a place of mind

THE UNIVERSITY OF BRITISH COLUMBIA

CPSC 259
Data Structures and Algorithms for Electrical Engineers

Introduction

Administration

- Instructor: Geoffrey Tien, gctien@cs.ubc.ca
  Office: ICCS 245
  Office hours: MWF 09:30–11:00

- Course website:
  - http://www.ugrad.cs.ubc.ca/~cs259/2017W1/
  - Lecture slides can be downloaded here
  - Administrative policies can be found here also

- Other dynamic course content can be found on Piazza

Piazza

Course bulletin

- http://piazza.com/ubc.ca/winterterm12017/cpsc259

- The Piazza bulletin board is required reading. It will be used for important material that may not be mentioned in class
- Problems with the CPSC 259 course contents (e.g. lecture, lab, textbook, assignments) can be posted to Piazza
- Students are encouraged to ask questions, and to respond to other students' questions
- Only send e-mail if you have a private issue that you cannot post to Piazza

Midterms

- Midterm 1
  - Wednesday, October 04
  - In-class – 08:00–08:50, WESB 100
- Midterm 2
  - Friday, November 03
  - In-class – 08:00–08:50, WESB 100
- You must notify me of extra-curricular conflicts before Monday, September 18

Labs

- There are 5 labs (cycles of 2 weeks each)

- In-lab component:
  - During week 1's lab time
  - Completed in pairs, has deliverables that are due either during your week 1 lab time, or, for certain deliverables, no later than during week 2's lab time

- In-lab programming quiz:
  - During week 2's lab time, the first hour will be a programming test, done individually

Labs

- There are 5 labs (cycles of 2 weeks each)

- Take-home programming assignment:
  - During each 2-week cycle (minus a day) starting with week 1's lab time, a take-home programming assignment to be completed with your in-lab partner
  - E.g. if your lab time is on Monday, then your "two weeks" end just before midnight on Sunday (>13 days from start of week 1)
  - The last 50 minutes of lab time during week 2 will allow you and your partner to work on the take-home assignment. Tas will be available in the lab to help.

Evaluation

Tentative – we reserve the right to change these!

- In-lab component and deliverables: $5 \times 1\% = 5\%$
- In-lab programming quizzes: $5 \times 2\% = 10\%$
- Take-home programming assignments: $5 \times 3\% = 15\%$
- Midterms: $2 \times 15\% = 30\%$
- Final exam: 40%

- To pass the course, you must obtain at least 50% overall by these weights, and you must pass the weighted average of the two midterms and final exam.

Prerequisites

- APSC 160
- If you do not have the prerequisite, you will be dropped from the course. Check with a CS advisor if you have a problem
- The instructor cannot change your lab section or add you to the course.
  - Check with CS front office

Programming environment

Microsoft Visual Studio

- Visual Studio (either 2012 or 2015) will be used in labs
  - You may use another IDE of your choice, but you should check that your submitted code compiles and runs under Visual Studio

- Details for obtaining a free copy via DreamSpark will be given in Lab 1.

