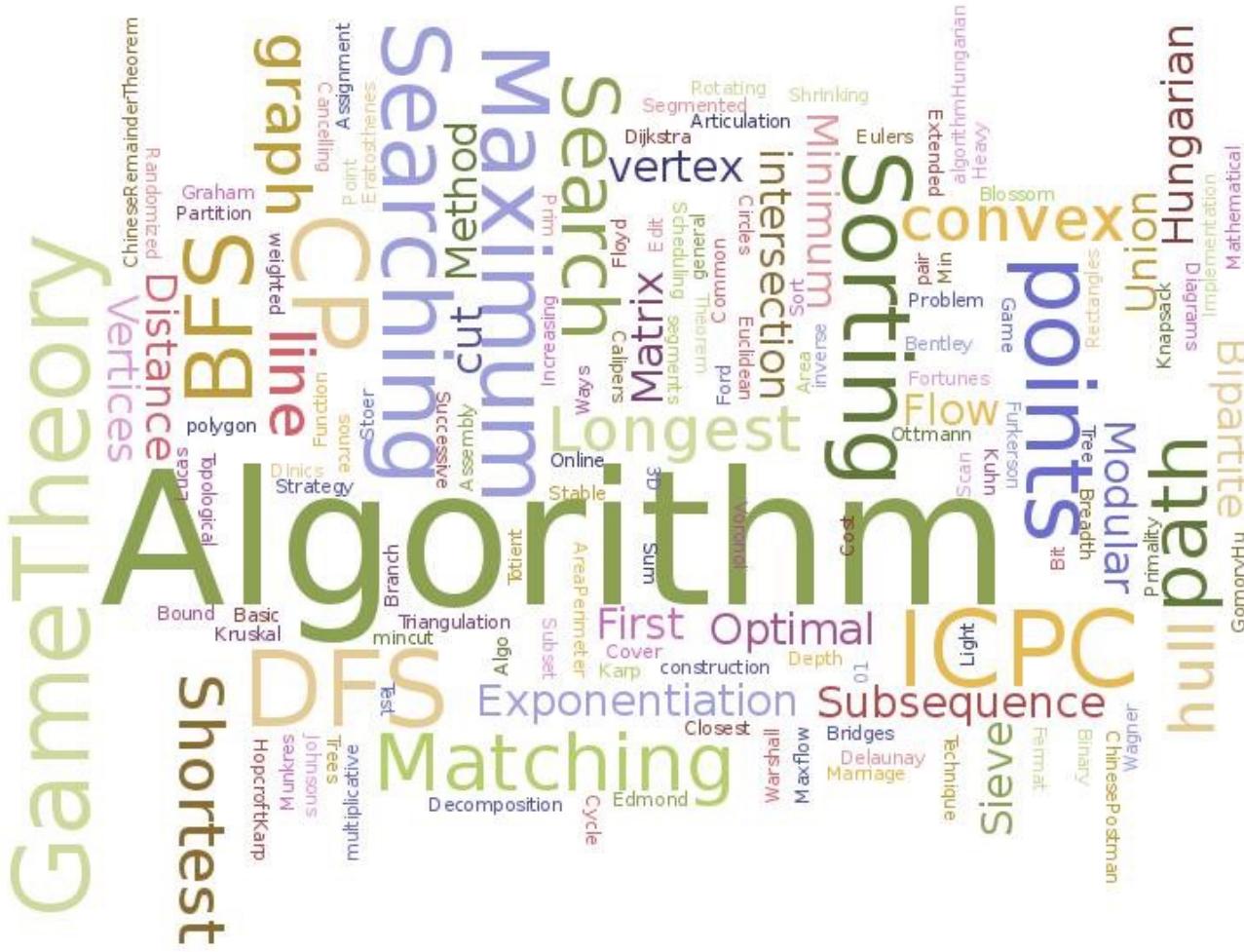


TIC2001 Data Structures and Algorithms



Today

- Introduction
- Course Information
- From C to C++

Lecturer

► CHENG, Ho Lun, Alan, 鄭浩璘

- Hong Kong
- UIUC, Duke (USA)

► Hobbies:

- Teaching
- Research Interests: Graphics, Geometry, Games

► Email:

- hcheng@comp.nus.edu
- (alan@comp.nus.edu)
- **DO NOT send to dcschl**
- **DO NOT send codes to me**
- Office: AS6 #05-03

► Ext. 68732



Just in case,
the less cute
one is me

About Me

- *“Those who know the truth are not up to those who love it; those who love the truth are not up to those who delight in it.”*
-- Confucius
- I want to make this course fun and interesting, but still fair, meaningful and with deep knowledge
- To me, it's always a challenge to maintain the balance between fun and fair
- My goal: Minimize your revision time

