Week 4
Repetitions
Testing and Debugging

1

Repetition - repeating a set of actions a number of times.

- **Sum 1 + 2 + 3 + 4 + 5 + … 50**
- **Find n! = 1 * 2 * 3 * 4 * 5 * 6 *…n**
- **m^n = m * m* m …. n-times**

Number of times known in advance

- Definite

- **Reading all the numbers until user enters a special value**
- **Adding input numbers until sum exceeds set value**

Number of times to repeat cannot be determined

- Indefinite

2

Finding average of 3 marks input

```
CALCULATION OF ASSIGNMENT AVERAGE
Enter mark of assignment 1:  5
Enter mark of assignment 2:  8
Enter mark of assignment 3: 10

The average mark is: 7.66
```

3

Design

calculate the sum of the marks

process the average

```
calculate the sum of marks
     for all assignments
        prompt for mark
        get mark
        add to previous total
process the average
     calculate the average
     display the average
```

```
Enter mark of assignment 1:  5
Enter mark of assignment 2:  8
Enter mark of assignment 3: 10
The average mark is: 7.66
```

num	sum
~~5~~ ~~8~~ 10	~~0~~ ~~5~~ ~~13~~ 23

average

7.66

4

```
import java.io.*;
public class AverageMarks {
  public static void main (String[] args)
                                  throws IOException  {
    BufferedReader stdin = new BufferedReader
                    (new InputStreamReader (System.in));
    String inString;
    int i, num, sum = 0;
    for ( i = 1 ; i <= 3 ; i++)  {
      System.out.println("Enter mark of assign" + i + " : ");
      inString = stdin.readLine();
      num = Integer.parseInt (inString);
      sum += num;  // accumulate total
    }
    System.out.println("The average is: " + (double)sum / 3);
  }
}
```

5

General form of for loop

expressions

```
for (initial; test ; increment)
   statement(s)
```

Single or block of statements

```
int sum = 0;
for (int i=0; i<3; i++){
   sum = sum + i;
   System.out.println(i);
}
System.out.println(i);
```

Convenient to declare loop variable here but lifetime is restricted to the loop

Error !

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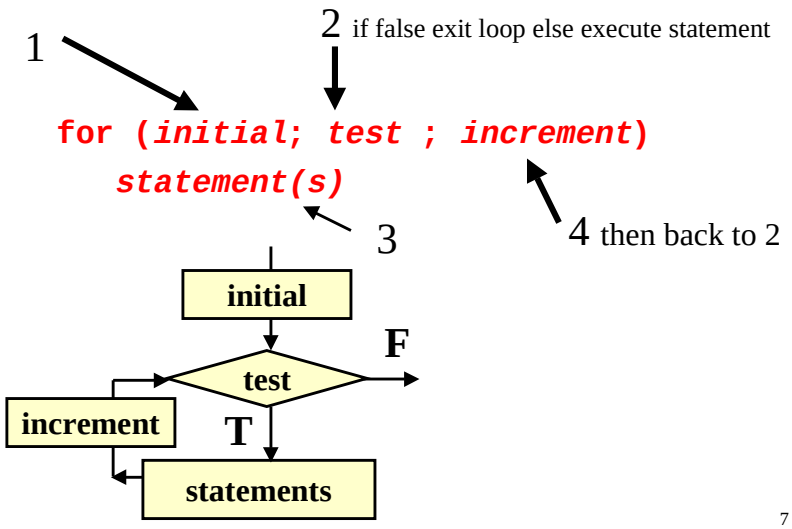
Behavior of the loop



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What is the output ? (if any)

1

```
for (int i=3; i<3; i--)
   System.out.println("i is now "+ i);
```

2

```
for (int i=3; i>0; i--)
   System.out.println("i is now "+ i);
```

3

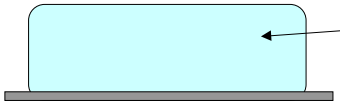
```
for (int i=0; i<3; i++)
   System.out.println(i*10);
```

4

```
for (int i=0; i<3;  )
   System.out.println("i is now "+ i);
```

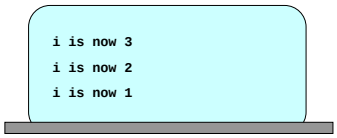
Output ...

