

Fundamental Programming Structures in Java

IFT 194: Lab 2

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Pre-Lab Exercises

A. Textbook Sections 5.1–5.3

1. We are tasked with rewriting various conditions in valid Java syntax.
 - (a) The condition $x > y > z$ may be written in Java as $x > y \ \&\& \ y > z$, i.e. we need to join the two comparisons by the \wedge -logical operator. This is a result of the type of objects the relational operators act upon; because $x > y$ returns a `boolean` type, we receive a compile-time error (invalid types).
Interestingly enough, this *is* valid Python syntax due its recursive `comp_op` Grammar definition, so we may (hypothetically) write an infinite sequence `expr comp_op ... expr comp_op expr`. \wedge -logical operators are automatically inserted.
 - (b) The statement “x and y are both less than 0” may quite simply be expressed as $x < 0 \ \&\& \ y < 0$.
 - (c) The statement “neither x nor y are less than 0” may be expressed as $x \geq 0 \ \&\& \ y \geq 0$, or the negation of the previous predicate, i.e. $!(x < 0 \ \&\& \ y < 0)$. I think the former is more readable, however.
 - (d) The statement “x equals y but not z” may be written as $x == y \ \&\& \ x != z$.
2. We are tasked with writing an `if-then` statement to state whether a student has made the Dean’s list. Please see [Figure 5](#) for my solution.
3. We are tasked with completing/fixing an example program that computes the raise an employee will receive based on their performance value. Please see [Figure 6](#) for my solution.

Textbook Section 5.4

1. Suppose we have a loop as follows.

```
package lab_2;

public class SimpleLoop {
    public static void main(String[] args) {
        final int LIMIT = 10;    // immutable
        int count = 1;           // mutable
        while (count <= LIMIT) {
            System.out.print(count + " ");
            count++;
        }
        System.out.println();
    }
}
```

Figure 1: SimpleLoop.java.

View the source of this document on [GitHub](#).

This program outputs the sequence **1..10** when it's executed. Reversing the order of the statements **count++** and **System.out.println(count + " ")** will thus print the sequence **2..11**. This is the case because we are then incrementing each value in **1..10** *prior* to printing.

As a quick comparison, because I think it's awesome how some languages (or paradigms) are better at expressing certain concepts than others, I've written the same program in Haskell with monads in [Figure 7](#). (I think most of the complexity is introduced by immutability.)

2. Next we will consider the following program/loop.

```
package lab_2;

public class TraceLoop
{
    public static void main(String[] args)
    {
        final int LIMIT = 16;
        int count = 1, sum = 0, nextValue = 2;

        while (sum < LIMIT)
        {
            sum += nextValue;
            nextValue += 2;
            count++;
        }
        System.out.println("The sum of your integers is " + sum);
    }
}
```

Figure 2: TraceLoop.java.

When run, the output of this program is the statement “The sum of your integers is 20.” Below is a table containing the values of **count**, **sum**, and **nextVal** as this program is executing.

count	sum	nextVal
1	0	2
2	2	4
3	6	6
4	12	8
5	20	10

If we wished instead to add the first *count* nonzero integers, we could modify the **count** variable to start at some positive integer, such as **5**, and the **while**-loop's predicate to instead state **count-- > 0** (while removing the following **count++**), which outputs the following.

count	sum	nextVal
4	0	2
3	2	4
2	6	6
1	12	8
0	20	10
-1	30	12

3. We're tasked next with writing a loop that will print the statement "I love computer science!!" 100 times. See [Figure 8](#) for my solution. Also, this type of loop is count-controlled, and I would much rather have used a `for`-loop.
4. In this question we're asked to write a program that accepts integers from the user and adds them all up. See [Figure 9](#) for my solution.

Also note that I've used a regular expression to match user input – this loop is *not* "count-controlled," it will exit only if the user decides to terminate the loop. The following is an example input.

```
Enter the next integer: 1
Intermediate total: 1
Keep going? [y|n]: y
Enter the next integer: 13
Intermediate total: 14
Keep going? [y|n]: 7
Total: 14
Input integers: 2
*** Exiting
```

5. We are asked to write a loop that counts backward from 10 to 1. The code provided has two issues, namely that the `while`-loop's predicate should be `count > 0` (we'd like to stop at 1, not 0), and the variable `count` should be decremented, not incremented, as `count--`. See [Figure 10](#) for my solution.

