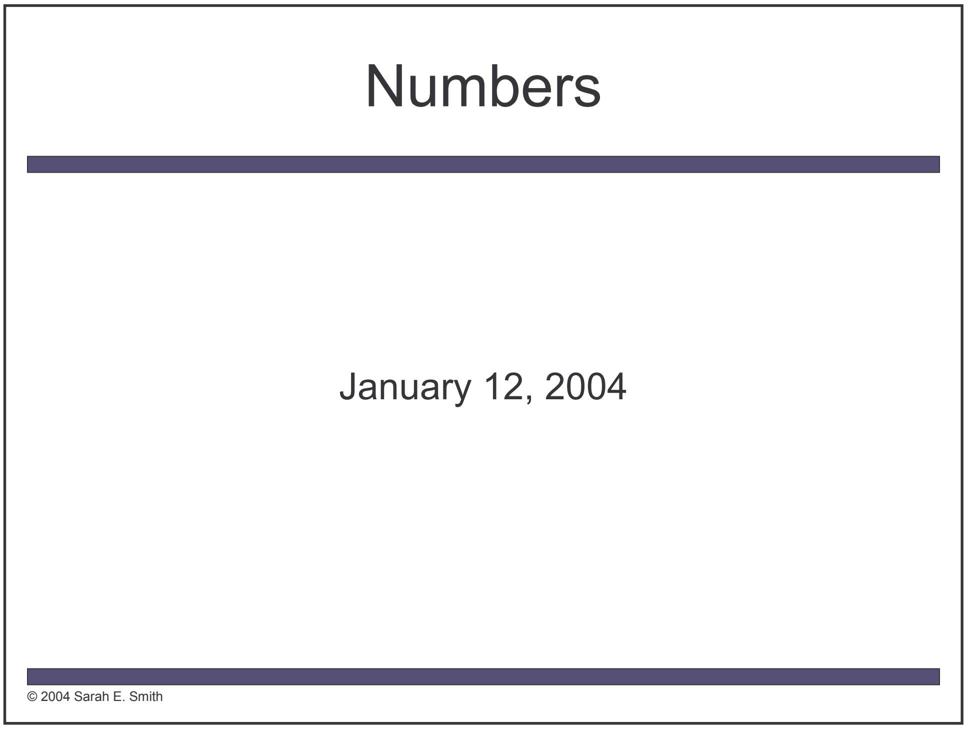
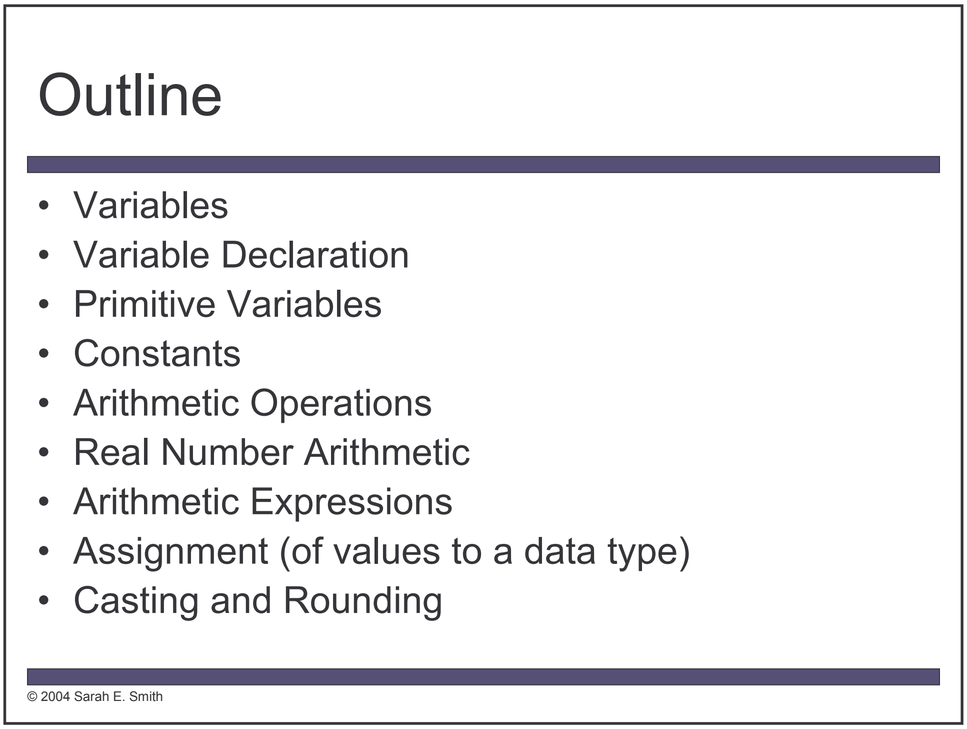


