University of British Columbia
CPSC 111, Intro to Computation
2009W2: Jan-Apr 2010

Tamara Munzner

Whitespace, Errors, Variables, Data Types, Assignment

Lecture 4, Wed Jan 13 2010

borrowing from slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/111-10

Reading This Week

- Chap 1: 1.3-1.8
- Chap 2: 2.1-2.2, 2.5
- Chap 4: 4.1-4.2

- reminder: weekly reading questions due next time (Fri) at start of lecture

Review: High-Level Language

- Must be translated into machine language so the computer can understand it.

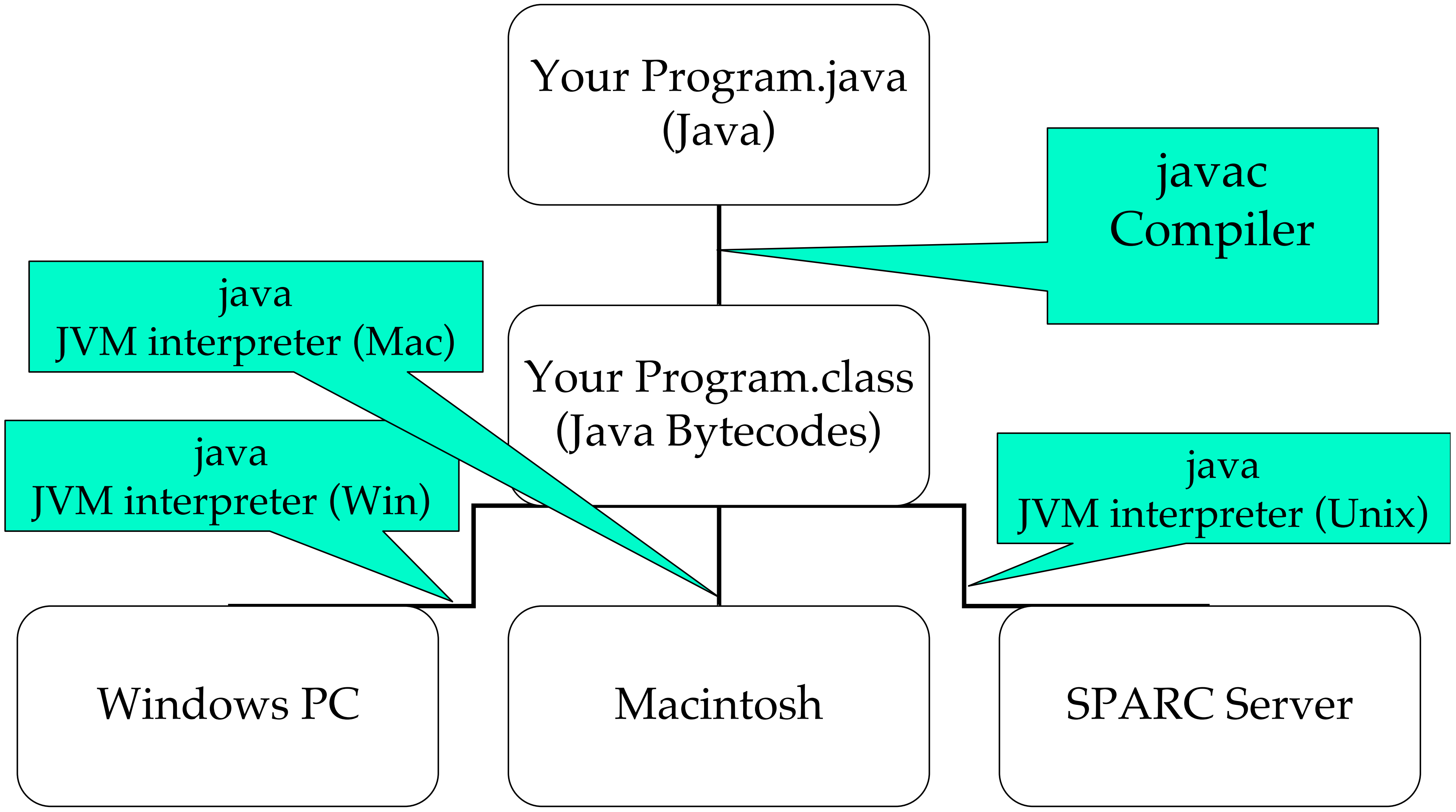
- High-level instruction: A = B + C

becomes at least four machine language instructions!

```
00010000001000000000000000000010   load B
00010000010000000000000000000011   load C
00000000001000100011000000100000   add them
00010100110000000000000000000001   store in A
```

- How?
  - You could translate it as you go (**interpreter**).
  - You could translate it in advance (**compiler**).

Review: Java Does Both!


Your Program.java (Java)
javac Compiler
Your Program.class (Java Bytecodes)
java JVM interpreter (Mac)
java JVM interpreter (Win)
java JVM interpreter (Unix)
Windows PC
Macintosh
SPARC Server

Review: Comments

- Comments: help humans understand
  - ignored by compiler
  - comment out rest of line: `//`
  - comment start/end: `/*     */`

Review: Identifiers

```
public class Oreo
{
  public static void main (String[] args)
  {
    System.out.println ("Feed me more Oreos!");
  }
}
```

- Words we use when writing programs are called identifiers
  - except those inside the quotes
  - Kurt made up identifier Oreo
  - Other programmers chose identifier System.out.println

Review: Reserved Words

- Get familiar with these
  - But you don’t need to memorize all 52 for exam

```
abstract    do          if          private       throw
boolean     double      implements  protected     throws
break       else        import      public        transient
byte        enum        instanceof  return        true
case        extends     int         short         try
catch       false       interface   static        void
char        final       long        strictfp      volatile
class       finally     native      super         while
const       float       new         switch
