CS 113 – Computer Science I

Lecture 27 – Review

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Announcements

HW10:
• Due tonight

Adam: Office Hours
• Next week, TBA

Updated HW grading policy:
• Dropping lowest 2 homeworks
Topics

Terminal commands, vim, directory structure
variables (int, double, char, bool, string, array), expressions
Methods
Conditionals
Recursion
Loops
Strings
Arrays
Frame diagrams
Object Oriented Programming
Searching
Sorting
Runtime Analysis
Variables & Expressions

Variables as containers. Variables have:

- A name
- Location
- Data

Expressions

- A combination of variables, operators, and values that represents a single value. Expressions also have types, as determined by their operators and operands.
- Operands vs Operators
Methods

Methods have:
• Signature
  • Name
  • Parameters
  • Return Type
• Body

Parameters vs arguments

Keep track of methods (and order of methods) on the Method Stack in Frame Diagrams

Static vs instance vs abstract
Conditionals

• Conditional Statements allow our code to react based on conditions

• Check conditions using Boolean expressions

• If/else if/else
Recursion

Recursion as breaking down problems into simple problems and punting the rest of the problem down to someone else

Base case

Recursive step
Loops

• Idea: block of code that executes repetitively

• Differences between while and for loops
Arrays and Strings

Arrays as single variable to contain a list of similar items

Accessing items from and inserting items into an array

Resizing an array

Strings as array of characters
  String methods
Frame Diagrams

• Keep track of code execution

• Function Stack

• Object Stack
  • If two variables point to the same object and we change the object, the change occurs in both variables
Object Oriented Programming

Classes vs objects
Designing classes
Mutable vs immutable objects
Instance vs static vs abstract methods
Relationship between classes
  Inheritance
  Interfaces
Classes vs Objects

Class:
• custom data types that contains
  - the data (instance variables)
  - the operations (instance methods)

Object:
• an instance of the class

Example:
• String vs “hello world”
Designing classes

All classes should have:

• Constructor:
  • Difference between value and empty constructor

• Getters/accessors

• Comparators (equal() or compareTo()) – zoom poll

• toString()

• Setters
  • We’ll see an example later where we wont want to have setters
Access modifiers

Instance variables and methods can be

- **private**
  - Can’t be accessed directly by anyone else

- **protected**
  - Only subclasses can access these

- **public**
  - Anyone that has access to the object can access these
Mutable vs immutable objects

Whether data stored inside an object can change (mutable) or cannot change (immutable) once the object is created.

Strings are immutable
Arrays are mutable

How would we design an immutable object:
- make instance variables private
- do not include any setters
Static vs instance methods

Static
• Do not require an object
• no access to \texttt{this} keyword

• Examples:
  • Integer.parseInt(“99”);
  • Math.random();

Instance
• Acts on an object -> requires an objects
• has access to \texttt{this} keyword

• Examples:
  • “hello,world”.split(“,”)
Abstract methods

Contains method signatures: name, arguments, and return type

Does not include an implementation

Specify what a method does, not how it does it

Often used in interfaces

Each subclass that implements the interface can choose how to implement the method
Class relationships - inheritance

A subclass is a class that extends an existing class; that is, it has the attributes and methods of the existing class, plus more.

- Refer to the existing class as a parent or superclass
- When a class extends another class, it inherits the attributes and methods from the parent class

All classes by default extend java.lang.Object.
- Consequence: Compiler knows to call “toString()”
Designing classes

Time class:
• Hour, minute, second

Date class:
• Day, month, and year
• Contains everything in Time as well

What's the superclass and what's the subclass?
How could we make these immutable?
How could we define the distance between two Time or two Date objects?
Linear Search

Check each item in a collection one by one

Why is this call linear search?

Time it takes to search increases linearly with the size of the list

If we have 100 items in a list, how many items do we have to check in the worstcase scenario?

All 100
Linear Search

What happens (in terms of speed) when the list is very large?
   The search becomes slower

In what cases do we do the most work (i.e. perform the most comparisons)?
   When the item is not in the list

In what cases do we do the least amount of work?
   When the item is the first element in the list
Binary Search

If the list is sorted in ascending order, we don’t need to consider every element.

Which element should we check? 
  The middle

If the middle element isn't what we are looking for, what should we do? 
  Chop the search space in half (this is why it's called binary search)
Binary Search run time

As the size of our collection increases, the number of guesses/comparisons increases, but not *linearly*

The time increases by \( \log n \) (we use base 2). Why?
   Because we cut our search space in half each time

If our collection contains 8 data points, how many comparisons in worst case do we make:
   \( \log_2 8 = 3 \)

If our collection contains 512 data points, how many comparisons in worst case do we make:
   \( \log_2 512 = 9 \)

\( O(\log(n)) \)
Sorting

• BubbleSort & SelectionSort

• Runtime - $O(n^2)$
Runtime Analysis

Difference between Runtime Analysis and timing performance

Big-Oh: as the size of the data increases, how does the amount of steps an algorithm perform also increase

\( O(\log(n)), O(n), O(n \log(n)), O(n^2), O(n^3) \)
Success in your learning/the course
Thanks you & Congrats!