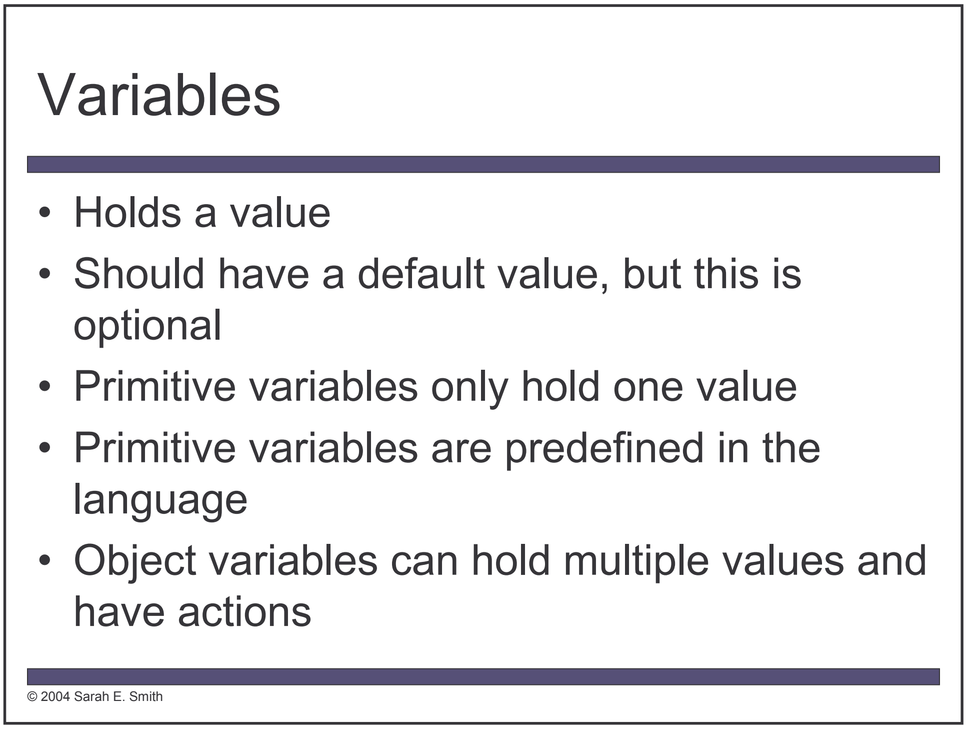
Numbers

January 12, 2004



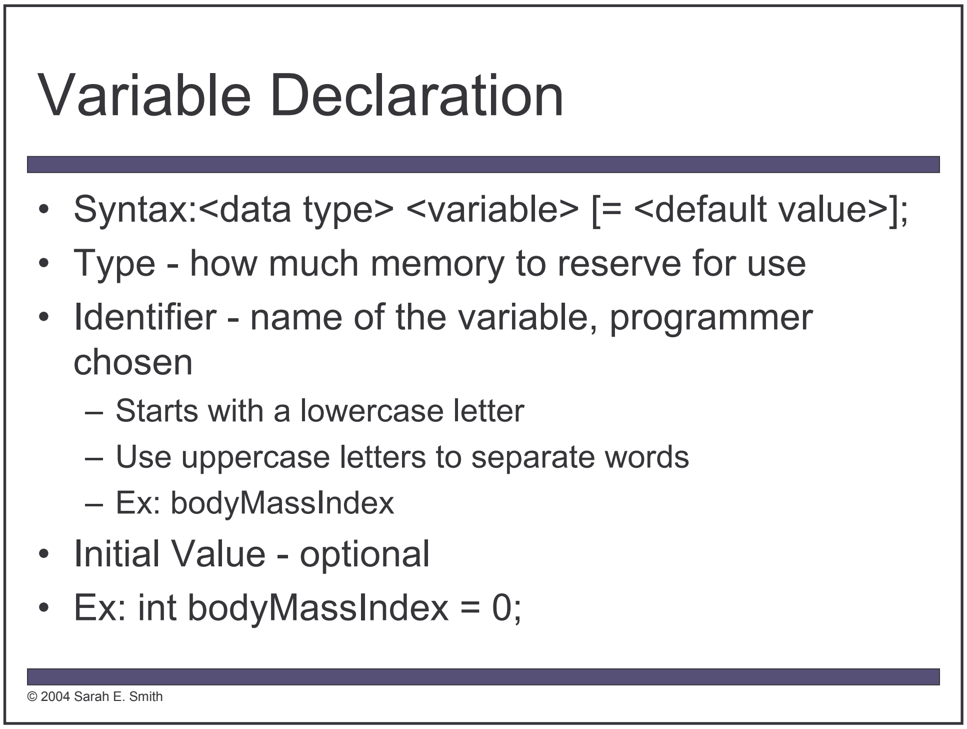
Outline

- Variables
- Variable Declaration
- Primitive Variables
- Constants
- Arithmetic Operations
- Real Number Arithmetic
- Arithmetic Expressions
- Assignment (of values to a data type)
- Casting and Rounding



Variables

- Holds a value
- Should have a default value, but this is optional
- Primitive variables only hold one value
- Primitive variables are predefined in the language
- Object variables can hold multiple values and have actions



Variable Declaration

- Syntax:<data type> <variable> [= <default value>];
- Type - how much memory to reserve for use
- Identifier - name of the variable, programmer chosen
  - Starts with a lowercase letter
  - Use uppercase letters to separate words
  - Ex: bodyMassIndex
- Initial Value - optional
- Ex: int bodyMassIndex = 0;

Primitive Variables - Numeric

Data Type	Content	Default Value	Min Value	Max Value
byte	Integer Number	0	-128	127
short	Integer Number	0	-32768	32767
int	Integer Number	0	-2147483648	2147483647
long	Integer Number	0	-9223372036854775808	9223372036854775807
float	Real Number	0.0	-3.40282347E+38	3.40282347E+38
double	Real Number	0.0	-1.7976931348623157E+308	1.7976931348623157E+308

Primitive Values – Non-numeric

- boolean – either true or false
- Ex: boolean is21 = true;

Constants

- Values cannot be changed after they have been assigned
- Keyword is *final*
- Named or symbolic constants – declared like a variable with the keyword *final*
- Literal constants – use the actual value
  - Literal constants default to *int* and *double* data types
  - Use L or l (lowercase L) and F or f at the end of a constant to make long (integer) or float (real)
  - May also use D or d to make a real constant a double

