EE106

Evaluation of Full Factorial and Latin Hypercube Sampling As Alternatives to Traditional Random Selection for Probabilistic Uncertainty Analyses

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BACKGROUND

- Probabilistic sensitivity analysis (PSA) is common in economic evaluations, but generating enough random samples achieve stability can be computationally intensive.

OBJECTIVE

- **This study evaluates the relative efficiency of alternative random sampling methods to stably estimate uncertainty within a cost-effectiveness analysis.**

METHODS

- We modified a published cost-effectiveness model of kidney disease[1] progression including 18 random parameters (Figure 1).
- The Full Factorial sampling method becomes computationally impossible with more than a few parameters and was evaluated with 3 random parameters with the sampling space divided into 5, 10, or 25 regions.
- The Latin Hypercube sampling method was evaluated with 18 random parameters and 10, 50, 500, 5000, and 15,000 regions.
- Probabilistic sampling from the 3 methods were evaluated to estimate the relative difference from the deterministic result at varying number of sampling iterations.

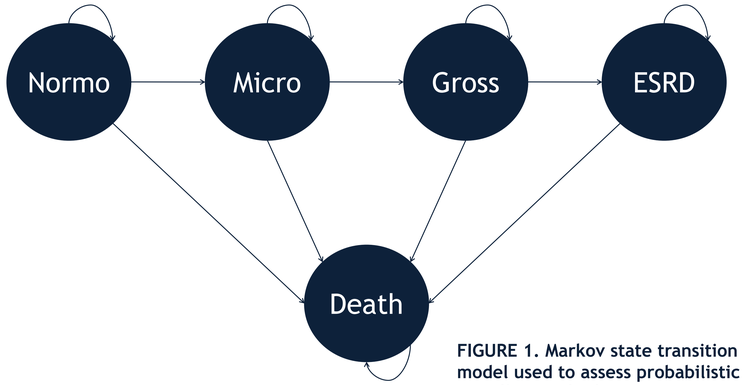
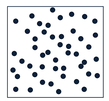


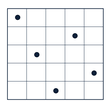
FIGURE 1. Markov state transition model used to assess probabilistic sampling methods

Sampling methods explained

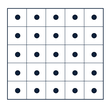
1. Random - The typical sampling method where multiple random draws from each parameter distribution are evaluated. Total samples per set = 1.



2. Latin Hypercube - The parameter space is divided into N regions of equal probability. N samples of the multidimensional grid containing one sample in each dimension (e.g., each row and column). Total samples per set = $n_{regions}$.



3. Full Factorial - The parameter space is divided in the N regions and sampled from every region. Total samples per set = $n_{regions}$^$n_{parameters}$.



CONCLUSIONS

- **As an alternative to Random sampling, the Full Factorial method is impractical.**
- **In our test model, Latin Hypercube sampling did result in individual sample sets with less variability than an equivalent number of random samples**
- **This suggests that the Latin Hypercube sampling method could potentially achieve stability faster in models where PSA convergence may be a challenge**

RESULTS

- In the sampling of a small parameter set, increasing PSA accuracy relative to the deterministic ICER was observed when the parameter space was divided into more regions (Figure 2).
- The Full Factorial method appeared as efficient as Random sampling.
- The Latin Hypercube method appeared more efficient than Random sampling when the parameter space was partitioned into fewer regions (Figure 2; blue dots closer to the deterministic line than green dots).
- With 18 random variables, the Latin Hypercube method is not obviously more efficient than Random sampling (Figure 3).
- However, with the 18-parameter space divided into 50 regions, there was less variability associated with multiple sets of 50 Latin Hypercube PSA samples than set of 50 Random samples (Figure 4).

FIGURE 2. Mean PSA ICER with parameter space of 3 random variables partitioned into 5, 10, 25, 50, 500, and 1000 regions

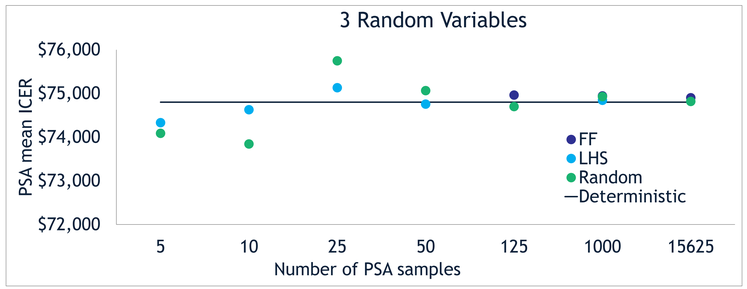


FIGURE 3. Mean PSA ICER with parameter space of 3 random variables partitioned into 10, 50, 500, 5000, and 15,000 regions

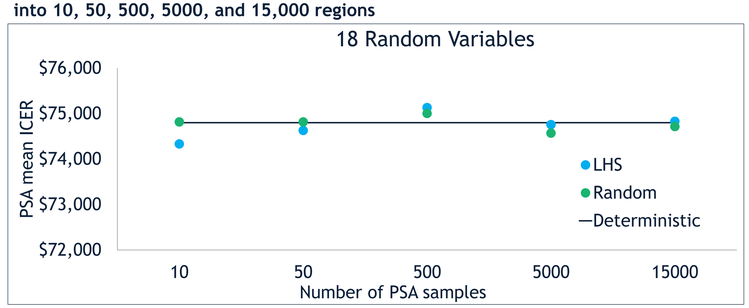
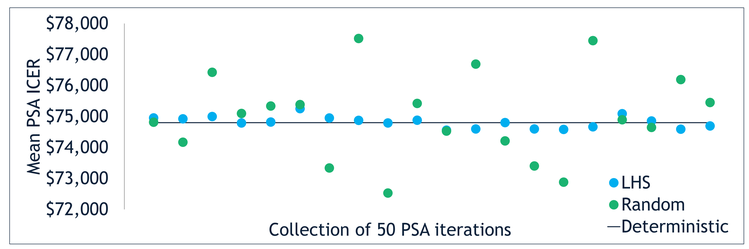


FIGURE 4. 20 sets of 50 stochastic iterations using LHS and Random sampling



Abbreviations: FF, Full factorial; ICER, Incremental cost-effectiveness ratio; LHS, Latin hypercube sampling; PSA, probabilistic sensitivity analysis

Citation: 1. Golan L et al. *Ann Intern Med*. 1999 Nov 2;131(9):660-7.

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