University of British Columbia
CPSC 111, Intro to Computation
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Constants, Objects, Strings

Lecture 4, Tue Jan 17 2006

based on slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/cpsc111-06-spr

Reading This Week

- Rest of Chap 2
  - 2.3-4, 2.6-2.10
- Rest of Chap 4
  - 4.3-4.7

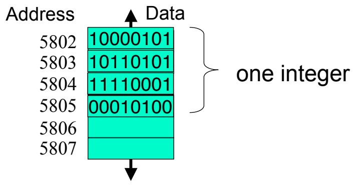
Objectives

- Understand when to use constants
- Understand difference between classes and objects
- Understand difference between objects and primitive data types

Recap: Data Type Sizes

Type	Size	Min	Max
`int`	4 bytes	-2,147,483,648	2,147,483,647
`double`	8 bytes	**approx -1.7E308 (15 sig. digits)**	**approx 1.7E308 (15 sig. digits)**

- fixed size, so finite capacity



Recap: Declaration and Assignment

- Variable declaration is instruction to compiler
  - reserve block of main memory large enough to store data type specified in declaration
- Variable name is specified by identifier
- Syntax:
  - *typeName variableName;*
  - *typeName variableName = value;*
    - can declare and assign in one step

- Java first computes value on right side
- Then assigns value to variable given on left side

```
x = 4 + 7;     // what’s in x?
```

Recap: Assignment Statements

- Here’s an occasional point of confusion:

```
a = 7;          // what’s in a?
b = a;          // what’s in b?
                // what’s in a now???
System.out.println(“a is ” + a + “b is ” +b);
a = 8;
System.out.println(“a is ” + a + “b is ” +b);
```

- Draw and fill in boxes for your variables at each time step if you’re confused

Recap: Expressions

- expression is combination of
  - one or more operators and operands
  - operator examples: +, *, /, ...
  - operand examples: numbers, variables, ...
- precedence: multiply/divide higher than add/subtract

Recap: Converting Between Types

- Doubles can simply be assigned ints
  - `double socks = 1;`
  - ints are subset of doubles
- Casting: convert from one type to another with information loss
- Converting from real to integer
  - `int shoes = (int) 1.5;`
- Truncation: fractional part thrown away
  - `int shoes = (int) 1.75;`
- Rounding: must be done explicitly
  - `shoes = Math.round(1.99);`

Recap: Primitive Data Types: Numbers

Type	Size	Min	Max
`byte`	1 byte	-128	127
`short`	2 bytes	-32,768	32,767
`int`	4 bytes	-2,147,483,648	2,147,483,647
`long`	8 bytes	-9,223,372,036,854,775,808	9,223,372,036,854,775,807
`float`	4 bytes	approx -3.4E38 (7 sig.digits)	approx 3.4E38 (7 sig.digits)
`double`	8 bytes	approx -1.7E308 (15 sig. digits)	approx 1.7E308 (15 sig. digits)

- Primary primitives are **`int`** and **`double`**
  - three other integer types
  - one other real type

Recap: Primitive Data Types: Non-numeric

- Character type
  - named char
  - Java uses the Unicode character set so each char occupies 2 bytes of memory.
- Boolean type
  - named boolean
  - variables of type boolean have only two valid values
    - true and false
  - often represents whether particular condition is true
  - more generally represents any data that has two states
    - yes/no, on/off

What Changes, What Doesn't?

```
//*******************************************
// Vroom.java Author: Tamara
// Playing with constants
//*******************************************
public class Vroom
{
 public static void main (String[] args)
 {
   double lightYears, milesAway;
   lightYears = 4.35; // to Alpha Centauri
   milesAway = lightYears * 186000 *60*60*24*365;
   System.out.println("lightYears: " + lightYears + "
milesAway " + milesAway);
   lightYears = 68; // to Aldebaran
   milesAway = lightYears * 186000 *60*60*24*365;
   System.out.println("lightYears: " + lightYears + "
milesAway " + milesAway);
 }
}
```

Constants

- Things that do not vary
  - unlike variables
  - will never change
- Syntax:
  - final *typeName variableName;*
  - final *typeName variableName* = *value;*
- Constant names in all upper case
  - Java convention, not compiler/syntax requirement

