illustrates the computer system architecture. At the top is the 'user' layer, which interacts with 'application programs' (compilers, web browsers, development kits, etc.). These application programs interact with the 'operating system' layer, which in turn interacts with the 'computer hardware' layer (CPU, memory, I/O devices, etc.). To the right of the diagram, there are three screenshots of operating systems: Microsoft Windows (showing a desktop with icons), Linux (showing a terminal window with command-line interface), and Mac OS (showing a desktop with various application windows).

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## Related Courses in NPTU

- 作業系統 (我, 3<sup>rd</sup> year)
- 嵌入式系統導論 (林伯星老師, 3<sup>rd</sup> year)
- 系統韌體開發與實作 (張仁俊老師, 4<sup>th</sup> year)

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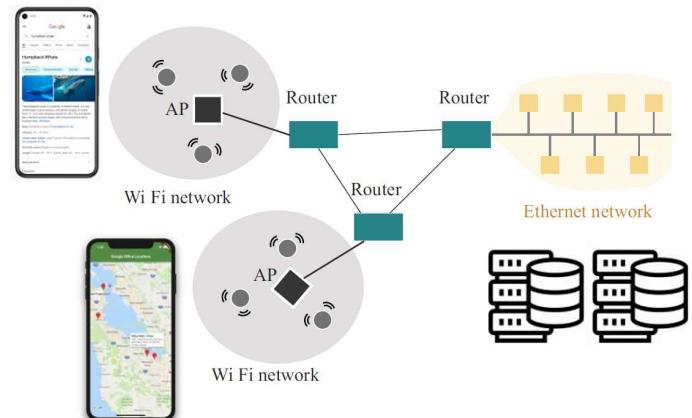
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## Chap 4: Networking and the Internet

How Computers are Connected to Each Other

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## Networking and the Internet



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## Related Courses in NPTU

- 電腦網路 (陳裕賢老師, 2<sup>nd</sup> year)
- 無線網路導論 (陳裕賢老師, 3<sup>rd</sup> year)
- 網路程式設計 (曾俊元老師, 3<sup>rd</sup> year)
- 網路安全與深度學習 (曾俊元老師, 3<sup>rd</sup> year)
- 高等電腦網路 (曾俊元老師, graduated)

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## Chap 5: Algorithms

A More Formal Perspective for Algorithms

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## Algorithms



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## Related Courses in NPTU

- 演算法 (吳信龍老師, 3<sup>rd</sup> year)
- 高等演算法 (張仁俊老師, graduated)

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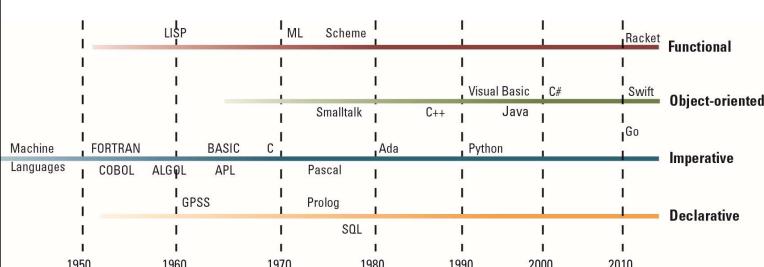
## Chap 6: Programming Languages

The Subject of Algorithm Representation and Development

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## Programming



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## Related Courses in NPTU

- 計算機程式設計 (陳志昌老師, 1<sup>st</sup> year)
- 物件導向程式設計 (戴志華老師, 1<sup>st</sup> year)
- 微算機與組合語言 (張玉山老師, 2<sup>nd</sup> year)
- 雲端計算與大數據程式設計 (張玉山老師, 3<sup>rd</sup> year)

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## Chap 8: Data Abstractions