About Me and this Course

- Some feedback from previous² years
 - Make the complex and dry theory into interesting and easy to understand examples
 - “Very funny lecturer. Always explains complex concepts in an easy way for understanding
 - “I can not expect anything more from him. He worked so hard to prepare for the test as well as to help students. The way he explain abstract concepts is just amazing. Furthermore, I can always receive the almost instant replies on the forum from him.“
 - “play nice guitar”

Last Year

Make the complex and dry theory into interesting and easy to understand examples

Weekly quizzes are good to encourage students to study weekly and earn marks

Interesting and attractive teaching style. And gives an easier way of understanding the difficult content. Good arrangement and well balanced between lecture and tutorial. And he will guide TA what to go through in the tutorial. This is the most important thing.

his coaching still very interesting and we are very enjoy in his class. He increased my interest in this module.

Have good sense of humour, lecture is not boring.

Patient and able to articulate well

Provide us very interesting practice questions which require us to apply the knowledge that we have learned from the module.

It enhanced our critical thinking and problem solving skills. Through the exercise, we have a better understanding of the knowledge that Mr. Alan Cheng thought us.

Engaging, improvises teaching to accommodate situation.

His funny way of teaching and analogy make us easier to remember and learn new things

his lectures are interesting and able to provide layman examples to relate to the teaching topic which is important as students are new to the topic.

especially during tutorial, he recapped and explained further with more examples which enhance the understanding of the topic

Clear concept and written practise to enhance students learning experience beside lecture.

Caring, compassionate, understanding, humorous, understanding, teaches complex concepts using simple examples.

Creatively using images. Use quizzes to encourage students to stay consistent studying. Interactive lessons. Provide lots of resources to suit different type of students study preferences

Last Last Year

Comments

Make the complex and dry theory into interesting and easy to understand examples

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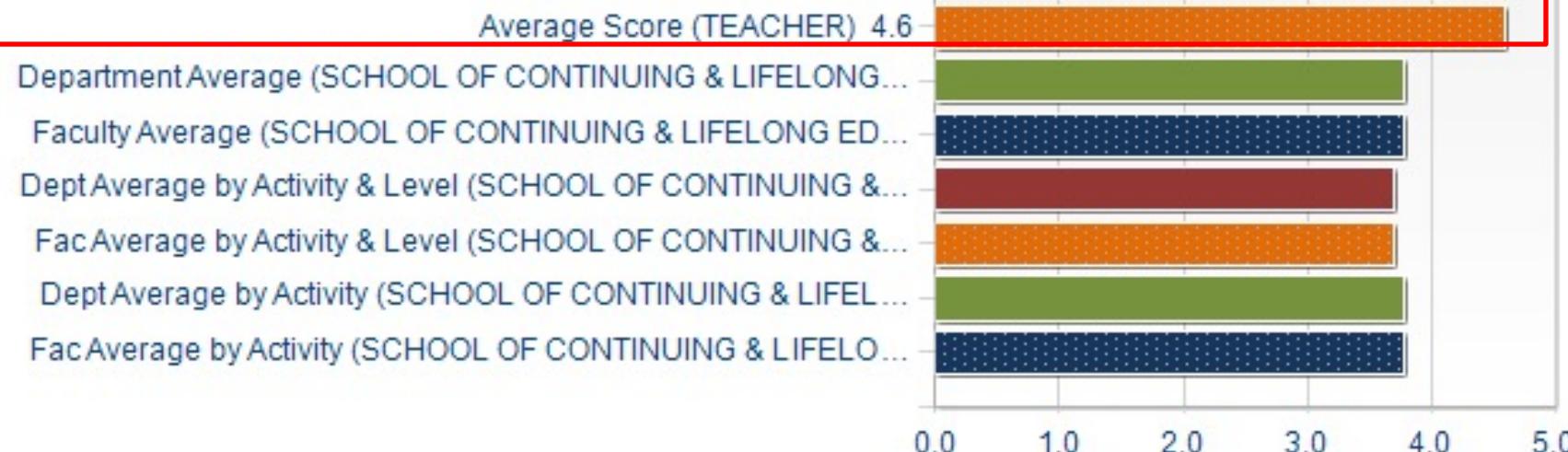
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Overall, the teacher is effective



Question	Average Score (TEACHER)		Department Average (SCHOOL OF CONTINUING & LIFELONG EDN)		Faculty Average (SCHOOL OF CONTINUING & LIFELONG EDN)	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
The teacher has enhanced my thinking ability.	4.7	0.5	3.9	0.8	3.9	0.8
The teacher provided timely and useful feedback.	4.5	0.6	3.8	0.8	3.8	0.8
The teacher has increased my interest in the subject.	4.6	0.6	3.8	0.9	3.8	0.9
Average of Q1-Q3	4.6	0.6	3.8	-	3.8	-



And Our TAs!



