EECS2030 Lab 01

Jan 16, 2017
Due: Jan 23, 2017 before 3PM

Introduction

The purpose of this lab is to review the following basic Java concepts that should have been covered in your previous courses:

- style
- using **`int`** and **`double`** values and variables
- arithmetic and the methods provided in **`java.lang.Math`**
- **`boolean`** expressions
- using objects
- **`if`** statements
- using **`String`**s
- using **`List`**s
- **`for`** loops

This lab also introduces code testing using JUnit. This lab will be graded for style and correctness.

Before you begin

The API for the class that you need to implement can be found here.

A local copy of the Java API can be found here.

Style Rules

The style rules are not overly restrictive in EECS2030.

1. Your programs should use the normal Java conventions (class names begin with an uppercase letter, variable names begin with a lowercase letter, **`public static final`** constants should be in all caps, etc.).

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2. In general, use short but descriptive variable names. There are exceptions to this rule; for example, traditional loop variables are often called i, j, k, etc.

Avoid very long names; they are hard to read, take up too much screen space, and are easy to mistype.

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3. Use a consistent indentation size. Beware of the TAB vs SPACE problem: Tabs have no fixed size; one editor might interpret a tab to be 4 spaces and another might use 8 spaces. If you mix tabs and spaces, you will have indenting errors when your code is viewed in different editors.

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4. Use a consistent brace style:

```
// left aligned braces

class X
{
  public void someMethod()
  {
    // ...
  }

  public void anotherMethod()
  {
    for (int i = 0; i < 1; i++)
    {
```

```
      // ...
    }
  }
}
```

or

```
// ragged braces

class X {
  public void someMethod() {
    // ...
  }

  public void anotherMethod() {
    for (int i = 0; i < 1; i++) {
      // ...
    }
  }
}
```

---

5. This one always causes problems for students. Insert a space around operators (except the period ".").

The following

```
    // some code somewhere
    boolean isBetween = (x > MIN_VALUE) && (x > MAX_VALUE);
    int someValue = x + y * z;
```

is much easier to read than this

```
    // AVOID DOING THIS

    // some code somewhere
    boolean isBetween=(x>MIN_VALUE)&&(x>MAX_VALUE);
    int someValue=x+y*z;
```

---

6. Avoid using "magic numbers". A magic number is a number that appears in a program in place of a named constant. For example, consider the following code:

```
int n = 7 * 24;
```

What do the numbers **7** and **24** mean? Compare the code above to the following:

```
final int DAYS_PER_WEEK = 7;
final int HOURS_PER_DAY = 24;
int n = DAYS_PER_WEEK * HOURS_PER_DAY;
```

In the second example, the meaning of **7** and **24** is now clear (better yet would be to also rename **n**).

Not all numbers are magic numbers. You can usually use the values **0**, **1**, and **2** without creating a named constant. If you ever find yourself doing something like:

```
final int TEN = 10;
```

then you are probably better off using **10** and explaining its meaning in a comment.

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7. A good IDE (integrated development environment) such as eclipse will correct many style errors for you. In eclipse, you can select the code that you want to format, right click to bring up a context menu, and choose *Source -> Format* to automatically format your

code.

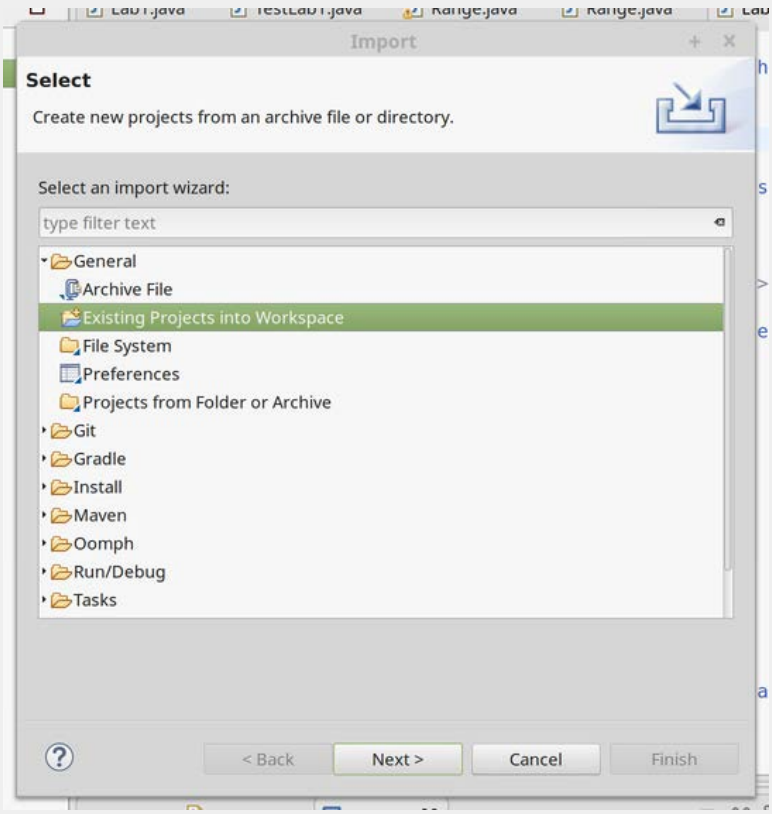
Getting started

These instructions assume that you have completed Lab 0 and are working in the Prism lab.

