CS145: Computer Science II
Programming Assignment 2
(100 points)
No late submission will be allowed!

Problem Statement:

In a game named Nim, two players alternately take marbles from a pile. In each turn, a player must make a legal move taking at least one but at most half of the marbles from the pile and then let the other player take a turn. The player who is to take the last marble loses the game.

1. You will write a C++ program that enables the computer to play against a human opponent.

2. Begin with generating a random integer between 10 and n (which is a user input >= 10) to denote the initial pile size.

3. Then generate 0 or 1 randomly to decide which player takes the first turn. Let 0 be player plays first, 1 computer plays first.

4. When the computer takes its turn, it makes the following legal move:

    a. take off enough marbles to make the size of the remaining pile a power of 2 minus 1 (1, 3, 7, 15, 31 are some examples of the power of 2 minus 1) if the current pile size is not one of those power of 2 minus 1.
    b. When the current pile size is already a power of 2 minus 1, make a random move taking at least one but at most half of the marbles.

5. When (human) player takes his/her turn, player can take at least one but at most half of the marbles from the pile. Your defined function will ask how many marbles the player wants to remove and verify if it is legal.

Supplements:

1. A number *n* is power of 2 minus 1 if $log_2(n+1)$ *is an integer*. To determine if $log_2(n+1)$ is an integer or not, we use the following statement:

    If($log_2(n+1)$ == static_cast<int>($log_2(n+1)$))

2. The number of marbles to be taken out to make the size n of plie a power of 2 minus 1 is calculated:

$$n - 2^{\lfloor log_2 n \rfloor} + 1$$

3. The function to determine if a string is a number is:

```
bool isNumber(string s) {
        if (s.length() == 0) {
                return false;
        }
        for (int i = 0; i < s.length(); i++) {
            if (!isdigit(s[i])) {
                    return false;
             }
        }
        return true;
}
```

4. The function to convert a string to an integer, assuming the sting is convertible to an integer:

```
int StringToInt(string s) {
   return atoi(s.c_str());
}
```

5. Headers that you need to include in the program are:

```
#include <iostream>
#include <string>
#include <time.h>
#include <math.h>
```

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The following is an example when you run the program:

```
Welcome to the game of Nim.
To start, please enter a number greater than 10 to serve as
the max range of the pile size.
7
Welcome to the game of Nim.
To start, please enter a number greater than 10 to serve as
the max range of the pile size.
a
Welcome to the game of Nim.
To start, please enter a number greater than 10 to serve as
the max range of the pile size.
7a
Welcome to the game of Nim.
To start, please enter a number greater than 10 to serve as
the max range of the pile size.
99
Computer plays first.
The size of the pile is 50
The Computer removed 19 marbles.  The
size of the pile is 31
How many marbles would you like to remove?
45.53
Illegal move. You must remove at least 1 or at most half of
the marbles.
How many marbles would you like to remove?
16
Illegal move. You must remove at least 1 or at most half of
the marbles.
15
The size of the pile is 16
The Computer removed 1 marbles.
The size of the pile is 15
How many marbles would you like to remove?  3
The size of the pile is 12
The Computer removed 5 marbles.
The size of the pile is 7
How many marbles would you like to remove?  8
```

```
Illegal move. You must remove at least 1 or at most half of
the marbles.
How many marbles would you like to remove? 3
The size of the pile is 4
The Computer removed 1 marbles.
The size of the pile is 3
How many marbles would you like to remove? 1
The size of the pile is 2
The Computer removed 1 marbles.
The size of the pile is 1
How many marbles would you like to remove? 1
The game is over! You
lose!
Thank you for playing this game.

Press ENTER to continue.
```

Your program must compile and execute without any errors or warnings.

Submission Guidelines:

To receive full credit, you must follow these guidelines

1. All code must include comments, be properly indented and use descriptive variable names where appropriate.
2. Compress the entire project folder with solution directory to a compressed file and *submit this to the appropriate dropdox on D2L*
3. After submission, double check to make SURE your submit the proper files, ***YOU WILL NOT HAVE A CHANGE TO FIX THIS AFTER THE DUE DATE!!***

Grading Guidelines:

1. If your program does not compile and lack efforts (i.e., lack comments and function implements), you receive 0.
2. If your program does not compile but shows significant efforts in code, you receive at most 50% of the total credit.
3. If you program can compile but missing small functionalities (i.e., checking if input is valid or not), you receive at most 70% of the total credit if you showed significant efforts in code. Or, graded according to the grading sheet below.

Grading Sheet for Programming Assignment 2

Total: 100 points.

	Points	Deducted Points
Correctness	90	
1. Program runs properly: asking for initial number of marbles in pile; user and computer taking turns to play.	40	
2. Program correctly determine who wins the game.	20	
3. Allow the user to choose how many marbles to remove and validate the user input, if handle accordingly.	10	
4. Computer correctly calculates number of marbles to remove.	20	
Style	10	
1. Lay out your program in a readable fashion	4	
2. Include comments as specified in the lecture notes	4	
3. User-friendliness in I/O design	2	
Your Score		