Homework 7 – Due: 10/16/2024 11:59 pm

Problem 1. [30 points] The mathematical combinations function c(n, k) is usually defined in terms of factorials, as follows:

$$c(n,k) = \frac{n!}{k! (n-k)!}$$

The values of c(n, k) can also be arranged geometrically to form a triangle in which n increases as you move down the triangle and k increases as you move from left to right. The resulting structure, which is called Pascal's Triangle, is arranged like this:

$$c(0,0)$$

$$c(1,0) c(1,1)$$

$$c(2,0) c(2,1) c(2,2)$$

$$c(3,0) c(3,1) c(3,2) c(3,3)$$

$$c(4,0) c(4,1) c(4,2) c(4,3) c(4,4)$$

Pascal's Triangle has the interesting property that every entry is the sum of the two entries above it, except along the left and right edges, where the values are always 1. For example, c(3,2) can be written as c(2,1)+c(2,2). Using this fact, write a recursive implementation of the c(n, k) function that uses no loops, no multiplication, and no calls to a function that computes factorial of n. The function should take two input arguments n and k and return c(n,k). Write a main program to display the results for n = 6 and k = 1, 2, ..., 6.

Report your result in the write-up.

Please submit your .cpp_file as "yourLastName hw7 prob1.cpp".

Problem 2. [35 points] *Roll Three Dice.* Write a C++ function that simulates the outcome of rolling three dice simultaneously. Each die is fair (with an equal probability of getting 1, 2, 3, 4, 5, 6) and independent. For example, if the first die gets 2, the second die gets 4 and the third die gets 3, the function returns 9. Write a main function that calls the function and simulates 10000 3-dice rolls, and the function calculates and displays probability for the sum of three dice equals 3, 3, 4, ..., 18.

Report your results in the write-up.

Submit your .cpp file as "yourLastName hw7 prob2.cpp".

Hint: We ask you to use vector to store the total number of rolls that gives the results of 3, 3, 4, ..., 18. Declaring 16 separate variables is a bad idea.

Problem 3. [35 points] *Pokemon Battle!* Write a function with the following signature to simulate one round of a Pokemon attack:

void attack(double &attackerHealth, double &defenderHealth, int move);

Here attackerhealth is the current health state for the attacker, and defenderHealth is the current health state for the defender. Both input variables have a possible value range from 0.0 to 100.0. The user and the computer will take turns to choose one of the following three moves based on the following value of move:

- 1: an attack with damage between 15.0 and 30.0 with equal probability to the defender
- 2: an attack with damage between 0.0 and 50.0 with equal probability to the defender.
- 3: Heal an amount between 5.0 and 20.0 with equal probability to the attacker.

Using this function, write a main program that simulates a Pokemon battle between the user and the computer (this function can be used for both user turn and the computer turn). Initially, both the user and the computer have a health point of 100. The user should take the first move, and the function should take the user's choice of move using Cin. If the user entered an invalid option, please ask the user to enter a new choice again until a valid option is entered. The computer should choose the heal option when its health is below 25, otherwise the computer will choose one of the three options with equal probability. After each attack, a message should be printed out that tells the user what just happened, and how much health the user and computer have. If a heal leads to a health state over 100.0, the health state will be set to 100.0. If an attack leads to a health state below 0.0, the health state will be set to 0.0, and the battle ends.

There is no write-up for this problem.

Submit your .cpp file as "yourLastName_hw7_prob3.cpp".

What to submit:

There should be 3 files in your submission:

- 1. A write up (any type-.txt, .docx, .pdf are all fine) that contains your answers to all questions in problem 1 and 2.
- 2. The .cpp file for your problem 1. Please name this file as [YourLastName]_prob1.cpp.
- 3. The .cpp file for your problem 2. Please name this file as [YourLastName]_prob2.cpp.

4. The .cpp file for your problem 3. Please name this file as [YourLastName]_prob3.cpp.

Optional Short answers questions. The following questions will not be graded. You may use them for preparing your next week's quiz.

(1) What will the following code output? #include <iostream> using namespace std; void printNumber(int num) { cout << "Integer: " << num << endl;</pre> } void printNumber(double num) { cout << "Double: " << num << endl;</pre> } void printNumber(int num1, int num2) { cout << num1 <<" and " << num2 << endl;</pre> int main() { double a = 4.1; int b = 3; printNumber(a); printNumber(b); printNumber(a, b); return 0; } (2) Please complete the following C++ function that computes the series (1) + (1+2) + (1+2+3) + (1+2+3+4) + ... + (1+2+3+4+...+n) using a nested for loops. int func(int n){ // you may assume n > 0.

// No error checking is needed

```
return ret;
}
```

(3) Please fix **FIVE** errors in the following code so the function computes abs(a-b), where a and b are both double variables. When you run the program, the correct code should display **0.9** on the screen.

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

int main() {

   double a = 1.5;
   double b = 2.4;

   cout<< difference(double a, double b)<< endl;
   return 0;
}

int difference(int x, int y){
   double diff = abs(x-y);
}</pre>
```

(4) Please identify and correct the error in the following function.

```
bool isPositive(double num) {
   // the function returns true if num is positive
   // the function returns false otherwise

if (num > 0){
   bool ret = true;
```

int t = a; a = b;

```
}else{
          bool ret = false;
        }
        return ret;
     }
(5) What is the output?
     int i = 150;
     for(int i = 0; i < 2; i++) {
          cout << i << endl;</pre>
     cout << i << endl;</pre>
(6) What is the output?
        int a = 5;
        int \&b = a;
        int c = a;
        cout << a << "," << b << ","<< c << endl;
        c = 3;
        cout << a << "," << b << ","<< c << endl;
        b = 4;
        cout << a << "," << b << ","<< c << endl;
        a = 7;
        cout << a << "," << b << "," << c << endl;
(7) What is the output of the following C++ code? Do you think it works in the correct
way?
     #include <iostream>
     using namespace std;
     void swap(int &a, int b) {
```

```
b = t;
}
int main() {
    int q = 3;
    int r = 5;
    swap(q, r);
    cout << "q" << q << endl;
    cout << "r" << r << endl;
    return 0;
}</pre>
```

(8) What is the output of the following code?

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

void doubleNumber(int num){
   num = num*2;
}

int main(){
   int num = 35;
   doubleNumber(num);
   cout << num << endl;
   return 0;
}</pre>
```