continue    for         null        synchronized
default     goto        package     this
```

Review: Identifiers

- Identifier must
  - Start with a letter and be followed by
  - Zero or more letters and/or digits
    - Digits are 0 through 9.
    - Letters are the 26 characters in English alphabet
      - both uppercase and lowercase
      - plus the $ and _
      - also alphabetic characters from other languages
  - Which of the following are not valid identifiers?

```
userName      user_name      $cash      2ndName
first name    user.age       _note_     note2
```

Identifiers

- Java is case sensitive
- Oreo   oreo   OREO   0reo
  - are all different identifiers, so be careful
  - common source of errors in programming

  - are these all valid identifiers?

Identifiers

- Creating identifiers in your Java programs
  - Remember other people read what you create
  - Make identifiers meaningful and descriptive for both you and them
- No limit to how many characters you can put in your identifiers
  - but don’t get carried away

```
public class ReallyLongNamesWillDriveYouCrazyIfYouGoOverboard
{
  public static void main (String[] args)
  {
    System.out.println ("Enough already!");
  }
}
```

White Space

```
//********************************************************
// Oreo.java        Author:  Kurt Eiselt
//
// Demonstrating good use of white space
//********************************************************

public class Oreo
{
  public static void main (String[] args)
  {
    System.out.println ("Feed me more Oreos!");
  }
}
```

White Space

```
//********************************************************
// Oreo1.java        Author:  Kurt Eiselt
//
// Demonstrating mediocre use of white space
//********************************************************

public class Oreo1
{
public static void main (String[] args)
{
System.out.println ("Feed me more Oreos!");
}
}
```

White Space

```
//********************************************************
// Oreo2.java       Author:  Kurt Eiselt
//
// Demonstrating bad use of white space
//********************************************************

public class Oreo2 { public static void main (String[]
args) { System.out.println ("Feed me more Oreos!"); } }
```