Course Overview

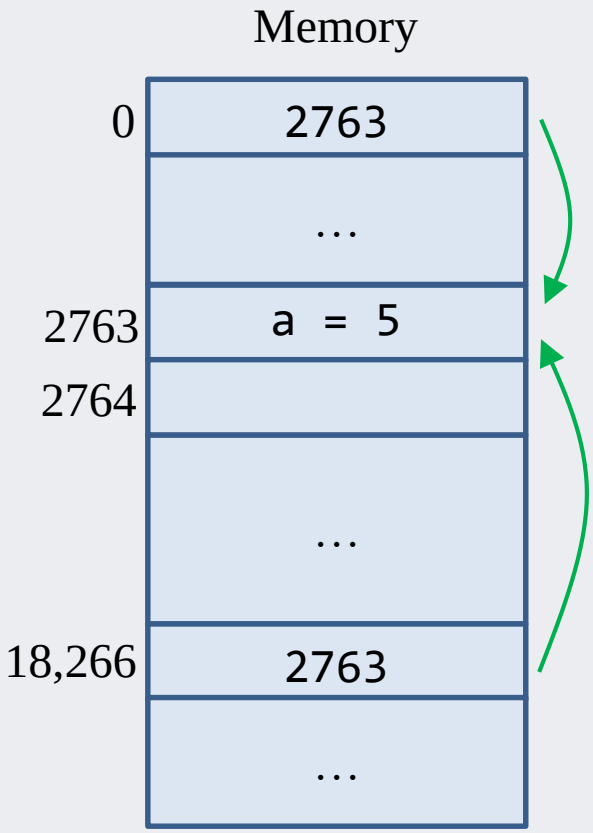
1 – APSC 160 review

- Briefly review some key programming concepts from APSC 160 (functions, modularity, arrays)

Course Overview

2 – Pointers

- An object variable residing in memory contains an object, but a pointer specifies *where* an object is located (address)
- Pointers can refer to objects that are allocated on demand
- Pointers can be used for shared access to objects
- Pointers are used in many complex data structures



Course Overview

3 – Structs (Records)

- We have used primitive data types
  - `int`, `float`, `string`…
- What if our program requires more complex data types?
  - E.g. a car dealership needs to keep track of its vehicle inventory
    - Year
    - Make
    - Model
    - VIN
    - Colour
    - List of options

- We'll see how we can create our own data types

Course Overview

4 – Complexity

- Suppose I have three functions that all produce the same result (on some given input)
  - How can I compare these algorithms? (in a platform-independent manner?
  - Are there tradeoffs between the algorithms?
  - Based on a specific set of inputs, can I conclude that one algorithm is better than the other algorithms?

Course Overview

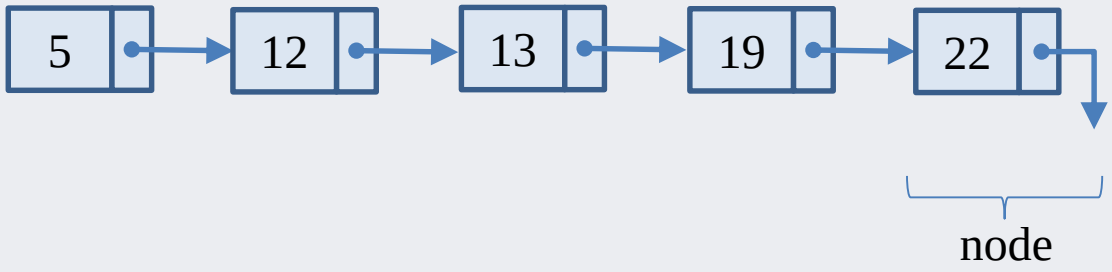
5 – Linked lists

- A linked list is a data structure for collecting a sequence of objects, such that addition and removal of elements in the middle of the sequence is efficient.
  - Selling (removing) a car from dealership inventory
  - Adding a new item into a sorted list
- This is not the case with arrays, assuming we keep the data compacted
- Linked lists are constructed using pointers

Course Overview

5 – Linked lists

- A data structure in which elements can be added to or deleted from anywhere
- Nodes are allocated as needed for each element (i.e. no need for extra unused space like arrays)
- Each node points to the location of the next node in the list, thus every node contains:
  - The data stored in the node, and
  - A pointer or link to the next node in the list



Course Overview

6 – Recursion

- Recursion is a powerful technique to break up complex computational problems into simpler ones.
  - "Recursion" refers to the same computation recurring, or occurring repeatedly, as the problem is solved
  - E.g. factorial
  - $5! = 5 \times 4 \times 3 \times 2 \times 1$
  - $4! = 4 \times 3 \times 2 \times 1$
  - $5! = 5 \times 4!$

- In APSC 160, we learned how to use an array to store some items and then search for them

