

Things to Note ...

- Last help lab on Friday ... ask about anything
- Pre-exam consultation: *Thursday 8 Nov, 2-4pm* in room 401K, K17
- MyExperience survey ends 1 Nov

In This Lecture ...

- Algorithm and Data Ethics, Course Review, Exam Preview, Fun Quiz

Coming Up ...

- Exams, Holidays ...
-

Assignment 2

Average performance result: 8.4 (out of 12) ... I'm impressed

Complexity analysis ...

- Sample Analysis for Task A

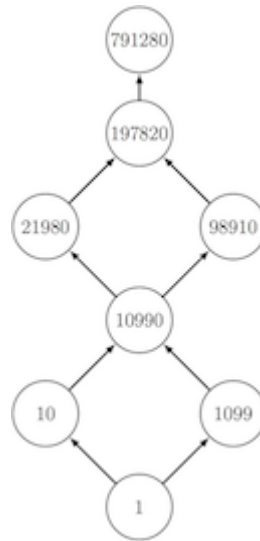
```
/* Returns true if 2 numbers x < y form a valid edge
 * Time complexity: O(m)
 * Explanation:
 * - the function loops to divide x and y as many times as x and y have digits
 * - so the time complexity is O(m), where m = digits used to represent y
 */
bool validEdge(int x, int y) {
    ...
    while (y > 0) {
        digits[y % NUM_DIGITS] = true;
        y /= 10;
    }
    while (x > 0) { // Ensure digits in x are in y
        if (!digits[x % NUM_DIGITS])
            return false;
        x /= 10;
    }
    return true;
}

/* Generates partial order graph
 * Time complexity: O(mn^2)
 * Explanation:
 * - outer loop executes n times, where n = #divisors
 * - inner loop executes n^2/2 times
 * - inside loops: validEdge() is O(m), inserting edge is O(1) (adj. matrix)
 */
Graph makePOG(int p, int *divisors, int *numDivisors) {
    ...
    for (int i = 0; i < *numDivisors; i++) // fill in edges
        for (int j = i + 1; j < *numDivisors; j++)
            if (validEdge(divisors[i], divisors[j]))
                insertEdge(g, (Edge) {i, j});
    return g;
}
```

... Assignment 2

- Task B

prompt\$./poG 791280



Longest monotonically increasing sequences:

1 < 10 < 10990 < 21980 < 197820 < 791280

1 < 10 < 10990 < 98910 < 197820 < 791280

1 < 1099 < 10990 < 21980 < 197820 < 791280

1 < 1099 < 10990 < 98910 < 197820 < 791280

Can go left or right at each branching node

⇒ there may be $O(2^n)$ longest paths in a graph

⇒ no polynomial algorithm can find and print them all

Algorithm and Data Ethics

Data Breaches

5/35

Major incidents ...

- *TJ Maxx credit and debit card theft (2005-07)*

Hackers gained access to accounts of over 100 million customers

⇒ Customers exposed to credit/debit card fraud

- *Yahoo! data breach (2013-16)*

Hackers gained access to all 3 billion user accounts

Details taken included names, DOBs, passwords, answers to security questions

⇒ Customers exposed to identity theft

⇒ Over 20 class-action lawsuits filed against Yahoo!

- *Facebook-Cambridge Analytica data scandal (2018)*

Millions of people's Facebook profiles used for political purpose without their consent

⇒ Cambridge Analytica went bust as a consequence

... Data Breaches

6/35

The Guardian, 30/03/15 ...

Personal details of world leaders accidentally revealed by G20 organisers

Exclusive: Obama, Putin, Merkel, Cameron, Modi and others kept in the dark after passport numbers and other details were disclosed in Australia's accidental privacy breach

- Follow our full coverage of this exclusive story
- Read the immigration department's letter outlining the circumstances of the G20 privacy breach



▲ Tony Abbott and Vladimir Putin cuddle koalas before the start of the first G20 meeting in November 2014. Photograph: Andrew Taylor/G20 Australia/Getty Images

The personal details of world leaders at the last G20 summit were accidentally disclosed by the Australian immigration department, which did not consider it necessary to inform those world leaders of the privacy breach.

The Guardian can reveal an employee of the agency inadvertently sent the passport numbers, visa details and other personal identifiers of all world leaders attending the summit to the organisers of the Asian Cup football tournament.

... Data Breaches

7/35

Australia's *Privacy Act 1988* ...

- outlines how personal information must be used and managed
- applies to government agencies, businesses and organisations with annual turnover of >\$3 million, private health services, ...

Individuals have the right to:

- have access to their personal information
- know why and how information is collected and who it will be disclosed to
- ask to stop unwanted direct marketing

Businesses and organisations must comply with the *Australian Privacy Principles*:

- how to collect personal information
- how (not) to use personal information
- how to secure personal information

... Data Breaches

8/35

Australia's Privacy Act 1988 *Notifiable Data Breaches scheme*

In the event of a suspected or known data breach ...

- contain breach where possible
- assess if personal information is likely to result in serious harm to affected individuals
 - individuals must be notified promptly
 - Australian Information Commissioner must also be notified
- take action to prevent future breaches

Data (Mis-)use

9/35

In 2012 several newspapers reported that ...

