

CS 161A/B: Programming and Problem Solving I

Algorithm Design Document

Make a copy before you begin (File -> Make a copy). Add the Assignment # above and complete the sections below **BEFORE** you begin to code. The sections will expand as you type. When you are finished, download this document as a PDF (File -> Download -> PDF) and submit to D2L.

This document contains an interactive checklist. To mark an item as complete, click on the box (the entire list will be highlighted), then right click (the clicked box will only be highlighted), and choose the checkmark.

Planning your program before you start coding is part of the development process. In this document you will:

- ☒ ~~Paste a screenshot of your zyBooks Challenge and Participation %~~
- ☒ ~~Paste a screenshot of your assigned zyLabs completion~~
- ☒ ~~Write a detailed description of your program, at least two complete sentences~~
- ☒ ~~If applicable, design a sample run with test input and output~~
- ☒ ~~Identify the program inputs and their data types~~
- ☒ ~~Identify the program outputs and their data types~~
- ☒ ~~Identify any calculations or formulas needed~~
- ☒ ~~Write the algorithmic steps as pseudocode or a flowchart~~
- ☐ Tools for flowchart - [Draw.io](https://draw.io) - [Diagrams.net](https://diagrams.net)

1. zyBooks

Add your zyBooks screenshots for the % and assigned zyLabs completions below. Required percentages: all **assigned** zyLabs, Challenge Activity with at least 70%, and Participation Activity with at least 80%.

Challenge and Participation % screenshot:

11. CS 161B: Arrays

100% 84% 80% ^

Assigned zyLabs completion screenshot:

11.15 LAB: Even/odd values in an array	100%	▼
11.16 LAB: Adjust array by normalizing - functions	100%	▼
11.17 LAB: Insert Values into an array	100%	▼
11.18 LAB: Remove Values from an array	100%	▼

2. Program Description

In the box below, describe the purpose of the program. You must include a detailed description with at least two complete sentences.

Program description:

This program uses a user's input of their grades (on a 0-4 scale) and shows the letter grade in a list next to the score upon output. There will also be a list printed that shows the user the scores in ascending order, and another line that shows the median score.

3. Sample Run

If you are designing your own program, you will start with a sample run. Imagine a user is running your program - what will they see? What inputs do you expect, and what will be the outputs from the given inputs? Choose test data you will use to test your program. Calculate and show the expected outputs. Use the sample run to test your program.

Sample run:

```
Welcome to my Parallel Arrays program!
Please enter the list of scores (-1 to end input:)
Valid scores are between 0 and 4 inclusive.
>> 3.5
>> 2.7
>> 3.3
>> 2.5
>> 3.2
>> 1.5
>> 4.0
>> 3.7
>> -1
```

Your stats are as below:

The list of scores and their grades are:

3.5 A
2.7 B
3.3 B
2.5 C
3.2 B
1.5 D
4.0 A
3.7 A

The list sorted by scores in ascending order:

1.5 D
2.5 C
2.7 B
3.2 B
3.3 B
3.5 A
3.7 A
4.0 A

The median score is 3.25

Thank you for using my Parallel Arrays program!!

Welcome to my Parallel Arrays program!

Please enter the list of scores (-1 to end input:)

Valid scores are between 0 and 4 inclusive.

>> 3.5

>> 2.7

>> 3.3

>> 4.5

Invalid score! Please try again!!

>> abc

Invalid score! Please try again!!

>> 3.2

>> 1.5

>> 4.0

>> 3.7

>> 4.0

>> -1

Your stats are as below:

The list of scores and their grades are:

3.5 A
2.7 B

```
3.3 B
3.2 B
1.5 D
4.0 A
3.7 A
4.0 A
```

The list sorted by scores in ascending order:

```
1.5 D
2.7 B
3.2 B
3.3 B
3.5 A
3.7 A
4.0 A
4.0 A
```

The median score is 3.40

Thank you for using my Parallel Arrays program!!

4. Algorithmic Design

Before you begin coding, **you must first plan out the logic** and think about what data you will use to test your program for correctness. All programmers plan before coding - this saves a lot of time and frustration! Use the steps below to identify the inputs and outputs, calculations, and steps needed to solve the problem.

