

Stimulation And Modeling Assignment: Mid Product Method

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Abstract

In this assignment, we do the following: 1. Generate sequence of numbers by Mid Square Method by considering k-digit numbers

2. cover all the k-digit numbers construct a directed graph (Planner?)
3. obtain the connected components
4. Provide your observations about each and every component
5. Repeat the above step from 1 to 4 by considering $K=2,4,6,8,\dots$ and provide your comments
6. Repeat the above by choosing some k digits of the result at random and give your comments.
7. Obtain an analytical relation of the selected digits of the result with the digits that you started.

PDF files and a jupyter notebook file can be found in the tar file.

1 Mid product for 2 digit numbers

Graph for mid product for combination of some two digit numbers taken from a random set of [11,45,27,97,60,79, 13,54,75,14,36,82] is given as a pdf named midProductK2.pdf. In the graph, the starting node with the seed are colored green and the terminating node for each generated sequence is given in red. $node_n$ is generated by multiplying $node_{n-1}$ and $node_{n-2}$, and extracting k digits from it. The edge between $node_n$ and $node_{n-1}$ indicates the product of $node_{n-1}$ and $node_{n-2}$. Some observation and comments:

- The highest count of numbers are generated by $x_0 = 97$ and $x_1 = 82$ as seed with a count of 122.

- The graphs terminates in two loops, one at zero which is a self loop and 80 -i 40 -i 20-i 80-i 80-i 60-i 80 and 20-i 40-i 80-i 20-i 60-i 20-i 20.

2 Mid product for 4 digit numbers

Graph for mid product for combination of some two digit numbers taken from a random set of $X_0 = [1181, 4025, 1273, 927, 3213, 1154, 7051]$ is given as a pdf named midProductK4.pdf.

- The highest count of numbers are generated by $x_0 = 1181$ and $x_1 = 7051$ as seed with a count of 1000, which was the limit we set for the number of iteration.
- The highest count of numbers are generated by $x_0 = 927$ and $x_1 = 1154$ as seed with a count of 35.

3 Mid product for 6 digit numbers

Graph for mid product for combination of some two digit numbers taken from a random set of $X_0 = [1181, 4025, 1273, 927, 3213, 1154, 7051]$ is given as a pdf named midProductK6.pdf.

- All most all the seeds have a count 1000, which was the limit we set for the number of iteration.

4 Result obtained by selecting some 2-digit at random from a 2 digit number

Examples of graphs obtained are given as pdf file in selectDigitmidProductK211.pdf and selectDigitmidProductK267.pdf

5 Obtain an analytical relation of the selected digits of the result with the digits that you started.

Let x_0 and x_1 be the numbers pf k digit we started with and let the least significant digit in the extracted result be s th digit. We define two quantities:

$$l = 10^{s-1}$$

$$m = 10^{k+start-1}$$

The new number x_2 can be obtained as:

$$x_2 = (((x_0 * x_1) \bmod m) / l)$$

Note the same equation holds for mid Square where $x_0 = x_1$.

Figure 1: Plot for variation of average count of random number produced before pattern is found for all 2 digit seed as a function of the least significant digit used for extraction of square of the number. It can be seen that the highest count is for $LSD = 1$