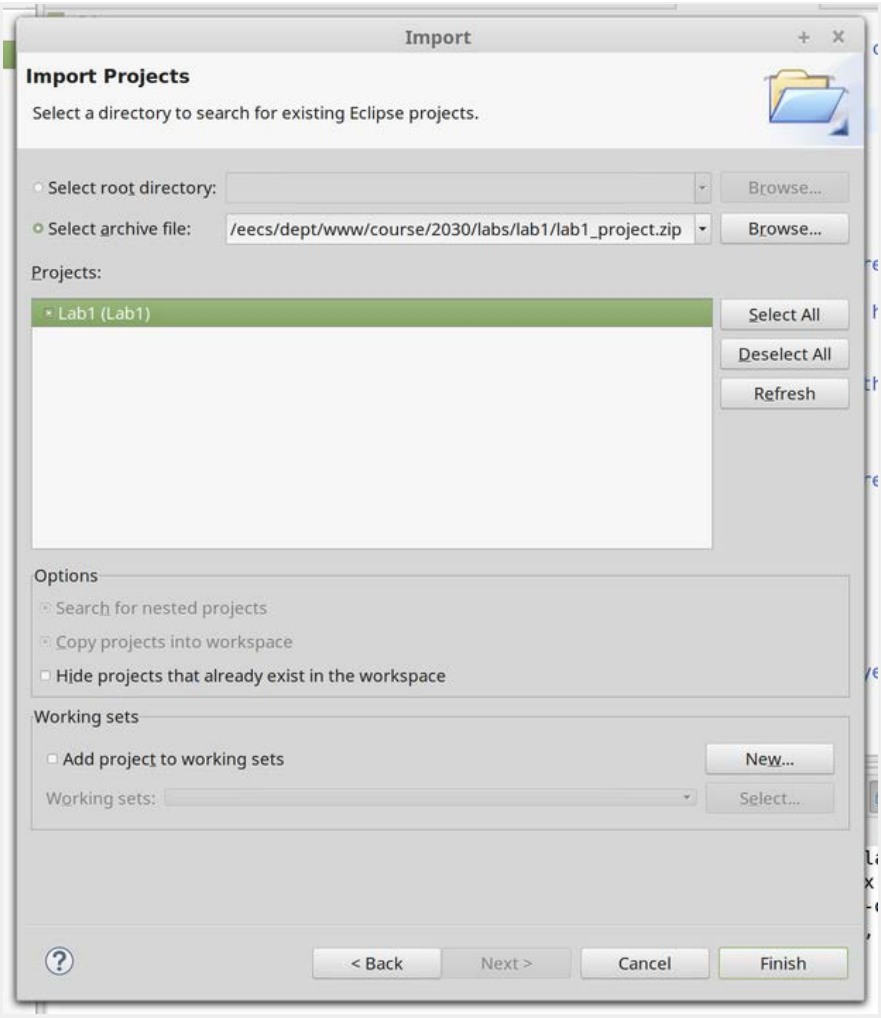
Start eclipse by typing **`eclipse &`** into a terminal, or by using the menu located in the bottom left corner of the screen.

In this lab, you will import an existing project rather than starting everything from scratch. In the eclipse *File* menu, choose the *Import...* menu item.

In the *Import* dialog box that appears, choose the *Existing Projects into Workspace* item and click *Next*:

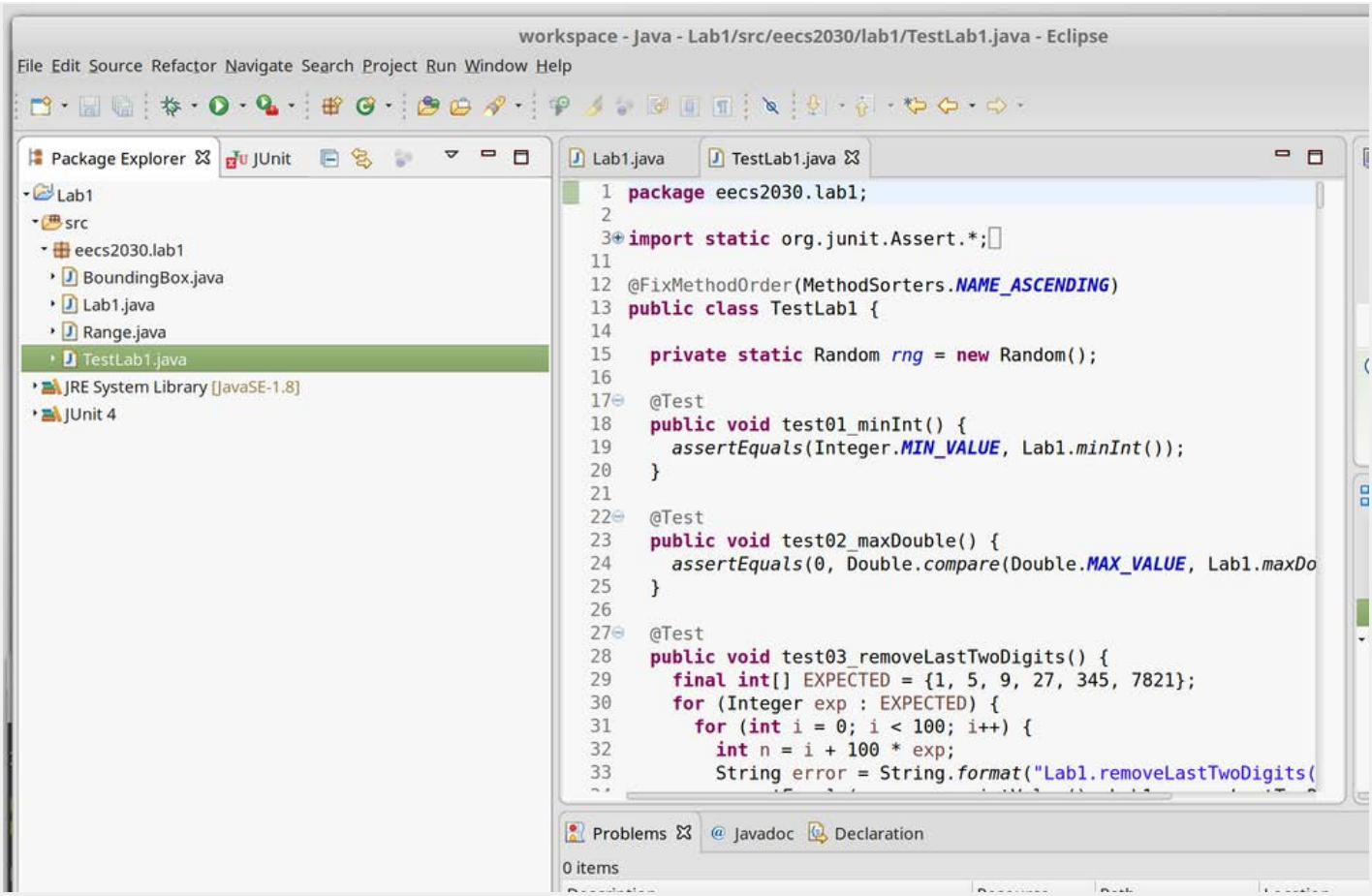


If you are working on a Prism lab computer:
Click on the *Select archive file* radio button. Click on the *Browse...* button and select the file **`/eecs/dept/www/course/2030/labs/lab1/lab1_project.zip`**. Click the *Finish* button to import the project:



