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

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Data Types, Assignment, Casting, Constants

Lecture 5, Fri Jan 15 2010

borrowing from slides by Kurt Eiselt

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

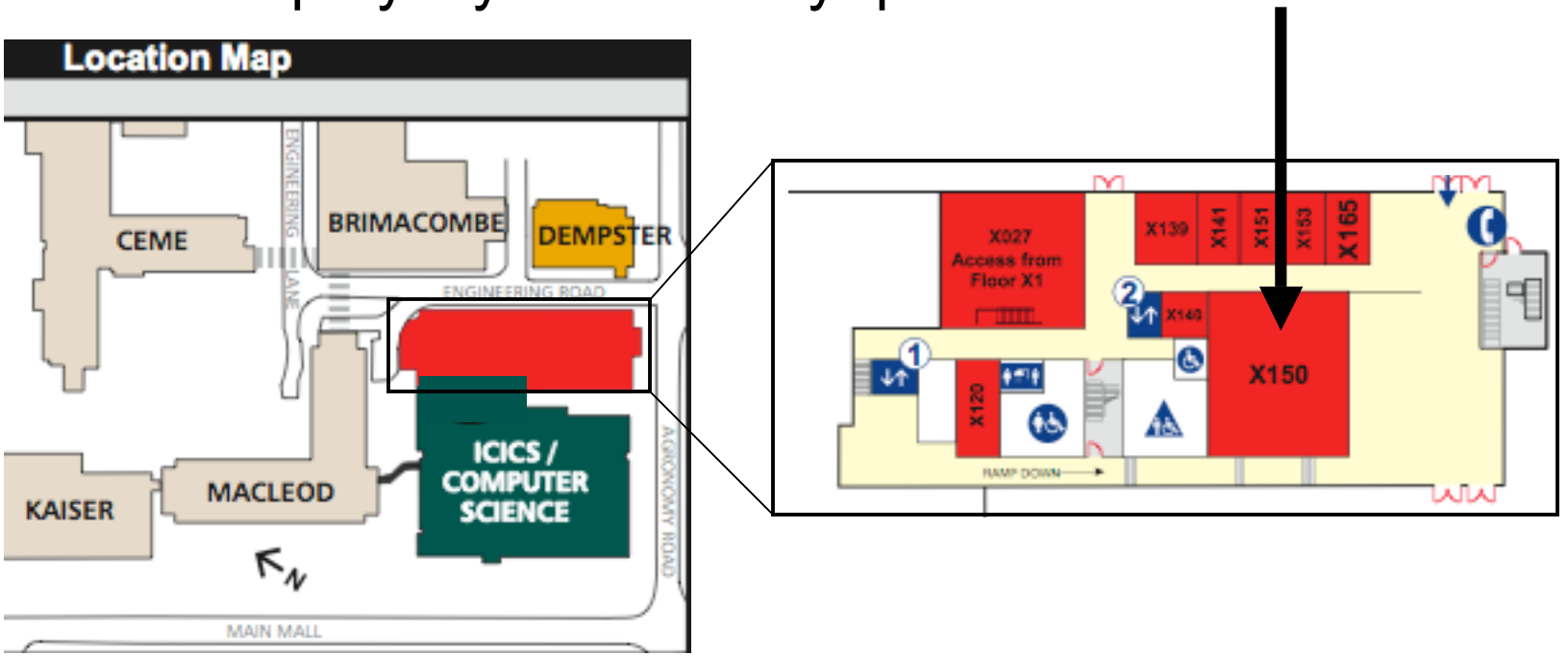
Reading This Week

- 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 now!

Resources

- Demco Learning Center
  - ICICS/CS x150
  - Learning center is ramping up starting Monday
  - Normal hours: 10 am - 6 pm M-Th, 10 am - 4 pm F
    - Staffed by TAs from all 1st year courses
    - Drop by if you have any questions



More Resources

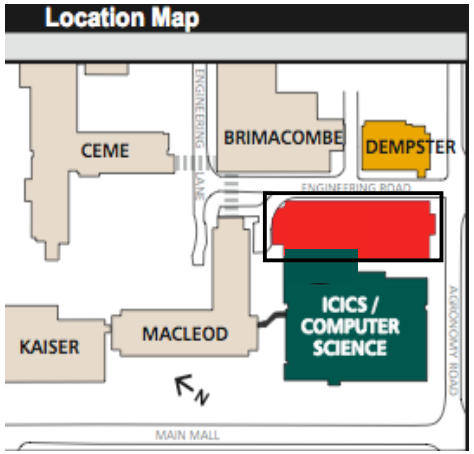
- WebCT discussion groups
  - Monitored by TAs/instructor, use to ask questions

- don't forget to check web page first/often!
  - lecture slides, handouts, schedule, links, ...
  - http://www.cs.ubc.ca/~tmm/courses/111-10