Programming With Constants

```
public static void main (String[] args)
 {
   double lightYears, milesAway;

   final int LIGHTSPEED = 186000;
   final int SECONDS_PER_YEAR = 60*60*24*365;

   lightYears = 4.35; // to Alpha Centauri
   milesAway = lightYears * LIGHTSPEED * SECONDS_PER_YEAR;
   System.out.println("lightYears:  " + lightYears + "
miles " + milesAway);

   lightYears = 68; // to Aldebaran
   milesAway = lightYears * LIGHTSPEED * SECONDS_PER_YEAR;
   System.out.println("lightYears:  " + lightYears + "
miles " + milesAway);
 }
```

Avoiding Magic Numbers

- magic numbers: numeric constants directly in code
  - almost always bad idea!
    - hard to understand code
    - hard to make changes
    - typos possible
  - use constants instead

Programming With Constants

```
public static void main (String[] args)
 {
   double lightYears, milesAway;
   final int LIGHTSPEED = 186000;
   final int SECONDS_PER_YEAR = 60*60*24*365;

   final double ALPHACENT_DIST = 4.35; // to AlphaCentauri
   final double ALDEBARAN_DIST = 68; // to Aldebaran

   lightYears = ALPHACENT_DIST;
   milesAway = lightYears * LIGHTSPEED * SECONDS_PER_YEAR;
   System.out.println("lightYears:  " + lightYears + "
miles " + milesAway);
   lightYears = ALDEBARAN_DIST;

   milesAway = lightYears * LIGHTSPEED * SECONDS_PER_YEAR;
   System.out.println("lightYears:  " + lightYears + "
miles " + milesAway);
 }
```

Programming

- Programming is all about specifiying
  - data that is to be manipulated or acted upon
  - operations that can act upon data
  - order in which operations are applied to data

- So far: specify data using primitive data types
  - come with pre-defined operations like +, -, *, and /

Programming with Classes

- What if data we want to work with is more complex these few primitive data types?

Programming with Classes

- What if data we want to work with is more complex these few primitive data types?

- We can make our own data type: create a class
  - specifies nature of data we want to work with
  - operations that can be performed on that kind of data
- Operations defined within a class called methods

Programming with Classes

- Can have multiple variables of primitive types (int, double)
  - each has different name
  - each can have a different value

```
int x = 5;
int y = 17;
```

- Similar for classes: can have multiple instances of class String
  - each has different name
  - each can have different value

```
String name = “Tamara Munzner”;
String computerName = “pangolin”;
```

Programming with Objects

- Object: specific instance of a class
- Classes are templates for objects
  - programmers define classes
  - objects created from classes

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String (“Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                           + " " + lastname);
    }
}
```

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String ("Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                           + " " + lastname);
    }
}
```

- Declare two different String objects
  - one called `firstname` and one called `lastname`

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
```

- Variable declaration does not create objects!

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
```

- Variable declaration does not create objects!
  - just tells compiler to set aside spaces in memory with these names
- Spaces will not actually hold the whole objects
  - will hold references: pointers to or addresses of objects
  - objects themselves will be somewhere else in memory

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String ("Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                              + " " + lastname);
    }
}
```

- So **`firstname`** and **`lastname`** will not contain String objects
  - contain references to String objects

Constructors

- Constructor: method with same name as class
  - always used with **`new`**
  - actually creates object
  - typically initializes with data

```
firstname = new String (“Kermit");
```

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String (“Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                              + " " + lastname);
    }
}
```

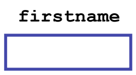
- Now create new instance of the String class
  - String object with data “Kermit”
- Puts object somewhere in memory
  - puts address of the object’s location in **`firstname`**: **`firstname`** holds reference to String object with data “Kermit”

Object Example

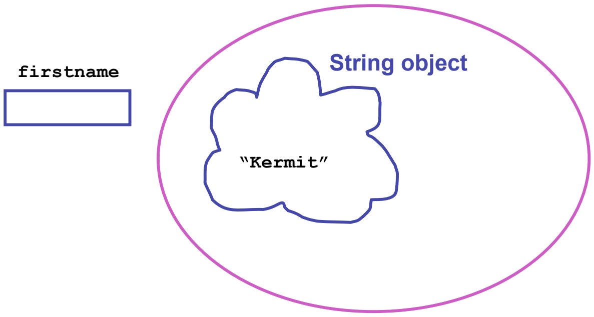
```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String (“Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                              + " " + lastname);
    }
}
```