White Space

```
//********************************************************
// Oreo3.java        Author:  Kurt Eiselt
//
// Demonstrating totally bizarre use of white space
//********************************************************

    public
class     Oreo3
        {
  public  static
void main  (String[] args)
                              {
  System.out.println   ("Feed me more Oreos!")
;
        }
             }
```

White Space

```
//*********************************************************
// Oreo4.java       Author:  Kurt Eiselt
//
// Demonstrating deep psychological issues with whitespace
//*********************************************************

public
class
Oreo4
{
public
static
void
main
(
String[]
args
)
{
System.out.println
("Feed me more Oreos!")
;
}
}
```

White Space

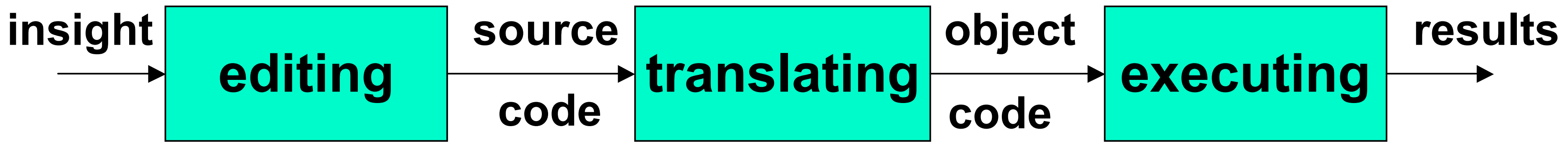
- White space
  - Blanks between identifiers and other symbols
  - Tabs and newline characters are included

- White space does not affect how program runs

- Use white space to format programs we create so they’re easier for people to understand

Program Development

- Use an editor to create your Java program
  - often called source code
  - code used interchangeably with program or instructions in the computer world
- Another program, a compiler or an interpreter, translates source code into target language or object code, which is often machine language
- Finally, your computer can execute object code



Compiling and Running

- Let’s try it!
  - command line for now
  - later we’ll use Eclipse
    - integrated development environment (IDE)

Compiling and Running Java

- what I did at the command line
  - create file HelloWorld.java in text editor
    - containing class HelloWorld
  - compile it: “javac HelloWorld.java”
    - compiler makes file HelloWorld.class
  - run it in the interpreter: “java HelloWorld”
- don’t panic if this is mysterious!
  - hands-on practice in labs this week
  - see detailed instructions on WebCT for how to download and configure your home desktop/laptop
    - if you get stuck, bring laptop to lab or DLC for help

- a few weeks from now: Eclipse IDE

Syntax

- Rules to dictate how statements are constructed.
  - Example: open bracket needs matching close bracket
- If program is not syntactically correct, cannot be translated by compiler
- Different than humans dealing with natural languages like English. Consider statement with incorrect syntax (grammar)

  for weeks. rained in Vancouver it hasn't

  - we still have pretty good shot at figuring out meaning

Semantics

- What will happen when statement is executed
- Programming languages have well-defined semantics, no ambiguity
- Different than natural languages like English. Consider statement:

