Experiment 1

Introduction to C++ Programming - I

Objectives

To write simple computer programs in C++.

Prelab Activities

Programming Output

For each of the given program segments, read the code and write the output in the space provided below each program. [Note: Do not execute these programs on a computer.]

1. What is the output of the following program?

```
#include <iostream>
using namespace std;

int main()
{
    int x;
    int y;

    x = 30;
    y = 2;
    cout << x * y + 9 / 3 << endl;
} // end main
```

2. What is output by the following line of code?

```
cout << ( 8 * 4 * 2 + 6 ) / 2 + 4;
```

For 3 and 4 , use the program given below.

```
#include <iostream>
using namespace std;

int main()
{
    int input;

    cout << "Please enter an integer: ";
    cin >> input;

    if ( input != 7 )
         cout << "Hello" << endl;

    if ( input == 7 )
         cout << "Goodbye" << endl;
} // end main
```

3. What is output by the program? Assume that the user enters 5 for input.

4. What is output by the program in? Assume that the user enters 7 for input.

For 5 and 6 , use the program given below.

```
#include <iostream>
using namespace std;

int main()
{
    int input;

    cout << "Please enter an integer: ";
    cin >> input;

    if ( input >= 0 )
         cout << "Hello" << endl;

    cout << "Goodbye" << endl;
} // end main
```

5. What is output by the program? Assume the user enters 2 for input.

6. What is output by the program? Assume the user enters -2 for input.

7. What is output by the following program?

```
#include <iostream>
using namespace std;

int main()
{
    int x = 3;
    int y = 9;
    int z = 77;

    if ( x == ( y / 3 ) )
         cout << "H";

    if ( z != 77 )
         cout << "q";

    if ( z == 77 )
         cout << "e";

    if ( z * y + x < 0 )
         cout << "g";

    if ( y == ( x * x ) )
         cout << "ll";

    cout << "o!" << endl;
} // end main
```

8. What is the output of the following program segment?

```cpp
int x = 1;

while ( x <= 5 )
{
   x++;
   cout << "The value of x is: " << x << endl;
}

cout << "The final value of x is: " << x << endl;
```

9. What is the output of the following program segment?

```cpp
int grade1 = 85;
int grade2 = 55;

cout << "The student with a grade of " << grade1 << " "
        << ( grade1 >= 60 ? "Passed\n" : "Failed\n" );

cout << "The student with a grade of " << grade2 << " "
        << ( grade2 >= 60 ? "Passed\n" : "Failed\n" );
```

10. What is the output of the following program segment?

```cpp
int a = 6;
int b = 2;
int c = -4;
int d = 1;

a += c;
d -= b;
b /= a;
c *= a;

cout << a << " " << b << " " << c << " " << d;
```

11. What is the output of the following program segment?

```cpp
int x = 1;

switch ( x )
{
     default:
          cout << "none ";
     case 1:
          cout << "one ";
     case 2:
          cout << "two ";
     case 3:
          cout << "three ";
     case 4:
          cout << "four ";
} // end switch
```

12. What is the output of the following program segment?

```
int x = 1;
int y = 2;
int z = 3;

if ( x == 2 || y + 1 == z )
    cout << "A";

if ( z / x < y && x + y > z )
    cout << "B";

if ( y - z <= 0 || x - z <= 0 )
    cout << "C";
```

Correct the Code

For each of the given program segments, determine if there is an error in the code. If there is an error, specify whether it is a logic or compilation error, write the corrected code. If the code does not contain an error, write “no error.” For code segments, assume the code appears in main and that using directives are provided. [*Note*: It is possible that a program segment may contain multiple errors.]

13. The following program should print an integer to the screen:

```
#include <iostream>;
using namespace std

int main()
{
    int x = 30;
    int y = 2;

    cout << x * y + 9 / 3 << endl;
} // end main
```

14. The following program segment should input and sum integers from the user until the sentinel value, -1, is entered.

```
    int total = 0;
    int input;

    while ( input != -1 )
    {
          cin >> input;
          total += input;
    }
```

15. The following switch statement should print either x is 5, x is 10 or x is neither 5 nor 10.

```
    switch ( x )
    {
          case: 5
                cout << "x is 5\n";

          case: 10
                cout << "x is 10\n";

          case default:
                cout << "x is neither 5 nor 10\n";
    }
```

Lab Exercises

Lab Exercise 1 — Random Data Generation, Mean, Variance and Standart Deviation Calculation

The problem is divided into five parts:

1. Lab Objectives
2. Description of the Problem
3. Sample Output
4. Program Template
5. Problem-Solving Tips

The program template represents a complete working C++ program. Read the problem description and examine the sample output; then study the template code. Using the problem-solving tips as a guide, implement the C++ code required. Compile and execute the program. Compare your output with the sample output provided.