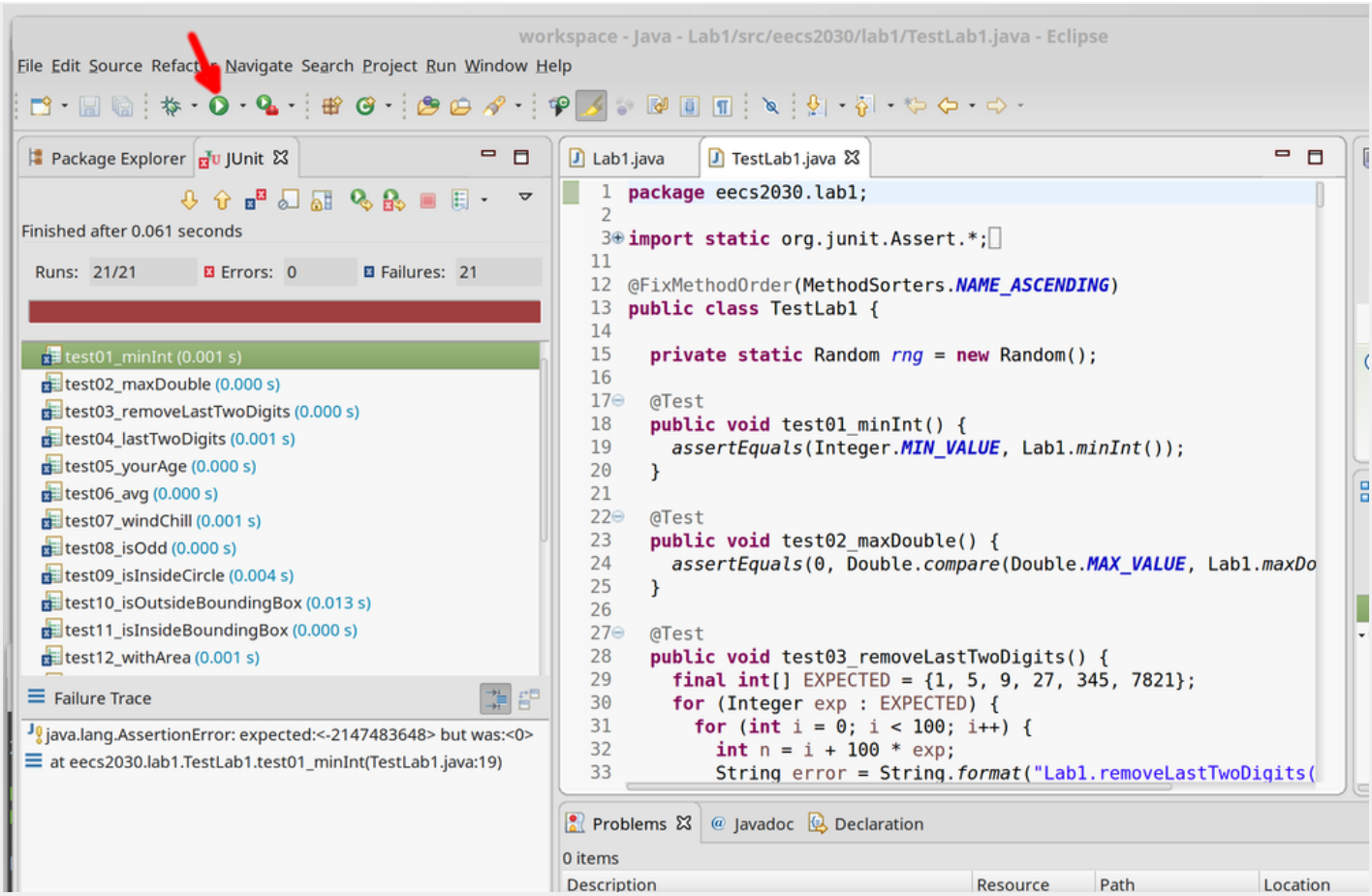
If you are NOT working on a Prism lab computer:
Download the following zip file. Click on the *Select archive file* radio button. Click on the *Browse...* button and select the file that you just downloaded. Click the *Finish* button to import the project.

On the left-hand side of the eclipse window, you will see a tab labelled *Package Explorer*. Use the small triangles to expand the *Lab1* contents, then the *src* contents, and finally the *eecs2030.lab1* contents. Double-click on **`Lab1.java`** and **`TestLab1.java`** to open these files in the editor:



`TestLab1.java` is a test class that contains unit tests for all of the methods that you will implement in this lab. You will learn more about unit tests in your next lecture. For now, all you need to know is that you can use the test class to check for errors in the methods in **`Lab1.java`**.