Yet More Resources

- reminder: my office hours Fridays 4-5pm, starting today

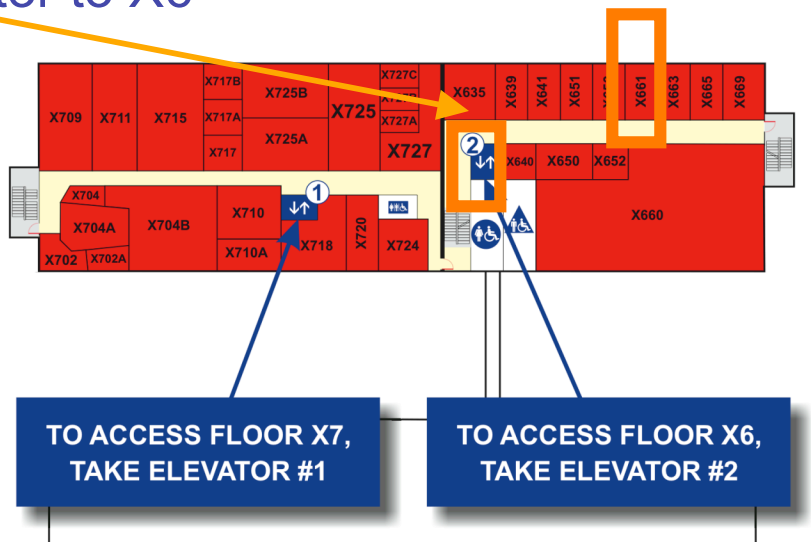
- office location is X661 (tall wing of ICICS/CS bldg)



Xwing entrances facing Dempster

this elevator to X6

me!



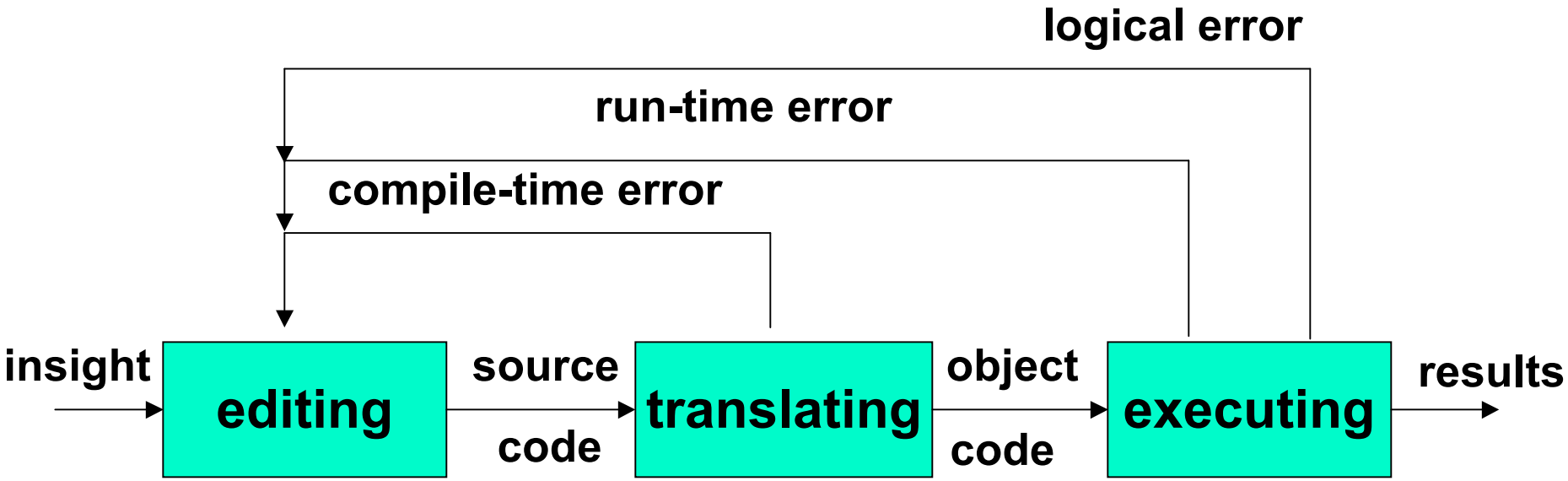
Recap: White Space

- 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

Recap: Errors



- Compile-time errors
  - syntax/structure
- Run-time errors
- Logical errors
  - semantics/meaning

Recap: Variables

- Variable: name for location in memory where data is stored
  - avoid having to remember numeric addresses
  - like variables in algebra class

- Variable names begin with lower case letters
  - Java convention, not compiler/syntax requirement

Recap: 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 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...