Myth Buster

- Is it better to attend the tutorial/lab by the lecturer than the TAs?



About This Module



Why This Module?

- How much data did you handle your last module? Think BIG!



Google?



why professor

why professor **x still alive in logan**

why professor **x can't walk**

why professor **not in nba**

why professor **mcgonagall is the best**

why professor **x died in logan**

why professor **green name**

why professors **s are arrogant**

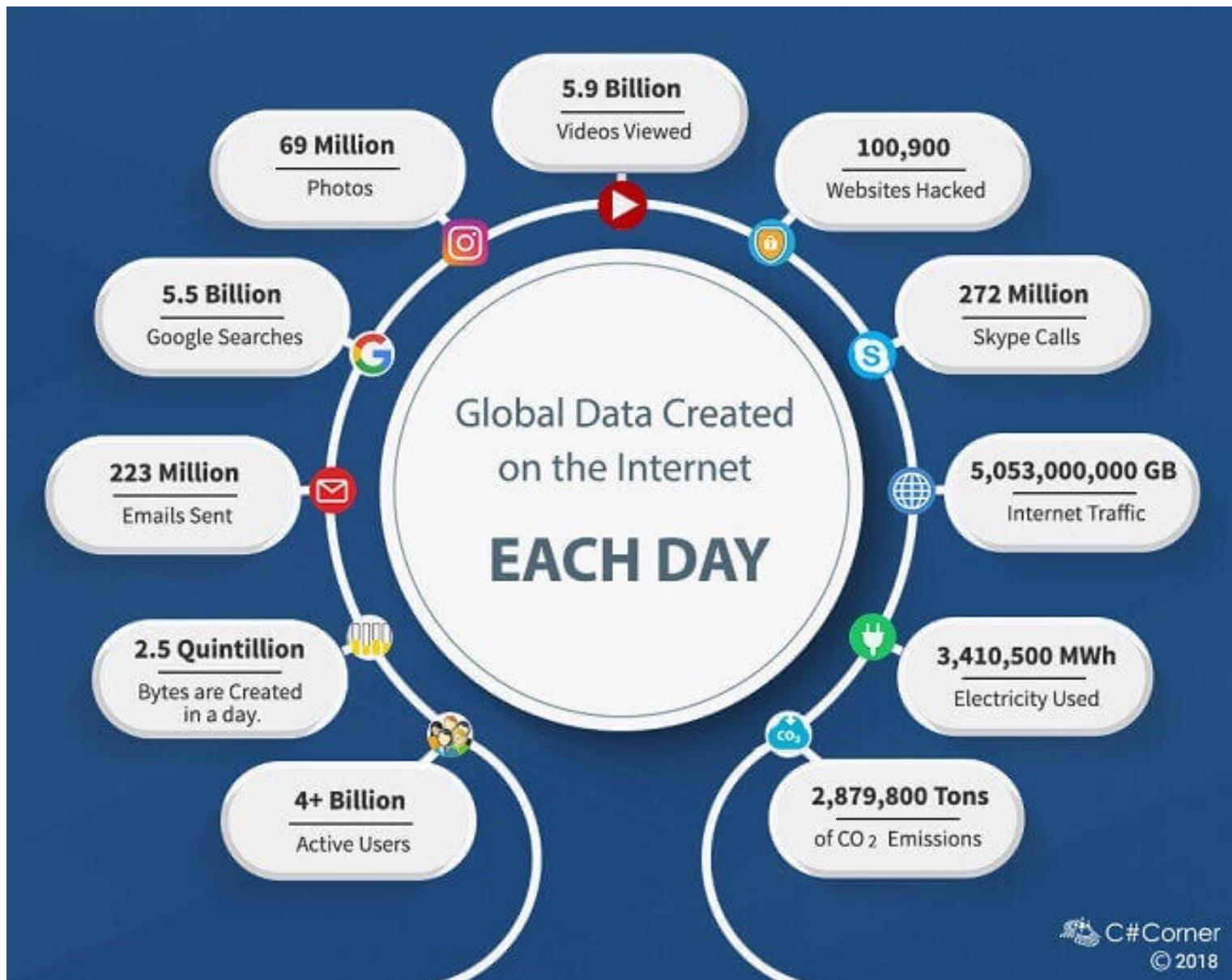
why professor **shape killed dumbledore**

why professors **s don't reply**

why professors **s are liberal**

A screenshot of a Google search results page. The search bar at the top contains the query "why professor". Below the search bar is a list of ten suggested search terms, each featuring a bolded word or phrase. At the bottom of the screenshot are two standard Google search buttons: "Google Search" and "I'm Feeling Lucky".