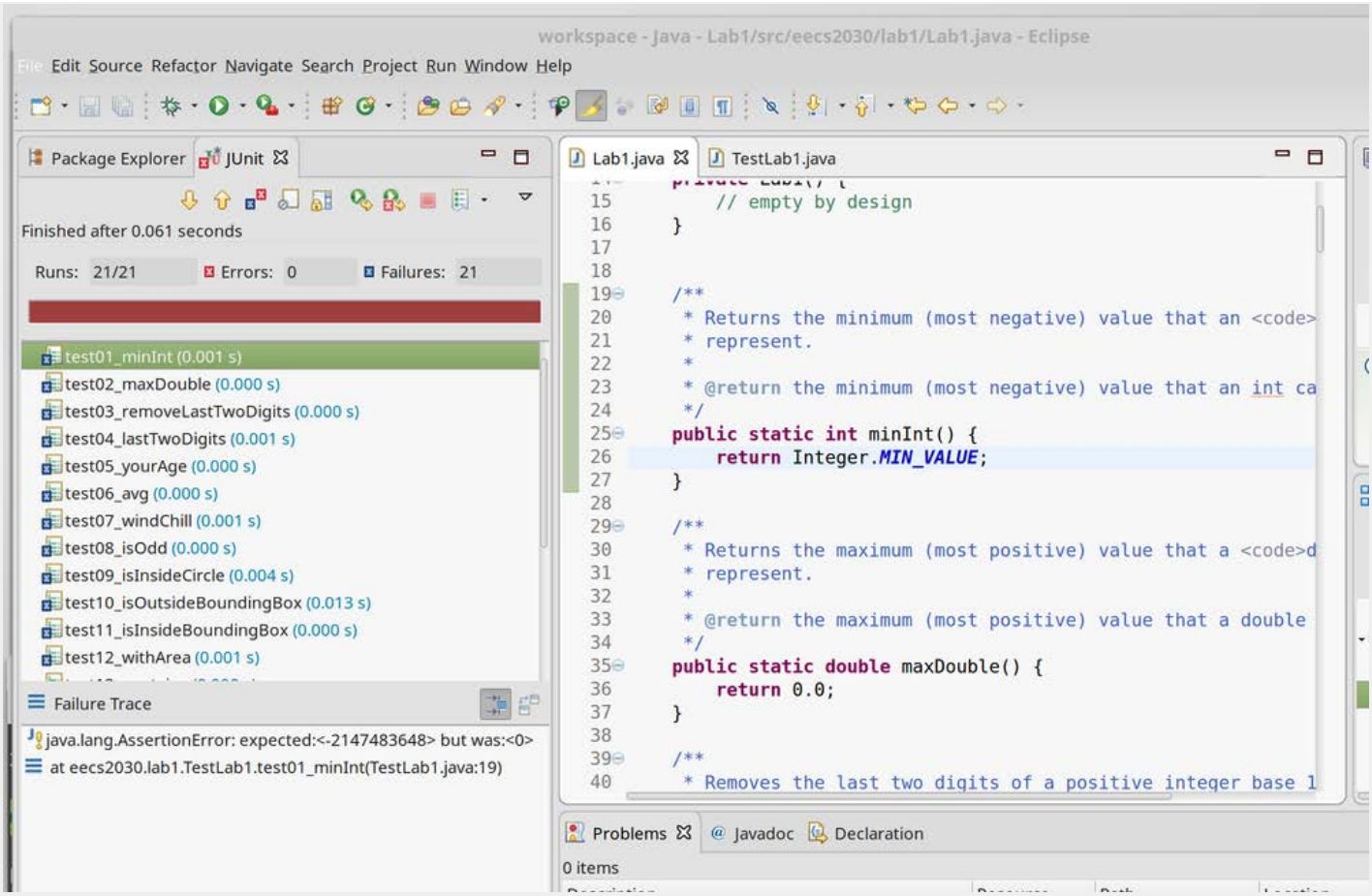
Click on the **`TestLab1.java`** tab in the editor window to view the contents of **`TestLab1.java`**. Run the test class by pressing the green run button indicated by the red arrow in the figure below:



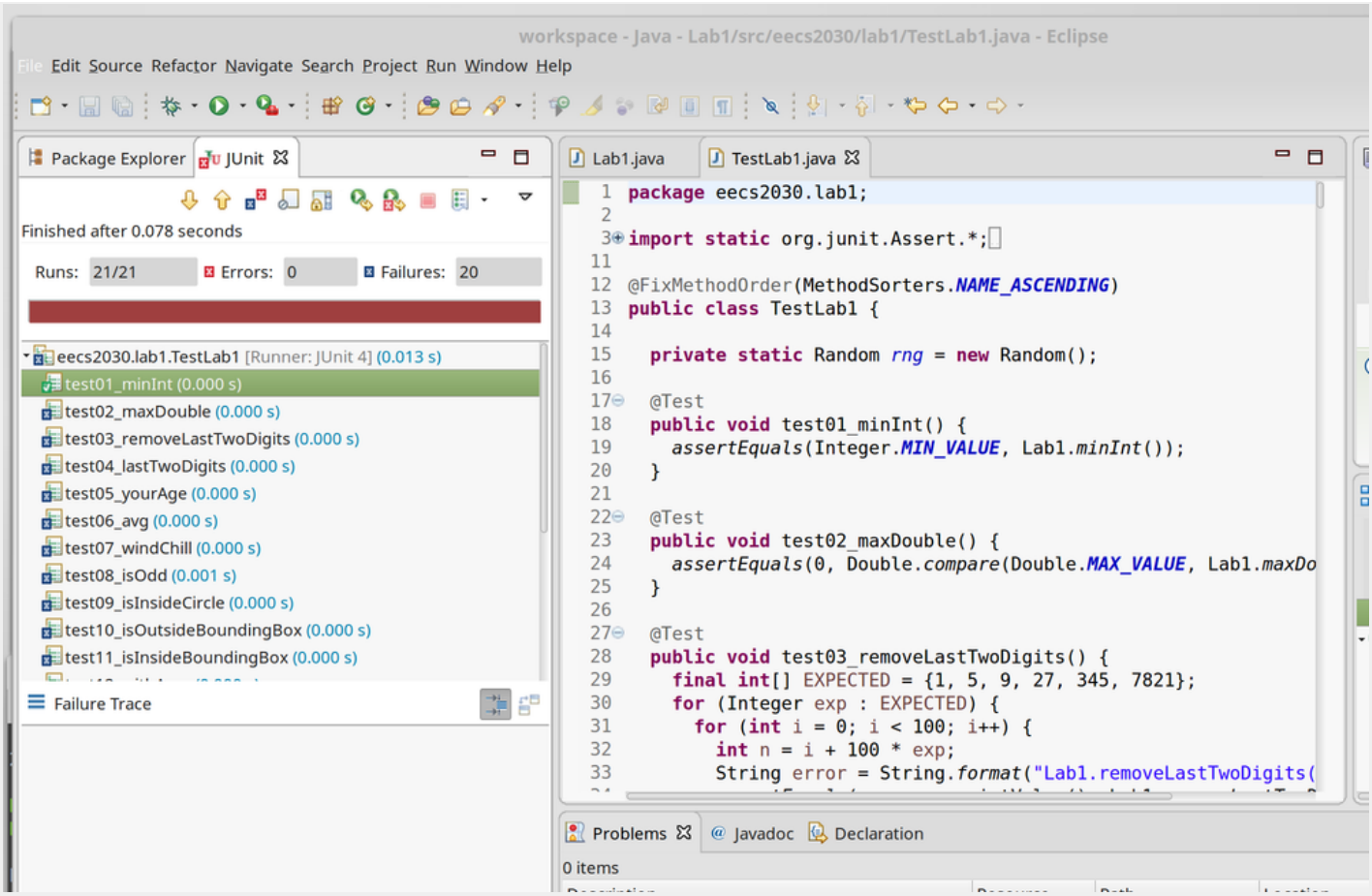
The results of running the tests are shown to you in the *JUnit* tab located on the left-hand side of the eclipse window (see figure above). Notice that all of the tests have a blue x beside them; the blue x indicates that the test has failed. In the *Failure Trace* panel, some diagnostic information is shown to you. For the **`test01_minInt`** test, the diagnostic information is indicating that the test expected a value of **`-2147483648`** but received a value of **`0`**. It seems like there is something wrong with our implementation of the **`minInt`** method.