Arithmetic Operations

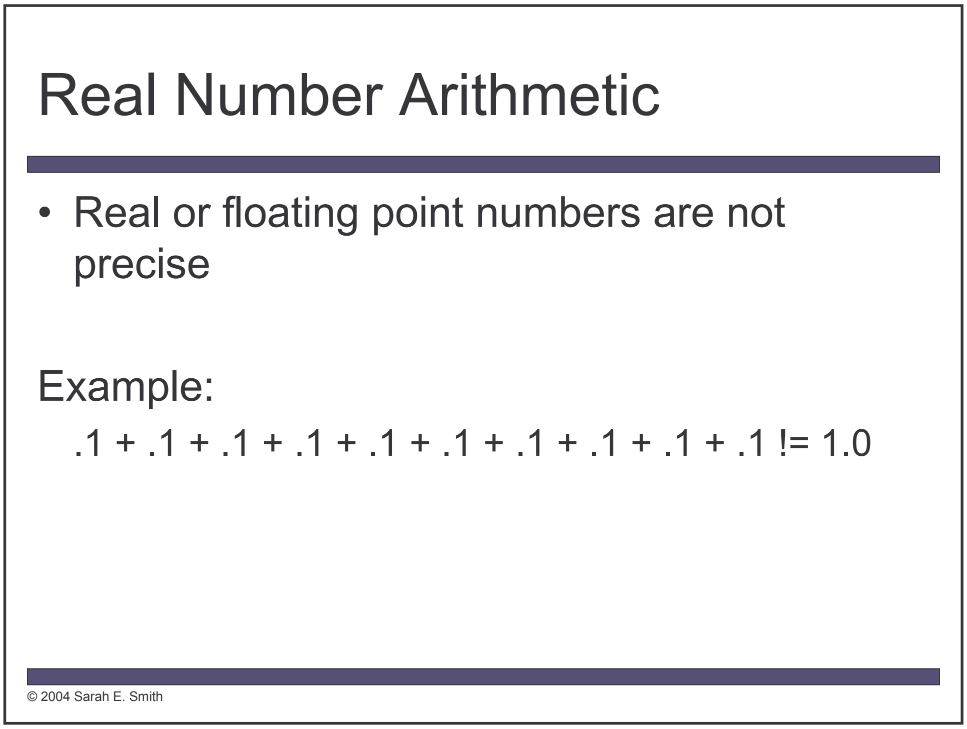
Operation	Java Operator	Example	Value (x = 10, y = 7, z = 2.5)
Addition	+	x + y	17
Subtraction	-	x – y	3
Multiplication	*	x * y	70
Division (Integer)	/	x / y	1
Division (Real)	/	x / z	4.0
Modulo Division (remainder on integer division)	%	x % y	3

Arithmetic Operations (2)

- Exponential numbers written with E notation
- *number x 10*^{exponent} = <number>E<exponent>
- May also use *e*
- Sign on exponent optional for positive numbers
- Always a double or float (even if no decimal in the number) Ex: 22E33
- May specify with D, d, F, or f at the end of the number

Arithmetic Operations (3)

- Other math operations can be found in the *java.lang.Math* library
- Square root – double Math.sqrt(double a)
- Power – double Math.pow(double a,double b)
- Round float – int Math.round(float a)
- Round double – long Math.round(double a)

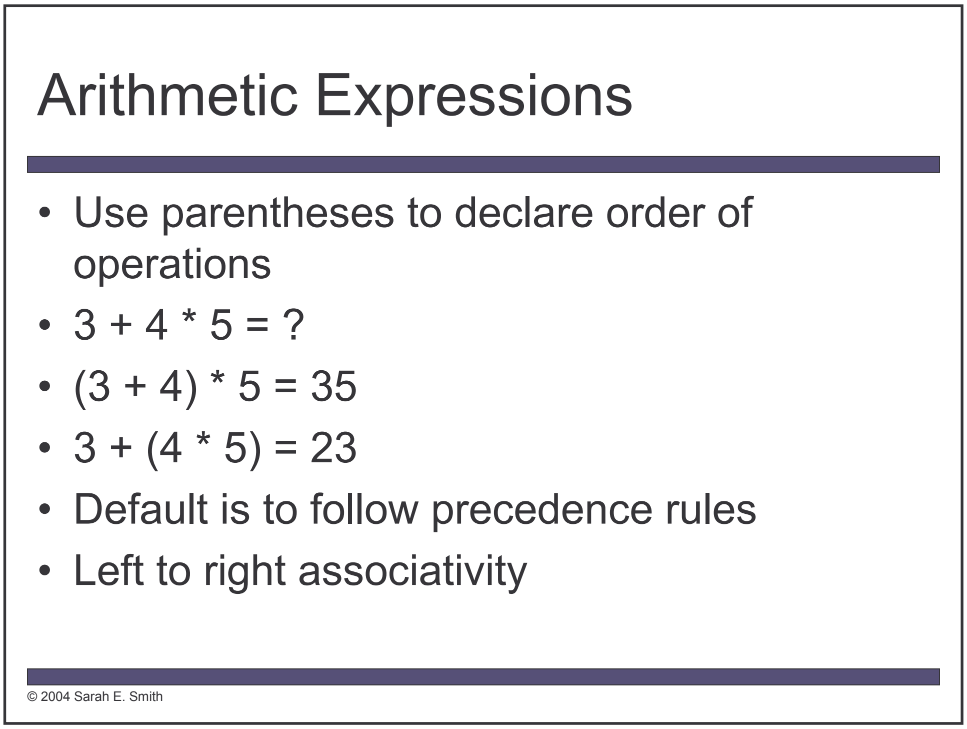


Real Number Arithmetic

- Real or floating point numbers are not precise

Example:

