Description:

Implementation of random number generation techniques:

a. linear congruential

b. blum-blum shub generator

The linear congruential method produces a sequence of integers X_1, X_2, X_3, ... between **zero** and **m-1** according to the following recursive relationship:

$$X_{i+1} \equiv (aX_i + c) \bmod m, \qquad i = 0, 1, 2, \ldots$$

- The initial value X_0 is called the seed;
- a is called the constant multiplier;
- c is the increment
- m is the modulus

The selection of **a, c, m** and **X_0** drastically affects the statistical properties such as mean and variance, and the cycle length.

Example: m=123, a=5, c=2, seed X_0=73

X_1=(5x73+2) mod 123
=367 mod 123
=121
X_2=(5x121+2) mod 123
=607 mod 123
=115
X_3=(5x115+2) mod 123
=577 mod 123
=85
……….
If we want to generate random bit
X_0=73 ≡ 1 mode 2=>1
X_1=121≡ 1 mode 2=>1
X_2=115≡ 1 mode 2=>1
X_3=85≡ 1 mode 2=>1
X_4=58≡ 0 mode 2=>0
….
We get random 0 and 1….

Instructions:
Take the input from the file i.e. m, a, c, X_0 and the range in which a random number is to be generated, and print the random numbers

The Blum Blum Shub (BBS) method is as pseudorandom number generator and was created by Lenore Blum, Manuel Blum and Michael Shub in 1968. It uses the form of:

$$X_i = (X_{i-1})^2 \bmod n$$

where X_0 is a random seed. The value of **n** is equal to pq and where p and q are prime numbers. These values of p and q are both congruent to 3 mod 4 (p=q=3 (mod4)). What does that mean? Well when I take the values of p or q and divide them by 4, I will get a remainder of 3.

So, p=7 is possible (as 7 divided by 4 is 1 remainder 3), and p=11 is also possible (as 11 divided by 4 is 2 remainder 3). A value of 13 is not possible is at will be 3 remainder 1
n=p.q=77
$X_1=(5)^2$ mod 77
$X_2=(25)^2$ mod 77
$X_3=(9)^2$ mod 77
$X_4=(4)^2$ mod 77
In this case we are using p=7 and q=11, and then a seed of $X_0=5$, and the random sequence is **25, 9, 4 and 16**

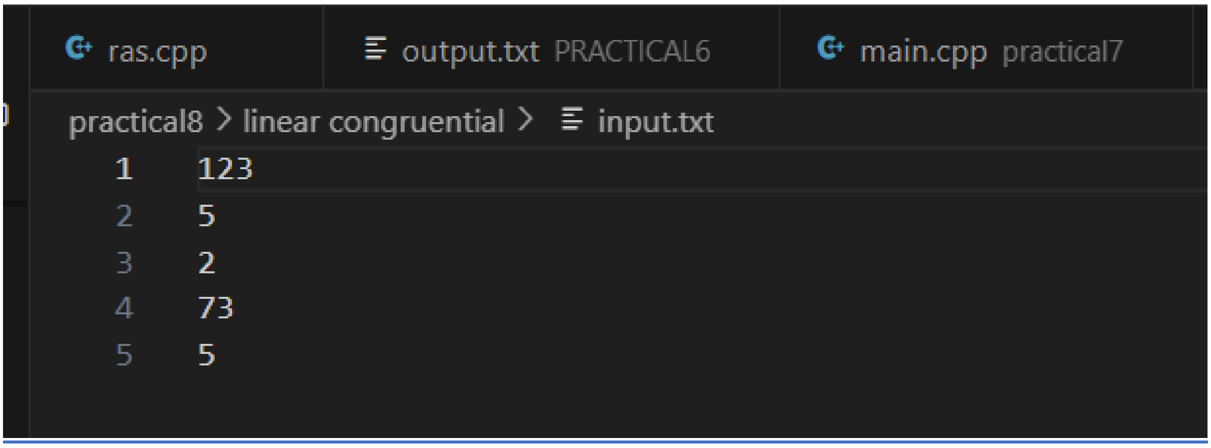
Instruction: Read the input from the file i.e. *p, q, X_0* and the range in which a random number is to be generated, and print the random numbers

Implementation of random number generation techniques:
a. linear congruential

- methodology followed

```
#include <iostream>
#include <bits/stdtr1c++.h>
#include <fstream>
using namespace std;

int main()
{

    ifstream fin;
    fin.open("input.txt");

    string s1;
    string s2;
    string s3;
    string s4;
    string s5;

    getline(fin, s1);
    getline(fin, s2);
    getline(fin, s3);
    getline(fin, s4);
    getline(fin, s5);

    long long int m = stoi(s1);
    long long int a = stoi(s2);
    long long int c = stoi(s3);
    long long int x0 = stoi(s4);
    long long int n = stoi(s5);
    vector<int> x;
    x.push_back(x0);

    for (int i = 1; i <= n; i++)
    {
        x.push_back((a * x[i - 1] + c) % m);
    }

    for (int i = 0; i <= n; i++)
    {
        cout << "X" << i << " : " << x[i] << "\n";
    }

    string binary;
    for (int i = 0; i <= n; i++)
    {
        binary.push_back(x[i] % 2 + '0');
    }

    cout << binary << "\n";
    fin.close();

    return 0;
}
```