Click on the **`Lab1.java`** tab in the editor window to view the contents of **`Lab1.java`**. Scroll down to the **`minInt`** method (the first method in the class). If you read the API for the method, you will see that the method postcondition promises to return the minimum value that an **`int`** can represent. However, when you examine the body of the method, you will see that them method returns **`0`**, which is obviously incorrect.

Edit the return value of the method so that it returns the correct value as shown below:



Click on the **`TestLab1.java`** tab in the editor window to view the contents of **`TestLab1.java`**. Re-run the test class; you should see the following:



Notice that the test **`test01_minInt`** now has a green check mark beside it indicating that the test has passed. Unfortunately, the other 20 tests are still failing.

In the remainder of this lab, you will use the test class to help you fix the remaining methods in the **`Lab1`** class. Follow the remainder of the lab to review some fundamentals of the Java language and complete the exercises in the pink sections. While there appears to be a great deal of work, many of the methods can be completed with a single line of code.

Primitive types

In Java, all values have a *type*. A type defines a set of values and the operations that can be performed using those values.

Java's *primitive types* are those types that are predefined by the Java language and are named by a reserved keyword. The primitive types are all numeric types and one type representing true/false values.

`int`

The **`int`** type represents integer values in the range -2^{31} to (2^{31} - 1). Java will interpret any number not having a decimal as being an **`int`** value.

The following is an example of a (not very useful) method that always returns the value of **`1`**. The method creates an **`int`** variable named **`result`**, assigns the variable a value of **`1`**, and returns the value of the variable:

```
public static int one() {
  int result = 1;
  return result;
}
```

Constant values important to the **`int`** type can be found in the class **`java.lang.Integer`**.

`double`

The **double** type represents real values in the approximate range of -1.7×10^{308} to 1.7×10^{308}. Java will interpret any number having a decimal as being a **double** value.

The following is an example of a (not very useful) method that always returns the value of **0.5**. The method creates a **double** variable named **result**, assigns the variable a value of **0.5**, and returns the value of the variable:

```
public static double oneHalf() {
  double result = 0.5;
  return result;
}
```

Constant values important to the **double** type can be found in the class **java.lang.Double**.

Exercise #1

Complete the methods **minInt()** and **maxDouble()**. Don't forget that you can always consult the API to read the documentation for all of the methods.

Run the JUnit tester after you complete each method to check your work.

Arithmetic

Java provides several operators for performing arithmetic operations using **int** and **double** values:

Assume that you have the following declarations for each example in the table below:

```
int x = 14;
int y = -7;
double u = 2.5;
double v = -0.9;
```

Operator	Name	Example	Value
+	unary plus operator	+x +y +u +v	14 -7 2.5 -0.9
-	unary minus operator	-x -y -u -v	-14 7 -2.5 0.9
*	multiplication operator	x * y u * v	-98 -2.25
/	division operator	x / y u / v	-2 -2.7777777777777777
%	remainder (after division) operator	x % y u % v	0 0.7
+	addition operator	x + y u + v	7 1.6

-	subtraction operator	x - y u - v	21 3.4

Note that there is no exponentiation operator.

Java arithmetic obeys the same order of operations as regular arithmetic. Parentheses can be used in the same way as regular arithmetic to control the order of operations. For example, the following method computes the value of $\frac{1}{1 + x}$

```
public static double f_of_x(double x) {
  double result = 1.0 / (1.0 + x);
  return result;
}
```

int division

Any arithmetic operation involving two **int** values always produces another **int** value. Dividing two **int** values in Java produces the same result as dividing the two values as real numbers and discarding the fractional part of the result; an exception is thrown when dividing by **0**:

Expression	True Division	Java Division
6 / 2	3	3
7 / 3	2.33...	2
1 / 2	0.5	0
-9 / 5	-1.8	-1
3 / 0	∞	ArithmeticException

A common usage of **int** division is when you want to evenly distribute a number of whole items between a number of groups.

```
public static int perPerson(int nItems, int nPeople) {
  int result = nItems / nPeople;
  return result;
}
```

int remainder

Java provides the remainder after division operator **%**. For two **int** values **x** and **y**, the value of **x % y** is the **int** value equal to the remainder after dividing **x** by **y**:

Expression	Java Division
6 % 2	0
7 % 3	1
1 % 2	1
-9 % 5	-4
9 % -5	4
3 % 0	ArithmeticException

The sign of the result is defined to be equal to the sign of the first operand (the value to the left of the **%** operator).