1



No output

2



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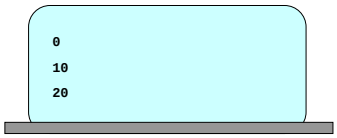

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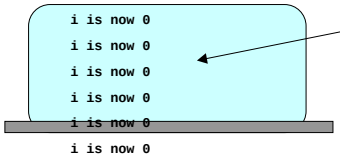

infinite loop

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Attempting to sum 1 to 10. What's wrong ?

```
int sum = 0;
for (int i=1; i<=10; i++)
   System.out.println("i is now "+ i);
   sum = sum + i;
System.out.println("1 + 2..10 is " + sum);
```

```
int sum = 0;
for (int i=1; i<=10; i++); {
   System.out.println("i is now "+ i);
   sum = sum + i;
}
System.out.println("1 + 2..10 is " + sum);
```

Ans 1. Braces missing 2. Semicolon (;) completes loop

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A Conversion Table

- **from cubic inches to cubic centimeters**
- **from 20 cubic inches down to 2, in step of 2**

```
double cubicCm;
int finish, step;
// constant conversion factor C.I to C.C
final double CONV_FACTOR = 1000.0/61.0;

finish = 10; step = 2;
System.out.println(”TABLE C.I TO C.C");
for ( int i = finish; i > 0 ; i--)  {
   cubicCm = (i * step) * CONV_FACTOR;
   System.out.println(cubicCm);
}
```

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```
TABLE C.I TO C.CM
327.86885245901635
295.08196721311475
262.2950819672131
229.50819672131146
196.72131147540983
163.93442622950818
131.14754098360655
98.36065573770492
65.57377049180327
32.78688524590164
```

Can I restrict the number of decimal places to two ?

```
import java.text.*;
...
DecimalFormat df = newDecimalFormat("0.00");
System.out.println(df.format(cubicCm));
```

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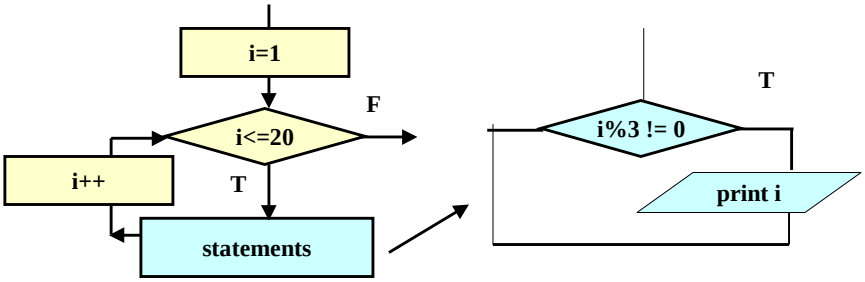
Nesting an if within for loop

Can I print all the numbers not divisible by 3 in the range 1 to 20 using a for loop ?




```
for ( ____; ____ ; _____)  {
   if (_____________________)
     System.out.println();
}
```

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Nested Loop

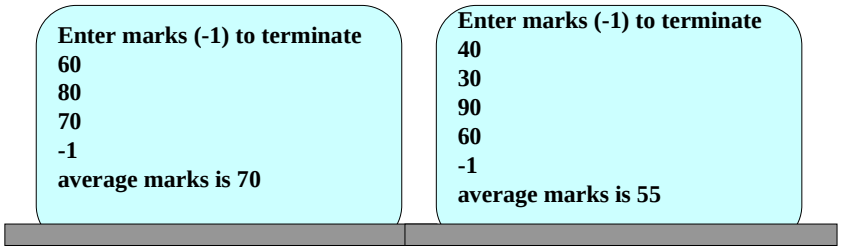
What will be the output of the program below ?