Use the pseudocode syntax shown in the document, supplemented with English phrases if necessary. **Do not include any implementation details (e.g. source code file names, class or struct definitions, or language syntax).** Do not include any C++ specific syntax or data types.

Algorithmic design:

- a. Identify and list all of the user input and their data types. Include a variable name, data type, and description. Data types include string, integer, floating point, (single) character, and boolean. Data structures should be referenced by name, e.g. "array of integer" or "array of string (for CS161B and up).

scores (double) - user can input scores in 0.0 format

scores[MAX_VALUES] (double array) - array representing user scores

&count (integer) - represents # of elements in the arrays that updates as scores are read

- b. Identify and list all of the user output and their data types. Include a variable name, data type, and description. Data types include string, integer, floating point, (single) character, and boolean. Data structures should be referenced by name, e.g. "array of integer" or "array of string" (for CS161B and up).

grades[MAX_VALUES] (char) - calculated by the user input for scores variable (with many conditions)

count (integer) - used to count grades and use to display lists for user and median

medianScore (double) - used to store and display the median score of all scores

- c. What calculations do you need to do to transform inputs into outputs? List all formulas needed, if applicable. If there are no calculations needed, state there are no calculations for this algorithm. Formulae should reference the variable names from step a and step b as applicable.

for the median:

$\text{mid} = \text{count} / 2$

- d. Design the logic of your program using pseudocode or flowcharts. Here is where you would use conditionals, loops or functions (if applicable) and list the steps in transforming inputs into outputs. Walk through your logic steps with the test data from the assignment document or the sample run above.

**Use the syntax shown at the bottom of this document and plain English phrases.
Do not include any implementation details (e.g. file names) or C++ specific syntax.**

FUNCTION void

welcome()

DISPLAY welcome message & prompt

END FUNCTION

FUNCTION void

readScores(double scores[], int &count)

END FUNCTION

FUNCTION void

readDouble (string prompt, double &num)

END FUNCTION

FUNCTION void

```
void calcGrade(double scores[], char grade[], int count)
END FUNCTION
```

```
FUNCTION void
```

```
void printList (double scores[], char grades[], int count)
END FUNCTION
```

```
FUNCTION void
```

```
    sort (double scores[], char grade[], int count)
END FUNCTION
```

```
FUNCTION double
```

```
    median (double scores[], int count)
END FUNCTION
```

```
DECLARE const integer MAX_VALUES = 20
```

```
FUNCTION int
```

```
    main()
    DECLARE double scores[MAX_VALUES]
    DECLARE char grades[MAX_VALUES]
    DECLARE integer count = 0
    DECLARE double medianScore = 0.0
```

```
    CALL welcome
    CALL readScores(scores, count)
    CALL calcGrade(scores, grades, count)
```

```
    DISPLAY your stats text
```

```
    CALL printList(scores, grades, count)
    CALL sort(scores, grades, count)
    CALL printList(scores, grades, count)
```

```
    SET double medianScore to:
        CALL median(scores, count)
```

```
    DISPLAY thank you text
```

```
END PROGRAM
```

```
// Function Definitions below
```

```
CALL void welcome
DISPLAY welcome text, enter scores prompt
```

```

CALL void readScores
  DECLARE double score, integer &count

  DISPLAY message to user about inputting scores

  CALL readDouble(">> ", score)

  WHILE score is not -1 or MAX_VALUES (aka 20)
    SET scores array with count++ equal to score

    IF count < MAX_VALUES (aka 20)
      CALL readDouble(">> ", score)
    ELSE
      DISPLAY List is now full message

CALL void readDouble(string prompt, double &num)
  DISPLAY prompt
  INPUT num
  WHILE num is less than 0 and NOT -1 or greater than 4
    DISPLAY invalid score message
    CLEAR BUFFER
    INPUT num
    CLEAR BUFFER

CALL void calcGrade
  DECLARE int i = 0
  FOR i = 0, i < count, i++
    IF scores[i] is between 3.3 and 4.0
      SET grade[i] = 'A'
    ELSE IF scores[i] is between 2.7 and 3.3
      SET grade[i] = 'B'
    ELSE IF scores[i] is between 1.9 and 2.7
      SET grade[i] = 'C'
    ELSE IF scores[i] is between 1.1 and 1.0
      SET grade[i] = 'D'
    ELSE IF scores[i] is between 0.0 and 1.1
      SET grade[i] = 'F'
    END IF

CALL void printList(double scores[], char grades[], int count)