How much data does Internet have?



According to MarTech

- According to MarTech, the total data size of the Internet is 2.7 Zettabytes until 2017.

Unit	Decimal Value	Binary Value	Size (in bytes)
Bit (b)	0 or 1	0 or 1	1/8 th
Byte (B)	8 bits	8 bits	1
Kilobyte (KB)	1000 ¹ bytes	1024 ¹ bytes	1,000
Megabyte (MB)	1000 ² bytes	1024 ² bytes	1,000,000
Gigabyte (GB)	1000 ³ bytes	1024 ³ bytes	1,000,000,000
Terabyte (TB)	1000 ⁴ bytes	1024 ⁴ bytes	1,000,000,000,000
Petabyte (PT)	1000 ⁵ bytes	1024 ⁵ bytes	1,000,000,000,000,000
Exabyte (EB)	1000 ⁶ bytes	1024 ⁶ bytes	1,000,000,000,000,000,000
Zettabyte (ZB)	1000 ⁷ bytes	1024 ⁷ bytes	1,000,000,000,000,000,000,000
Yottabyte (YB)	1000 ⁸ bytes	1024 ⁸ bytes	1,000,000,000,000,000,000,000,000

How much data does Google handle?

- About 10 to 15 Exabyte of data
 - 1 Exabyte(EB)= 1024 Petabyte(PB)
 - 1 Petabyte(PB) = 1024 Terabytes(TB)
 - 1 Terabyte(PB) = 1024 Gigabytes(TB)
 - = 4 X 256GB iPhone
- So Google is handling about 60 millions of iPhones

Data Structures

- Always deal with large volume of data
- How to **organize** data so that we can
 - Modify
 - Search
 - Analyze
 - or manipulate in any way
- in the fastest **way**

Data
Structure

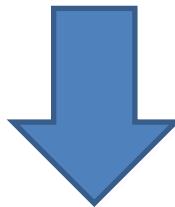
A blue curved arrow originates from the word "organize" in the middle of the second bullet point and points to a light green rectangular box containing the text "Data Structure".

Algorithm

A blue curved arrow originates from the word "fastest" in the end of the third bullet point and points to a light green rectangular box containing the text "Algorithm".

Find a number

[257, 186, 63, 231, 321, 312, 210, 249, 149, 339, 420, 299, 252, 34, 128, 281, 313, 370, 109, 120, 454, 133, 496, 460, 302, 419, 9, 466, 412, 326, 493, 248, 31, 222, 201, 193, 23, 214, 165, 157, 253, 206, 223, 268, 45, 217, 156, 447, 367, 392, 86, 402, 85, 380, 294, 65, 131, 292, 277, 172, 192, 340, 459, 492, 140, 341, 336, 27, 346, 208, 282, 278, 71, 124, 254, 243, 47, 96, 436, 189, 418, 371, 242, 389, 94, 87, 481, 19, 444, 26, 499, 52, 245, 62, 461, 205, 169, 14, 143, 163]



[9, 14, 19, 23, 26, 27, 31, 34, 45, 47, 52, 62, 63, 65, 71, 85, 86, 87, 94, 96, 109, 120, 124, 128, 131, 133, 140, 143, 149, 156, 157, 163, 165, 169, 172, 186, 189, 192, 193, 201, 205, 206, 208, 210, 214, 217, 222, 223, 231, 242, 243, 245, 248, 249, 252, 253, 254, 257, 268, 277, 278, 281, 282, 292, 294, 299, 302, 312, 313, 321, 326, 336, 339, 340, 341, 346, 367, 370, 371, 380, 389, 392, 402, 412, 418, 419, 420, 436, 444, 447, 454, 459, 460, 461, 466, 481, 492, 493, 496, 499]

