CMSC 131

Object-Oriented Programming I

Introduction to Classes

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

Overview

- Objects
- Heap
- Equals

Objects

- Bundles of (related)
  - data ("state")
  - operations ("behavior")
- Data often referred to as instance variables
- Operations usually called methods
- Invoking operations can change state (values stored in instance variables)
- Example of objects
  - Bank Account
  - Student
  - Scanner
- Object-Oriented Programming
  - Program is a collection of interacting objects

Sample (Student Class)

State		Methods	
Name		getAge	date → age
ID		getGrades	sem., class → grades
DOB			
Major			etc.
	etc.		

Sample (Student Object)

State		Methods	
Name	Kerry Keenan	getAge	date → age
ID	444230695	getGrades	sem., class → grades
DOB	06-22-1987		
Major	CMSC		
	etc.		etc.

Classes

- Class → Blueprint/"Recipe" for objects
- Classes include specifications of
  - Instance variables (including types, etc.) to include in objects
  - Implementations of methods to include in objects
- Classes can include other information also, as will be seen later
  - Static methods / instance variables
  - public / private methods
  - And so on

Student Class Example

- Instance variables:

```
String name
int id
int dateOfBirth
String major
```

- Methods

```
getAge()
getGrades()
```

  etc.

- The actual class implementation will include code for the methods
- This describes a blueprint for student objects

Student Class (Definition Overview)

```
class Student {

    /* These are the instance variables */
    String name;
    int id;
    int dateOfBirth;
    String major;

    /* Instance methods */
    getAge() {
        // put code here
    }
    getGrades() {
        // put code here
    }

    Etc.
}
```

How Are Objects Created?

- In Java: using `new`

  Recall:

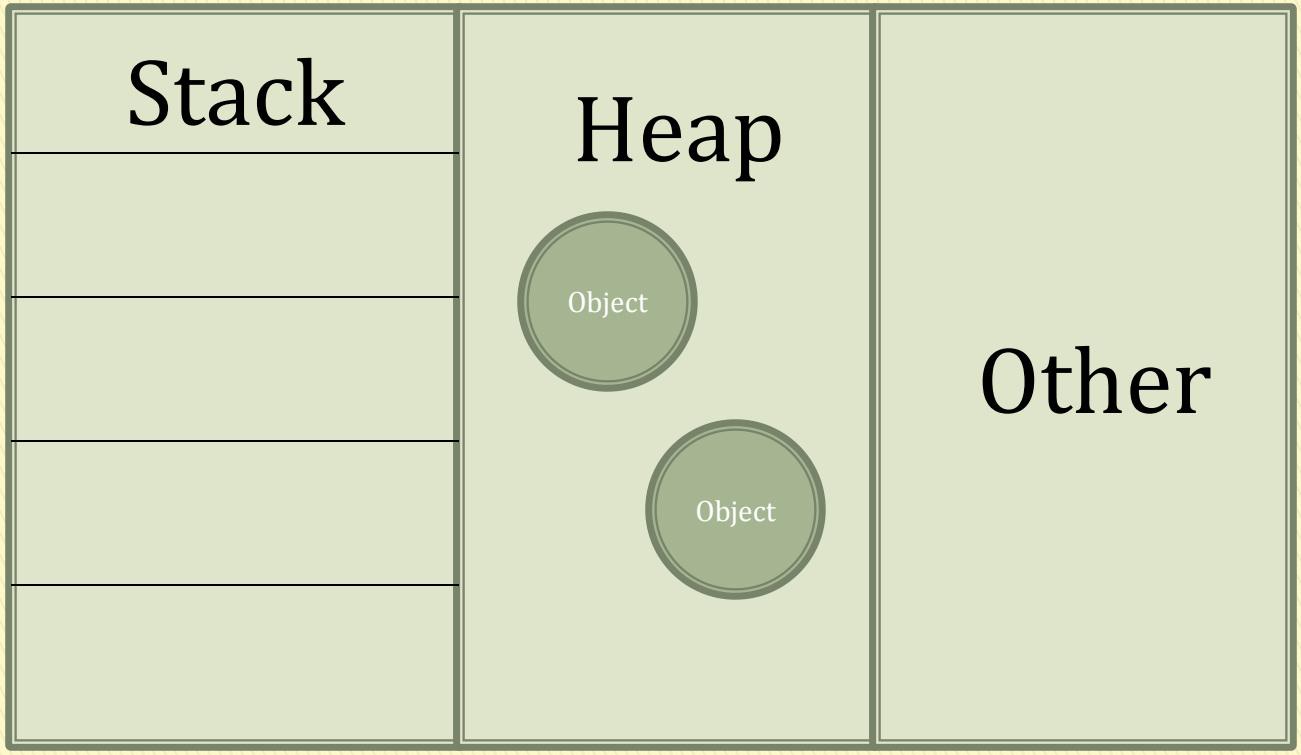
  ```
  Scanner sc = new
  Scanner(System.in);
  ```