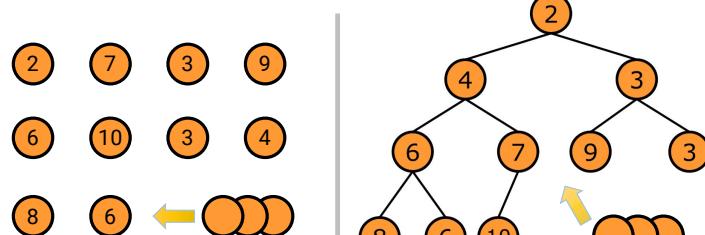
Ways of Data Organization in a Computer's Main Memory

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## Data Abstraction (Data Structures)

Problem: design an algorithm to pop the smallest number iteratively when new numbers are coming in



Naïve approach: compare  $n$  times in each iteration

Using a min heap:  $O(1)$  for finding the minimum,  $O(\log(n))$  to update

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## Related Courses in NTPU

- 資料結構 (莊東穎老師, 2<sup>nd</sup> year)
- 進階資料結構 (莊東穎老師, 2<sup>nd</sup> year)

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## Chap 9: Database Systems

Ways of Data Organization in a Computer's Mass Storage

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## Database System

ID	Name	Birthday	BirthPlace	HealthStatus	CrimeHistory	...

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## Related Courses in NTPU

- 資料庫系統 (戴志華老師, 3<sup>rd</sup> year)

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## Chap 10: Computer Graphics

The subject of Graphics and Animation

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## Computer Graphics



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## Related Courses in NTPU

- 多媒體技術與應用 (我, 2<sup>nd</sup> year)
- 計算機圖學導論 (我, 3<sup>rd</sup> year)

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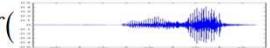
## Chap 11: Artificial Intelligence

Develop More Intelligent (Useful) Machines

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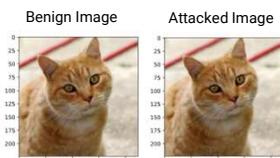
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## Artificial Intelligence

$f([$    $]) = \text{ "How are you"}$

$f([$    $]) = \text{ "Cat"}$

$f([$    $]) = \text{ "5-5"}$   
 (next move)



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## Related Courses in NTPU

- 人工神經網路與深度學習 (林道通老師, 3<sup>rd</sup> year)
- 機器學習導論 (吳信龍老師, 3<sup>rd</sup> year)

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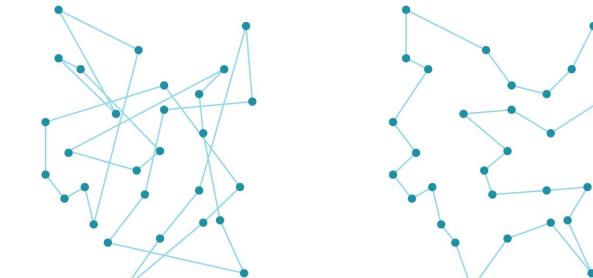
## Chap 12: Theory of Computation

The Theoretical Foundations of Computer Science

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## Computation Theory



The travel salesman problem  
 $P = NP?$

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## Related Courses in NTPU

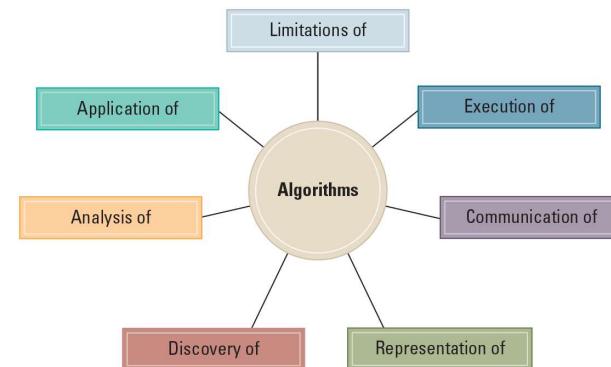
- There are no related courses in NTPU
- But you can discuss with 吳信龍老師 if you are interested!

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## Summary: Computer Science and Algorithms

- Computer science is the science of algorithms



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**Any Questions?**