Inverse Functions for Monte Carlo Simulations with applications to hitting time distributions

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Abstract

Random sampling is a ubiquitous tool in simulations and modeling in a variety of applications. There are efficient algorithms for these for several known distributions, but in general, one must resort to computing or approximating the inverse to the distribution to generate random samples, given a random number generator for a uniform distribution. In certain physical and biomedical applications with which we have been particularly concerned, it has proven to be more efficient to provide random times for a walk of a fixed length, rather than the conventional random step lengths in a given time step for the walker. For these, the hitting-time distributions which have to be sampled have been computed, and proved to be complicated expressions with no efficient method to compute the inverse. In this paper, we explore a well known probability (the F-ratio distribution) - whose inverses are efficiently computable - as an alternative to generating look-up tables and interpolations to obtain the required time samples. We find that this distribution approximates the hitting-time distribution well, and report on error measures for both the approximation to the desired, and the error in the generated time samples. Future Monte Carlo simulations in a number of fields of application may benefit from methods such as we report here.

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