.1 + .1 + .1 + .1 + .1 + .1 + .1 + .1 + .1 + .1 != 1.0



Arithmetic Expressions

- Use parentheses to declare order of operations
- 3 + 4 * 5 = ?
- (3 + 4) * 5 = 35
- 3 + (4 * 5) = 23
- Default is to follow precedence rules
- Left to right associativity

Assignment

- Syntax: <variable> = <value>
- Identifiers on right and left side of =
- Identifier on right specifies a value
- Identifier on left specifies location to store result
- Ex: int result = 5;
- Ex: result = 7;
- Ex: int newResult = 5 * result;

Casting

- "Converts the value of one data type to another data type" [Wu]
- Implicit - numeric promotion
- Explicit - use a type cast operator to convert

Numeric Promotion

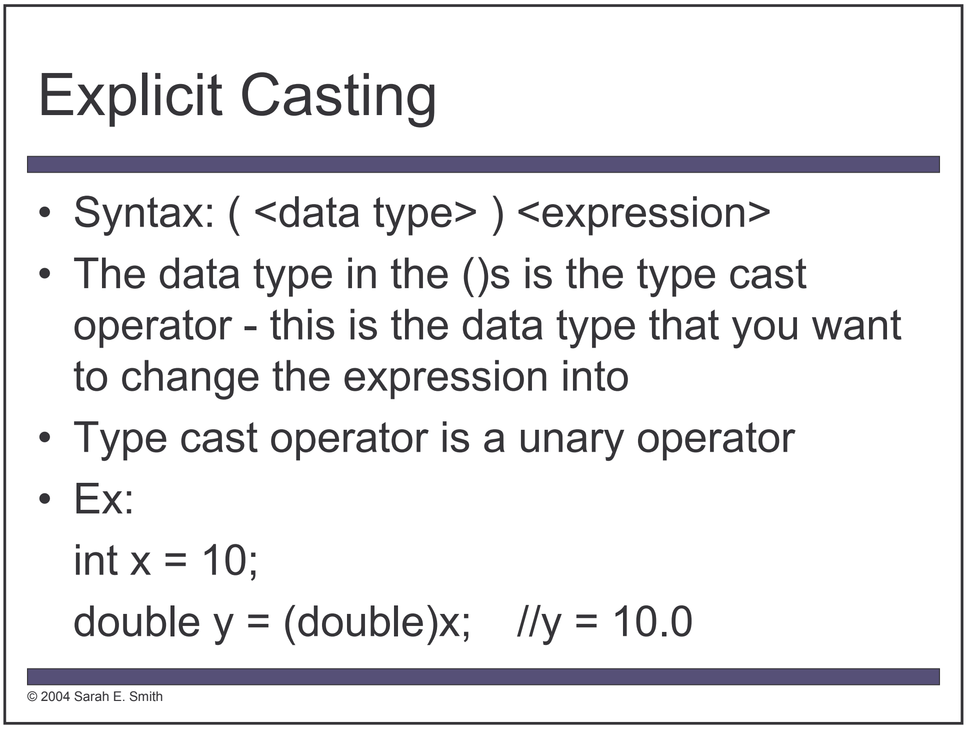
- If operations are performed on the same type of data then the result will be the type involved in the operation
- Ex: int result = 2 + 3;
- If you perform an operation on two different data types the result is promoted to the data type with the higher precision (more space)
- Ex: double result = 2 + 3.0;
- More explicit rules are given in Table 3.4 (p96) in the book.

