CMSC 131
Object-Oriented Programming I

Introduction to Classes II

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This material is based on material provided by Ben Bederson, Bonnie Dorr, Fawzi Emad, David Mount, Jan Plane
Overview

- Heap
- Equals
Class Review

• Let’s review what we have discussed so far about classes
• Class vs. Object
• How to define a class
• How to define methods and data in a class
• What is an instance variable
• What is static method
• What are getters and setters
• How to use methods to avoid code duplication
How Are Objects Created?

• In Java: using new
  Recall:
    Scanner sc = new Scanner(System.in);
• Invoking new:
  • Creates an object in a memory area called the “heap”
  • Space is created for instance variables
  • Returns the address/reference where the object lives
Main Memory Organization

Stack

Heap
  Object
  Object

Other
In Java, 9 Sorts of Variables

- 8 primitive types
  - Types are the 8 built-ins (int, byte, double, etc.)
- Reference type
  - Objects always stored in heap (including all data)
  - Reference to objects are another type, and hold one memory address (typically one word)
- Stack holds local variables
  - e.g. int x
  - e.g. String str; // str is reference variable
- Heap holds allocated memory (i.e., with “new”)
  - e.g. Scanner sc = new Scanner(System.in);
Strings Are Objects

• Where is new in
  String name = “Batman”; ?
• Java provides it!
  • String is special because it is used so often
  • Java automatically “fills in” new
• You can too:
  String name = new String(“Batman”);
Heap Issues

- What happens if new is called and there is no free heap?
  - Crash!
- What happens if following are executed?
  String s;
  s = new String("cat");
  s = new String("dog");
  s = new String("cow");
- Let’s draw a diagram
- Wasted heap
  - “cat”, “dog” no longer referenced by stack
  - Crashes become a problem!
Garbage Collection

• This “heap management” or “memory management” issue is central in CS
• Java copes by invoking the garbage collector to reclaim unused, but still-allocated heap space
• Garbage collector **reclaims** memory in allocated heap and returns it to free heap
• In previous example, “cat” and “dog” would be reclaimed
• In some languages (e.g., C++) you need to take care of reclaiming memory
  • Use of delete operator in C++ otherwise you will have memory leaks
Example

String a = new String ("abc");
String b = new String ("abc");

if (a == b) {
    println ("Equal");
} else {
    println ("Not equal");
}
=> Not equal
String a = new String ("abc");
String b = a;

if (a == b){
    println ("Equal");
} else {
    println ("Not equal");
}
=> Equal

- This is called ALIASING \(\rightarrow\) Two variables refer to same object.
equals

• `==` checks if two reference variables refer to the same object
• Methods like `str.equals()` check if two different objects have the same “content”
• Other classes will have an `equals` method also
Advanced Diagram

Here is a more advanced diagram for memory organization