**Common Random Numbers Application in Discrete Event Simulation for Disease Modeling**

Hanxuan Yu1, John Graves1, Shawn Garbett2, Ashley Leech1, Jinyi Zhu1

*Affiliations:*

*1Department of Health Policy, Vanderbilt University School of Medicine, Nashville, TN*

*2Department of Biostatistics, Vanderbilt University School of Medicine, Nashville, TN*

**Word count**: out of 375

**Submission Category:** Quantitative Methods and Theoretical Developments (QMTD)

**Purpose:** When applying disease simulation techniques to the decision-making progress, stochastic noise can always be distracting and overlap the true difference between strategies, which lead to more effort and higher cost in time and computational resource. Common random numbers(CRNs) help to reduce the variance between model runs and emphasize the effect of changing parameters of the modeller's interest. Compared to micro-simulation, less research and application of CRN have been found among previous literature using DES for disease simulation modelling. We provide an application of CRN to demonstrate its advantages in DES.

**Methods:** Based on the 2017-2018 National Health and Nutrition Examination Survey database, we developed a DES model to evaluate the cost-effectiveness of statin treatment in people aged 40 to 80 in the US at risk of atherosclerotic cardiovascular disease (ASCVD) over a lifetime horizon. Every possible event within an individual, including death due to background mortality, fatal ASCVD event, non-fatal ASCVD, death after ASCVD and statin adverse event was assigned an independent random number which is individual-specific and event-specific but stayed the same ("common") across model runs. The random number was used to be compared to the alterable probability and determine the stochastic event. The time to the event is usually a random number generated from an exponentiation distribution. CRN is used as standard uniform random input in the inverse cumulative distribution function to generate the non-uniform quantile which can be converted into the time variable.

**Results:**

Panel A demonstrates CRNs reduced the variance of outcomes through model runs with varying RR of ASCVD. The Use of CRNs enabled direct comparison between alternative parameters. Panel B indicates CRNs emphasize the difference between the strategies on the background of patient-level noises and contribute to faster convergence.

**Conclusion:**

Due to the need for hundreds of thousands of trajectories to converge and hundreds of model runs in the probabilistic sensitivity analysis, it is meaningful in discrete event simulation to converge faster and reduce the stochastic noise when doing the sensitivity analysis. Common Random Numbers promote efficiency in the disease simulation and help with the decision-making progress.

A graph of different sizes and colors

Description automatically generated

**Figure.** Panel A shows the effect of CRNs (left: No CRNs; right: CRNs) on model outputs through runs with varying RR of ASCVD. Panel B shows the convergence progress (left: No CRNs; right: CRNs) for both strategies with varying sample size.