Assignment Conversion

- Narrowing

  ```
  int dollars;
  dollars = 20.50;        //No! (lose precision)
  ```
- Widening

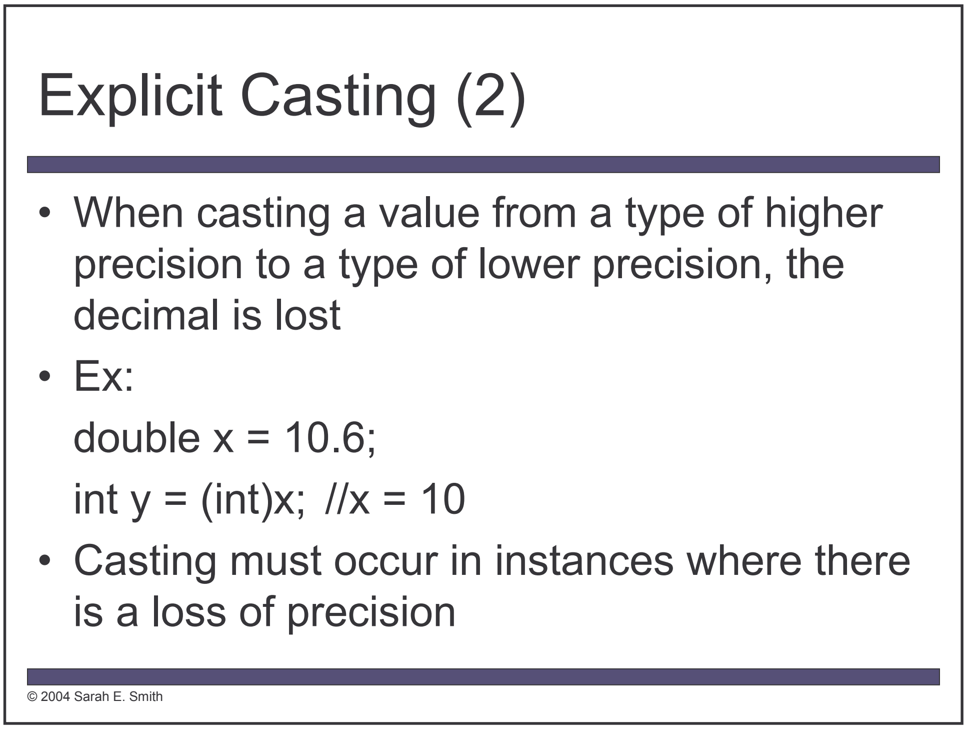
  ```
  double area;
  area = 20;              //Yes! (gain precision)
  ```
- “An assignment conversion only occurs when the data type of the variable has a higher precision than the data type of the expression’s value.” [Wu]



Explicit Casting

- Syntax: (<data type>) <expression>
- The data type in the ()s is the type cast operator - this is the data type that you want to change the expression into
- Type cast operator is a unary operator
- Ex:

```
int x = 10;
double y = (double)x;    //y = 10.0
```