- New operator and String constructor method instantiate (create) new instance of String class (a new String object)

Object Example

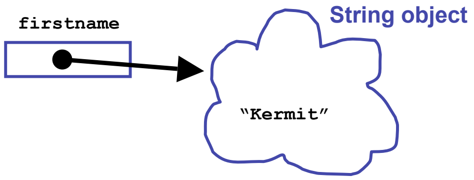


Object Example



expression on right side of assignment operator

Object Example



bind variable to
expression on right side
of assignment operator

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String ("Kermit");
        lastname = new String ("theFrog");
        System.out.println("I am not " + firstname
                                + " " + lastname);
    }
}
```

- And so on

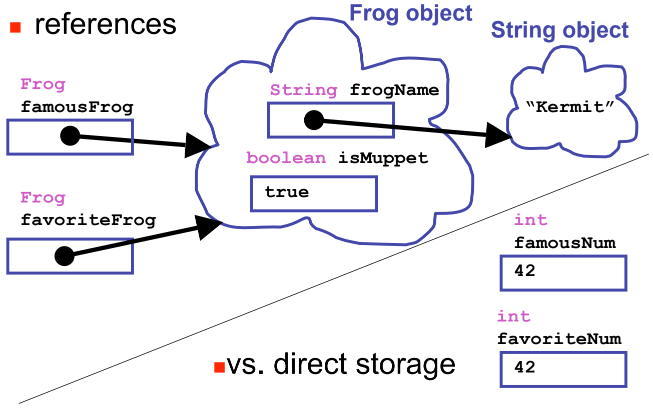
Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname = new String ("Kermit");
        String lastname = new String ("theFrog");
        System.out.println("I am not " + firstname
                                + " " + lastname);
    }
}
```

- Can consolidate declaration, assignment
  - just like with primitive data types

Objects vs. Primitives

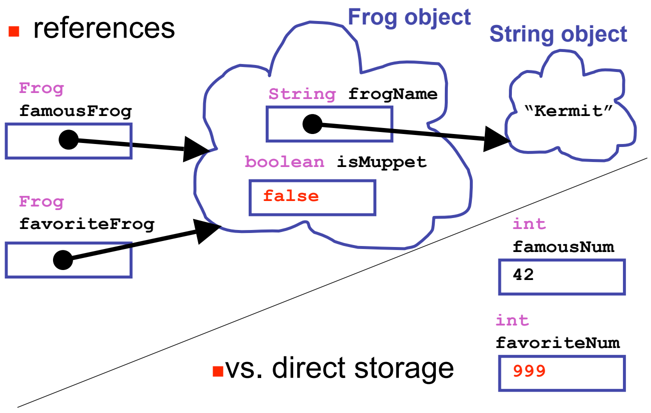
- references



- vs. direct storage

Objects vs. Primitives

- references



- vs. direct storage

Class Libraries

- Before making new class yourself, check to see if someone else did it already
  - libraries written by other programmers
  - many built into Java
- Example
  - Java has single-character primitive data type
  - what if want to work with sequence of characters
  - String class already exists

API Documentation

- Online Java library documentation at http://java.sun.com/j2se/1.5.0/docs/api/
  - textbook alone is only part of the story
  - let's take a look!
- Everything we need to know: critical details
  - and often many things far beyond current need
- Classes in libraries are often referred to as Application Programming Interfaces
  - or just API

Some Available String Methods

`public String toUpperCase();`
Returns a new `String` object identical to this object but with all the characters converted to upper case.

`public int length();`
Returns the number of characters in this `String` object.

`public boolean equals( String otherString );`
Returns true if this `String` object is the same as `otherString` and false otherwise.

`public char charAt( int index );`
Returns the character at the given index. Note that the first character in the string is at index 0.

More String Methods

`public String replace(char oldChar, char newChar);`
Returns a new `String` object where all instances of `oldChar` have been changed into `newChar`.

`public String substring(int beginIndex);`
Returns new `String` object starting from `beginIndex` position

`public String substring( int beginIndex, int endIndex );`
Returns new `String` object starting from `beginIndex` position and ending at `endIndex` position

- up to but not including endIndex char:

`substring(4, 7)    "o K"`

H	e	l	l	o		K	e	r	m	i	t	F	r	o	g
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Questions?