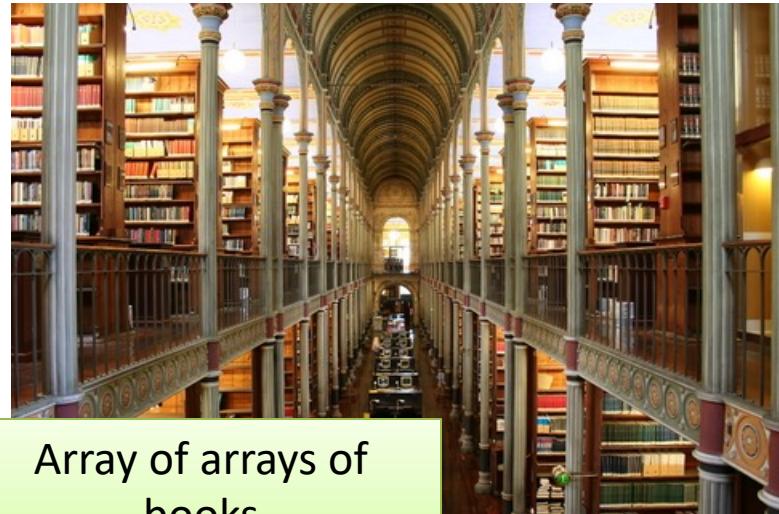
Data Structure and Algorithm

- Data Structure
 - Store the numbers in a sorted way
- Algorithm
 - Searching for a number x:
 - Look for the “middle” number, m
 - If hit, found
 - Search the left or the right part depending if $x > m$ or not

```
[9, 14, 19, 23, 26, 27, 31, 34, 45, 47, 52, 62, 63, 65, 71, 85, 86, 87, 94, 96, 109, 120, 124, 128, 131, 133, 140, 143, 149, 156, 157, 163, 165, 169, 172, 186, 189, 192, 193, 201, 205, 206, 208, 210, 214, 217, 222, 223, 231, 242, 243, 245, 248, 249, 252, 253, 254, 257, 268, 277, 278, 281, 282, 292, 294, 299, 302, 312, 313, 321, 326, 336, 339, 340, 341, 346, 367, 370, 371, 380, 389, 392, 402, 412, 418, 419, 420, 436, 444, 447, 454, 459, 460, 461, 466, 481, 492, 493, 496, 499]
```

Data Structures

- How to organize a lot of data
- with some sophisticated ways



Array of arrays of books



Array of arrays of baskets of books

Algorithm

- What is an algorithm?
- Set of instructions for solving a problem
 1. “wash the tomatoes.”
 2. “peel and cut the carrots.”
 3. “mix the olive oil and vinegar.”
 4. “combine everything in a bowl.”
- Finite sequence of steps
- English, Chinese, pseudocode, Java, etc.
- **Unambiguous**

Ambiguous Human Language

John, honey, could you peel half the potatoes and put them on to boil?

Mission accomplished.



Algorithms

- History
 - Named for al-Khwārizmī (780-850)
 - Persian mathematician
- Many ancient algorithms
 - Multiplication: Rhind Papyrus
 - Babylon and Egypt: ~1800BC
 - Euclidean Algorithm: Elements
 - Greece: ~300BC
 - Sieve of Eratosthenes
 - Greece: ~200BC



“If you need your software to run twice as fast,
hire better programmers.

But if you need your software to run more than
twice as fast, use a better **algorithm**.”

-- *Software Lead at Microsoft*

Language Does Not Matter

Algorithms are more important:

Fact: C can be 20x as fast as Python!

Algorithm	Language	Time	10,000 elements
Fast (MergeSort)	Slow (Python)	$2n \log(n) \mu s$	0.266s
Slow (InsertionSort)	Fast (C)	$0.01n^2 \mu s$	1s

(Source: MIT 6.006, 2008)

Course Information

Programming Language

- We assume you know C++ well already
 - Including pointers
- IDE will be MSVC
 - Not command line
 - Not MS Visual Studio Code

Syllabus

- Linked List
- Sorting
- Balanced Binary Trees (AVL)
- Hash Tables
- Binary Heaps
- Graphs
 - SSSP
 - MST
 - And more
- Extra topics, e.g. Computational Geometry

Module Information

CA

Visualgo Quizzes	5%
Assignments(x5)	20%
Mock Quiz	2%
Quizzes (x2)	18%
PE	10%
Final Assessment:	45%

May subject to changes , ±5%

Important Dates

Week	Thu Quiz/PE	VAQ	Assignments	PE (Thu)
1				
2				
3		Linked List	1	
4	Mock Quiz (2%)			
5		Sorting	2	
6	Quiz 1 (30 min)			
	Recess Week			
7			3	
8		AVL		
9	Quiz 2 (30 min)		4	
10		Heap		
11	PE (2 hours)		5	6pm-9pm
12		SSSP		
13				

Make-up PEs, Quizzes

- You are qualified for make-ups for
 - Sick leave with a valid MCs from doctors
 - NS (for boys)
 - Represent NUS for international oversea events e.g. Olympics
 - Excluding trainings
- Any thing other than the above are not qualified, some unqualified examples:
 - Oversea Travel (except the above)
 - Representing halls or clubs
 - Including with letters from hall officials
- **There will be no more make-up for make-ups.**
- By NUS rule, once you started a PE or assessment, you cannot do any make-ups. Same goes for other assessments.