A common usage of **int** division is when you want to evenly distribute a number of whole items between a number of groups.

```
public static int remainder(int nItems, int nPeople) {
```

```
    int result = nItems % nPeople;
    return result;
  }
```

Exercise #2

Complete the methods **removeLastTwoDigits(int n)**, **lastTwoDigits(int n)**, and **yourAge(int address, int birthYear, int birthdays)**.

Run the JUnit tester after you complete each method to check your work.

Mixing int and double

Be careful when using **int** values to compute a **double** value. For example, suppose that you compute the fractional value one-third like so:

```
double oneThird = 1 / 3;    // results in 0.0
```

Java uses the types of the operands to determine what version of an operator to use. In this case, the **1** and the **3** are both **int** literals; therefore, Java uses **int** division to compute the value of **1 / 3** before converting the computed value to **double** and assigning it to **oneThird**.

The solution is convert one or both of the operands to **double** to force Java to use **double** division; any of the following will work:

```
double oneThird = 1.0 / 3;
```

```
double oneThird = 1 / 3.0;
```

```
double oneThird = 1.0 / 3.0;
```

```
double oneThird = (0.0 + 1) / 3;
```

```
double oneThird = (double) 1 / 3;
```

Exercise #3

Complete the method **avg(int a, int b, int c)**.

Run the JUnit tester after you complete each method to check your work.

java.lang.Math

Mathematical functions such as exponentiation, trigonometric functions, roots, and others are provided by methods in the **java.lang.Math** class. This class also provides mathematical constants such as e and π and many other useful methods relating to basic mathematics operations.

Humidex is an index to indicate how hot the weather feels to the average person when there is some humidity. For example, if the temperature on a humid day is 30 degrees and the humidex is 40 then it means that it feels similar to a dry day where the temperature is 40 degrees. The Humidex formula used by Environment Canada when the air temperature in degrees Celcius is T_a and the dewpoint temperature in degrees Celcius is T_d is:

$T_a + 0.5555(6.11 e^{5417.7530(\frac{1}{273.16} - \frac{1}{T_d + 273.16})} - 10)$

```
public static double humidex(double airTemp, double dewPoint) {
  final double A = 0.5555;
  final double B = 6.11;
  final double C = 5417.7530;
  final double D = 273.16;
  final double E = 10.0;
```

```
    double power = C * (1 / D - 1 / (dewPoint + D));
    return airTemp + A * (B * Math.exp(power) - E);
  }
```

Exercise #4

Environment Canada describes how to compute a value called the *wind chill*. The wind chill is an index that indicates how cold the weather feels to the average person when there is some wind. For example, if the air temperature is -5 degrees Celcius and the wind chill is -15 then it means that it feels similar to a windless day where the temperature is -15 degrees Celcius. The formula for computing wind chill W when the air temperature T is 0 degrees or less and the wind speed V is 5 km/h or greater is:

$W = 13.12 + 0.6215T + (0.3965T - 11.37)V^{0.16}$

Complete the method **`windChill(double airTemp, double windSpeed)`**.

Comparing primitive values

Java's primitive type for representing values that can be **`true`** or **`false`** is named **`boolean`**. One way to generate a **`boolean`** value is to compare two numeric values. Java provides the following equality and comparison operators for numeric values:

Expression	Meaning
`x == y`	is the value of **`x`** equal to the value of **`y`**
`x != y`	is the value of **`x`** not equal to the value of **`y`**
`x < y`	is the value of **`x`** less than the value of **`y`**
`x > y`	is the value of **`x`** greater than the value of **`y`**
`x <= y`	is the value of **`x`** less than or equal to the value of **`y`**
`x >= y`	is the value of **`x`** greater than or equal to the value of **`y`**

An integer is even if the remainder after dividing by **`2`** is equal to **`0`**. A method that determines if an integer is even could be implemented like so:

```
  public static boolean isEven(int x) {
    int remainder = x % 2;
    boolean result = (remainder == 0);
    return result;
  }
```

Exercise #5

Complete the methods **`isOdd(int x)`** and **`isInside(double x, double y)`**.

Run the JUnit tester after you complete each method to check your work.

Boolean expressions

`boolean` values can be combined to produce a new **`boolean`** value using boolean algebra. In boolean algebra, the basic operations are AND, OR, and NOT, and the corresponding Java operators are:

boolean operation	Java operator
AND	**`&&`**
OR	**`||`**
NOT	**`!`**

Use the AND operator **&&** to determine if two **boolean** values are both true. For example, if you want to determine if a number **x** is greater than both **y** and **z** you could write:

```
boolean result = (x > y) && (x > z);    // is x greater than y and is x greater than z
```

The parentheses are not necessary because **&&** has lower precendence than the comparison operators, but are included in the example to help readability.

Use the OR operator **&&** to determine if at least one of two **boolean** values are both true. For example, if you want to determine if a number **x** is greater than either **y** or **z** you could write:

```
boolean result = (x > y) || (x > z);    // is x greater than y or is x greater than z
```

Again, the parentheses are not necessary.

The NOT operator **!** negates a **boolean** value. Consider the following:

```
boolean isEqual = (x == y);
boolean isNotEqual = !equal;
```

In the example, **isEqual** is **true** if **x** and **y** have the same value, and **false** otherwise. The value of **isNotEqual** is **true** if **x** and **y** have the different values, and **false** otherwise.

Exercise #6

Complete the methods **isOutside(int x, int y, BoundingBox box)** and **isInside(int x, int y, BoundingBox box)**.

Run the JUnit tester after you complete each method to check your work.

if statement

Java's **if** statement lets you choose to execute a block of code depending on a **boolean** value. For example, the following method uses an **if** statement to validate an input to the method:

```
public static double circleCircumference(double radius) {
  if (radius < 0.0) {
    radius = -radius;     // make the radius positive
  }
  return 2.0 * Math.PI * radius;
}
```

The method in the above example computes the circumference of a circle given a radius. The method first checks if the value of **radius** is negative; if **radius** is negative, the code inside the block of the **if** statement is run (shown in red). The code inside the block simply converts the value of **radius** to the correct positive value. If **radius** is not negative, then the block in red does not run. Whether or not the block in red runs, the value of the circumference is computed and returned.

