Design and Implementation of Vectorized Pseudorandom Number Generators and their Application to Simulations of Photon Propagation

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Outline

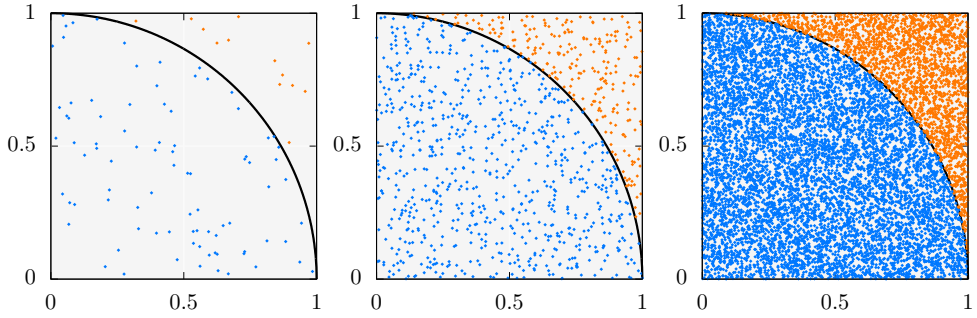
Introduction and Motivation

Preliminaries

- no c++ code shown
- why c++
- only two generators
- a few things will not be shown
- no theory shown why prngs good

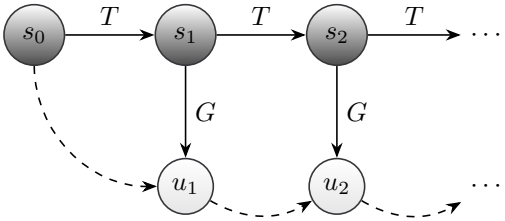
Monte-Carlo Methods and Physical Simulations