“Qualified” Leave

- If you are “qualified” for a leave in the previous slide for
 - Attendance
 - Can get
 - Visalgo Quiz
 - Can take it in the next session
 - Written Quiz
 - Make-up in the Saturday morning in the same week

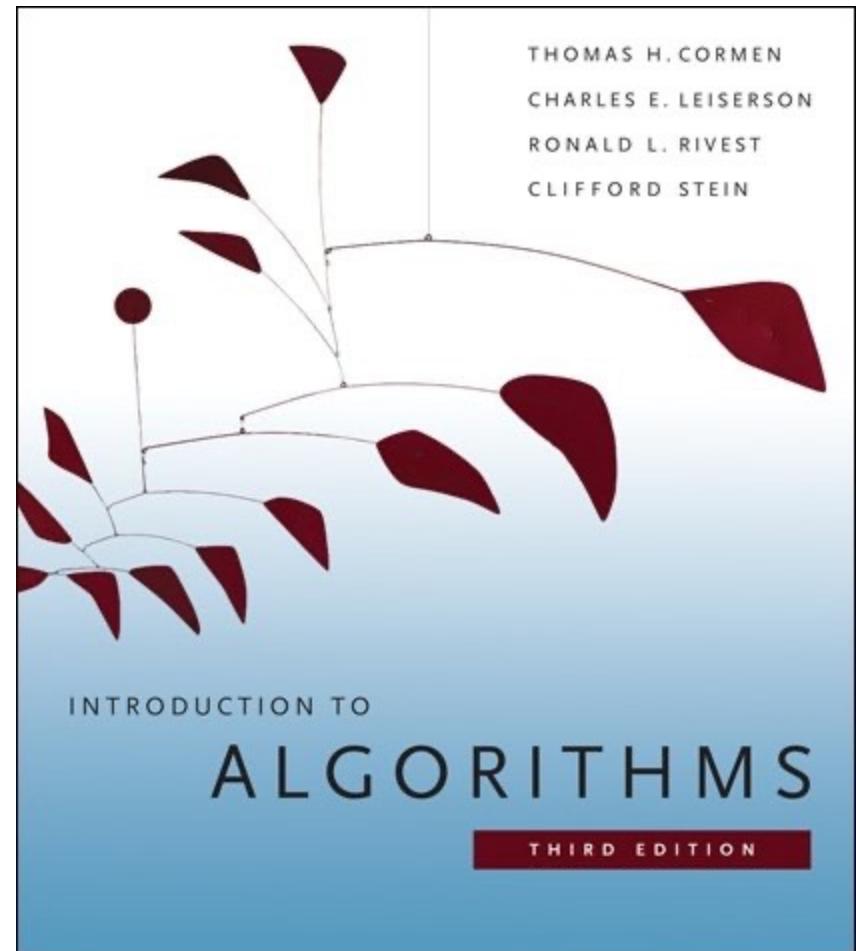
Problem Sets: Collaboration Policy

- You can “work” together with your classmates
- You must write/code your problems sets alone.
- You must list on your submission the name of everyone you worked with, and all sources used.
- Cheating / plagiarism will be dealt with harshly.
- Please do not post any code in forum or any public domain

Textbooks

(Not Necessary but Good to have)

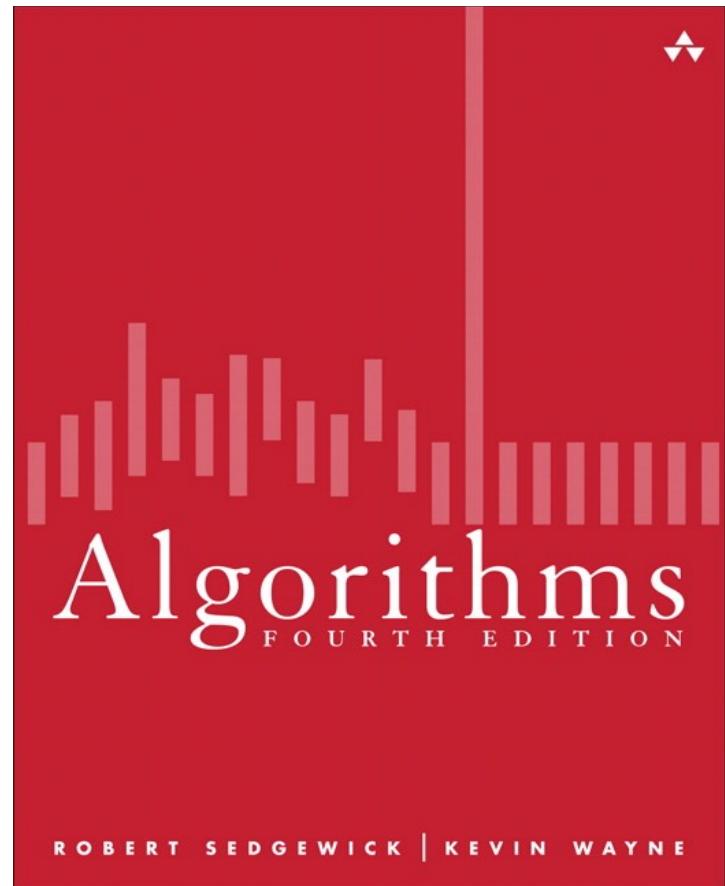
- Introduction to Algorithms, Third Edition
 - Cormen, Leiserson, Rivest, Stein