- 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

Accessing State/Methods

- If
  - **`obj`** is an object reference
  - **`v`** is an instance variable of the object
  - **`m`** is a method of the object
- Then
  - **`obj.v`** is how to access the data `v` in **`obj`**
  - **`obj.m()`** is how to invoke `m` in **`obj`**
- So
  - If you have already done `String str = "Joe"`
- Then `str` is a String
  - `str` is an instance of a class.
  - Methods of this object→ `equals`, `compareTo`, etc.
  - `str.equals()`, `str.compareTo()`, etc. invokes these methods on that object

Main Memory Organization



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?

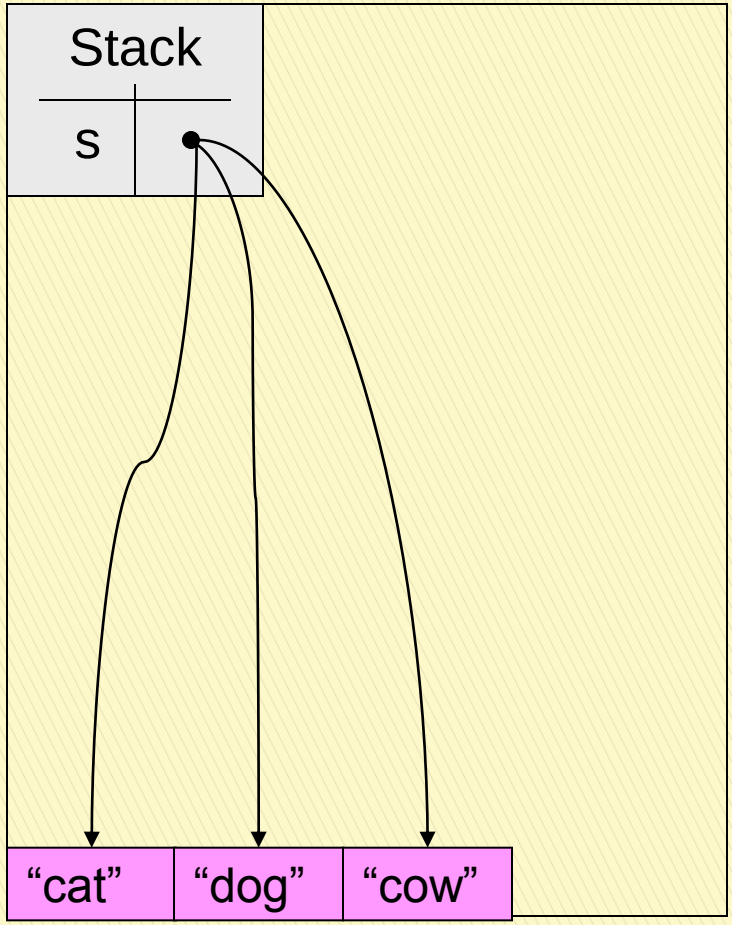
  Crash!
- What happens if following are executed?

  String s;

  s = new String(“cat");

  s = new String(“dog");

  s = new String(“cow");
- Wasted heap
  - “cat”, “dog” no longer referenced by stack
  - Crashes become a problem!