Instead of correcting the negative radius value, we might have chosen to indicate that an error has occurred by throwing an exception:

```
public static double circleArea(double radius) {
  if (radius < 0.0) {
    throw new IllegalArgumentException("negative radius");
    // method stops running here because an exception was thrown
  }
  return Math.PI * radius * radius;
}
```

The method in the above example computes the area of a circle given a radius. The method first checks if the value of **radius** is negative; if **radius** is negative, the code inside the block of the **if** statement is run (shown in red). The code inside the block creates an **IllegalArgumentException** object and throws the exception. Throwing the exception causes the method to stop running

immediately. If **radius** is not negative, then the block in red does not run, and the area is computed and returned.

Exercise #7

Complete the method **withArea(int area)**.

Run the JUnit tester after you complete each method to check your work.

if-else statement

An **if-else** statement causes exactly one of two separate blocks of code to run depending on a **boolean** value. For example, the following method computes the minimum of two values using an **if-else** statement:

```
public static int min2(int x, int y) {
  int min;
  if (y < x) {
    min = y;
  }
  else {
    min = x;
  }
  return min;
}
```

In the above example, the red block is run if the value of **y** is less than the value of **x**; otherwise, the block in blue is run. After the red or blue block runs, the value of **min** is returned.

Exercise #8

Complete the method **contains(double x, Range range)**.

Run the JUnit tester after you complete each method to check your work.

Chained if-else statement

In situations where exactly one of several blocks of code must run, you can chain multiple **if-else** statements together:

```
public static int contains2(double x, Range range) {
  int result;
  if (x <= range.getMinimum()) {
    result = -1;
  }
  else if (x >= range.getMaximum()) {
    result = 1;
  }
  else {
    result = 0;
  }
  return result;
}
```

The example code above determines if a value **x** lies to the left of a **Range**, the right of a **Range**, or is strictly inside the **Range**. The red block is run if **x** is less than or equal to the minimum value of the range, otherwise the blue block is run if **x** is greater than or equal to the maximum value of the range, otherwise the purple block is run. After the red, blue, or purple block runs, the value of **result** is returned.

Exercise #9

Complete the method **`compareTo(Range r1, Range r2)`**.

Run the JUnit tester after you complete each method to check your work.

Strings

A **`String`** is a sequence of zero or more characters. A **`String`** can be written as a sequence of zero or more characters enclosed by quotation marks:

```
String s = "";           // the empty string
String t = "Hello";
```

The following method returns the title of this course as a **`String`**:

```
  public static String getCourse() {
    return "EECS2030";
  }
```

An important feature of Java strings is that once you create a **`String`** instance it is impossible to change its sequence of characters. This is because the **`String`** class provides no *mutator* methods (methods that mutate, or modify, the state of a **`String`** instance). If you need to change the sequence of characters of a **`String`**, you must create a new **`String`** instance.

Exercise #10

Complete the method **`getCourseName()`**.

Run the JUnit tester after you complete each method to check your work.

String concatenation

Two **`String`** instances can be joined, or *concatenated*, using the **`+`** operator; this results in a new **`String`** instance. For example, the string **`"Hello, world"`** could be created using concatenation like so:

```
  String u = "Hello" + ", " + "world";
```

The following method returns the title of this course and the course name separated by a space:

```
  public static String getCourseWithName() {
    return Lab1.getCourse() + " " + Lab1.getCourseName();
  }
```

The following method returns the title of this course and the course name separated by a user-defined separator **`String`**:

```
  public static String getCourseWithName(String separator) {
    return Lab1.getCourse() + separator + Lab1.getCourseName();
  }
```

Exercise #11

Complete the method **`toString(Range r)`**.

Run the JUnit tester after you complete each method to check your work.

String length and indexing

Individual characters can be retrieved from a **`String`** using an integer index. The first character has an index of **`0`**, the second character has an index of **`1`**, and so on. The last character of a **`String`** having **`n`** characters is **`(n - 1)`**. For example, the characters of the string **`"abcd"`** have the following indices:

Index	Character
0	'a'
1	'b'
2	'c'
3	'd'

The **String** method **charAt(int index)** returns the character at the given **index**. The following method returns the first character of a non-empty string:

```
public static char firstChar(String s) {
  if (s.isEmpty()) {
    throw new IllegalArgumentException("string has length 0");
  }
  return s.charAt(0);
}
```

The **String** method **length()** returns the length (number of characters) of a string. The following method returns the last character of a non-empty string:

```
public static char lastChar(String s) {
  if (s.isEmpty()) {
    throw new IllegalArgumentException("string has length 0");
  }
  return s.charAt(s.length() - 1);
}
```

Exercise #12

Complete the method **hasValidLengthAndSeparator(String s)**.

Run the JUnit tester after you complete each method to check your work.

Lists

A **List** is a data type that represents a sequence of elements where all of the elements have the same type. Java lists use Java's generic notation to indicate the type of the elements:

List declaration	Meaning
List<Integer> t;	t is a list of **Integer** references
List<Double> u;	u is a list of **Double** references
List<String> v;	v is a list of **String** references
List<Range> w;	w is a list of **Range** references

List indexing and length

Like strings, lists use a **0**-based index to access individual elements. The **get** method is used to get the value of an element using an index. Assume that **t** is the list of 4 **Double** references **[-0.33, 0.25, 8.99, 24.01]** and that **elem** is a variable of type **double**; then the following table shows the results of indexing into the list:

Expression	Value of elem
elem = t.get(0);	-0.33

```
elem = t.get(1);    0.25

elem = t.get(2);    8.99

elem = t.get(3);    24.01

elem = t.get(4);    throws an IndexOutOfBoundsException
```

The **set** method is used to set the value of an element using an index. Assume that **t** is the list of 4 **String** references **["abc", "xyz", "123", "###"]**; then the following table shows the results of setting the elements of the list:

Expression	Elements of t
	["abc", "xyz", "123", "###"]
t.set(0, "ABC");	["ABC", "xyz", "123", "###"]
t.set(1, "XYZ");	["ABC", "XYZ", "123", "###"]
t.set(2, "789");	["ABC", "XYZ", "789", "###"]
t.set(3, "***");	["ABC", "xyz", "789", "***"]
t.set(4, "oops");	throws an IndexOutOfBoundsException

The number of elements in a list is returned by the **size** method.