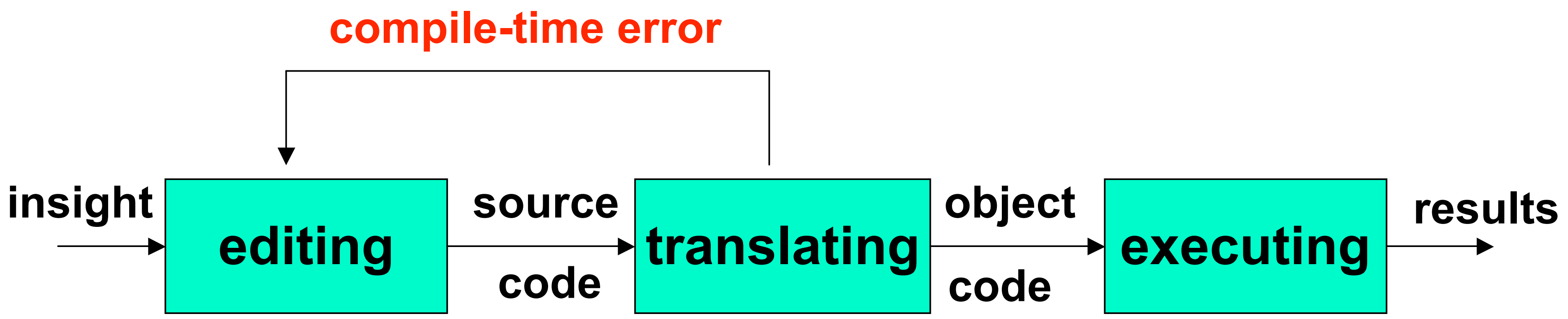
  Mary counted on her computer.
- How could we interpret this?

- Programming languages cannot allow for such ambiguities or computer would not know which interpretation to execute

Errors

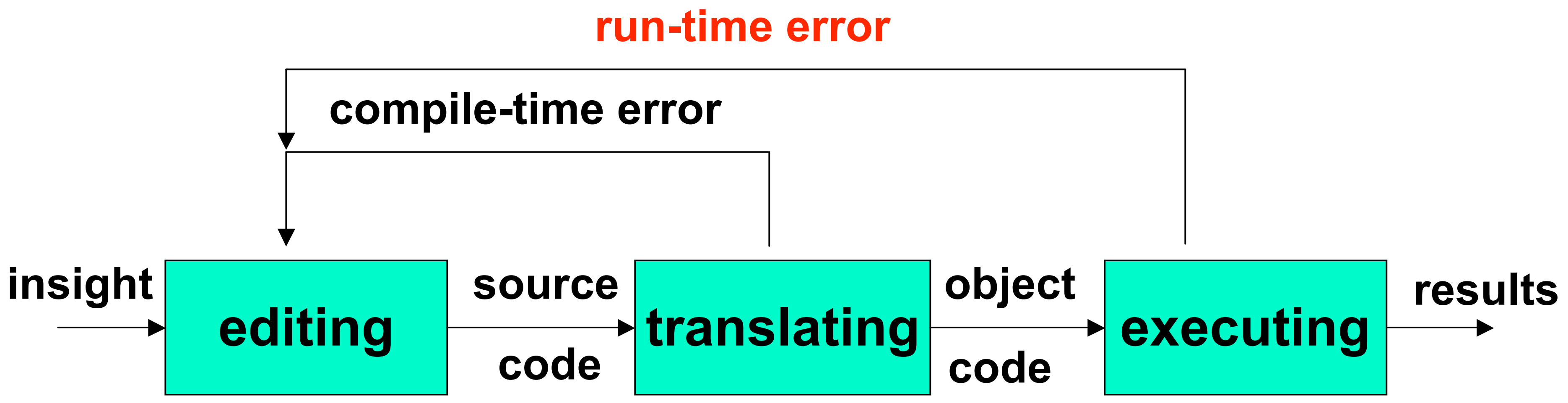
- Computers follows our instructions exactly
- If program produces the wrong result it’s the programmer’s fault
  - unless the user inputs incorrect data
  - then cannot expect program to output correct results: “Garbage in, garbage out” (GIGO)
- Debugging: process of finding and correcting errors
  - Unfortunately can be very time consuming!