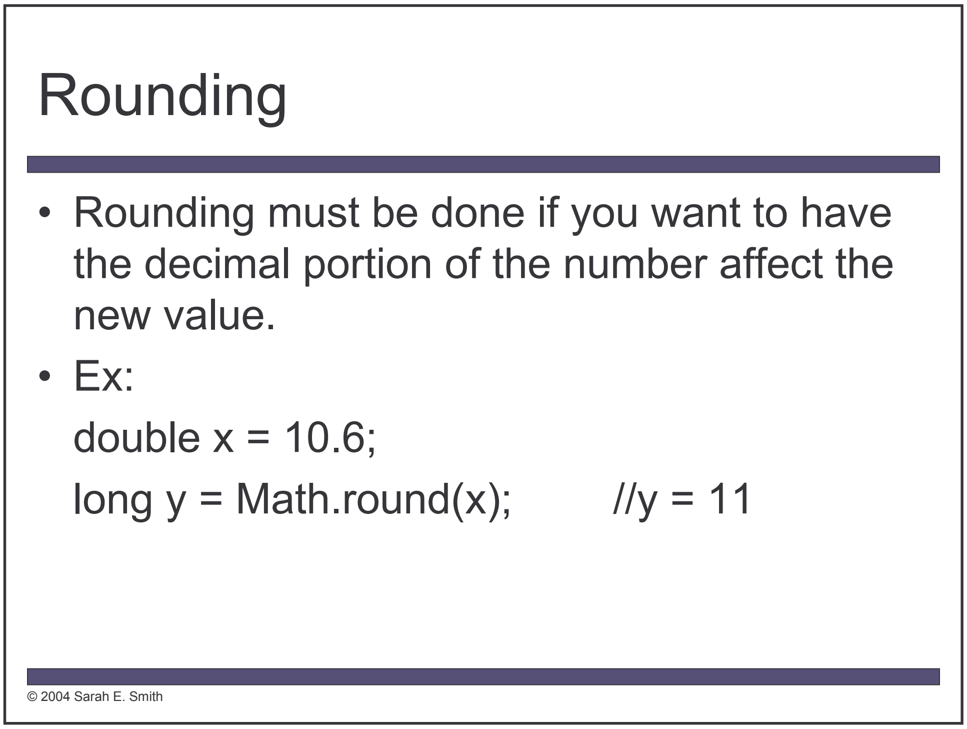


Explicit Casting (2)

- When casting a value from a type of higher precision to a type of lower precision, the decimal is lost
- Ex:

```
double x = 10.6;
int y = (int)x;  //x = 10
```

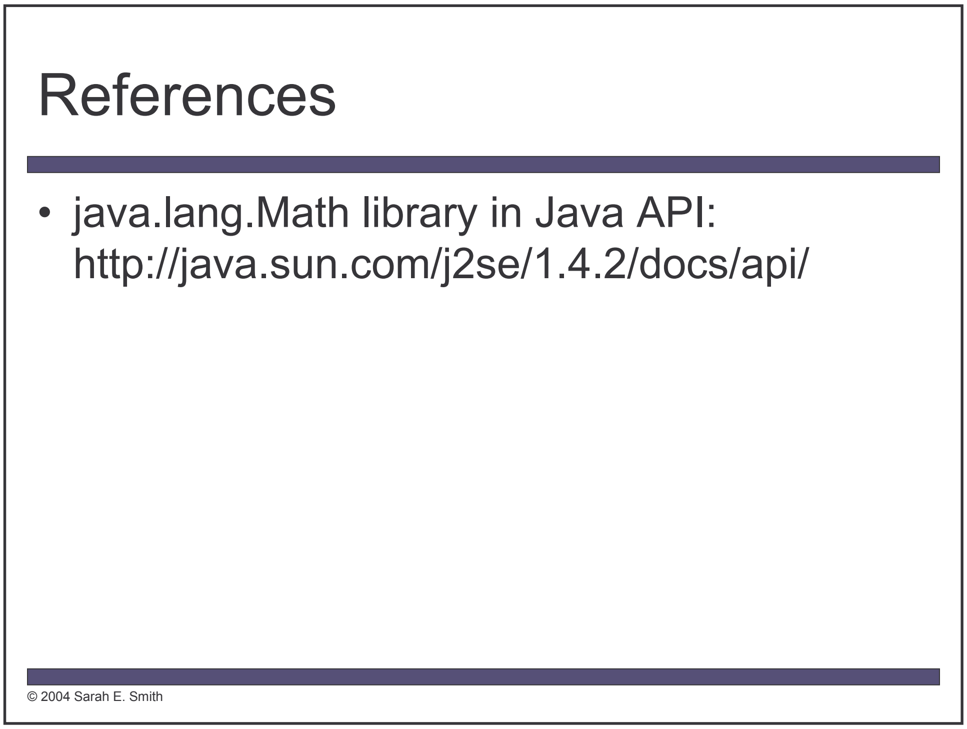
- Casting must occur in instances where there is a loss of precision



Rounding

- Rounding must be done if you want to have the decimal portion of the number affect the new value.
- Ex:

```
double x = 10.6;
long y = Math.round(x);        //y = 11
```



References

- java.lang.Math library in Java API: http://java.sun.com/j2se/1.4.2/docs/api/