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COMPARING RANDOM NUMBER GENERATORS USING MONTE CARLO INTEGRATION

V. Lakshmikantham, Syamal Kumar Sen and Tathagata Samanta

Department of Mathematical Sciences
Florida Institute of Technology
Melbourne, FL, 32901, USA
{ lakshmik, sksen, tsamanta }@fit.edu

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Abstract. *An indirect approach based on numerical integration of single and double variable test functions by Monte Carlo methods is used to rank/compare several random number generators (RNGs) based on linear congruential, lagged Fibonacci, generalized feedback shift register, subtract with borrow, and combined linear congruential procedures. This approach helps us to decide in a given context which RNG should be employed in a randomized/probabilistic algorithm to achieve error/complexity reduction. The concerned error and time complexity of the RNGs are studied statistically as well as graphically to reveal the relative character/capability of the RNGs in exponential/combinatorial problem-solving in polynomial time.*
Keywords: Monte Carlo integration, Random number generators, Root mean square error, Time complexity

1. **Introduction.** *Non-existence of true random numbers in nature.* The dictionary meaning of the word "random" is "made or done by chance without plan". By this meaning it implies that no one will be able to predict the outcome out of several possible outcomes of any process. In nature, the outcome of any process cannot be strictly random since there is a relationship between the outcome and the inputs of the process through the process which obeys all the laws of nature perfectly and exactly. This observance of all the concerned laws of nature by any activity/process/method/algorithm is a hypothesis which has never been disproved. There is no question of breaking any law of the material universe under any circumstances at any time. Of course due to our limitations such as the lack of complete and/or perfect knowledge of the system and of all the laws governing the system, we, the human beings, are not able to explain or predict many phenomena/outcomes. If there is no process, then there is no outcome and hence no random numbers (RNs). Similarly, artificially too, we are not able to generate true RNs. Thus *RN generation does exist neither in nature nor in digital computers. Nature never produces any situation associated with a number that is random nor does it ever create chaos*[1]. It is relevant to quote John von Neumann who said in 1951 "Anyone who considers arithmetical methods of producing random digits is, of course, in a state of sin."

[1]The dictionary meaning of the word "chaos" is complete disorder or confusion. Chaos in science and engineering refers to an apparent lack of order in a system that nevertheless obeys certain laws and rules. This understanding of chaos is the same as that of dynamical instability.