Errors



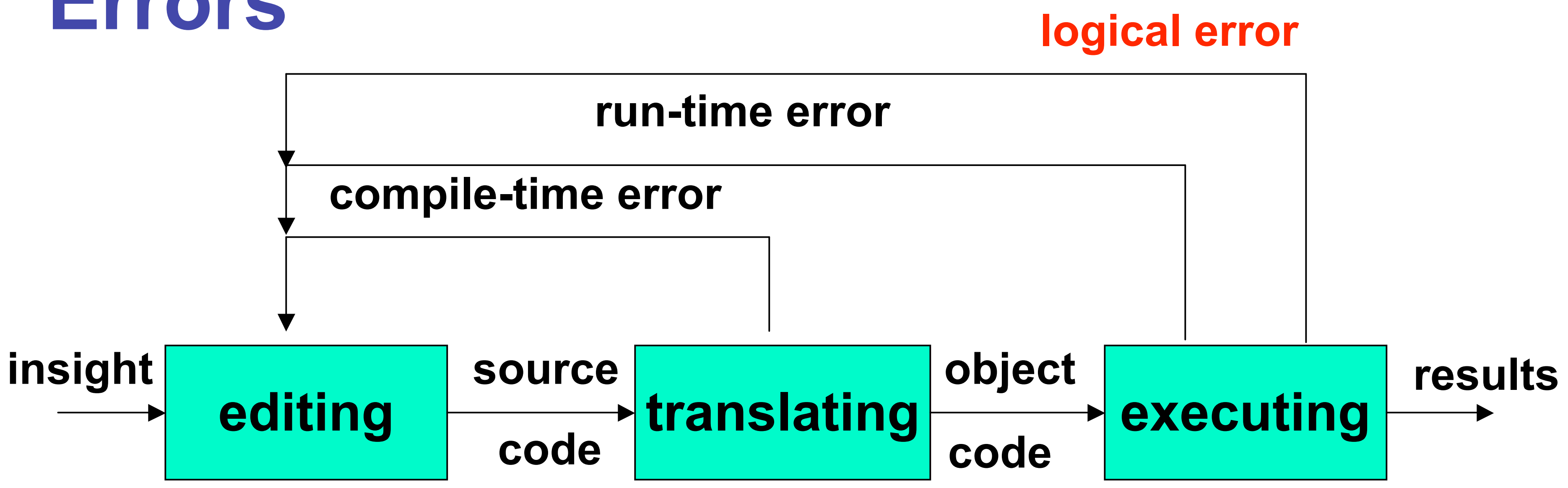
- Error at compile time (during translation)
  - you did not follow syntax rules that say how Java elements must be combined to form valid Java statements

Errors



- Error at run time (during execution)
  - Source code compiles
    - Syntactically (structurally) correct
  - But program tried something computers cannot do
    - like divide a number by zero.
  - Typically program will crash: halt prematurely

Errors



- Logical error
  - Source code compiles
  - Object code runs
  - But program may still produce incorrect results because logic of your program is incorrect
    - Typically hardest problems to find

Errors

- Let’s try it!
    - usually errors happen by mistake, not on purpose...

