# Laboratory 5: Random Number generator using LCG and MCG

1. Introduction and Purpose of Experiment
2. Aim and Objectives
3. Experimental Procedure
4. Develop and implement a Java program to generate pseudorandom numbers based on the linear congruential random number generator to produce a sequence of 20 integers, 12 between 0 and y following a recursive relationship: Use 0, and.
5. Modify the above program for multiplicative congruential method to determine the period of the generator for, and0,.

Satisfy the following property of max period

1. Generate random numbers with longest possible period is
2. Generate random numbers with longest possible period is
3. Algorithms
4. Presentation of Results

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 \* To change this license header, choose License Headers in Project Properties.

 \* To change this template file, choose Tools | Templates

 \* and open the template in the editor.

 \*/

package lab05;

import java.util.ArrayList;

import java.util.Arrays;

/\*\*

 \*

 \* @author shadowleaf

 \*/

public class Lab05 {

    /\*\*

     \* @param args the command line arguments

     \*/

    public static void main(String[] args) {

        {

            // X\_n+1 = (aX\_n + c) mod m

            // X\_0 = 27

            // a = 17

            // c = 43

            // m = 100

            // n = 20

            System.out.println("LCG ----------\n");

            Integer a = 17, c = 43, m = 100, n = 20;

            ArrayList<Integer> X = new ArrayList<>();

            X.add(27);

            System.out.printf("X0 = %d, a = %d, c = %d, m = %d, n = %d\n", X.get(0), a, c, m, n);

            for (int i = 0; i < n; i++) {

                X.add((a \* X.get(i) + c) % m);

            }

            Integer i = 0;

            for (Integer e : X) {

                System.out.printf("X%d = %d, ", i++, e);

            }

            System.out.println("\n");

        }

        {

            System.out.println("MCG ----------\n");

            // a = 13

            // m = 2^6

            // X\_0 = 1, 2, 3, 4

            Integer a = 13;

            Integer m = 1 << 6;

            // important

            ArrayList<Integer> C = new ArrayList(Arrays.asList(17, 0));

            for (Integer c : C) {

            ArrayList<ArrayList<Integer>> X = new ArrayList<>();

            X.add(new ArrayList(Arrays.asList(1))); // X0 = 1

            X.add(new ArrayList(Arrays.asList(2))); // X0 = 2

            X.add(new ArrayList(Arrays.asList(3))); // X0 = 3

            X.add(new ArrayList(Arrays.asList(4))); // X0 = 4

                for (int i = 0; i < X.size(); i++) {

                    Integer X0 = X.get(i).get(0);

                    // if X0 is even c should not be zero

                    if ( (X0 % 2 == 0) && (c == 0) ) {

                        continue;

                    }

                    System.out.printf("X0 = %d, a = %d, c = %d, m = %d\n", X0, a, c, m);

                    Integer j = 0;

                    while (true) {

                        Integer Xnew = (a \* X.get(i).get(j++) + c) % m;

                        X.get(i).add(Xnew);

                        if (Xnew.equals(X0)) {

                            System.out.printf("P = %d\n", j);

                            Integer k = 0;

                            for (Integer e : X.get(i)) {

                                System.out.printf("X%d = %d, ", k++, e);

                            }

                            System.out.println("\n");

                            break;

                        }

                    }

                }

            }

        }

    }

}

1. Analysis and Discussions

run:

LCG ----------

X0 = 27, a = 17, c = 43, m = 100, n = 20

X0 = 27, X1 = 2, X2 = 77, X3 = 52, X4 = 27, X5 = 2, X6 = 77, X7 = 52, X8 = 27, X9 = 2, X10 = 77, X11 = 52, X12 = 27, X13 = 2, X14 = 77, X15 = 52, X16 = 27, X17 = 2, X18 = 77, X19 = 52, X20 = 27,

MCG ----------

X0 = 1, a = 13, c = 17, m = 64

P = 64

X0 = 1, X1 = 30, X2 = 23, X3 = 60, X4 = 29, X5 = 10, X6 = 19, X7 = 8, X8 = 57, X9 = 54, X10 = 15, X11 = 20, X12 = 21, X13 = 34, X14 = 11, X15 = 32, X16 = 49, X17 = 14, X18 = 7, X19 = 44, X20 = 13, X21 = 58, X22 = 3, X23 = 56, X24 = 41, X25 = 38, X26 = 63, X27 = 4, X28 = 5, X29 = 18, X30 = 59, X31 = 16, X32 = 33, X33 = 62, X34 = 55, X35 = 28, X36 = 61, X37 = 42, X38 = 51, X39 = 40, X40 = 25, X41 = 22, X42 = 47, X43 = 52, X44 = 53, X45 = 2, X46 = 43, X47 = 0, X48 = 17, X49 = 46, X50 = 39, X51 = 12, X52 = 45, X53 = 26, X54 = 35, X55 = 24, X56 = 9, X57 = 6, X58 = 31, X59 = 36, X60 = 37, X61 = 50, X62 = 27, X63 = 48, X64 = 1,