Computation of π

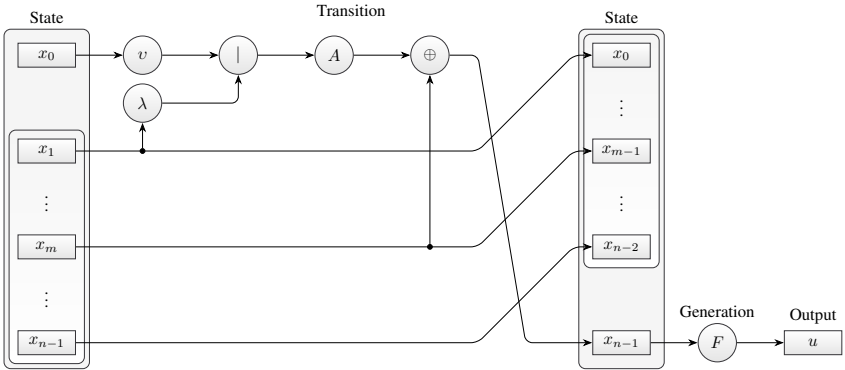


Pseudorandom Number Generators

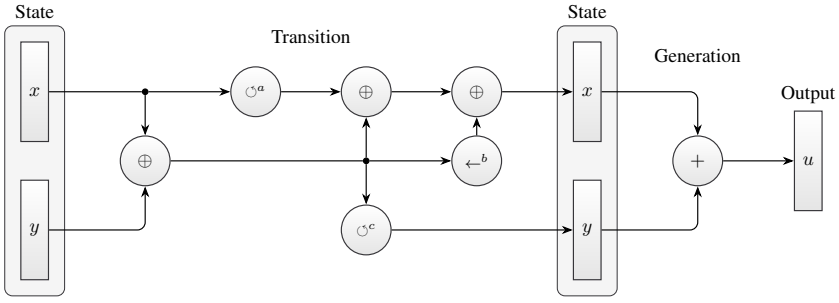
Concepts



Mersenne Twister MT19937

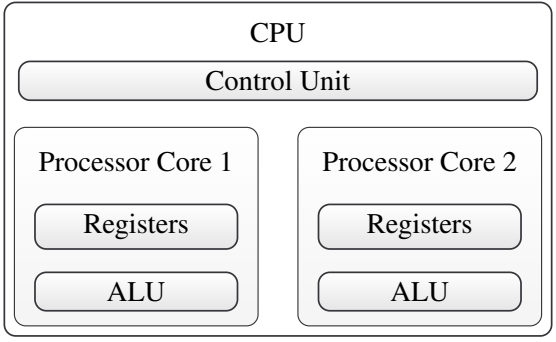


Xoroshiro128+

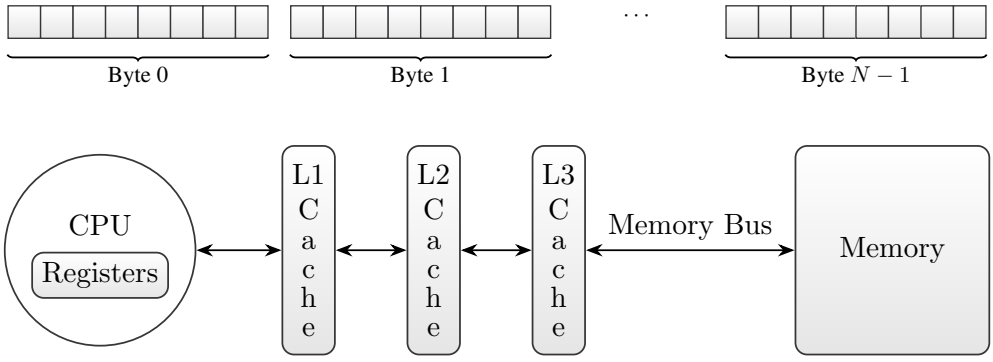


Fundamentals of Computer Architecture

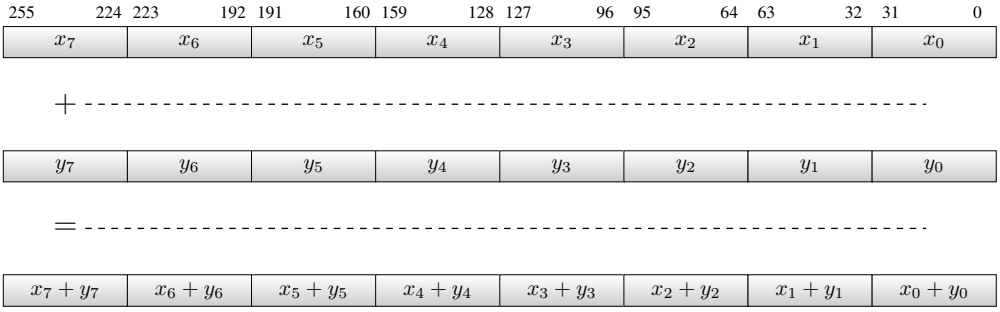
Processor and Memory



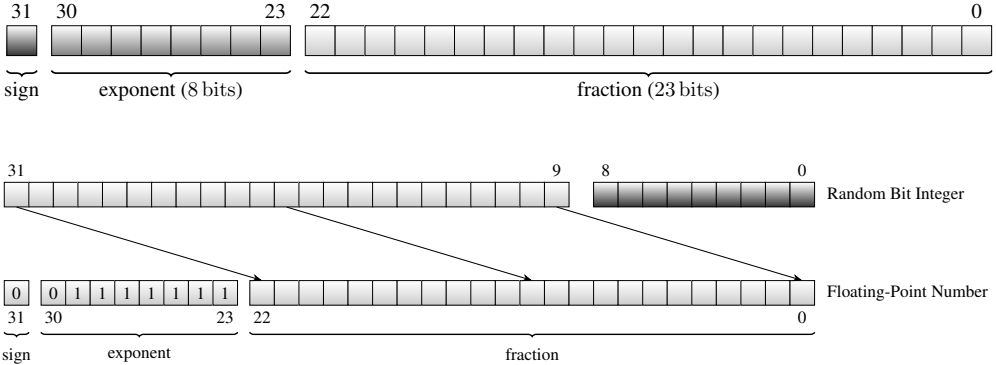
Memory Hierarchy



SIMD and Intrinsics



Uniform Floating-Point Numbers

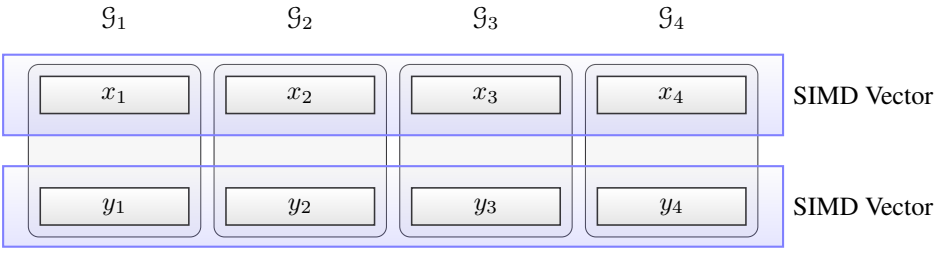


Design

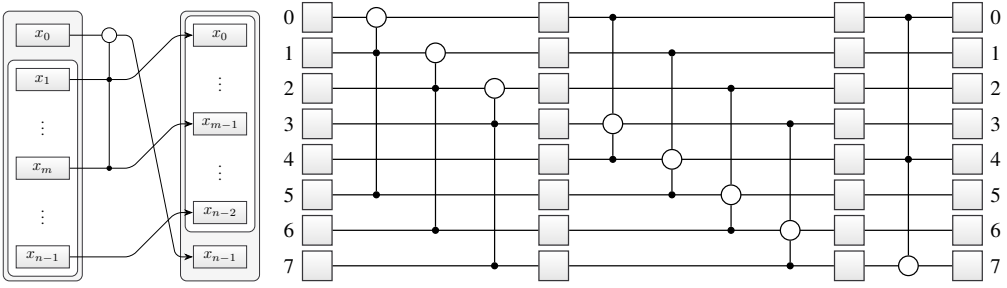
C++ Design Concepts for Libraries

Implementation

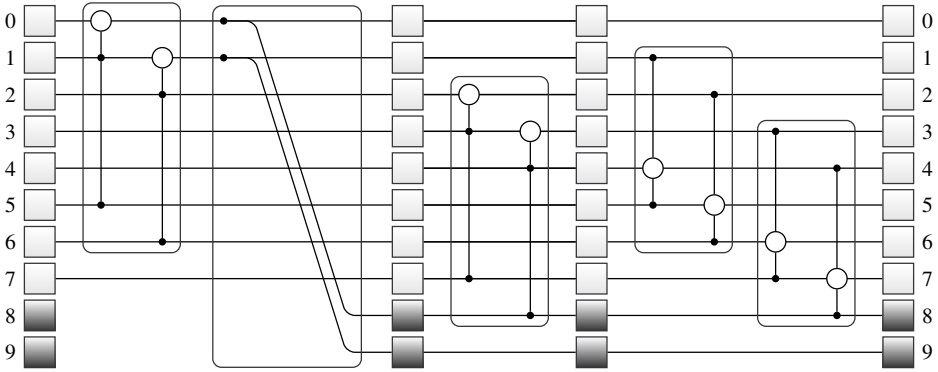
Xoroshiro128+ Scalar and Vectorized