Lab Objectives

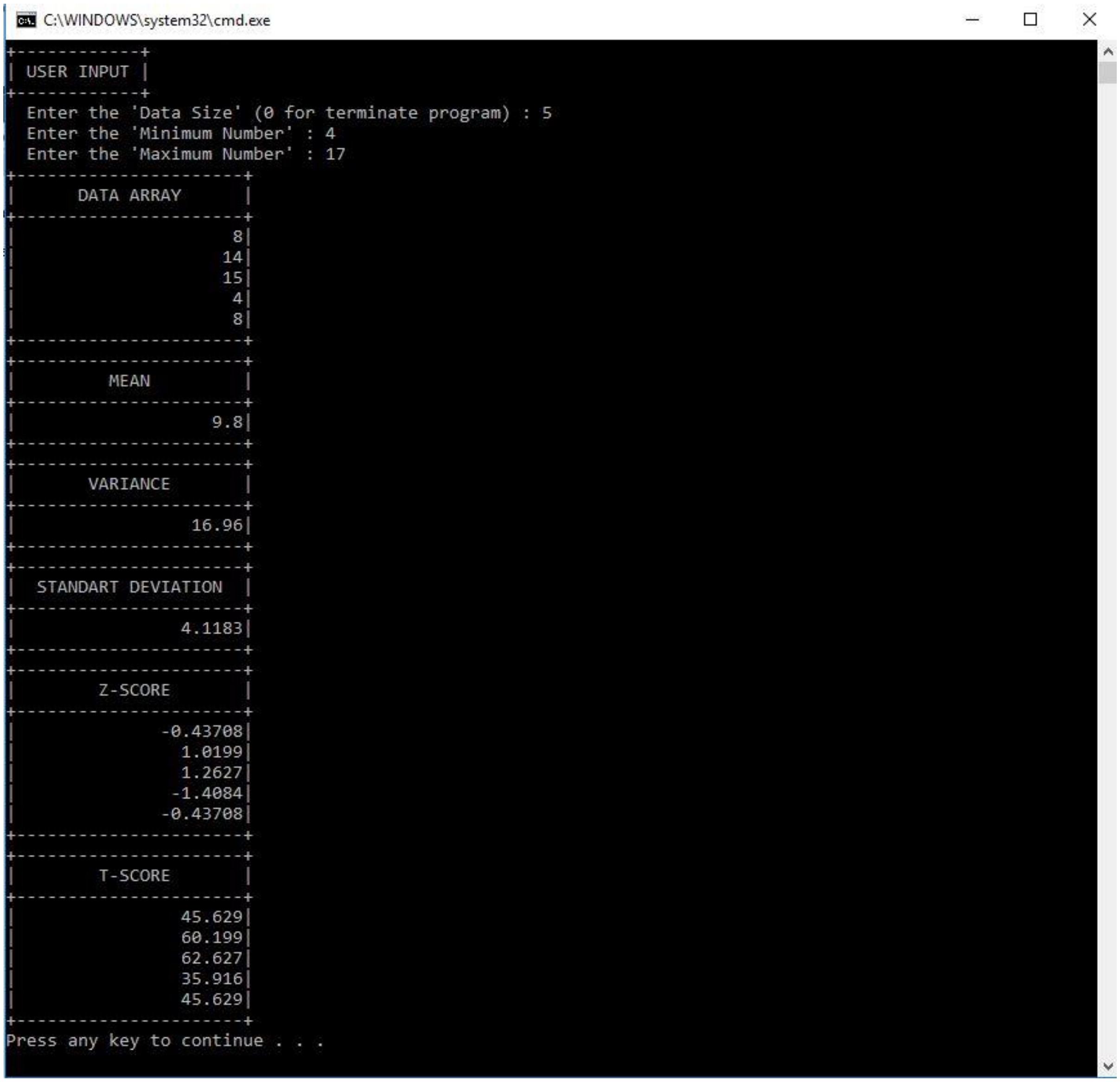
In this lab, you will practice:

- Using cout to output text and variables.
- Using cin to input data from the user.
- Using if statements to make decisions based on the truth or falsity of a condition.
- Using the arithmetic operators to perform calculations.
- Using relational operators to compare values.
- Using arrays to hold data
- Using loops to calculate some operations
- Using C++ references to reference a variable
- Using I/O manipulation to visualize output in a proper way

Description of the Problem

Write a C++ console application program that calculates the “Mean”, “Variance”, “Standard Deviation”, “Z-Score” and “T-Score” of a randomly generated data. Program template and required function prototypes are given to you. Your job is to implement the given functions and visualize the generated data and calculated values on the command prompt. (Note: You are not allowed to change the given function prototypes or add a new function, just implement required functions)