Two Meanings of Plus

In Java the `(+)` operator has the ability to work on numbers and strings. This is a form of polymorphism, because the way the code works depends upon the the type of data it's acting upon.

1. As an example, we're given the program in [Figure 11](#) to run. The output is as follows.

```
This is a long string that is the concatenation of two shorter strings.
The first computer was invented about55years ago.
8 plus 5 is 85
8 plus 5 is 13
13 equals 8 plus 5.
```

In the first statement, the two strings are concatenated. In the second, the strings and number are concatenated, but space wasn't provided at the end of the former string, and at the beginning of the second, so it's a bit "scrunched." In the third, both integers were cast to `Strings` and concatenated to the end; however, in the forth parentheses were added, so the expression was evaluated prior to being cast and concatenated. Lastly, no parentheses were necessary to evaluate the leading expression because the argument is evaluated left-to-right.

2. Please see [Figure 12](#) for my solution to this problem (it's quite simple).

Painting a Room

In this section we're presented with the problem of prompting a user for the dimensions of a room, the walls of which we would like to paint. However, each gallon of paint will only cover 350 ft², and we would like to know the amount of paint we need to buy. See [Figure 13](#) for my initial solution. An example session is as follows.

```
Please enter an integer for the length: 5
Please enter an integer for the width: 5
Please enter an integer for the height: 10
L, W, H: 5, 5, 10
Gallons of paint required: 0.5714285714285714
```

Recall that the area of the walls is given by

$$\underbrace{2 \times H \times L}_{\text{adding 2 walls length-wise}} + \underbrace{2 \times H \times W}_{\text{two walls width-wise}} = 2 \times H \times (L + W).$$

Hence, working out the example above, we have

$$\begin{aligned} \frac{2 \times 10 \times (5 + 5)}{350} &= \frac{20 \times (10)}{350} \\ &= \frac{200}{350} \\ &= 0.57... \end{aligned}$$

which is exactly my program's output.

Now, suppose we wanted to subtract windows and doors? Assuming they have areas of 15 ft² and 20 ft², respectively, we can add this functionality by adding two more field variables, local variables, and calls to `getAttr`, in addition to modifying the equation to

$$2 \times H \times L + 2 \times H \times W - \Omega \times 15 - D \times 20 = 2 \times H \times (L + W) - \Omega \times 15 - D \times 20.$$

To save space in this document I've submitted a gunzipped tarball with all of my code. Another command that may be of use if you're using Linux is to run `diff -y -w 150 code/Paint* | less`, which will display relevant changes side-by-side (or simply `cat` the included `differences.txt` file).

Counting Characters

In this section we're concerned with writing a program that will accept a string via a `Scanner` object from the user and count certain characters in the string. See [Figure 14](#) for my solution and [Figure 3](#) an example session so you may see how it works.

Tracking Sales

In this section we're concerned with tracking the number of sales of salespersons and printing various statistics about the data as it's entered by a user. See figure ?? for my solution, and [Figure 4](#) for another example session.

```

Character Counter
=====

Please enter a string of text: hello, world! I enjoy writing JAVa

Number of blank spaces: 5
Number of [aA]'s: 2
        [eE]'s: 2
        [sS]'s: 0
        [tT]'s: 1

Add another string? [y|n]: y

Please enter a string of text: of course yo

Number of blank spaces: 2
Number of [aA]'s: 0
        [eE]'s: 1
        [sS]'s: 1
        [tT]'s: 0

Add another string? [y|n]: quit

*** Exiting

```

Figure 3: Example session with my program in [Figure 14](#).

```

Enter the number of salespeople: 3

Enter sale for a salesperson 1: 5
Enter sale for a salesperson 2: 3
Enter sale for a salesperson 3: 8

Salesperson sales
-----
1      5
2      3
3      8

Total sales: 16
Average sale: 5.333333333333333
The max sale was by salesperson 3, which was 8
The minimum sale was by salesperson 2, which was 3

Enter a cutoff value (int): 4

Salesperson 1 exceeded the cutoff with 5 sales
Salesperson 3 exceeded the cutoff with 8 sales

Total salespeople exceeding the cutoff amount: 2

```

Figure 4: Example session with my program in ??.

