CS 103 Lab - Arrays and Functions

1 Introduction

In this lab you will write a program to plot out a simple version of the "bell curve" or "normal distribution" based on the sum of 4 random dice rolls.

2 What you will learn

After completing this lab you should be able to:

- Prototype and write the implementation of a function
- Understand array indexing
- Understand how to use loops to iterate over arrays
- Introduce randomness into your program

3 Background Information and Notes

The "normal distribution" is a very important family of probability distributions. If you take any random event that produces numerical values, and repeat it often, the average of those values, although random, behaves in a predictable way. In this lab we are using only a small number of rolls (4), which is not infinite, but enough to yield a curve that resembles the bell curve. Here is a sample run of your program:

```
How many rolls do you want? 500 (this is the user input)
 4:
 5:X
 6:XXX
 7:XXXXXXXXXXXXX
 8:XXXXXXXXXXXXX
 9:XXXXXXXXXXXXXXXXXXXXX
10:XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
11:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
12:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
13:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
14:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
15:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
17:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
18:XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
19:XXXXXXXXXXXXXXXXX
20:XXXXXXXXXX
21:XXX
22:XX
23:
24:X
```

In this example, we asked the program to simulate 500 4-dice rolls. The sum was never four, the sum was five on 1 of the 500 trials, the sum was six on 3 of the trials, etc.

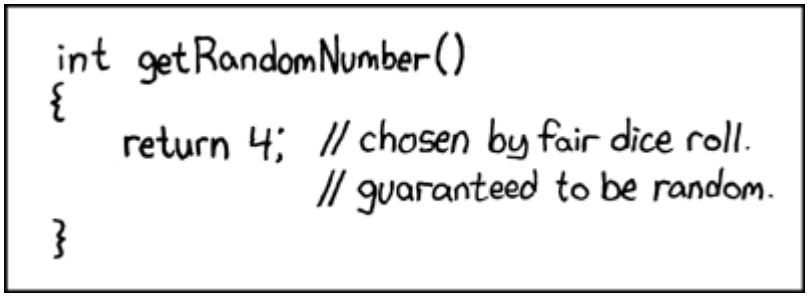
4 Procedure

You'll write this week's lab from scratch. Call your file `diceplot.cpp`.

4.1 [2 pts.] int roll()

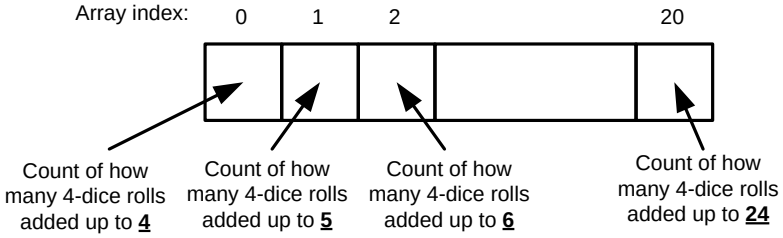
Define a function roll() that takes no arguments, and returns a random integer from 1 to 6. Before proceeding further, we recommend you write a short main method to test it out and make sure it gives you the right values. Comment this main out after you are satisfied that roll() works.

Remember: textbook Section 4.9 is on randomness, and Chapter 5 is on functions.



HTTP://XKCD.COM/221/ (NOTE: THIS FUNCTION IS A JOKE…DON'T USE IT)

Overview of the rest of the lab: The rest of your lab will be to write a program to simulate 500 rolls of 4-dice.



4.2 [3 pts.] void printHistogram(int counts[])

Before moving on to the logic to add up rolls and count them, we will implement a function that encapsulates the output display of our sums. You will write a function **void printHistogram(int counts[])** that takes an array of integers (assumed to be of

size 21 elements), then prints out sequential labelled lines from **4 to 24** with as many `X` symbols on that line as is indicated in the appropriate element of the array (i.e. **counts[i]**). We start our labels at 4 since rolling 4 dice can't produce a sum of 0-3 (i.e. index 0 of the array corresponds to roll totaling 4, index 1 to a roll totaling 5, index 2 a roll totaling 6, …, and index 20 to a roll totaling 24).

Let's test our printHistogram function by writing a sample main() that calls it. We will fill in a dummy array and just ask printHistogram to print it out. You should try the same and ensure your printHistogram is working with our dummy main():

```
int main() {
   int testCounts[21];  // 21 options of sum of 4 dice => [4,24]
   for (int i=0; i<21; i++)
      testCounts[i] = i/2; // fill the array
   printHistogram(testCounts); // call your method
}
```

it should produce the following output:

```
 4:
 5:
 6:X
 7:X
 8:XX
   …
24:XXXXXXXXXX
```

4.3 [4 pts.] main function

Finally, write the main function of the program. (Comment out all the other test main methods you used earlier.) It should

- Ask the user for a number, call it **n**
- Run **n** experiments, where each experiment rolls 4 dice and adds them up
- Throughout the experiments, keeps track of how often each possible sum (from 4 to 24) occurred
- Prints out the histogram showing how many times each sum occurred (so in total it should print out **n** of the X symbols)
- Your program should give different results each time it runs. Make sure you seed the random number generator appropriately.

4.4 [1 pt.] Reflection

Suppose we wanted to change the program to roll 10 three-sided dice instead. Is there a different way to write your program to facilitate this change easily? (Hint: refer to page 39 of the textbook.)

You can just answer this question to the TA verbally. You don't need to change your program.

Demonstrate your program and show your TA/CP the two functions you wrote explaining how it works.