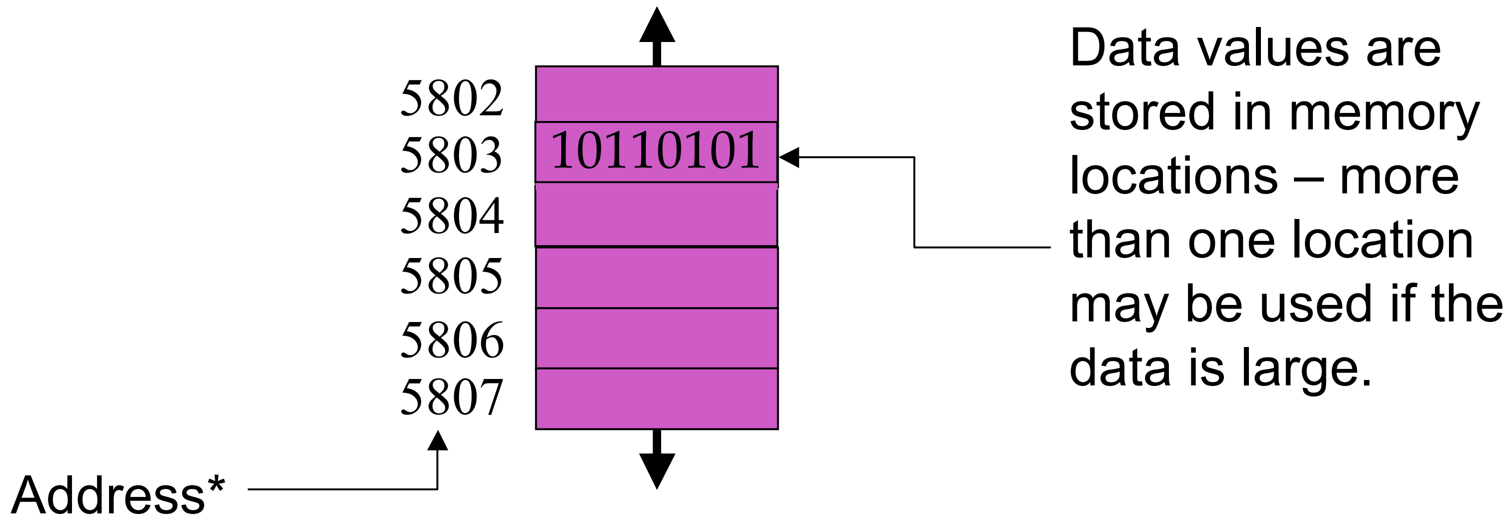
Memory and Identifiers

- Example of a high-level instruction
  - A = B + C
- Tells computer to
  - go to main memory and find value stored in location called B
  - go to main memory and find value stored in location called C
  - add those two values together
  - store result in memory in location called A

- Great! But... in reality, locations in memory are not actually called things like a, b, and c.

Memory Recap

- Memory: series of locations, each having a unique address, used to store programs and data
- When data is stored in a memory location, previously stored data is overwritten and destroyed
- Each memory location stores one byte (8 bits) of data


5802
5803
5804
5805
5806
5807
10110101
Address*
Data values are stored in memory locations – more than one location may be used if the data is large.

*For total accuracy, these addresses should be binary numbers, but you get the idea, no?

Memory and Identifiers

- So what's with the a, b, and c?
  - Machine language uses actual addresses for memory locations
  - High-level languages easier
    - Avoid having to remember actual addresses
    - Invent meaningful identifiers giving names to memory locations where important information is stored
- `pay_rate` and `hours_worked` vs. 5802 and 5806
  - Easier to remember and a whole lot less confusing!

Memory and Identifiers: Variables

- Variable: name for location in memory where data is stored
  - like variables in algebra class
- `pay_rate`, `hours_worked`, `a`, `b`, and `c` are all variables
- Variable names begin with lower case letters
  - Java convention, not compiler/syntax requirement
- Variable may be name of single byte in memory or may refer to a group of contiguous bytes
  - More about that next time

Programming With Variables

```
//*******************************************
// Test.java       Author: Kurt
//
// Our first use of variables!
//*******************************************

public class Test
{
    public static void main (String[] args)
    {
        a = b + c;
        System.out.println ("The answer is " + a);
    }
}
```

- Let’s give it a try...

Programming With Variables

```
//*******************************************
// Test.java        Author: Kurt
//
// Our first use of variables!
//*******************************************

public class Test
{
    public static void main (String[] args)
    {
        a = b + c;
        System.out.println ("The answer is " + a);
    }
}
```

- Let's give it a try...
  - b and c cannot be found!
  - need to assign values

Programming With Variables: Take 2

```
//*******************************************
// Test2.java       Author: Kurt
//
// Our second use of variables!
//*******************************************

public class Test2
{
    public static void main (String[] args)
    {
        b = 3;
        c = 5;
        a = b + c;
        System.out.println ("The answer is " + a);
    }
}
```