Conclusion

```

package lab_2;

public class DeansList
{
    public final static double DEANS_LIST_CUTOFF = 3.5;

    /**
     * Determine if a GPA is eligible for the Dean's list.
     *
     * @param args Ideally contains a single number. If more than one argument is
     *             provided, only the first is taken.
     */
    public static void main(String[] args)
    {
        if (args.length < 1) {
            System.out.println("Please provide your GPA");
            System.exit(0);
        }

        double gpa = 0.0;

        try {
            gpa = Double.parseDouble(args[0]);
        } catch (NumberFormatException e) {
            System.out.println("Please provide a float");
            System.exit(0);
        }

        if (gpa >= DeansList.DEANS_LIST_CUTOFF) {
            System.out.println("Congratulations -- you made the Dean's list");
        } else {
            System.out.println("Sorry you didn't make the Dean's list");
        }
    }
}

```

Figure 5: DeansList.java. I decided to turn this program into a super simple command line utility to test the usage of **args** in the **main** function.

```

package lab_2;

import java.util.Scanner;
import java.util.InputMismatchException;

public class Sales
{
    public static void main(String[] args)
    {
        try (var scnr = new Scanner(System.in)){
            int sum = 0, maxUser = -1, maxSale = 0, minUser = -1, minSale = 0,
                cutOff = 0, salesPeople = 0, totalExceedingCutOff = 0;

            while (true) {
                System.out.print("Enter the number of salespeople: ");
                try {
                    salesPeople = scnr.nextInt();
                    if (salesPeople <= 0)
                        System.out.println("*** Error: please provide a positive integer");
                    else
                        break;
                } catch (InputMismatchException ex) {
                    System.out.println("*** Error: please provide a positive integer");
                }
            }
        }
    }
}

```

```

package lab_2;

import java.util.InputMismatchException;
import java.util.Scanner;

public class Salary
{
    /**
     * Compute the salary of a worker based on their performance rating.
     *
     * @param args Not used.
     */
    public static void main(String[] args)
    {
        // 'try with resources', since Scanner implements AutoCloseable
        try (var scnr = new Scanner(System.in)) {
            double currentSalary = 0.0, raiseAmount = 0.0;
            int employeeRating = 0;

            while (true) {
                System.out.print("Enter the current salary: ");
                try {
                    currentSalary = scnr.nextDouble();
                } catch (InputMismatchException ex) {
                    System.out.println("*** ERROR: Please enter a float");
                    scnr.next();
                    continue;
                }
                if (currentSalary < 0.0)
                    System.out.println("Please enter a positive float");
                else
                    break;
            }

            while (true) {
                System.out.print("Enter the employee performance rating: ");
                try {
                    employeeRating = scnr.nextInt();
                } catch (InputMismatchException ex) {
                    System.out.println("*** ERROR: Please enter an integer");
                    scnr.next();
                    continue;
                }
                if (employeeRating < 1 || employeeRating > 3)
                    System.out.println("Please enter a number in [1, 2, 3]");
                else
                    break;
            }

            switch (employeeRating) {
                case 1: raiseAmount = (0.06 * currentSalary);
                        break;
                case 2: raiseAmount = (0.04 * currentSalary);
                        break;
                case 3: raiseAmount = (0.015 * currentSalary);
                        break;
            }

            currentSalary += raiseAmount;

            System.out.println("Amount of your raise: $" + raiseAmount);
            System.out.println("Your new salary: $" + currentSalary);
        }
    }
}

```

Figure 6: Salary.java. See also the documentation on [AutoCloseable](#), which provides a nice interface for closing files like Python's [context managers](#).


```

{- increment.hs -}

import Control.Monad

inc :: Int -> Int
inc = (+ 1)

addSpace :: Show a => a -> String
addSpace el = show el ++ " "

-- Increment prior to printing
priorIncrement :: Int -> Int -> IO ()
priorIncrement start stop = if stop < start then print stop
                             else (mapM_ (putStr . addSpace . inc) [start..stop]) >> putStrLn ""

-- Increment after printing
postIncrement :: Int -> Int -> IO ()
postIncrement start stop = if stop < start then print stop
                             else foldM unit start [start..(stop - 1)] >=> print
    where
        unit :: Int -> Int -> IO Int
        unit i acc = (putStr . addSpace $ acc) >> return (inc i)

main :: IO ()
main = (postIncrement 1 10) >=> (\() -> priorIncrement 1 10)

$ ghc --make increment.hs
$ ./increment
1 2 3 4 5 6 7 8 9 10
2 3 4 5 6 7 8 9 10 11

