

CS 180: Problem Solving and Object-Oriented Programming

Lecture 2: Numbers and Java Programs

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Announcements

- Friday lectures
- Quizzes will be posted around 5pm



Lecture 02

- Numbers
- Classes and encapsulation
- Programs
- Input



Hello, world!

```
class Hello {
    public static void main(String[] args) {
        System.out.println("Hello, world!");
    }
}
```



Memory and storage sizes

Unit	Size	Bytes	Practical Measure
byte	8 bits	$2^0 = 1 = 10^0$	A single character
kilobyte (KB)	1,024 bytes	$2^{10} = 1,024 = 10^3$	A paragraph of text
megabyte (MB)	1,024 kilobytes	$2^{20} = 1,048,576 = 10^6$	A minute of MP3 music
gigabyte (GB)	1,024 megabytes	$2^{30} = 1,073,741,824 = 10^9$	A half hour of video
terabyte (TB)	1,024 gigabytes	$2^{40} = 1,099,511,627,776 = 10^{12}$	80% of a human's memory capacity



Positional numbering

- Value of a digit is related to the distance of its position from the decimal point
- Has a base - 2, 8, 10, 16, etc
- Each position multiplies or divides value by the base



Examples

- Decimal...
 - $352 = 3 * 10^2 + 5 * 10^1 + 2 * 10^0$
 - $352 = 3 * 100 + 5 * 10 + 2$
- Binary...
 - $1110 = 1 * 2^3 + 1 * 2^2 + 1 * 2^1 + 0 * 2^0$
 - $1110 = 1 * 8 + 1 * 4 + 1 * 2 = 14$
- Hexadecimal...
 - $3F = 3 * 16^1 + F * 16^0$
 - $3F = 3 * 16 + 15 * 1 = 48 + 15 = 63$



Conversion Algorithm

- Divide number by base
- Prepend remainder to the result string
- Replace number by quotient
- Repeat until quotient is zero



Example

- 42 to base 2...
 - $42 / 2 = 21 + 0$ remainder
 - $21 / 2 = 10 + 1$ remainder
 - $10 / 2 = 5 + 0$ remainder
 - $5 / 2 = 2 + 1$ remainder
 - $2 / 2 = 1 + 0$ remainder
 - $1 / 2 = 0 + 1$ remainder
- Answer: 101010



Finite precision

- Computers store numbers using bits (base 2)
- Bits organized into bytes (8 bits)
- Bytes organized into words, typically
 - 4 bytes = 32 bits
 - 8 bytes = 64 bits
- Can only represent values that "fit" into that many bits
- Negative numbers?



4-bit Word	Unsigned Interpretation	Unsigned N-bit Generalization	Signed Interpretation	Signed N-bit Generalization
0000	0	0	0	0
0001	1		1	
0010	2		2	
0011	3		3	
0100	4		4	
0101	5		5	
0110	6		6	
0111	7		7	$2^{n-1} - 1$
1000	8		-8	-2^{n-1}
1001	9		-7	
1010	10		-6	
1011	11		-5	
1100	12		-4	
1101	13		-3	
1110	14		-2	
1111	15	$2^n - 1$	-1	-1



2's complement

- Flip the bits, add one
- -1?
 - $0001 \rightarrow 1110$
 - $+0001$
 - 1111
- 1101 $\rightarrow 0010$
 - $+0001$
 - $0011 \rightarrow -3$



Who cares?

- Overflow
 - $127 + 1$ in eight bits = ?
- Underflow
 - $-128 - 1$ = ?



- Largest (signed) positive number
 $2^{N-1} - 1$
- Negative: -2^{N-1}
- N = number of bits



Objects and Classes

- We encounter a lot of objects in life
- Parking lots contain vehicles
- Vehicles have attributes
 - Color
 - Make
 - Model
 - License plate number
- In Java, we can create classes that describe objects



Wheel Class

- Can contain attributes like...
 - Radius (e.g. 27.5")
 - Material (e.g. rubber)
- Each instance of the class (object) can have different attributes
- Can also create operations (methods)
 - circumference = $2 * \pi * \text{diameter}$
 - 15" radius $\rightarrow 2 * 3.14159 * 15$



Class declarations

- Member variable declarations
- Method declarations
 - Modifiers – public, private, etc (later)
 - Return type (can be void)
 - Method name
 - Parameter list
 - Exception list (later)
 - Method body
- Method signature: Method name & parameter types



