CSE2016 Programming Methodology

Week 3: Arithmetic and Variables

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Coin Program

- Coins
  - quarter = 25-cent
  - dimes = 10-cent
  - nickels = 5-cent
  - pennies = 1-cent
- An example
  - 9 quarters, 2 dimes, no nickels, and 6 pennies
    - $(9\times25)+(2\times10)+(0\times5)+(6\times1) = 251$ cents = $2.51
- Coin Program

For 9 quarters, 2 dimes, no nickels, and 6 pennies, the total is 251

Coins.java

```
public class Coins
{
    public static void main(String[] args)
    {
        System.out.println("For 9 quarters, 2 dimes, no nickels, and
        6 pennies,");
        System.out.print("the total is ");
        System.out.println( (9 * 25) + (2 * 10) + (0 * 5) + (6 * 1) );
    }
}
```

02. Named Quantities: Variables

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Variable?

```
public class Coins
{
    public static void main(String[] args)
    {
        System.out.println("For 9 quarters, 2 dimes, no nickels, and
        6 pennies,");
        System.out.print("the total is ");
        System.out.println( (9 * 25) + (2 * 10) + (0 * 5) + (6 * 1) );
    }
}
```

What if # pennies is changed?

We should modify two places!

02. Named Quantities: Variables

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Variables

- **Place** where values are stored

- Naming rules
  - Alphabet, numbers, _, …
    - E.g., quarters, QUArTers, Q123, my_quarter
  - Do not start with a number
  - Do not use Java keywords: public, class, etc.

- Variable declaration, initialization, and usage
  - int quarters = 5;
  - System.out.println(quarters * 25);

02. Named Quantities: Variables

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CoinsVariables.java

```
public class CoinsVariables
{
     public static void main(String[] args)
     {
          int quarters = 9;
          int dimes = 2;
          int nickels = 0;
          int pennies = 6;
          System.out.println("For these quantities of coins:");
          System.out.print("Quarters = "); System.out.println(quarters);
          System.out.print("Dimes = "); System.out.println(dimes);
          System.out.print("Nickels = "); System.out.println(nickels);
          System.out.print("Pennies = "); System.out.println(pennies);
          System.out.print("The total is ");
          System.out.println((quarters*25)+(dimes*10)+(nickels*5)+(pennies*1) );
     }
}
```

```
For these quantities of coins:
Quarters = 9
Dimes = 2
Nickels = 0
Pennies = 6
The total is 251
```

02. Named Quantities: Variables

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Printing Tips

- System.out.print(x); System.out.print(y);

  -> System.out.print(x+y);

- System.out.print(x); System.out.println(y);

  -> System.out.println(x+y);

02. Named Quantities: Variables

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CoinsVariables2.java

Printing succinctly!

```
public class CoinsVariables2
{
    public static void main(String[] args)
    {
        int quarters = 9;
        int dimes = 2;
        int nickels = 0;
        int pennies = 6;
        System.out.println("For these quantities of coins:");
        System.out.println("Quarters = " + quarters);
        System.out.println("Dimes = " + dimes);
        System.out.println("Nickels = " + nickels);
        System.out.println("Pennies = " + pennies);
        System.out.println("The total is " +
        ((quarters*25)+(dimes*10) +(nickels*5)+(pennies*1)));
    }
}
```

Converting to Dollars

- 251 cents -> $2.51
  - **How to convert cents-scale to dollar-scale?**

- Hint
  - 251/100 = 2 (**quotient**)
  - 251%100 = 51
    - % => **mod**, i.e., remainder operator

- "251" is used twice
  - Let's use a variable, "total"

02. Named Quantities: Variables

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TotalVariablesDollar.java

```
public class TotalVariablesDollar
{
     public static void main(String[] args)
     {
          int quarters = 9;
          int dimes = 2;
          int nickels = 0;
          int pennies = 6;
          System.out.println("For these quantities of coins:");
          System.out.println("Quarters = " + quarters);
          System.out.println("Dimes = " + dimes);
          System.out.println("Nickels = " + nickels);
          System.out.println("Pennies = " + pennies);
          System.out.print("The total is ");
          int total = (quarters * 25) + (dimes * 10) + (nickels * 5) + (pennies * 1);
          System.out.print("The total is $");
          System.out.print(total / 100);
          System.out.print(".");
          System.out.println(total % 100);
     }
}
```

