CS121 Parallel Computing
Lab 1 - Pseudorandom Number Generator

Pseudorandom numbers are sequences of numbers that appear to be random when examined using various statistical tests. They have a number of applications, for example in cryptography, complexity theory and Monte Carlo simulations. Simulations in particular often need a large number of pseudorandom numbers, so it is important to be able to generate them efficiently. In this lab you will design an algorithm to generate pseudorandom sequences in parallel.

A simple and fast method for generating pseudorandom numbers is a linear congruential generator (LCG). Starting with an arbitrary "seed" value x_0, an LCG outputs a sequence x_1, x_2, ..., where $x_{i+1} = (ax_i + c) \bmod m$, for $i = 0, 1, \dots$. Here, m, a and c are integers, and we require $m > 0$, $0 < a < m$, and $0 \leq c < m$. LCGs do not produce high quality pseudorandom numbers, in the sense that the outputs have certain statistical regularities. However, with the right settings for m, a and c, LCG outputs can be good enough for many basic applications. One setting commonly used in practice is $m = 2^{31}, a = 1103515245$ and $c = 12345$. Other settings which give good results can be found at https://en.wikipedia.org/wiki/Linear_congruential_generator.

For this lab you will implement a parallel LCG. Start by writing a sequential LCG in C. Then write a parallel LCG using OpenMP, focusing on making your program as fast and scalable as possible. To compile and run your code you can either install OpenMP on your own machine, or use the school's HPC cluster. Instructions for the latter are given in the post "HPC account assignment" on the course Piazza. Benchmark both your implementations by generating a sequence $x_0, x_1, \dots, x_k$, for some arbitrary initial x_0, and for $k = 10, 100, 1000, \dots, 10^9$. Measure the speedup you obtain as a function of the number of threads you use. Prepare a report clearly describing both your sequential and parallel implementions, your benchmarks, and the configuration of the machine you benchmarked on. Please submit your report and code (in an easily compilable form) to fanrui@shanghaitech.edu.cn, using the subject line "CS121 Lab 1", by the project due date **11:59pm, April 21, 2019**.