Today’s topics

Java
   Input
   More Syntax

Upcoming
   Decision Trees
   More formal treatment of grammers

Reading
   Great Ideas, Chapter 2
Java Details

- **Variable:** *an item of data named by an identifier*
- **Constants (also called self-defining term)**
  - 42
  - 35.45
  - "Hello"
- **Operators**
  - Arithmetic
  - Relational and conditional
  - Assignment
  - Other
- **Expression:** *a series of variables, operators, and method calls that evaluates to a single value*
Syntax, Semantics, and Style

- **Syntax**
  - Grammar
  - Java requires it be perfect
  - Compiler will generate error messages

- **Semantics**
  - Meaning
  - Compiler will not *(can not !)* check most of it
  - You can write incorrect (or stupid, or inefficient) programs

- **Style**
  - Make program more readable for *humans*
  - Actually very important!
  - Helps understanding and writing correct programs
Data Input

- For program to be versatile it must have *Input*
- Have used Buttons as a form of input
  - It’s one way to make our wishes known
- Need more flexibility
  - Can input text: `String`
  - Can input numbers
    - Whole numbers called integers: `int`
    - Real numbers (allow fractions) called doubles: `double`
- Use `getText` of `TextField` class to input strings
- Use `getInt` of `IntField` class to input integers
Text (string) Input

- Use **TextFields** to *read in* string data
- **Use the** `getText` **method of the TextField class**
  - After creating a TextField object we can use method
  - Syntax (we’ve used it before) is
    ```java
    object.method()
    ```
  - For example note following code fragment:
    ```java
    // declare and create TextField instr
    TextField instr = new TextField(50);
    // declare message (new not needed)
    String message;
    // message gets value from TextField instr
    message = instr.getText();
    ```
public class DupThree extends java.applet.Applet
    implements ActionListener
{
    TextField m1, m2, m3, m4, m5;
    Button b1;
    String message;

    public void init()
    {
        m1 = new TextField(80);
        m2 = new TextField(80);
        m3 = new TextField(80);
        m4 = new TextField(80);
        m5 = new TextField(80);
        b1 = new Button("button");
        m1.setText("Please enter some text below, then press button");
        add(m1); add(m2); add(b1); add(m3); add(m4); add(m5);
        b1.addActionListener(this);
    }
}
public void actionPerformed(ActionEvent event)
{
    // since there is only one button, no if needed
    message = m2.getText();
    m3.setText(message);
    m4.setText(message);
    m5.setText(message);
}
}
Dealing with numbers

- **Primitive data type: int**
  - Does not require a new operator to create
  - Primitive type is not a class
  - Must declare
  - Should initialize
  - Other primitive types include: boolean, char, double

- **Operations using integers**
  - +, -, *, /, %
  - Operator Precedence
Some arithmetic details

- Java adheres to traditional order of operations
  - * and / have higher precedence than + and –

  ```java
  int x = 3 + 5 * 6;   int y = (3 + 5) * 6;
  ```

  - Parentheses are free, use them liberally

- Arithmetic expressions are evaluated left-to-right in the absence of parentheses

  ```java
  int x = 3 * 4 / 6 * 2;   int y = (3*4)/(6*2);
  ```

- There are limits on int and double value, be aware of them.
Numeric Input

- **Use IntFields to read in numeric data**
- **Use the getInt method of the IntField class**
  - After creating an IntField object we can use method
  - Syntax (we’ve used it before) is
    ```java
    object.method()
    ```
  - For example note following code fragment
    ```java
    // declare and create IntField intin
    IntField intin = new IntField(20);
    // declare n (new not needed)
    int n;
    // n reads value from IntField intint
    n = intin.getInt();
    ```
public class AboveBelow extends java.applet.Applet
{
    TextField m1, m2;
    IntField i1;
    Button b1, b2;
    int secret, guess;
    public void init ()
    {
        m1 = new TextField(80);
        m1.setText("Enter number between 0 and 100 below, then push SECRET");
        i1 = new IntField(40);
        m2 = new TextField(80);
        b1 = new Button("SECRET");
        b2 = new Button("GUESS");
        add(m1); add(b1); add(i1); add(b2); add(m2);
        b1.addActionListener(this);
        b2.addActionListener(this);
    }
}
Game Example (page 2)

```java
public void actionPerformed(ActionEvent event)
{
    Object cause = event.getSource();

    if (cause == b1)
    { secret = i1.getInt();
        i1.setInt();
        m1.setText("Now, enter your guess below, then press GUESS");
    }
    if (cause == b2)
    { guess = i1.getInt();
        if (guess == secret)
            m2.setText("You've got it!");
        if (guess < secret)
            { i1.setInt();
                m2.setText("The number is greater than " + guess);
            }
}
Game Example continued:

```java
if (guess > secret)
{
    i1.setInt();
    m2.setText("The number is less than "+guess);
}
```

- What is best strategy to play this game?
  - Where have we seen it before?
Types for Numbers

- The type `String` is not a built-in type, actually it’s a class

- There are many numerical types in Java. We’ll use two
  - `int`, represents integers: {...-3,-2,-1,0,1,2,3,...}
    - Conceptually there are an infinite number of integers, but the range is limited to \([-2^{31}, 2^{31}-1]\) or \([\text{Integer.MIN_VALUE}, \text{Integer.MAX_VALUE}]\)
    - Alternatives? Why is range limited?
  - `double`, represents real numbers like \(\pi, \sqrt{2}\)
    - Not represented exactly, so expressions like 100*0.1 may yield unexpected results
    - Double precision `floating point` numbers, another type `float` exists, but it’s a terrible choice (can generate poor results)
GIGO: program as good as its data?

- In calculations involving floating point numbers it’s easy to generate errors because of accumulated approximations:
  - What is $10^{23} + 1$?
  - When is $(x + y) + z$ different from $x + (y + z)$?

- The type `int` is severely constrained on 16-bit computers, e.g., running DOS, largest value is $32,767$ ($2^{15} - 1$)
  - Even on 32-bit machines, how many seconds in a millennium? $60*60*24*365*1000$, problems?
  - On UNIX machines time is measure in seconds since 1970, problems?
  - What was Y2K all about?
What arithmetic operations exist?

- Syntax and semantics for arithmetic operations
  - Addition, subtraction: + and −, int and double
    - $23 + 4$, $x + y$, $d - 14.0 + 23$
  - Multiplication: *, int and double
    - $23 * 4$, $y * 3.0$, $d * 23.1 * 4$
  - Division: /, different for int and double
    - $21 / 4$, $21 / 4.0$, $x / y$
  - Modulus: %, (think of it as remainder) only for int
    - $21 % 4$, $17 % 2$, $x % y$

- Mixed type expressions are converted to “higher” type
  - Associativity of operators determines left-to-right behavior

- Use parentheses liberally
  - Without ( ) use operator precedence: *, /, %, before +, −