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Variable Initialization

- Variable declaration
  - A new “cell” is created
- Variable initialization
  - Initial value is stored in the cell
- We can split “declaration” and “initialization”
  - int dollars;
  - dollars = 3

```
public class TotalVariablesDollar
{
     public static void main(String[] args)
     {
          int quarters = 9;
          int dimes = 2;
          int nickels = 0;
          int pennies = 6;

     }
}
```

02. Named Quantities: Variables

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Assignment

- Variable value can be changed

```
public static void main(String[] args)
{
      int money = 100;
      System.out.println(money);
      money = 0;
      System.out.println(money);
}
```

```
public static void main(String[] args)
{
      int money = 100;
      System.out.println(money);
      money = money + 50;
      System.out.println(money);
}
```

02. Named Quantities: Variables

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A Problem: Change Making

- Input: 3 dollars and 46 cents
- Output
  - quarters = 13
  - dimes = 2
  - nickels = 0
  - pennies = 1
- How to calculate?
  - 3.46 – (13 * 0.25) = 0.21
  - 0.21 – (2 * 0.10) = 0.01
  - 0.01 – (0 * 0.05) = 0.01
  - 0.01 – (1 * 0.01) = 0.00

02. Named Quantities: Variables

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Algorithm

1. Set the starting value of money.
2. Subtract the maximum number of quarters from money, and print the quantity of quarters extracted.
3. Subtract the maximum number of dimes from money, and print the quantity of dimes extracted.
4. Subtract the maximum number of nickels from money, and print the quantity of nickels extracted.
5. The remainder of money is printed as pennies.

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MakeChange.java

%: modulo

```
public class MakeChange
{
    public static void main(String[] args)
    {
        int dollars = 3;
        int cents = 46;
        int money = (dollars * 100) + cents;
        System.out.println("quarters = " + (money / 25));
        money = money % 25;
        System.out.println("dimes = " + (money / 10));
        money = money % 10;
        System.out.println("nickels = " + (money / 5));
        money = money % 5;
        System.out.println("pennies = " + money);
    }
}
```

03. Arithmetic with Fractions: Doubles

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Degree Converting

- Degree Converting Problem
  - Celsius into Fahrenheit
  - f = (9/5)c + 32
  - E.g., c = 22 -> f = 71.6

- Fractional numbers representation in Java
  - “double”

03. Arithmetic with Fractions: Doubles

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CelsiusToFahrenheit0.java

```
public class CelsiusToFahrenheit0
{
    public static void main(String[] args)
    {
        int c = 22; // the degrees Celsisus
        double f = ((9.0/5.0) * c) + 32;
        System.out.println("For Celsius degrees "+ c + ",");
        System.out.println("Degrees Fahrenheit = " + f);
    }
}
```

```
For Celsius degrees 22,
Degrees Fahrenheit = 71.6
```

03. Arithmetic with Fractions: Doubles

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Type Cast

- Is it ok?

```
int i = 1;
double d = i
```

O

implicit type casting!

- How about this?

```
double d = 1.5;
int i = d;
```

X

```
double d = 1.5;
int i = (int) d
```

explicit type casting!

Booleans

- "True" and "False"
  - boolean b = false;
- Comparison Operations
  - > < <= >= == !=
- Logic Operations
  - "and", "or", "not" -> &&, ||, !
- E.g., x<y && !(y >= 20)

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Operator Precedence

- 1*2+3
  - (1*2)+3 ? or 1*(2+3) ?