MT19937 Scalar and Vectorized



MT19937 SIMD



Tests and Benchmarks

Statistical Performance

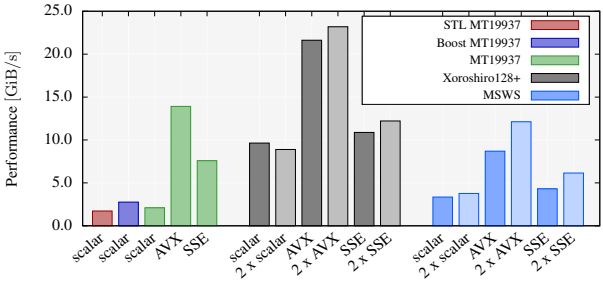
API Tests

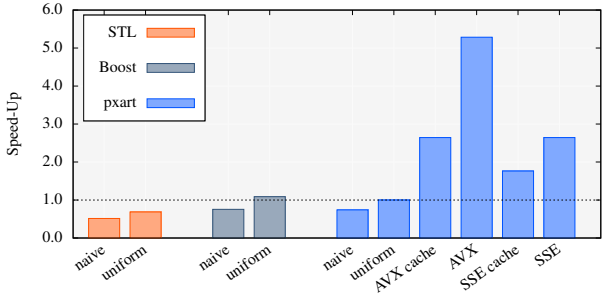
Photon Simulation

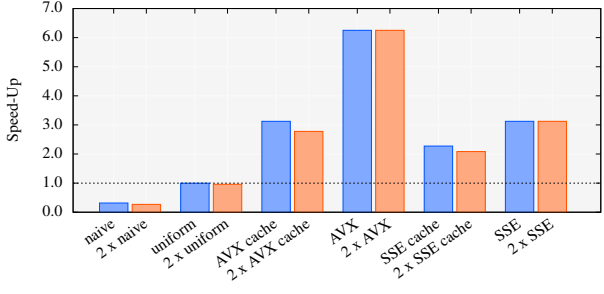
Previous Work

Evaluation and Results

Evaluation and Results




Speed-Up
6.0
5.0
4.0
3.0
2.0
1.0
0.0
STL
Boost
pxart
naive
uniform
naive
uniform
naive
uniform
AVX cache
AVX
SSE cache
SSE


Speed-Up
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
naive
2 x naive
uniform
2 x uniform
AVX cache
2 x AVX cache
AVX
2 x AVX
SSE cache
2 x SSE cache
SSE
2 x SSE

Conclusions and Future Work

Conclusions and Future Work

- possible applications in simulations
- mt19937 vs. xoroshiro128+

References