Sample Output



```
+------------+
| USER INPUT |
+------------+
  Enter the 'Data Size' (0 for terminate program) : 5
  Enter the 'Minimum Number' : 4
  Enter the 'Maximum Number' : 17
+----------------------+
|      DATA ARRAY      |
+----------------------+
|                     8|
|                    14|
|                    15|
|                     4|
|                     8|
+----------------------+
+----------------------+
|         MEAN         |
+----------------------+
|                   9.8|
+----------------------+
+----------------------+
|       VARIANCE       |
+----------------------+
|                 16.96|
+----------------------+
+----------------------+
|  STANDART DEVIATION  |
+----------------------+
|                4.1183|
+----------------------+
+----------------------+
|        Z-SCORE       |
+----------------------+
|              -0.43708|
|                1.0199|
|                1.2627|
|               -1.4084|
|              -0.43708|
+----------------------+
+----------------------+
|        T-SCORE       |
+----------------------+
|                45.629|
|                60.199|
|                62.627|
|                35.916|
|                45.629|
+----------------------+
Press any key to continue . . .
```

Template

```
/******************************************
 * Source.cpp                           *
 *****************************************
 * IDE : Visual Studio 2015              *
 * Author : Cihan UYANIK                 *
 * Experiment 1: Introduction to C++ - I *
 *****************************************/

#include <iostream>
#include <time.h>
#include <iomanip>
#include <string>
using namespace std;

bool TakeUserInput(int& data_size, int& min_number, int& max_number);
int* CreateDataSet(int dataSize, int min_number, int max_number);
double CalculateMean(int* data_array, int data_size);
double CalculateVariance(int* data_array, int data_size, double mean);
double CalculateStandartDeviation(int* data_array, int data_size, double mean);
double* CalculateZScore(int* data_array, int data_size, double mean, double
std_deviation);
void PrintMessage(const string& message);
void PrintDataArray(int* data_array, int data_size);
void PrintMean(double mean);
void PrintVariance(double variance);
void PrintStandartDeviation(double std_deviation);
void PrintZScoreArray(double* zscore, int data_size);
double* CalculateTScore(int* data_array, int data_size, double mean, double
std_deviation);
void PrintTScoreArray(double* tscore, int data_size);

int main()
{
	srand(time(NULL));
	int dataSize, minNumber, maxNumber;
	if (!TakeUserInput(dataSize, minNumber, maxNumber)){
		PrintMessage("TERMINATED BY USER!");
		return 1;
	}
	int* DataArray = CreateDataSet(dataSize,minNumber,maxNumber);
	PrintDataArray(DataArray, dataSize);
	double mean = CalculateMean(DataArray,dataSize);
	PrintMean(mean);
	double variance = CalculateVariance(DataArray, dataSize, mean);
	PrintVariance(variance);
	double stdDeviation = CalculateStandartDeviation(DataArray, dataSize, mean);
	PrintStandartDeviation(stdDeviation);
	double* zscore = CalculateZScore(DataArray, dataSize, mean, stdDeviation);
	PrintZScoreArray(zscore, dataSize);
	double* tscore = CalculateTScore(DataArray, dataSize, mean, stdDeviation);
	PrintTScoreArray(tscore, dataSize);

	return 0;
}
```

Problem-Solving Tips

1. “TakeUserInput” function receives three reference arguments and changes this variable values and returns true or false depending on user input.
2. To create a randomly generated dataset you can use “rand()” function. However, you have to generate random numbers depending on the minimum and maximum values. That is, generated numbers must be in the given range. To generate a random number between the given range. You can use rand() function as given:

```
int randomNumber = min_number + rand() % (max_number - min_number + 1);
```

3. Use “iomanip” library to adjust the number width on a line.

4. To calculate the “Mean” of a data set, look at the given mean calculation formula.

$$\mu = \frac{\sum_{i=1}^{n} x_i}{n}$$

$\mu : Mean$
$x_i : A\ member\ of\ a\ dataset$
$n : Number\ of\ elements\ in\ the\ dataset$

5. To calculate the “Variance” of a data set, look at the given variance calculation formula.

$$\sigma^2 = \frac{1}{\mathrm{n}} \sum_{i=1}^{n} (x_i - \mu)^2$$

$\sigma^2 : Variance\ of\ the\ dataset$
$x_i : A\ member\ of\ a\ dataset$
$n : Number\ of\ element\ in\ the\ dataset$
$\mu : Mean$

6. To calculate the “Standart Deviation” of a data set, look at the given standart deviation calculation formula.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \mu)^2}{n}}$$

$\sigma : Standart\ Deviation$
$x_i : A\ member\ of\ a\ dataset$
$n : Number\ of\ element\ in\ the\ dataset$
$\mu : Mean$

7. To calculate the Z-Score, look at the given Z-Score calculation formula.

$$Z_i = \frac{x_i - \mu}{\sigma}$$

$Z_i : ZScore\ of\ a\ i'th\ element\ of\ the\ dataset$
$x_i : ith\ element\ of\ the\ dataset$
$\mu : Mean$
$\sigma : Standart\ Deviation$

8. To calculate the T-Score, look at the given T-Score calculation formula.

$$T_i = 10 * \left(\frac{x_i - \mu}{\sigma}\right) + 50$$

$T_i : TScore\ of\ a\ i'th\ element\ of\ the\ dataset$
$x_i : ith\ element\ of\ the\ dataset$
$\mu : Mean$
$\sigma : Standart\ Deviation$