- Priority

unary negation, e.g., -3	High
multiplication, *, division/quotient, /, and modulo %	
addition/string concatenation, +, and subtraction, -	
comparison operations, <, <=, >, >=	
comparisons of equality, ==, and inequality, !=	
logic, &&, ||	Low

05. Operator Precedence

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Associativity

- 1-2-3
  - (1-2)-3 ? Or 1-(2-3)?
  - We need some operator precedence rules

- General rule
  - Unary operator: right associativity
    - E.g., ----4 = -(-(-(-4)))
  - Binary operator: left associativity
    - 1-2-3 = (1-2)-3

String

- String
  - “Object”
  - String name = “Gildong Hong";

- String concatenation
  - System.out.println("My name is " + name);
  - System.out.println("My name is R2D" + (5-3));

String Methods

- S1.equals(S2)
  - equality comparison – returns whether strings S1 and S2 hold the same sequence of characters
- S1.compareTo(S2)
  - compares the characters in string S1 to S2
- S.length()
  - returns the length of string S
- S.charAt(E)
  - returns the character at position E in S
- S1.indexOf(S2,i)
  - searches S1 for the first occurrence of S2 that appears inside it, starting from index i within S1
- S.substring(E1,E2)
  - returns the substring starting at position E1 and extending to position E2 - 1
- S.toUpperCase(), S.toLowerCase()
  - returns a string that looks like S but in upper-(or lower-)case letters only
- S.trim()
  - returns a string like S but without leading or trailing blanks

- Please refer to the API document!

Characters

- Individual symbols within a string
  - “char”
- Special symbols
  - \b (backspace), \t (tab), \n (newline), \r (return), \" (doublequote), \' (single quote), \\ (backslash)
- Character <-> Number
  - Based on Unicode
  - (char)(‘a’ + 1)?
  - (int)(‘a’ + 1)?

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Data Type

- Java has two type categories
  - primitive type: int, double, boolean, char
  - reference type or object type: String, GregorianCalendar
- Type error examples

```
boolean b = true;
System.out.println(b * 5); // data type error
int i = 3 * 2.1; // data type error
int x;
x = "abc"; // data type error!

GregorianCalendar c = new GregorianCalendar();
System.out.println(c.getTime());
c.println("oops"); // data type error
```

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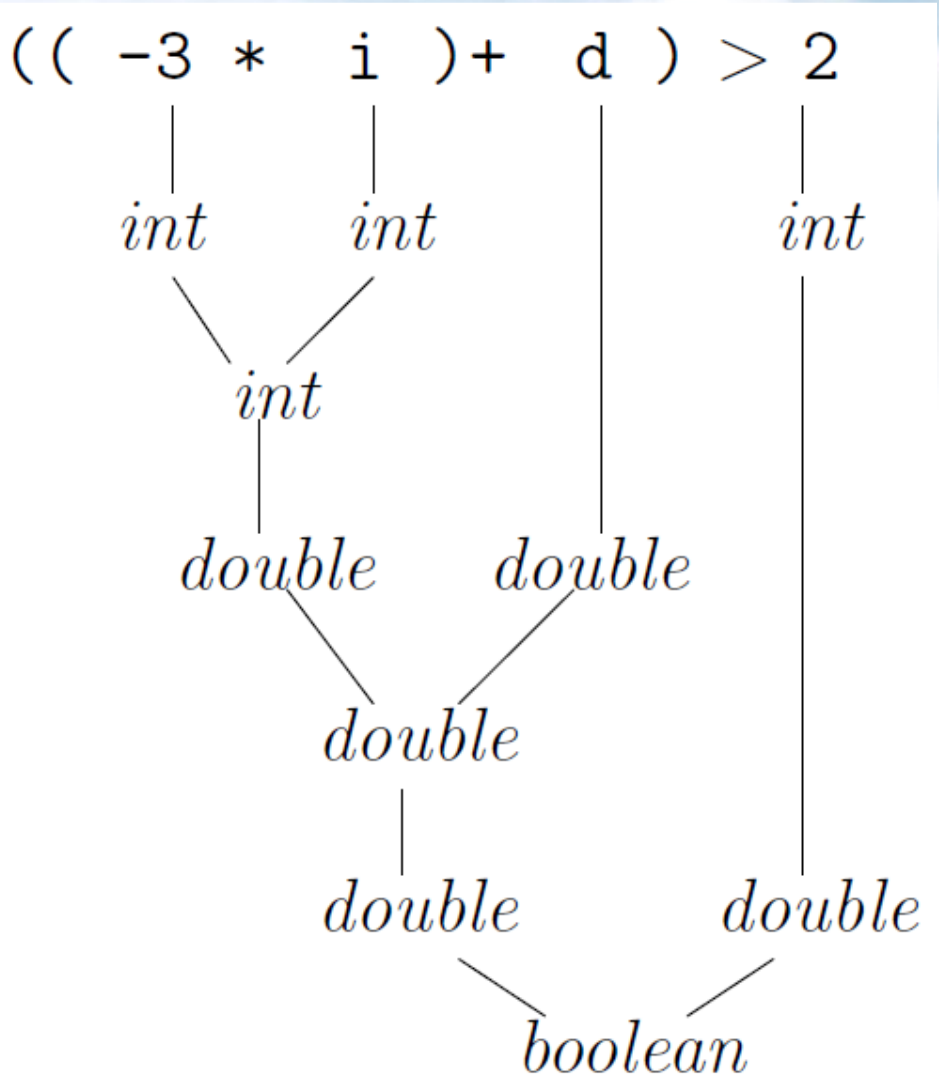
Data Type Tree