```

```

DECLARE i = 0
FOR i = 0, i < count, i ++
    DISPLAY scores[i] and grades [i] with a " " inbetween them

CALL void sort(double scores[], char grade[], int count)
    DECLARE minIndex (integer) = 0
    DECLARE tempScore (double) = 0.0
    DECLARE tempGrade (char) = ' '
    DECLARE i (integer) = 0
    DECLARE j (integer) = 0

    FOR i = 0, i < count, i++
        SET minIndex = i
        FOR j = i + 1, j < count, j++
            IF scores[j] < scores[minIndex]
                SET minIndex = j
            END IF
        IF minIndex does not equal i
            SET tempScore = scores[minIndex]
            SET scores[minIndex] = scores[i]
            SET scores[i] = tempScore

            SET tempGrade = grade[minIndex]
            SET grade[minIndex] = grade[i]
            SET grade[i] = tempGrade

CALL double median (double scores[], int count)
    DECLARE mid (integer) = 0
    DECLARE medianScore (double) = 0.0

    IF count modulo 2 is 1
        RETURN scores[count/2]
    ELSE
        SET mid = count / 2
        RETURN scores[mid - 1] + scores[mid] / 2.0
    DISPLAY median score message + medianScore

END

```


5. Pseudocode Syntax

Think about each step in your algorithm as an action and use the verbs below:

To do this:	Use this verb:	Example:
Create a variable	DECLARE	DECLARE integer num_dogs
Print to the console window	DISPLAY	DISPLAY "Hello!"
Read input from the user into a variable	INPUT	INPUT num_dogs
Update the contents of a variable	SET	SET num_dogs = num_dogs + 1
Conditionals		
Use a single alternative conditional	IF <i>condition</i> THEN <i>statement</i> <i>statement</i> END IF	IF num_dogs > 10 THEN DISPLAY "That is a lot of dogs!" END IF
Use a dual alternative conditional	IF <i>condition</i> THEN <i>statement</i> <i>statement</i> ELSE <i>statement</i> <i>statement</i> END IF	IF num_dogs > 10 THEN DISPLAY "You have more than 10 dogs!" ELSE DISPLAY "You have ten or fewer dogs!" END IF
Use a switch/case statement	SELECT <i>variable or expression</i> CASE <i>value_1</i> : <i>statement</i> <i>statement</i> CASE <i>value_2</i> : <i>statement</i> <i>statement</i> CASE <i>value_2</i> : <i>statement</i> <i>statement</i> DEFAULT: <i>statement</i> <i>statement</i> END SELECT	SELECT num_dogs CASE 0: DISPLAY "No dogs!" CASE 1: DISPLAY "One dog.." CASE 2: DISPLAY "Two dogs.." CASE 3: DISPLAY "Three dogs.." DEFAULT: DISPLAY "Lots of dogs!" END SELECT
Loops		
Loop while a condition is true - the loop body will	WHILE <i>condition</i> <i>statement</i>	SET num_dogs = 1 WHILE num_dogs < 10

execute 0 or more times.	<i>statement</i> END WHILE	DISPLAY num_dogs, " dogs!" SET num_dogs = num_dogs + 1 END WHILE
Loop while a condition is true - the loop body will execute 1 or more times.	DO <i>statement</i> <i>statement</i> WHILE <i>condition</i>	SET num_dogs = 1 DO DISPLAY num_dogs, " dogs!" SET num_dogs = num_dogs + 1 WHILE num_dogs < 10
Loop a specific number of times.	FOR <i>counter</i> = <i>start</i> TO <i>end</i> <i>statement</i> <i>statement</i> END FOR	FOR count = 1 TO 10 DISPLAY num_dogs, " dogs!" END FOR
Functions		
Create a function	FUNCTION <i>return_type</i> <i>name (parameters)</i> <i>statement</i> <i>statement</i> END FUNCTION	FUNCTION Integer add(Integer num1, Integer num2) DECLARE Integer sum SET sum = num1 + num2 RETURN sum END FUNCTION
Call a function	CALL <i>function_name</i>	CALL add(2, 3)
Return data from a function	RETURN <i>value</i>	RETURN 2 + 3