Wheel Class

```
public class Wheel {
    double radius;
    String material;

    Wheel(double radius, String material) {
        this.radius = radius;
        this.material = material;
    }

    Wheel(double radius) {
        this.radius = radius;
        this.material = "unknown";
    }

    double getCircumference() {
        return 2 * Math.PI * radius;
    }

    double getArea() {
        return Math.PI * radius * radius;
    }

    double getRadius() {
        return radius;
    }

    double getMaterial() {
        return material;
    }

    void setRadius(double radius) {
        this.radius = radius;
    }

    void setMaterial(String material) {
        this.material = material;
    }

    void setRadiusAndMaterial(double radius,
                             String material) {
        this.radius = radius;
        this.material = material;
    }
}
```



Basic syntax

- `//` or `/* */` for comments
- White space ignored
- Semicolon (`;`) ends or separates statements
- Curly braces (`{}`) group statements
- Some words are reserved
- `import` gives access to other classes or packages



Purdue trivia

- "Harvey Washington Wiley was the first professor of chemistry, the first state chemist, the first ROTC instructor, the first baseball coach, and the 'father of the U.S. pure food and drug law.' Yet, the Purdue board of trustees once censured him for riding a bicycle - considered unseemly conduct by a faculty member."
- - A Century and Beyond,
by Robert W. Topping



Class and Instance Data

- An object is comprised of data values and methods
- An instance data value maintains information specific to individual instances
- A class data value maintains information shared by all instances
 - Avoids repeated storage
 - Easy to modify



Constructors

- Create objects from the class "blueprint"
- Similar to method declarations
 - Use class name
 - No return type
- Provided automatically if not specified
 - Be careful



this Keyword

- Most commonly used if a field is shadowed by a method or constructor parameter
 - Look at wheel again
- Can also be used to call another constructor in the same class
 - Explicit constructor invocation



Encapsulation

- Constructs that aid in the bundling of data with methods operating on that data
- Mechanism for restricting access to some of an object's components
 - Information hiding - abstraction
- Improves readability and manageability of code
- Procedural languages do not have these constructs



Class vs. Program

- In Java, a full program includes a single “main” method
 - Program execution starts, and usually ends, here
- May have many different classes
- One *public* class per file
 - Matches the filename.java
- Files can be combined into packages
 - Later



Calculator.java

```
public class Calculator {
    int add(int x, int y) {
        return x + y;
    }

    int subtract(int x, int y) {
        return x - y;
    }

    public static void main(String[] args) {
        Calculator c = new Calculator();

        System.out.println(c.add(3, 5));
        System.out.println(c.subtract(3, 5));
    }
}
```



System class

- Contains variables that reference “standard input” and “standard output”
- Can be keyboard and display, can be other things (redirection)
- System.in: input stream
- System.out: output stream



Parsing input

- class Scanner
- To read from standard input, create a Scanner object and use its methods:

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

int i = s.nextInt();
double d = s.nextDouble();
String s = s.nextLine();
```



UseCalculator.java

```
import java.util.Scanner;

public class UseCalculator {
    public static void main(String[] args) {
        Calculator c = new Calculator();

        Scanner scanner = new Scanner(System.in);
        int x = scanner.nextInt();
        int y = scanner.nextInt();
        System.out.println(c.add(x, y));
    }
}
```



Formatting notes

- Naming conventions
 - Variables: lowerCamelCase
 - Classes: UpperCamelCase
 - Symbolic constants: UPPER_CASE
- Open curly at end of line
- Consistent indentation (eg, 2 spaces)
- Complete documentation on course website



Assignments

- “Create a class Henway...”
 - Create a file Henway.java that contains the class declaration

```
public class Henway {  
}
```
 - Note capitalization
 - Compile it
 - Run it



Good Day, World!

```
import javax.swing.*;  
  
class HelloWorld {  
    public static void main(String[] args) {  
        JFrame myWindow;  
        myWindow = new JFrame();  
  
        myWindow.setSize(300, 200);  
  
        myWindow.setTitle("Good Day, World!");  
        myWindow.setVisible(true);  
    }  
}
```



- “At the source of every error which is blamed on the computer you will find at least two human errors, including the error of blaming it on the computer”



Boiler Up!