Textbooks

(Not Necessary but Good to have)

- Algorithms
 - Robert Sedgewick and Kevin Wayne

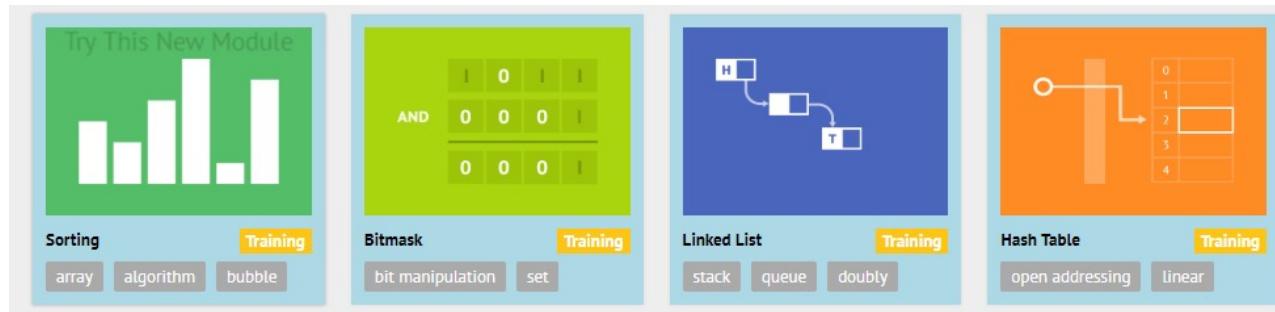


Online Teaching Tools

- Coursmology (<https://coursemology.org/>)



- Visualgo (<https://visualgo.net/en>)



- Archipelago (<https://archipelago.comp.nus.edu.sg/>)