- Using a different data structure, we can potentially find items more efficiently

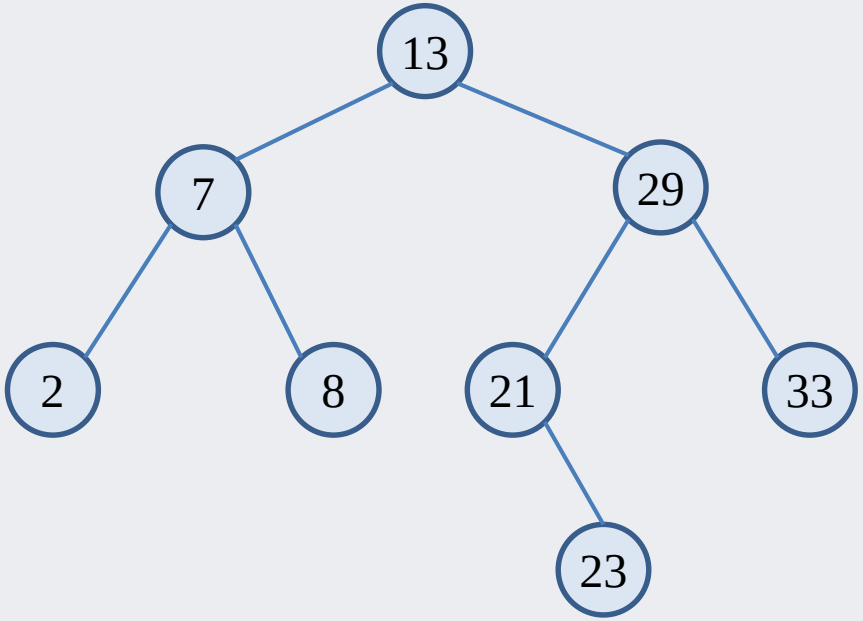
Course Overview

7 – Binary search tree

- A binary tree is a data structure built from nodes (like linked lists)
  - Each node contains a data element, "left" pointer, and "right" pointer

- Advantages: (mostly) quick search, insert, and remove operations

- Disadvantage: complicated removal algorithm



Course Overview

8 – Heaps and priority queues

- Suppose I have the following tasks to do for next week:

  6 – Respond to Piazza questions
  6 – Update course website
  8 – Release homework
  2 – Eat lunch
  9 – Make lecture slides
  1 – Sleep
  3 – Replace worn-out pants
  –1 – Bathe

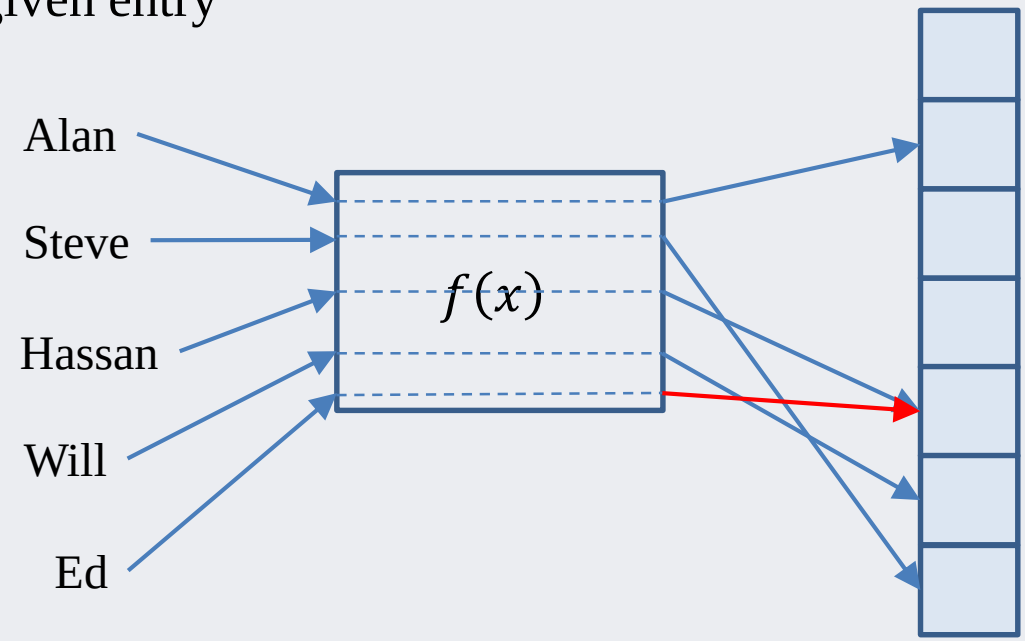
- If the larger numbers represent greater urgency, what kind of data structure can we use to help us (efficiently) pick high priority tasks first?