```
for (i=1; i<=4;i++) {
     for (j=1; j<=3; j++)
          System.out.print("i+j);
     System.out.println();
}
```

i	j
~~1~~	~~1 2 3~~ 4
~~2~~	~~1 2 3~~ 4
~~3~~	~~1 2 3~~ 4
~~4~~	~~1 2 3~~ 4

```
2 3 4
3 4 5
4 5 6
5 6 7
```

Indefinite repetition



- **Asked to write a program to find the average marks.**
- **Number of students in class may vary**
- **We must read the marks input until user enters -1**
- **A while loop is more appropriate**

```
Initialization; // if any
while (boolean_expression)
   statement;
```

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Design

Set sum to 0

Display Prompt "enter marks (-1) to terminate"

read mark

while (mark != -1) {

add mark to sum

increment number_of_students

read next mark

}

if (number_of_students > 0) compute and print average

otherwise print error message

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```
import java.io.*;
public class FindAverage {
   public static void main (String[] args)
                                    throws IOException {
      ConsoleReader console = new ConsoleReader(System.in);
      int mark, sum = 0, num = 0;
       System.out.println("Enter marks (-1) to terminate");
       mark = console.readInt();
       while ( mark != -1) {
          sum += mark;
          num++;
          mark = console.readInt();
       }
       if (num ==0)
          System.out.println("No students in class");
       else
          System.out.println(”Aver = " +(double)sum/num);
   }
}
```

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Write a program to accept characters as input, and quit when a 'Q' or a 'q' is typed, printing how many characters other than 'q' or 'Q' have been typed.

```
This program counts the number of characters entered.
Input a character, 'Q' or 'q' to quit:
r
Input a character, 'Q' or 'q' to quit:
e
Input a character, 'Q' or 'q' to quit:
s
Input a character, 'Q' or 'q' to quit:
P
Input a character, 'Q' or 'q' to quit:
J
Input a character, 'Q' or 'q' to quit:
q
The number of characters entered is:    5
```

Design

```
initialisation
   show initial prompts
while input not a q or a Q
   process character
      prompt for a character
      get character
      add 1 to total
display total
```

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```
import java.io.*;
public class CharTest {
   public static void main (String[] args)
                                throws IOException {
     BufferedReader charInput = new BufferedReader
                    (new InputStreamReader (System.in));
     char answer;
     int charTotal = 0;
     System.out.println("This program counts the "
                   + "number of characters entered.");
     System.out.println("Input char 'Q' ,'q' to quit:");
     answer = charInput.readLine().charAt(0);
     while (answer != 'Q' && answer != 'q')  {
         charTotal++;
        System.out.println("Input char 'Q','q' to quit:");
        answer = charInput.readLine().charAt(0);}
     }
     System.out.println("Num. of chars = "+ charTotal);
  }
}
```

repeated

Note the use of charAt()

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Using a do - while loop

We could avoid the double prompting using a do-while loop and break.

```
do  {
   System.out.println("Input a character, "
                +  "'Q' or 'q' to quit:");
   answer = charInput.readLine().charAt(0);
   if (answer == 'Q' || answer == 'q') break;
      charTotal++;
}  while (true);
```

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The general formof do-while

```
do  {
   statements;
}  while (condition);
```

- **Difference between `while` and do -while**
- **while is skipped altogether if the condition is `false` - hence it it termed '0 or more repetitions'**
- **The `do` loop is executed at least once, so it is called a '1 or more repetitions' loop.**

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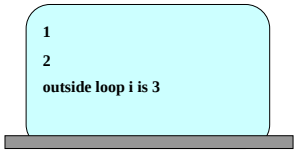
The break

break statement allows you to break out of a loop or switch statement

```
int i;
for (i=1; i<=10; i++) {
   if (i % 3 == 0)
            break;
   System.out.println(i);
}
System.out.println("Outside loop i is " + i);
```



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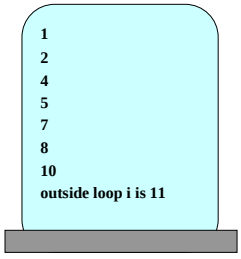
continue statement

continue statement causes the flow of control to pass to the next iteration of the loop.