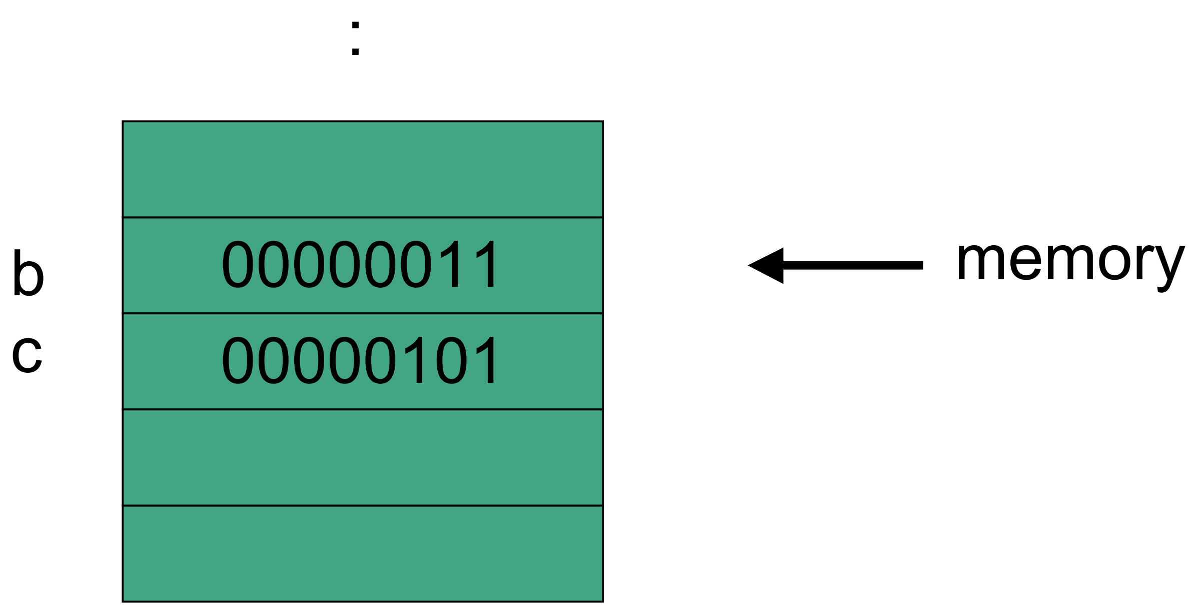
Programming With Variables: Take 2

```
//*****************************************
// Test2.java       Author: Kurt
//
// Our second use of variables!
//*****************************************

public class Test2
{
    public static void main (String[] args)
    {
        b = 3;
        c = 5;
        a = b + c;
        System.out.println ("The answer is " + a);
    }
}
```

- Now what?
  - such a lazy computer, still can’t find symbols...

Now What?



- Java doesn't know how to interpret the contents of the memory location
  - are they integers? characters from the keyboard? shades of gray? or....

Data Types

- Java requires that we tell it what kind of data it is working with
- For every variable, we have to declare a data type
- Java language provides eight primitive data types
  - i.e. simple, fundamental
- For more complicated things, can use more data types
  - created by others provided to us through the Java libraries
  - that we invent
    - More soon - for now, let's stay with the primitives
- We want `a`, `b`, and `c` to be integers. Here's how we do it...

Programming With Variables: Take 3

```
//*****************************************
// Test3.java       Author: Kurt
//
// Our third use of variables!
//*****************************************

public class Test3
{
    public static void main (String[] args)
    {
        int a;  //these
        int b;  //are
        int c;  //variable declarations
        b = 3;
        c = 5;
        a = b + c;
        System.out.println ("The answer is " + a);
    }
}
```

Data Types: Int and Double

- int
  - integer
- double
  - real number
  - (double-precision floating point)