INPUT:

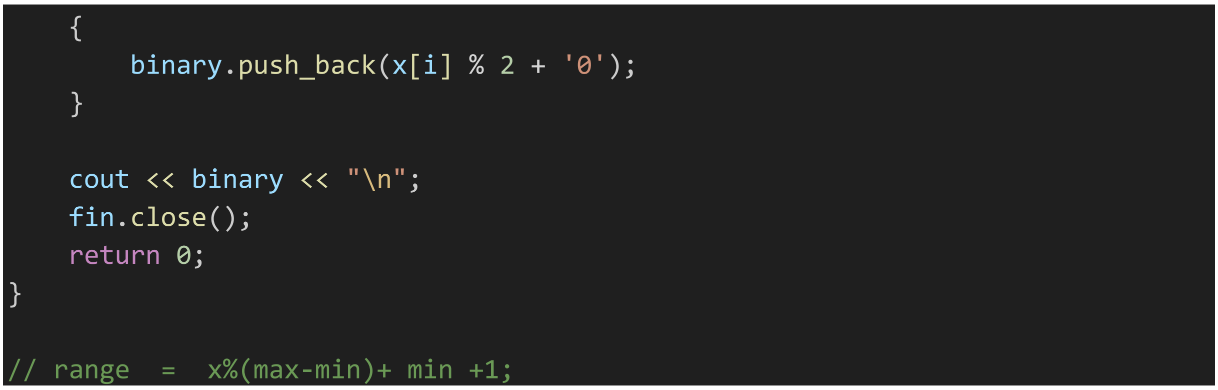


```
123
5
2
73
5
```

b. blum-blum shub generator

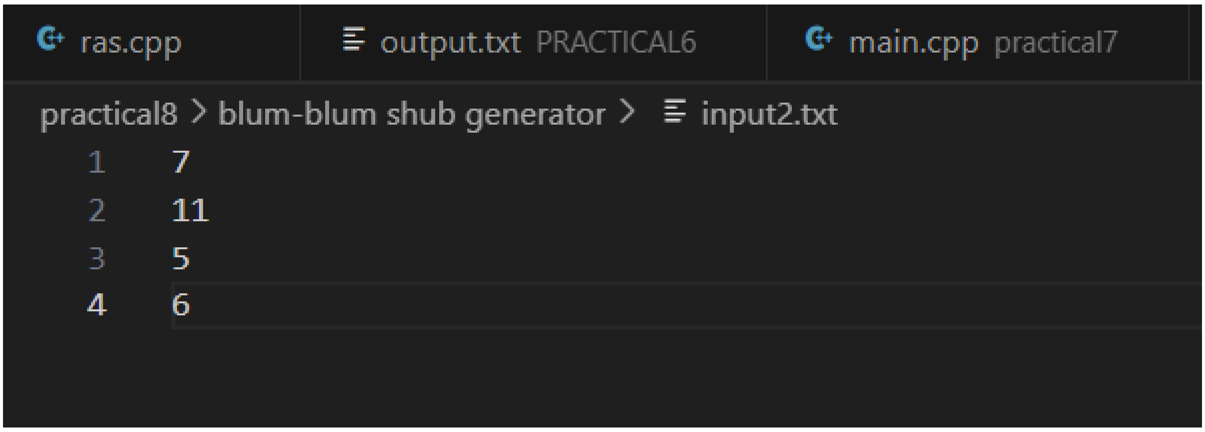
➢ methodology followed

```cpp
#include <iostream>
#include <bits/stdtr1c++.h>
#include <fstream>
using namespace std;

int main()
{

    ifstream fin;
    fin.open("input2.txt");

    string s1;
    string s2;
    string s3;
    string s4;

    getline(fin, s1);
    getline(fin, s2);
    getline(fin, s3);
    getline(fin, s4);

    long long int p = stoi(s1);
    long long int q = stoi(s2);
    long long int x0 = stoi(s3);
    long long int nx = stoi(s4);

    long long int n = p * q;

    vector<long long int> x;
    x.push_back(x0);

    for (int i = 1; i <= nx; i++)
    {
        x.push_back((x[i - 1] * x[i - 1]) % n);
    }

    for (int i = 0; i <= nx; i++)
    {
        cout << "X" << i << " : " << x[i] << "\n";
    }

    string binary;
    for (int i = 0; i <= nx; i++)
```



```
    {
        binary.push_back(x[i] % 2 + '0');
    }

    cout << binary << "\n";
    fin.close();
    return 0;
}

// range  =  x%(max-min)+ min +1;
```

INPUT:



```
7
11
5
6
```