int i = 1;
double d = 2.5;



08. Input via Program Arguments

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Input

- Program arguments (also known as command-line arguments)
- How?
  - Command line: java CelsiusToFahrenheit 20
  - Eclipse: Run configuration > Arguments > Program arguments
- Arguments are stored in args[0], args[1], ..., args[n]

08. Input via Program Arguments

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LengthOfName.java

```
public class LengthOfName
{
    public static void main(String[] args)
    {
        String name = args[0];
        int length = name.length();
        System.out.println("The name, " + name + ", has length " +
        length);
    }
}
```

08. Input via Program Arguments

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String <-> Number

- Arguments – **String**
  - E.g., argument 20 -> “20”
- How to change the string “20” into an integer (or double) value?
  - int c = new Integer(“20”).intValue();
  - double c = new Double(“3.14159”).doubleValue();
- Integer, Double ∈ java.lang

08. Input via Program Arguments

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DecimalFormat

- java.text.DecimalFormat
  - DecimalFormat Object: new DecimalFormat(<pattern>)
  - E.g., pattern = “0.00”

- Using “format” method
  - DecimalFormat f = new DecimalFormat(“0.00”);
  - String s = f.format(100.0/3.0);

08. Input via Program Arguments

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CelsiusToFahrenheit1.java

```
import java.text.*;

public class CelsiusToFahrenheit1
{
    public static void main(String[] args)
    {
        int c = new Integer(args[0]).intValue();
        double f = ((9.0/5.0)*c) + 32;
        System.out.println("For Celsius degrees " + c + ",");
        DecimalFormat formatter = new DecimalFormat("0.0");
        System.out.println("Degrees Fahrenheit = " +
        formatter.format(f));
    }
}
```

09. Diagnosing Errors

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Compile-Time Error

- Syntax error
  - Grammar error
  - E.g., System.out.println ((1+2(*3);
  - Compiler can detect it

- Type error
  - E.g., System.out.println(3 + true);
  - Detected by compiler
  - Variable initialization error
    - E.g., System.out.println(a);
    - int a=1; double a=2.5; System.out.println(a);

Run-Time Error

- Errors occurred during run-time
  - E.g., divided by zero error
    - i/x //x=0
  - E.g., conversion error
    - new Integer(x).intValue() // x="abc"

- Java generates an exception for run-time error

```
java.lang.NumberFormatException: abc
    at java.lang.Integer.parseInt(Integer.java)
    at java.lang.Integer.<init>(Integer.java)
    at Test.main(Test.java:4)
```

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Tricky Error

- Compiler cannot detect the following error
  - int x=3;
  - int y=7;
  - ~~System.out.println(x==y);~~
  - System.out.println(x=y);

10. Summary

Summary

- Variable usage
  - int, double, bool, String, char
- Type
- Input arguments

Thanks

Week 3: Arithmetic and Variables

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