Recap: Variables and Data Types

```
//*****************************************
// 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);
    }
}
```

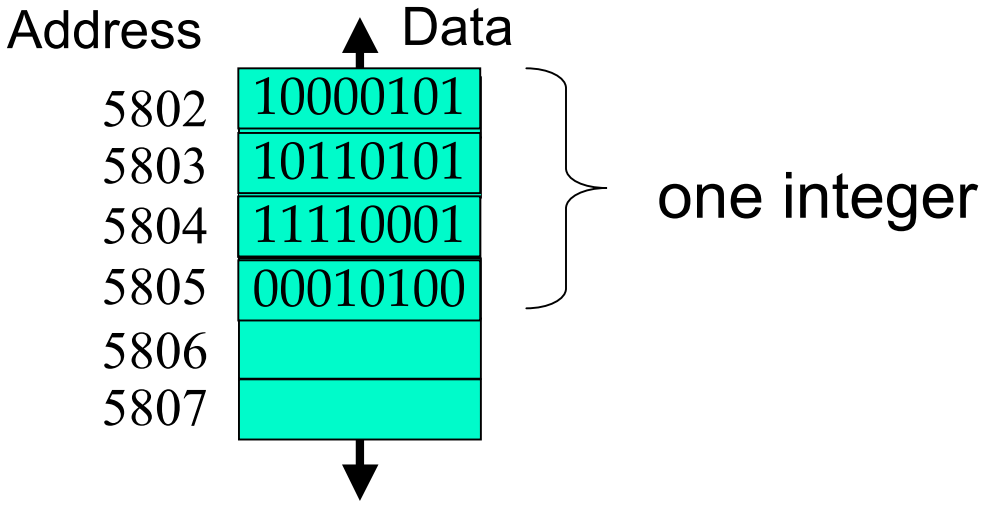
Recap: Floating Point Numbers

- 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

Expressions

- expression is combination of
  - one or more operators and operands
  - operator examples: +, *, /, ...
  - operand examples: numbers, variables, ...
  - usually performs a calculation
    - don't have to be arithmetic but often are
  - examples

3
7 + 2
7 + 2 * 5
(7 + 2) * 5

Operator Precedence

- What does this expression evaluate to?

7 + 2 * 5

Operator Precedence

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7 + 2 * 5

- Multiplication has higher operator precedence than addition (just like in algebra)

precedence	operator	operation
1 higher	+ -	unary plus and minus
2	* / %	multiply, divide, remainder
3 lower	+ -	add, subtract

Operator Precedence

- What does this expression evaluate to?

7 + 2 * 5

- Multiplication has higher operator precedence than addition (just like in algebra)

precedence	operator	operation
1 higher	+ -	unary plus and minus
2	* / %	multiply, divide, remainder
3 lower	+ -	add, subtract

- Use parentheses to change precedence order or just clarify intent

(7 + 2) * 5 **7 + (2 * 5)**

Converting Between Types

- Which of these are legal?
  - `int shoes = 2;`
  - `double socks = 1.75;`
  - `double socks = 1;`
  - `int shoes = 1.5;`

Converting Between Types

- Which of these are legal?
  - `int shoes = 2;`
  - `double socks = 1.75;`
  - `double socks = 1;`
  - `int shoes = 1.5;`
- Integers are subset of reals
  - but reals are not subset of integers

Casting

- 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;`
  - `int shoes = (int) 1.25;`
- Rounding: must be done explicitly
  - `shoes = Math.round(1.99);`

Converting Between Types

```
//*************************************
// Feet.java   Author: Tamara
// What type of things can be put on feet?
//*************************************
public class Feet
{
 public static void main (String[] args)
 {
   int shoes = 2;
   int socks = (int) 1.75;
   System.out.println("shoes = " + shoes + " socks = " +
socks);
   int toes = Math.round(1.99);
   System.out.println("toes = " + toes);
 }
}
```

- What's wrong?

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)**

- is there more to life than 4-byte ints or 8-byte doubles?

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
  - range of choices for storage capacity

Using Long Integers

```
//*************************************
// Feet2.java   Author: Tamara
// What type of things can be put on feet?
//*************************************
public class Feet2
{
 public static void main (String[] args)
 {
   int shoes = 2;
   int socks = (int) 1.75;
   System.out.println("shoes = " + shoes + " socks = " +
socks);
   long toes = Math.round(1.99);
   System.out.println("toes = " + toes);
 }
}
```

Or Cast To Int

```
//*************************************
// Feet3.java   Author: Tamara
// What type of things can be put on feet?
//*************************************
public class Feet3
{
 public static void main (String[] args)
 {
   int shoes = 2;
   int socks = (int) 1.75;
   System.out.println("shoes = " + shoes + " socks = " +
socks);
   int toes = (int) Math.round(1.99);
   System.out.println("toes = " + toes);
 }
}
```

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);
 }
```

Reading Next Week

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