

CMSC 131: Chapter 5 (Supplement)

Program Design and Development

Program Design Strategies

Design Strategies: Different strategies can be used to develop a computer program that implements a solution to a particular set of specifications.

Flowchart:

Pseudocode:

How much detail?

- possible to **translate** it into a programming language
- but it is **free of language-dependent details**

Program Design Strategies

Large software systems: Software engineering techniques are required to manage the process:

- requirements documents
- design documents
- design presentations and reviews
- software systems for rebuilding, performing tests, handling trouble reports.
- and many more...

Program Design Strategies

Smaller projects: Are usually maintained by a single programmer. They still require good clean design to reduce the effort in debugging and maintenance.

Object-Oriented design:

Design before implementing:

Pseudocode+Homeworks: For several homework assignments you will be asked to provide pseudocode for several methods.

Example: Olympic Scoring

(Semi)-Olympic Scoring:

- Input a list of integer **scores**,
- **Drop the lowest** score, and output the **average** of the **remaining scores**.
- Scores are given by the user as **integers**. The average is expressed as a **double**.
- Terminate when **"quit"** is entered.
- We assume **at least two scores** are given (otherwise the problem is not well defined). We do not do error checking, but this should be added for a complete program.

Example: Olympic Scoring

Attempt 1: (A really rough cut)

- Initialize variables
- Repeat
 - Input a score
 - Update variables
- until seeing "quit"
- Compute and output final average

Olympic Scoring: Attempt 2

Attempt 2: (A bit more detail) Will need at least the following variables:

- **total**: a running total of the scores seen so far.
- **count**: a **count** of the number of scores seen so far.
- **min**: the **minimum score** seen so far.
- **score**: the **current score** being processed.
- **average**: the **final average**

Question: Should total and count include the contribution of min?

Olympic Scoring: Attempt 2

Attempt 2: (continued)

- Initialize variables: total = 0; count = 0; min = ??;
- Repeat
 - Input score
 - Update total and count: total += score; count++
 - Update min: if (score < min) min = score
- until seeing "quit"
- Factor min out: total -= min; count--
- Compute the average: average = total / count;

Remaining issues:

How to initialize min?

When "quit" is seen:

Olympic Scoring: Final Pseudocode

Attempt 3: We will initialize min to 11 (max score + 1). We will also add a check for "quit". We will create a boolean flag "isDone" and will set it to true when we see "quit".

- Initialize variables:
 - total = 0; count = 0;
 - min = 11;
 - isDone = false;
- Repeat
 - Read inputString
 - If (inputString equals "quit") then set isDone = true
 - Otherwise convert inputString to numeric score and do the following:
 - Update total and count: total += score; count++
 - Update min: if (score < min) min = score
- until isDone is true
- Factor min out: total -= min; count--
- Compute the average: average = total / count;

Sample Trace

It's a good idea to trace your pseudocode on a simple input to see that it will do what you expect. **Input:** {5, 7, 3, 2, 4, "quit"}

<u>Step:</u>	<u>total</u>	<u>count</u>	<u>min</u>	<u>isDone</u>
Initially:	0	0	11	false
Input 5:	5	1	5	
Input 7:	12	2	5	
Input 3:	15	3	3	

Input 1:	17	4	2
Input 4:	21	5	2
Input "quit":			true

After loop: 19 4 **Average** $\leftarrow 19/4 = 4.75$

Olympic Scoring: Almost correct

```
import javax.swing.*;

public class OlympicScoring {

    public static void main( String[] args ) {
        int total = 0;           // sum of scores
        int count = 0;           // number of scores seen
        int min = 11;            // minimum so far
        int score;               // the current input value
        boolean isDone = false;  // are we done?

        do {
            // ...(the rest of the loop shown on the next slide)
        } while ( ! isDone );

        total -= min;             // remove minimum from total
        count--;                 // ...and remove from the count
        double average = total / count; // compute the final answer
        JOptionPane.showMessageDialog( null, "Average score: " + average );
        System.exit( 0 );        // terminate swing
    }
}
```

Olympic Scoring: Adding in the Loop

```
do {
    // repeat until sentinel seen
    String inputString = JOptionPane.showInputDialog(
        "Enter a score\n (Enter quit to terminate)" );
    if ( inputString.equals( "quit" ) ) {
        isDone = true;           // we are now done
    } else {
        score = Integer.parseInt( inputString );
        total += score;
        count++;
        if ( score < min )        // update minimum if needed
            min = score;
    }
} while ( ! isDone );
```

Olympic Scoring: Remaining Issues

Cryptic variable values: In the initialization:

```
int min = 11;
```

the value 11 is hard to understand. We know how we got it (anything bigger than the maximum possible score of 10), but a reader of the code might not.

```
int maxValidScore = 10;    // maximum valid score
int min = maxValidScore + 1;
```

The output is wrong: On the input test "3 4 5" we should drop the minimum 3 and return the average of 4 and 5, which is 4.5. But instead we get 4.0. Why? Total and count are int. Thus:

```
double average = total / count;
```

We suffer from integer division truncation. Need a cast.

```
double average = (double) total / (double) count;
```

General Suggestions for Implementation

Once you have designed a solution for a particular problem, proceed to implement the design. Here are some suggestions.

Incremental code development:

Make frequent backups: (in our environment AutoCVS takes care of that for us.)

Better variable names: Use **refactoring** to improve variables names. (**Eclipse:** Highlight a variable name, then right-click and select **Refactor** → **Rename**.)

Fix indentation: Stupid typing errors are often revealed by proper indentation (e.g. missing braces). (**Eclipse:** Highlight the entire procedure, right-click and select **Source** → **Correct Indentation**.)

More Suggestions for Implementation

Here are more suggestions.

Test on "boundary cases": Most errors occur in the **limiting cases**. Be sure to test these.
Retest after each **major change**.

Don't assume, verify: Assumptions about how a construct or API method work can lead to future bugs.

Debugger: Later we will see a tool called a debugger, which will enable us to debug programs.

Testing and Debugging

Good Testing is Critical: A significant effort goes into this phase

Start simple: with basic test cases as you develop your code.

Printing: Use `System.out.println` in order to:

- determine the value associated with variables

```
System.out.println( "total = " + total );
```

- trace the flow of execution

```
public void foobar( ) {  
    System.out.println( "Entering foobar" );  
    // ... (the rest of foobar - omitted)  
    System.out.println( "Exiting foobar" );  
}
```

What happens if the program "hangs"?

- You probably have an **infinite loop** if this happens. Very common bug.
- **Eclipse:** Press the **red square button** on the upper right-hand side of the console window. This is your "abort" key—your escape hatch in an emergency. ☺

- **Example:**

```
int counter = 0;  
do {  
    counter += 1;  
    System.out.println(counter);  
}  
while (counter >= 0);
```