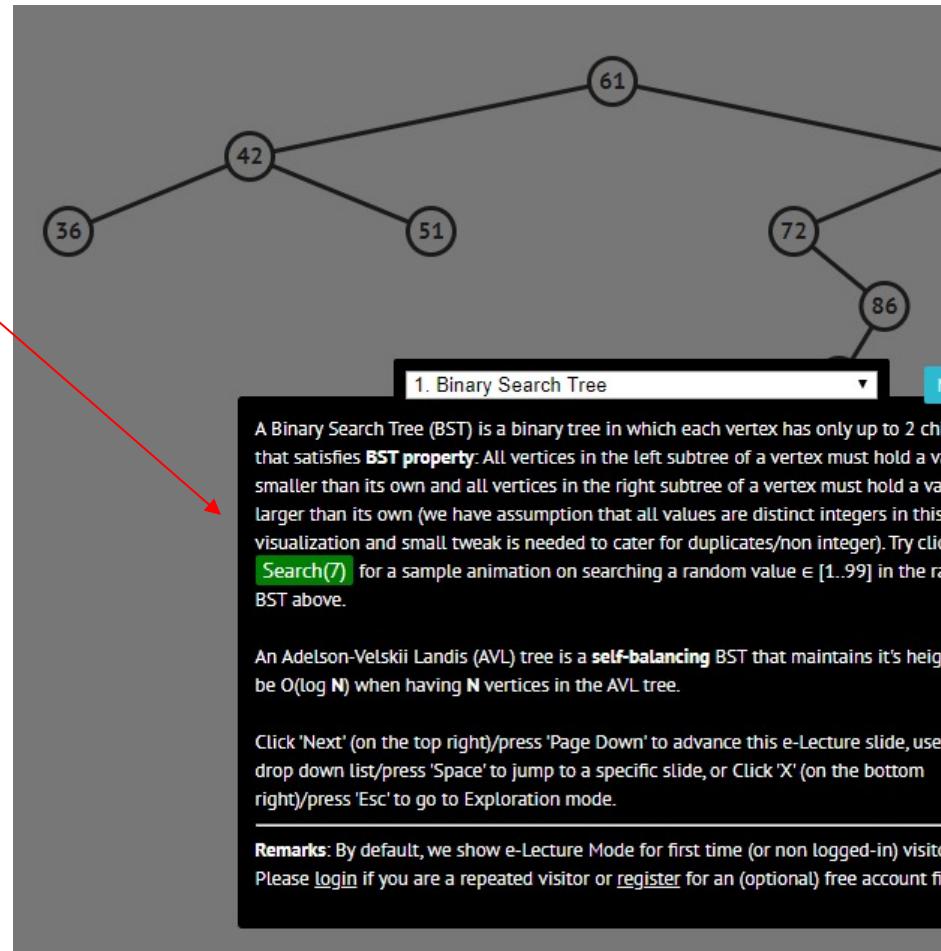


Coursemology

- Our main platform
 - All materials
 - Homework submission
 - Trainings
 - PE
 - Etc
- We only use Luminus for grade verification at the end of the semester

Visualgo

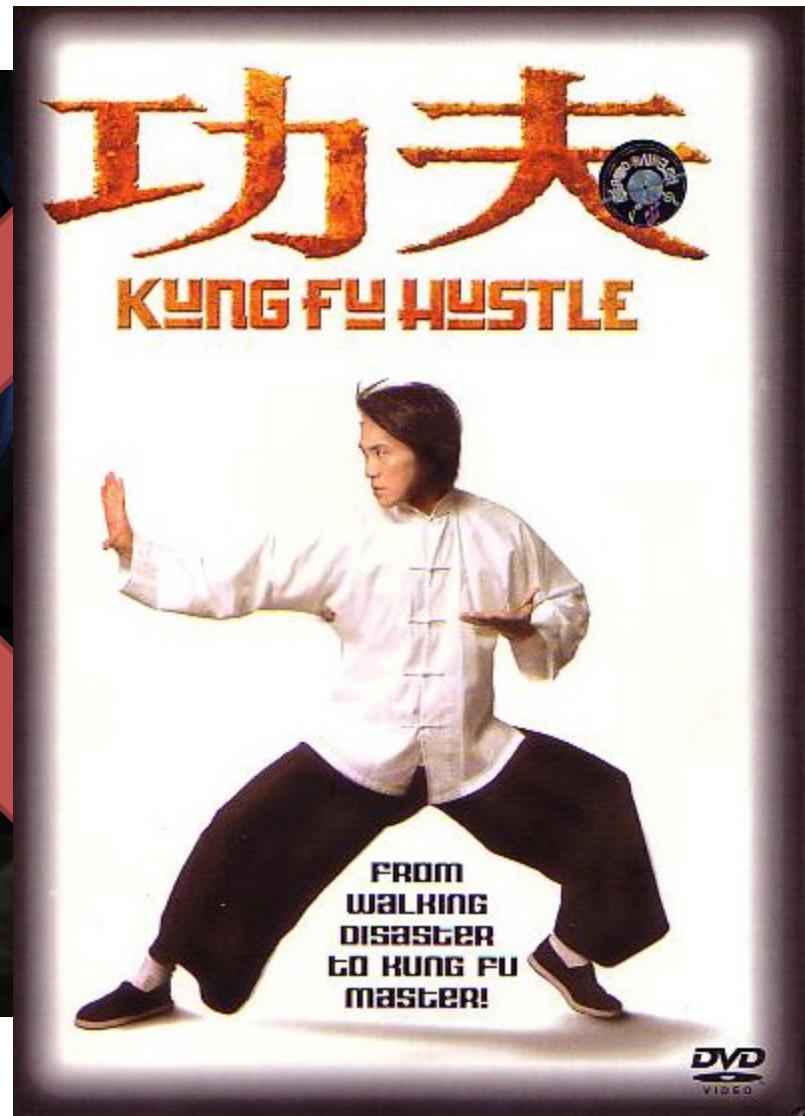
- Interactive demo
- Flip classroom lecture
- Visualgo Quiz



Programming Tools

- Microsoft Visual Studio 20XX **Community Version**
 - Not MS VS **Code**
 - You may download other previous versions, but may have problem
 - Remember to register
- Mac users can use XCode

C++ is so Difficult?



How to be a good programmer

- What is the different between old and new fighting movies?



Grit

[https://www.ted.com/talks/angela lee
duckworth grit the power of passion
and perseverance?language=en](https://www.ted.com/talks/angela_lee_duckworth_grit_the_power_of_passion_and_perseverance?language=en)