- Target used data analysis to predict whether female customers are likely pregnant
- Target then sent coupons by mail
- A Minneapolis man thus found out about the pregnancy of his teenage daughter

Not based on a factual story, but not implausible either

Who "owns" your data?

- big companies (Google, Facebook, ...)?
- governments?
- you?

... Data (Mis-)use

10/35

From the [*ACM Code of Ethics and Professional Conduct*](#) ...

- Respect privacy
 - Store only the minimum amount of personal information necessary
 - Prevent re-identification of anonymised data
- Carefully analyse the consequences of data aggregation
- Access data only when authorised or compelled by the public good
 - **Whistleblower Manning's** disclosing of classified military data to Wikileaks (2010-11)
 - **Paradise papers** that disclosed offshore investments (2017)

Costly Software Errors

11/35

NASA's Mars Climate Orbiter ...

- launched 11/12/1998
- reached Mars on 23/9/1999
- came too close to surface and disintegrated

Cause of failure:

- spec said impulse must be calculated in *newton seconds*
- one module calculated impulse in *pound-force seconds*
- 1 newton \cong 0.2248 pound-force

... Costly Software Errors

12/35

Toyota vehicle recall (2009-11)

- Vehicles experienced sudden unintended acceleration
- 89 deaths have been linked to the failure
- 9 million cars recalled worldwide

Causes of failure included ...

- a deficiency in the electronic throttle control system:
stack overflow
 \Rightarrow stack grew out of boundary, overwrote other data

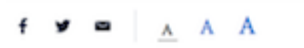
... Costly Software Errors

13/35

Sydney Morning Herald, 05/01/10:

Welcome to 2016: Eftpos glitch spreads

By Chris Zappone
5 January 2010 – 10:32am



The computer bug that brought Bank of Queensland's Eftpos transactions to a grinding halt in the first days of the New Year has hit other banks - including the Commonwealth Bank-owned BankWest.

The glitch, which started on January 1, left Australian retailers struggling to perform routine electronic point-of-sale transactions.

Merchants instead had to rely on carbon vouchers provided by banks or temporary measures that overrode the machines' internal time stamp.

Because of the error, Eftpos terminals recognise the year as 2016.

EFTPOS terminals inoperable for several days in early 2010

- customers' cards rejected as expired

Cause of failure:

- one module interpreted the current year as hexadecimal
 - **0x09** = 09
 - **0x10** = 16 (\neq 10)

Sidetrack: Year 2038 Problem

14/35

Recall:

```
#include <time.h>
time(NULL) // returns the time as the number of seconds
           // since the Epoch, 1970-01-01 00:00:00 +0000
```

Year 2038 problem ...

- **time(NULL)** on 19 January 2038 at 03:14:07 (UTC) will be 2147483647 = 0x7FFFFFFF
- a second later it will be **0x80000000** = -2,147,483,648
- $\Rightarrow -2^{31}$ seconds since 01/01/1970 ("Epoch") is 13 December 1901 ...

Programming Ethics

15/35

From the [*ACM/IEEE Software Engineering Code*](#) ...

- Software engineers shall ensure that their products meet the highest professional standards possible
 - Strive to fully understand the specifications for software
 - Ensure that specifications have been well documented and satisfy the users' requirements
 - Ensure adequate testing, debugging, and review of software and related documents
- Approve software only if it
 - is safe
 - meets specifications
 - passes appropriate tests
 - does not diminish quality of life, diminish privacy or harm the environment

... Programming Ethics

Algorithms can save lives.

Uberlingen airplane collision 1/7/02 at 11:35pm ...

- passenger jet V9 2937 and cargo jet QY 611 on collision course at 36,000 feet
- ground air traffic controller instructed V9 pilot to descend
- seconds later, the automatic Traffic Collision Avoidance System (TCAS)
 - instructed V9 2937 to climb
 - instructed QY 611 to descend
- flight 611's pilot followed TCAS, flight 2937's pilot ignored TCAS
- all 71 people on board the two planes killed

⇒ Collision would not have occurred had both pilots followed TCAS

Exercise #1: Collision Avoidance Algorithm

17/35

The TCAS ...

- builds 3D map of aircraft in the airspace
- determines if collision threat occurs
- automatically negotiates mutual avoidance manoeuvre
- gives synthesised voice instructions to pilots ("climb, climb")

What algorithm would you use for reaching an agreement (climb vs. descent)?

Moral Dilemmas

18/35

How to program an autonomous car ...

- for a potential crash scenario
- when you have to choose between two actions that are both harmful

This is a modern version of the *Trolley Problem* ...

- A runaway trolley is on course to kill five people
- You stand next to a lever that controls a switch
- If the trolley is diverted, it will kill one person on the side track

Is it ethical to pull the lever and kill the one in order to save the five?

Exercise #2: Moral Dilemmas

19/35

What would you do?

