

## 4. Exercise

Out      Discussion  
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Contact by questions

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### Problem 1: Simulation Graphs

Review the approach of Simulation Graphs and develop Simulation Graphs for the following models.

- A mobility model for a single node.
- Simple transport protocol using Stop-and-Wait.

### Problem 2: Linear Congruential Generator

For 16-bit computers it was recommended to combine three multiplicative generators with  $m_1 = 32363$ ,  $a_1 = 157$ ,  $m_2 = 31727$ ,  $a_2 = 146$ ,  $m_3 = 31657$ , and  $a_3 = 142$ . The period of this generator is approximately  $8 \times 10^{12}$ .

- a) Generate 5 random numbers with the combined generator, using the initial seeds  $X_{i,0} = 100, 300, 500$ , for the individual generators  $i = 1, 2, 3$ .
- b) Apply the tests described in the class to the generator.

### Problem 3: Characteristics of Random Numbers

Test the following sequence of numbers for uniformity and independence, using procedures presented in class.

0.594, 0.928, 0.515, 0.055, 0.507, 0.351, 0.262, 0.797, 0.788, 0.442, 0.097, 0.798, 0.227, 0.127, 0.474, 0.825, 0.007, 0.182, 0.929, 0.852

### Problem 4: Characteristics of Random Numbers

In some applications, it is useful to be able to quickly skip ahead in a pseudo-random number sequence without actually generating all of the intermediate values.

- a) For a linear congruential generator with  $c = 0$ , show that  $X_{i+n} = a^n X_i \pmod{m}$ .
- b) Show that  $(a^n X_i) \pmod{m} = (a^n \pmod{m}) X_i \pmod{m}$
- c) Use this result to compute  $X_5$  with a congruential generator with  $m = 100$ ,  $a = 19$ , and  $c = 0$ . Start with  $X_0 = 63$  and check your answer by computing  $X_5$  in the usual way.

## Problem 5: Random-Variate Generator

Develop a random-variate generator for a random variable  $X$  with the pdf

$$f(x) = \begin{cases} e^{2x}, & -\infty < x \leq 0 \\ e^{-2x}, & 0 < x < \infty \end{cases}$$

## Problem 6: OMNeT++

Go to the web page of the Tic-Toc-Tutorial<sup>1</sup>. Exercise the tutorial up to “3. Turning it into a real network”.

## Problem 7: Simulation models, reading

Download the paper »Modeling and simulation best practices for wireless ad hoc networks« by Perrone et. al from the website of the class.

Discuss the paper and the findings of the authors. What are their main point?

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<sup>1</sup><http://www.omnetpp.org/doc/omnetpp/tictoc-tutorial/>