The following method swaps the position of the elements in a list of size 2:

```
public static void swap2(List t) {
  if (t.size() != 2) {
    throw new IllegalArgumentException("list size != 2");
  }
  // get the first two elements
  int t0 = t.get(0);
  int t1 = t.get(1);

  // set the first two elements swapping their original order
  t.set(0, t1);
  t.set(1, t0);
}
```

Exercise #13

Complete the method **sort2(List<Double> t)**.

Run the JUnit tester after you complete each method to check your work.

for-each loops

Many tasks involving lists require using *but not setting* each element in the list. To visit each element of a list (sequentially from the first element to the last) you can use a **for**-each loop. The following is an example of a **for**-each loop that simply prints each element of a list of strings on a separate line:

```
public static void print(List<String> t) {
  for (String s : t) {
    System.out.println(s);
  }
}
```

The loop above reads as "for each **String s** in **t**." Inside the body of the loop (shown in red), you use the variable **s** to refer to the current string in the list **t**. The loop body runs once for each element of **t** starting with the first element of **t** and ending with the last element of **t**. If the list **t** is empty then the loop body never runs (and the method does nothing).

Looping over the elements of a sequence is called *iterating* over the sequence. Iterating over a sequence of n elements with a **for**-each loop requires running the loop body n times; each time the loop body runs is called an *iteration* of the loop.

The following is slightly more complicated example that finds the greatest value in a list of **Integer** values:

```
public static int max(List<Integer> t) {
  int result = Integer.MIN_VALUE;
  for (Integer elem : t) {
    if (elem > result) {
      result = elem;
    }
  }
  return result;
}
```

The method starts by assuming the largest value in the list is the *smallest* possible **Integer** value. The method then uses a **for**-each loop to iterate over the elements of the list. During each iteration, the current element of the list is compared to **result**; if the current element is greater than **result** then we know that we've found an element that is greater than the greatest element seen so far, and we store the value of the element in **result**. After iterating over all of the elements, **result** holds the greatest value of the elements in the list.

Exercise #14

Complete the method **sum(List<Double> t)**.

Run the JUnit tester after you complete each method to check your work.

for loops

The **for**-each loop has a very clean and simple syntax, but it is not usable if you need to set the value of an element while iterating over the list. For example, suppose that you have a list of temperatures in degrees Fahrenheit and you want to convert the values to degrees Celcius. If you try using a **for**-each loop you will run into a problem:

```
/**
 * Convert a list of temperatures in Fahrenheit to Celcius
 */
public static void toCelcius(List<Double> t) {
  for (Double fahr : t) {
    // convert fahr to degrees Celcius
    double cel = (fahr - 32.0) * 5.0 / 9.0;

    // how do you set the element in t without an index?
  }
}
```

In this situation we need an index to set the appropriate element of the list. This can be done using an ordinary **for** loop:

```
/**
 * Convert a list of temperatures in Fahrenheit to Celcius
 */
public static void toCelcius(List<Double> t) {
  for (int i = 0; i < t.size(); i++) {

    // get element i
    double fahr = t.get(i);
```

```
      // convert fahr to degrees Celcius
      double cel = (fahr - 32.0) * 5.0 / 9.0;

      // replace element i
      t.set(i, cel);
    }
  }
```

The **for** statement has three parts:

- *initialization expression*: runs once before the loop begins and usually declares a loop variable that can be used inside the loop body
- *logical expression*: is a **boolean** expression that is evaluated at the beginning of each iteration. If the logical expression evaluates to **true** the loop body runs, otherwise the loop stops. The logical expression usually, but not always, involves the loop variable.
- *increment expression*: is evaluated at the end of each loop iteration. The increment expression usually, but not always, modifies the value of the loop variable.

In the above example, the:

- *initialization expression* creates an **int** loop variable named **i** that represents the index of the element in the list that we want to manipulate on the current iteration
- *logical expression* compares the index **i** to the size of the list. If the index is smaller than the size of the list, then the loop runs.
- *increment expression* At the end of each iteration, the index is increased by one so that the next iteration of the loop can manipulate the next element in the list

If you trace through the above loop using a list of n elements, you'll see that the value of the loop variable **i** follows the sequence **0, 1, 2, ..., (n - 1)**.

Exercise #15

Complete the method **toRadians(List<Double> t)**.

Run the JUnit tester after you complete each method to check your work.

Submit your work

To submit your work, you need to transfer your **Lab1.java** file to a Prism lab computer. You can use a USB stick, a secure FTP program, or a secure copy program to do so.

Once you have transferred your files, log onto a Prism computer and follow the instructions below.

These instructions will be updated to include instructions for submitting from a computer outside of the Prism labs.

Submit for students NOT working in a group

If you are *not* working in a group, submit your solution using the **submit** command. Remember that you first need to find your workspace directory, then you need to find your project directory. In your project directory, your files will be located in the directory **src/eecs2030/lab1**

```
submit 2030 lab1 Lab1.java
```

Submit for students working in a group

If you are working in a group, create a plain text file named **group.txt**. You can do this in eclipse using the menu *File -> New -> File*. Type your login names into the file with each login name on its own line. For example, if the students with login names **rey**, **finn**, and **dameronp**, worked in a group the contents of **group.txt** would be:

```
rey
finn
```

```
dameronp
```

Submit your solution using the **submit** command. Remember that you first need to find your workspace directory, then you need to find your project directory. In your project directory, your files will be located in the directory **src/eecs2030/lab1**

```
submit 2030 lab1 Lab1.java group.txt
```