Variations:

- Fat man on bridge
- Transplant

⇒ try it yourself on the [Moral Machine](#)

Course Review

Course Review

Goal:

For you to become competent Computer Scientists able to:

- choose/develop effective data structures
- choose/develop algorithms on these data structures
- analyse performance characteristics of algorithms (time/space complexity)
- package a set of data structures+algorithms as an abstract data type
- represent data structures and implement algorithms in C

Assessment Summary

22/35

```

assn1 = mark for assignment 1    (out of 10)
assn2 = mark for assignment 2    (out of 15)
mid   = mark for mid-term test   (out of 15)
exam  = mark for final exam      (out of 60)

```

```

if (exam >= 25)
    total = assn1 + assn2 + mid + exam
else
    total = exam * (100/60)

```

To pass the course, you must achieve:

- at least **25/60** for exam
- at least **50/100** for total

... Assessment Summary

23/35

Check your results

```

prompt$ 9024 classrun -sturec

ClassKey: 18s2COMP9024
...
assignment1: 8.5/10
midterm: 12/15
Score: 20.5/100

```

Final Exam

24/35

Goal: to check whether you have become a competent Computer Scientist

Requires you to demonstrate:

- understanding of fundamental data structures and algorithms
- ability to analyse time complexity of algorithms
- ability to develop algorithms from specifications

Lectures, problem sets and assignments have built you up to this point.

... Final Exam

25/35

2-hour exam on **Saturday 10th November**

2pm-4pm, reading time from 1:50, be there at 1:45

- 12 multiple-choice questions, 4 open questions
- Covers *all* of the contents of this course
- Each multiple choice question is worth 2 marks ($12 \times 2 = 24$)
Each open question is worth 9 marks ($4 \times 9 = 36$)
- Answer multiple-choice questions directly in the exam paper
- Write your answers for the open questions in an Examination Answer Book
- Closed book, but you can bring one A4-sized sheet of your own notes

For complete instructions see:

www.cse.unsw.edu.au/~cs9024/ExamInstructions.pdf

... Final Exam

26/35

Sample Open Question

1. Consider inserting the following values into an initially empty AVL tree:

15 30 35 8 25 22 3 21

Show the order that values would be displayed if we traversed the resulting tree in each of the following orders:

- a. Postorder (LRN)
- b. Level order

2. Describe an algorithm in pseudocode that takes a Binary Search Tree (BST) as input and modifies the values of all nodes by adding the height of the node to the current value. Analyse the time complexity of your algorithm depending on the number n of nodes in the input tree.

... Final Exam

27/35

Sample Multiple-Choice Questions

1. Consider a red-black tree storing n items. Which of the following is *not* true?
 - Searching for an entry takes $O(\log n)$ time in the worst case.
 - The height of the tree is always greater or equal to the height of the corresponding 2-3-4 tree.
 - A black node with two red children corresponds to a 3-node in a 2-3-4 tree.
 - There may be two consecutive black nodes on a branch.
2. How many character comparisons does the Boyer-Moore algorithm need to find a match of the pattern `car` in the text `racecars`?
 - 4
 - 5
 - 6
 - 7

... Final Exam

28/35

Of course, assessment isn't a "one-way street" ...

- I get to assess you in the final exam
- you get to assess me in UNSW's MyExperience Evaluation
 - go to <https://myexperience.unsw.edu.au/>
 - login using `zID@ad.unsw.edu.au` and your zPass

Response rate (as of Monday week 13): 10.2% 🤖

Please fill it out ...

- give me some feedback on how you might like the course to run in the future
- even if that is "Exactly the same. It was perfect this time."

Revision Strategy

29/35

- Re-read lecture slides and example programs
- Read the corresponding chapters in the recommended textbooks
- *Review/solve problem sets*
- Invent your own variations of the weekly exercises (problem solving is a *skill* that improves with practice)

Supplementary Exam

30/35

You can apply formally for *special consideration*

- a supplementary examination may or may not be granted
- a supplementary examination is typically more difficult than the original examination

If you attend an exam

- you are making a statement that you are "fit and healthy enough"
- it is your only chance to pass (i.e. no second chances)

If you do not meet the requirements for passing but achieve an overall score of ≥ 47 : You can sit the supplementary exam, in which you must score 50% or higher to pass with an overall mark of 50.

Assessment

31/35

Assessment is about determining how well *you* understand the syllabus of this course.

If you can't *demonstrate your understanding*, you don't pass.

In particular, we don't pass people just because ...

- please, please, ... my parents will be ashamed of me
- please, please, ... I tried *really hard* in this course
- please, please, ... I'll be excluded if I fail COMP9024
- please, please, ... this is my final course to graduate
- etc. etc. etc.

Failure is a fact of life. For example, my scientific papers or project proposals get rejected sometimes too.

Summing Up ...

So What Was the Real Point?

33/35

The aim was for you to become a better computer scientist

- more confident in your own ability to design data structures and algorithms
- with an expanded set of fundamental structures and algorithms to draw on
- able to analyse and justify your choices
- ultimately, enjoying the software design and development process



Book 9
Epilogue

Thus spake the Master Programmer:

"Time for you to leave."

T h a t ' s A l l F o l k s

**Good Luck with the Exams
and with your future studies**