```
int i;
for (i=1; i<=10; i++) {
   if (i % 3 == 0)
            continue;
      System.out.println(i);
}
System.out.println("Outside loop i is " + i);
```



Coding Guideine:Try and avoid break and continue

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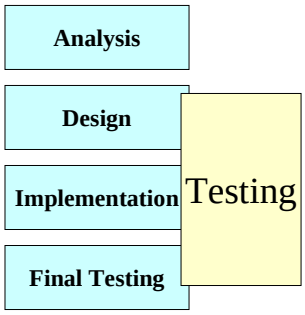
Program Testing

- **Testing is intended to reveal any bugs.**
- **debugging is intended to locate and remove them.**
- **Testing is an important part of program development. it should be planned from the outset.**
- **Program testing can never prove the absence of bugs, but it can show their presence. (Dijkstra)**
- **Object oriented and modular programming facilitate testing since programs are constructed with tested building blocks (classes)**



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Exhaustive testing

Consider a simple example of adding two integers (X+Y).

- **We need to consider all possible input combinations.**
- **How long will it take to test all combinations of X + Y ?**
- **Java the maximum `int` is 2^{31}–1 = 2,147,483,647**
- **Possible combinations are in billions taking years to complete the test**

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Black Box Testing

Black-box testing :

does <u>not</u> consider program's design structure

test plan derived from program specification

plans some specific inputs and inspect the outputs

The test values can be reused in future

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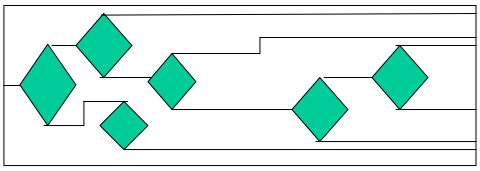
White-box (Glass-box) testing:



Control paths

- **inputs chosen to exercise (all) control paths.**
- **exercises them with boundary value inputs**
  X = a * b / (c * d)

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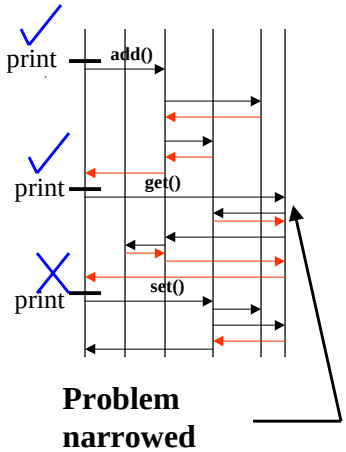
Debugging - locating

- **A basic technique to test a piece of code is to insert *diagnostic* output statement (print) after each method call.**
- **When the error is seen in one output but not the one prior to it, it must be between the relevant two diagnostics.**
- **Then we can step into the last method call trying to locate the problem. Debuggers (JBuilder, kawa) automate this process.**

Object Interaction Diagram showing how the methods in various objects interact.



Problem narrowed

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Input Validation

***Input validation* is the process of writing extra code to ensure the user inputs only valid data.**

A simple validation technique is to:

- **declare input variable of an appropriate type**
- **prompt user for input in the valid sub-range**
- **check if input value is of appropriate type and within valid sub-range**
- **if so, continue normal processing,**
- **if not, re-prompt and re-check until valid**

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Sample

```
int inputDigit;
      ..........
do  {       //  until input is a digit
   System.out.println("Please enter a digit: ");
   inString = stdin.readLine();
   inputDigit = Integer.parseInt (inString);
}  while(inputDigit < 0 || inputDigit > 9);
```

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