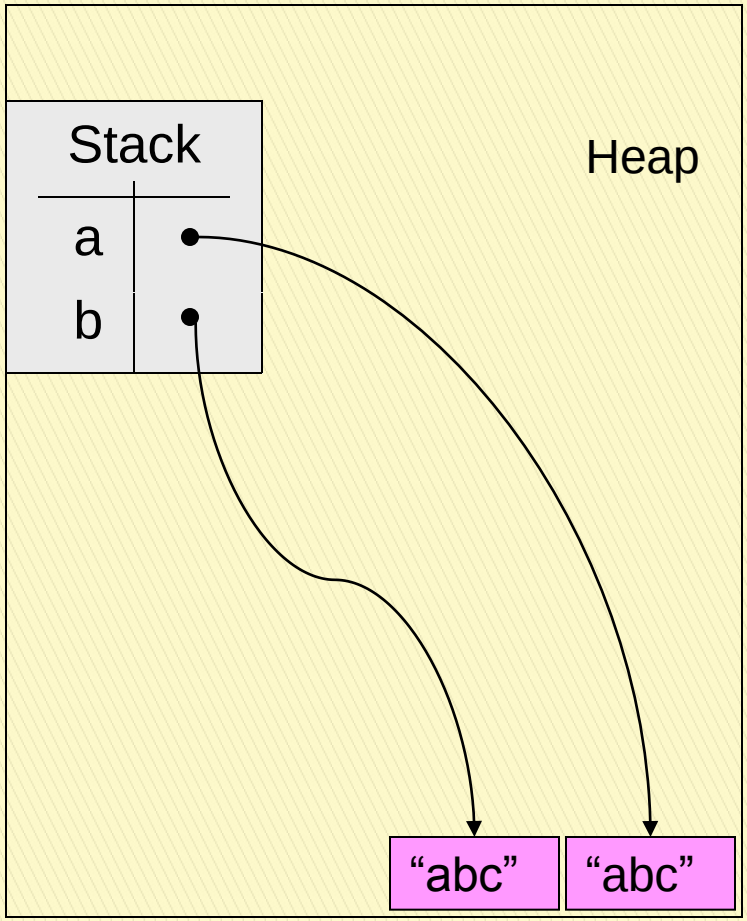
Garbage Collection

- This “heap management” or “memory management” issue is central in CS
- Java copes by invoking 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”);
}
```

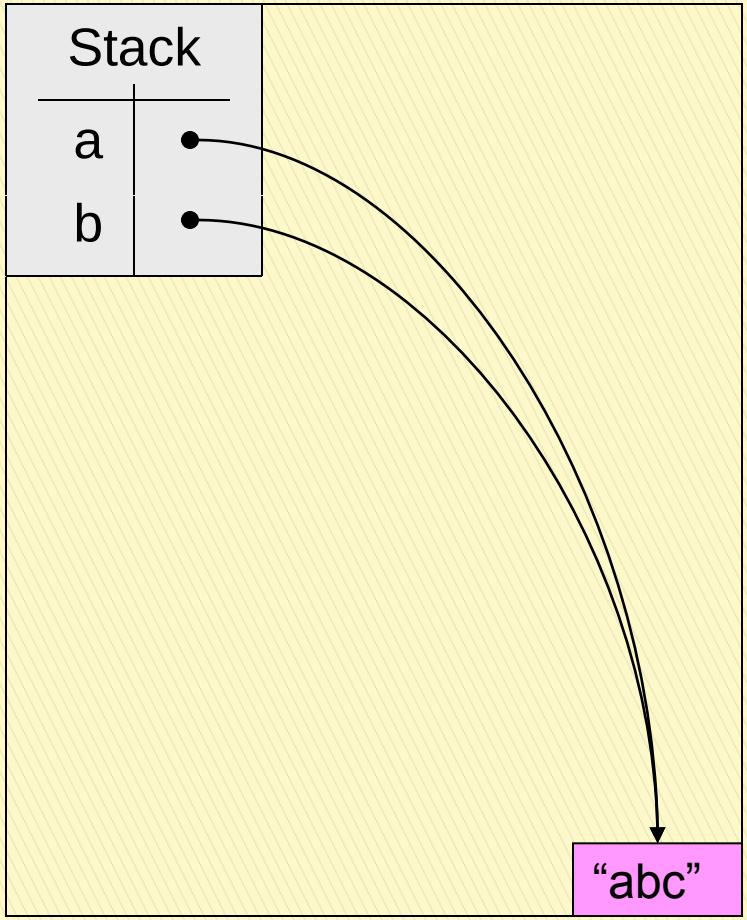
=> Not equal



Contrasting Example

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

- This is called ALIASING →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

Example

- Let's define a class called SuperHero with
  - Instance variables name and strength
  - Get/Set methods
  - print method
- Let's define a driver class for our example
- Eclipse allow us to generate code ☺
  - Source → Generate Getters and Setters

Honors Material

- Here is a more advanced diagram for memory organization
  - http://blog.codecentric.de/wp-content/uploads/2009/12/java-memory-architecture.jpg