Floating Point Numbers

- significant digits
  - 42
  - 4.2
  - 42000000
  - .000042

Floating Point Numbers

- significant digits
  - 42 = 4.2 * 10 = 4.2 * 10^1
  - 4.2 = 4.2 * 1 = 4.2 * 10^0
  - 42000000 = 4.2 * 10000000 = 4.2 * 10^7
  - .000042 = 4.2 * .00001 = 4.2 * 10^{-5}

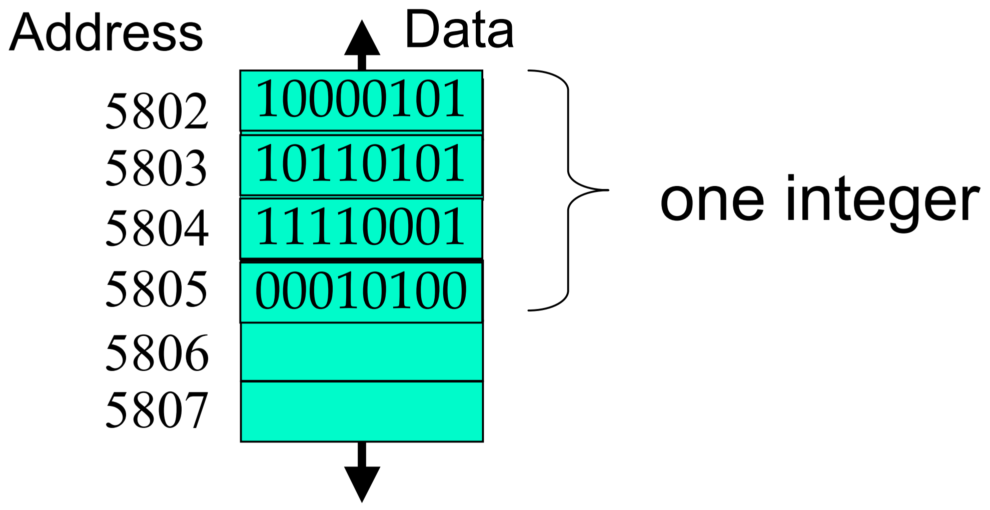
Floating Point Numbers

- significant digits
  - 42 $= 4.2 * 10 = 4.2 * 10^1$
  - 4.2 $= 4.2 * 1 = 4.2 * 10^0$
  - 42000000 $= 4.2 * 10000000 = 4.2 * 10^7$
  - .000042 $= 4.2 * .00001 = 4.2 * 10^{-5}$
- only need to remember
  - nonzero digits
  - where to put the decimal point
    - floats around when multiply/divide by 10

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



Variable Declaration Examples

- person’s age in years
- height of mountain to nearest meter
- length of bacterium in centimeters
- number of pets at home

Variable 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;*

Assignment

```
//*****************************************
// Test3.java       Author: Kurt
//
// Our third use of variables!
//*****************************************

public class Test3
{
    public static void main (String[] args)
    {
        int a;
        int b;
        int c;
        b = 3;      // these
        c = 5;      // are
        a = b + c;  // assignment statements
        System.out.println ("The answer is " + a);
    }
}
```

Assignment Statements

- Assignment statement assigns value to variable
  - sometimes say binds value to variable
- Assignment statement is
  - identifier
  - followed by assignment operator (=)
  - followed by expression
  - followed by semicolon (;)

```
b = 3;
c = 8;
a = b + c;
weekly_pay = pay_rate * hours_worked;
```

- Note that = is no longer a test for equality!

Assignment Statements

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

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

- Old value will be overwritten if variable was assigned before

```
x = 2 + 1;      // what’s in x now?
```

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???
```

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);
```

- Find out! Experiments are easy to do in CS

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);
```

- Variable values on left of = are clobbered
- Variable values on right of = are unchanged
  - copy of value assigned to a also assigned to b
  - but that doesn’t change value assigned to a

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);
```

- Memory locations a and b are distinct
  - copy of value assigned to a also assigned to b
  - changing a later does not affect previous copy
    - more later

Variable 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