Course Overview

9 – Sorting

- If I have a collection of values (in an array), how can I put them in order?
  - Is there one algorithm that works well for all the different arrays and permutations I can supply?
  - Study some well-known sorting algorithms
  - Analyze the complexity of these sorting algorithm and look at tradeoffs

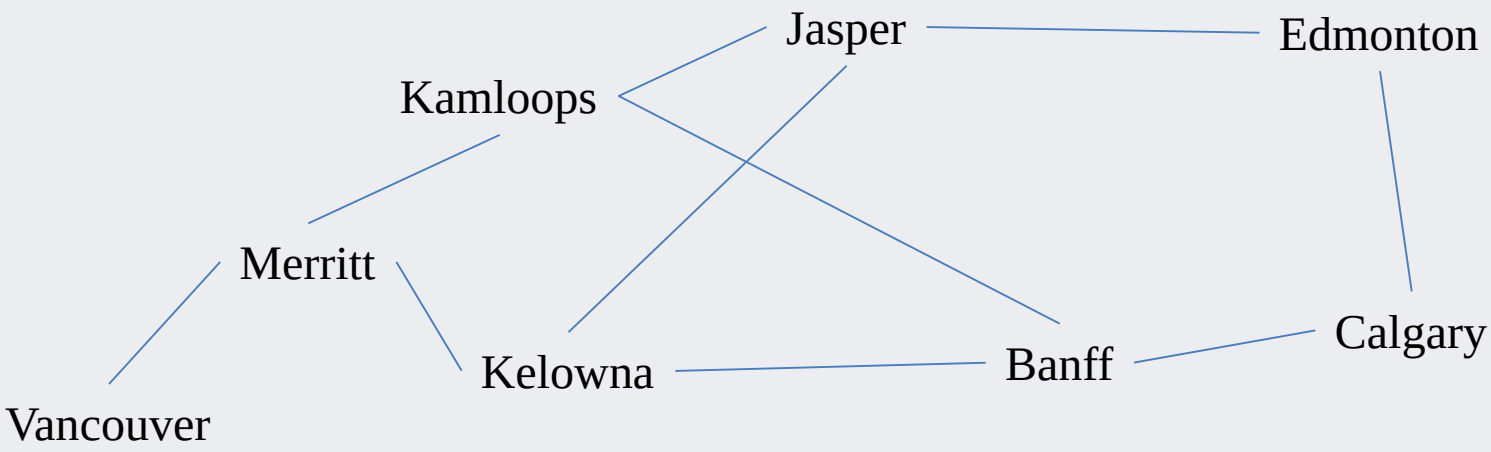
- In APSC we learned how to use an array to store some items and then search for them
- Hashing still uses arrays, but uses a hash function to map keys (values) to integers
  - The converted integer is used to quickly find the right spot in the array for a given entry



Course Overview

11 – Graph theory (time permitting)

- Graph is a structure for representing network relations
- Many real-world problems can be shown by graphs



- What data structure is suitable for representing a graph (in a computer's memory)?
- What is the shortest path between two cities on a road/flight map?

That's all!

- Next class we start with APSC 160 review