```

Figure 7: increment.hs. See question 1 in Textbook Section 5.4's questions above.

```

package lab_2;

public class CSLoop
{
    /**
     * Print a statement a hundred times.
     *
     * @param args Not used.
     */
    public static void main(String[] args)
    {
        int i = 100;
        while (i-- > 0)
            System.out.println("I love computer science!! ");
    }
}

```

Figure 8: CSLoop.java.

```

package lab_2;

import java.util.Scanner;
import java.util.InputMismatchException;

public class Loop
{
    /**
     * Add numbers from user input.
     *
     * TODO: Handle size limit of int type (wrapping).
     *
     * @param args Not used.
     */
    public static void main(String[] args)
    {
        try (Scanner scnr = new Scanner(System.in)) {
            int sum = 0, nextVal = 0, inputs = 0;
            String keepGoing = "y";

            while (!keepGoing.matches("^[^yY]"))
            {
                System.out.print("Enter the next integer: ");

                try {
                    nextVal = scnr.nextInt();
                } catch (InputMismatchException ex) {
                    System.out.println("*** Error: please enter an integer");
                    scnr.next();
                    continue;
                }

                sum += nextVal;
                inputs++;

                System.out.println("Intermediate total: " + sum);
                System.out.print("Keep going? [y|n]: ");
                keepGoing = scnr.next();
            }

            System.out.println("Total: " + sum);
            System.out.println("Input integers: " + inputs);
            System.out.println("*** Exiting");
        }
    }
}

```

Figure 9: Loop.java.

```

package lab_2;

public class Decrement {
    public static void main(String[] args) {
        // Print 10..1 to the console
        int count = 10;
        while (count > 0) {
            System.out.println(count);
            count--;
        }
    }
}

```

Figure 10: Decrement.java.

```

package lab_2;

public class Add
{
    public static void main(String[] args)
    {
        // Demonstrate (+) as a concatenation operator
        System.out.println("This is a long string that is the " +
                           "concatenation of two shorter strings.");

        // Demonstrate (+) as having the ability to implicitly cast integers to
        // the String type.
        System.out.println("The first computer was invented about" + 55 +
                           "years ago.");

        // How to incorrectly use (+), because both integers are implicitly cast
        // to String before the expression is evaluated as (13) (from left-to-right).
        System.out.println("8 plus 5 is " + 8 + 5);
        System.out.println("8 plus 5 is " + (8 + 5));    // correct

        // Demonstrate that (+) is evaluated left-to-right
        System.out.println (8 + 5 + " equals 8 plus 5.");
        //
        //      \ /
        //      13 + " equals 8 plus 5."
        //
        //      \      /
        //      "13" + " equals 8 plus 5."
        //
        //      \      /
        //      "13 equals 8 plus 5."
    }
}

```

Figure 11: Add.java.

```

package lab_2;

public class MyOwnAdd
{
    public static void main(String[] args)
    {
        int robins = 10, canaries = 13;
        System.out.println("Ten robins plus " + canaries + " is " +
                           (robins + canaries) + " birds.");
    }
}

```

Figure 12: MyOwnAdd.java.

```

package lab_2;

import java.util.InputMismatchException;
import java.util.Scanner;

public class Paint
{
    final public static int COVERAGE = 350;

    /**
     * Calculate the amount of paint needed to paint the walls of a room given the
     * length and width.
     *
     * @param args Not used.
     */
    public static void main(String[] args)
    {
        try (Scanner scnr = new Scanner(System.in)) {
            int length = 0, width = 0, height = 0;
            double totalSquareFeet = 0.0, paintNeeded = 0.0;

            length = getAttr("length", scnr);
            width = getAttr("width", scnr);
            height = getAttr("height", scnr);

            totalSquareFeet = 2 * height * (width + length);

            paintNeeded = totalSquareFeet / COVERAGE;

            System.out.println("L, W, H: " + length + ", " + width + ", " + height);
            System.out.println("Gallons of paint required: " + paintNeeded);
        }
    }

    /**
     * Because length, width, and height are all the same type, we may 'outsource'
     * this common code to prompt a user for a value for each.
     *
     * @param prompt A string containing either "length", "width", or "height".
     * @param scnr A Scanner object for collecting user input.
     * @return int The length, width, or height of a room as an int.
     */
    public static int getAttr(String prompt, Scanner scnr)
    {
        int attr = 0;
        while (true)
        {
            System.out.print("Please enter an integer for the " + prompt + ": ");
            try {
                attr = scnr.nextInt();
            } catch (InputMismatchException ex) {
                System.out.println("Please input an integer");
                scnr.next();
                continue;
            }
            if (attr <= 0) {
                System.out.println("Please input a positive integer");
                continue;
            }
            break;
        }
        return attr;
    }
}