X0 = 2, a = 13, c = 17, m = 64

P = 64

X0 = 2, X1 = 43, X2 = 0, X3 = 17, X4 = 46, X5 = 39, X6 = 12, X7 = 45, X8 = 26, X9 = 35, X10 = 24, X11 = 9, X12 = 6, X13 = 31, X14 = 36, X15 = 37, X16 = 50, X17 = 27, X18 = 48, X19 = 1, X20 = 30, X21 = 23, X22 = 60, X23 = 29, X24 = 10, X25 = 19, X26 = 8, X27 = 57, X28 = 54, X29 = 15, X30 = 20, X31 = 21, X32 = 34, X33 = 11, X34 = 32, X35 = 49, X36 = 14, X37 = 7, X38 = 44, X39 = 13, X40 = 58, X41 = 3, X42 = 56, X43 = 41, X44 = 38, X45 = 63, X46 = 4, X47 = 5, X48 = 18, X49 = 59, X50 = 16, X51 = 33, X52 = 62, X53 = 55, X54 = 28, X55 = 61, X56 = 42, X57 = 51, X58 = 40, X59 = 25, X60 = 22, X61 = 47, X62 = 52, X63 = 53, X64 = 2,

X0 = 3, a = 13, c = 17, m = 64

P = 64

X0 = 3, X1 = 56, X2 = 41, X3 = 38, X4 = 63, X5 = 4, X6 = 5, X7 = 18, X8 = 59, X9 = 16, X10 = 33, X11 = 62, X12 = 55, X13 = 28, X14 = 61, X15 = 42, X16 = 51, X17 = 40, X18 = 25, X19 = 22, X20 = 47, X21 = 52, X22 = 53, X23 = 2, X24 = 43, X25 = 0, X26 = 17, X27 = 46, X28 = 39, X29 = 12, X30 = 45, X31 = 26, X32 = 35, X33 = 24, X34 = 9, X35 = 6, X36 = 31, X37 = 36, X38 = 37, X39 = 50, X40 = 27, X41 = 48, X42 = 1, X43 = 30, X44 = 23, X45 = 60, X46 = 29, X47 = 10, X48 = 19, X49 = 8, X50 = 57, X51 = 54, X52 = 15, X53 = 20, X54 = 21, X55 = 34, X56 = 11, X57 = 32, X58 = 49, X59 = 14, X60 = 7, X61 = 44, X62 = 13, X63 = 58, X64 = 3,

X0 = 4, a = 13, c = 17, m = 64

P = 64

X0 = 4, X1 = 5, X2 = 18, X3 = 59, X4 = 16, X5 = 33, X6 = 62, X7 = 55, X8 = 28, X9 = 61, X10 = 42, X11 = 51, X12 = 40, X13 = 25, X14 = 22, X15 = 47, X16 = 52, X17 = 53, X18 = 2, X19 = 43, X20 = 0, X21 = 17, X22 = 46, X23 = 39, X24 = 12, X25 = 45, X26 = 26, X27 = 35, X28 = 24, X29 = 9, X30 = 6, X31 = 31, X32 = 36, X33 = 37, X34 = 50, X35 = 27, X36 = 48, X37 = 1, X38 = 30, X39 = 23, X40 = 60, X41 = 29, X42 = 10, X43 = 19, X44 = 8, X45 = 57, X46 = 54, X47 = 15, X48 = 20, X49 = 21, X50 = 34, X51 = 11, X52 = 32, X53 = 49, X54 = 14, X55 = 7, X56 = 44, X57 = 13, X58 = 58, X59 = 3, X60 = 56, X61 = 41, X62 = 38, X63 = 63, X64 = 4,

X0 = 1, a = 13, c = 0, m = 64

P = 16

X0 = 1, X1 = 13, X2 = 41, X3 = 21, X4 = 17, X5 = 29, X6 = 57, X7 = 37, X8 = 33, X9 = 45, X10 = 9, X11 = 53, X12 = 49, X13 = 61, X14 = 25, X15 = 5, X16 = 1,

X0 = 3, a = 13, c = 0, m = 64

P = 16

X0 = 3, X1 = 39, X2 = 59, X3 = 63, X4 = 51, X5 = 23, X6 = 43, X7 = 47, X8 = 35, X9 = 7, X10 = 27, X11 = 31, X12 = 19, X13 = 55, X14 = 11, X15 = 15, X16 = 3,

1. Conclusions

**The max period(P) is:**

* + For m a power of 2, say m = 2b, and c ≠0, the longest possible period is P = m = 2b , which is achieved provided that c is relatively prime to m (that is, the greatest common factor of c and m is 1), and a = 1 + 4k, where k is an integer.

1. For m a power of 2, say m = 2b, and c = 0, the longest possible period is P = m / 4 = 2b-2 , which is achieved provided that the seed X0 is odd and the multiplier, a, is given by a = 3 + 8k or a = 5 + 8k, for some k = 0, 1,...
2. For m a prime number and c = 0, the longest possible period is P = m - 1, which is achieved provided that the multiplier, a, has the property that the smallest integer k such that ak - 1 is divisible by m is k = m - 1,