```

Figure 13: Paint.java.

```

package lab_2;

import java.util.Scanner;

public class Count
{
    /**
     * Count specific characters in a string and print the number of each.
     *
     * @param args Not used.
     */
    public static void main(String[] args)
    {
        try (var scnr = new Scanner(System.in)){
            String phrase = "", keepGoing = "y";

            // Print a fancy header
            String header = "Character Counter";
            System.out.println(String.format("\n%s", header));
            var underline = "";
            for (int i = 0, n = header.length(); i < n; ++i) underline += "=";
            System.out.println(underline + "\n");

            while (!keepGoing.matches("^[^yY].*"))
            {
                int spaces = 0, as = 0, es = 0, ss = 0, ts = 0;

                // Get user input
                while (true) {
                    System.out.print("Please enter a string of text: ");
                    phrase = scnr.nextLine();
                    if (phrase.length() != 0)
                        break;
                }

                // Convert string to lowercase prior to looping
                for (char ch : phrase.toLowerCase().toCharArray()) {
                    switch (ch) {
                        case 'a': as++;
                                break;
                        case 'e': es++;
                                break;
                        case 's': ss++;
                                break;
                        case 't': ts++;
                                break;
                        case ' ': spaces++;
                                break;
                        default : break;
                    }
                }

                System.out.println("\nNumber of blank spaces: " + spaces);
                System.out.println("Number of [aA]'s: " + as);
                System.out.println("        [eE]'s: " + es);
                System.out.println("        [sS]'s: " + ss);
                System.out.println("        [tT]'s: " + ts + "\n");

                System.out.print("Add another string? [y|n]: ");
                keepGoing = scnr.nextLine();
                System.out.println();
            }
            System.out.println("*** Exiting");
        }
    }
}

```

Figure 14: Count.java.

```

    }
}

int[] sales = new int[salesPeople];
System.out.println();

for (int i = 0; i < sales.length; ++i)
{
    while (true) {
        System.out.print("Enter sale for a salesperson " + (i + 1) + ": ");
        try {
            sales[i] = scnr.nextInt();
            break;
        } catch (InputMismatchException ex) {
            System.out.println("*** Error: please input an integer");
            scnr.next();
        }
    }
}

System.out.println("\nSalesperson sales");
System.out.println("-----");

for (int i = 0; i < sales.length; sum += sales[i], ++i) {
    // Initialize minSale
    if (i == 0) {
        minSale = sales[i];
        minUser = i + 1;
    }

    // Show tabular data
    System.out.println(" " + (i + 1) + "\t" + sales[i]);

    // Update min and max sales data
    if (sales[i] > maxSale) {
        maxSale = sales[i];
        maxUser = i + 1;
    }

    if (i != 0 && sales[i] < minSale) {
        minSale = sales[i];
        minUser = i + 1;
    }
}

System.out.println("\nTotal sales: " + sum);
System.out.println("Average sale: " + ((double)sum / sales.length));
System.out.println("The max sale was by salesperson " + maxUser
    + ", which was " + maxSale);
System.out.println("The minimum sale was by salesperson " + minUser
    + ", which was " + minSale + "\n");

while (true) {
    System.out.print("Enter a cutoff value (int): ");
    try {
        cutOff = scnr.nextInt();
        break;
    } catch (InputMismatchException ex) {
        System.out.println("*** Error: Please enter an integer");
    }
}

System.out.println();
for (int i = 0; i < sales.length; ++i) {
    if (sales[i] > cutOff) {
        System.out.println("Salesperson " + (i + 1)

```

```
        + " exceeded the cutoff with " + sales[i] + " sales");
        totalExceedingCutOff++;
    }
}
System.out.println("\nTotal salespeople exceeding the cutoff amount: "
    + totalExceedingCutOff);
}
}
```