HTA220

Evaluating the Reliability of Value of Information Methods: A Simulation-Based Comparison

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BACKGROUND

- Healthcare resource allocation is often made under **uncertainty due to imperfect information** in economic evaluations.
- Collecting additional evidence can reduce uncertainty but comes with higher costs. **Value of Information (VoI)** analysis provides a framework to assess whether reducing uncertainty is worth the investment.[1]
- The **Expected Value of Partial Perfect Information (EVPPI),** the value of gaining **perfect information on a subset** of uncertain cost-effectiveness model parameters, can be estimated using Nested Monte Carlo (NMC), regression-based methods (Gaussian Process (GP), Multivariate Adaptive Regression Splines (MARS), and Bayesian Additive Regression Trees (BART)), Multi-Level Monte Carlo (MLMC), and other methods.[2-3]
- However, their **accuracy remains underexplored**.

OBJECTIVE

This study aims to conduct a **simulation study** to evaluate the **reliability and efficiency** of different **VOI methods** and provide insights on selecting methods suited to specific circumstances.

METHOD

Model simulation

- **Generic R code** was developed to generate Markov models with flexible structures, treatments, and parameters.
- **Transition probabilities** generated via copulas to account for correlation.
- **12,000** simulations conducted to ensure estimate accuracy.

Measure performance

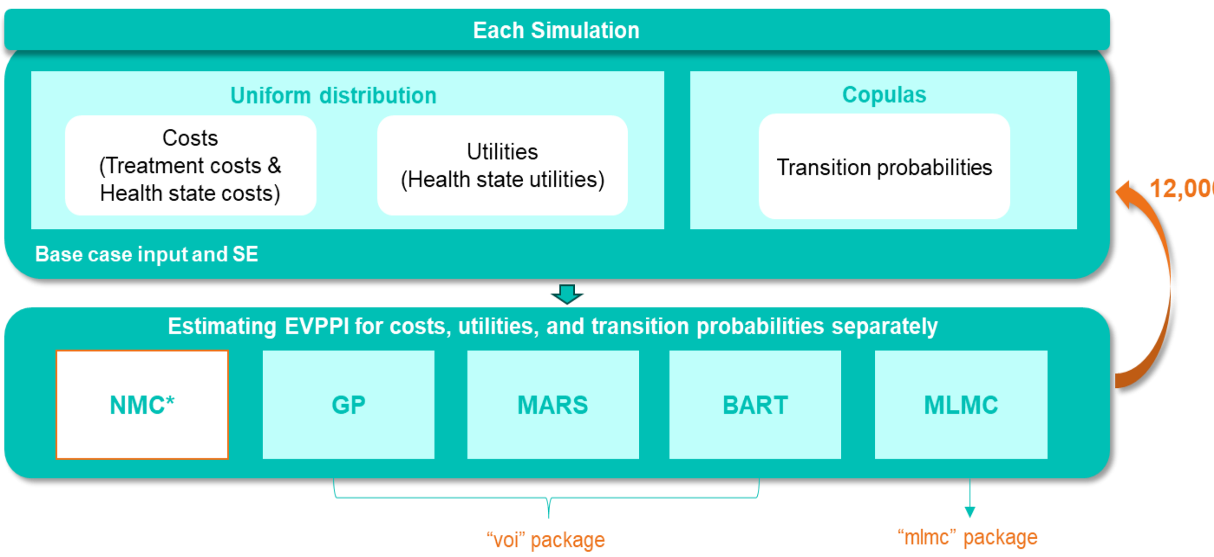
Linear regression used:

- Dependent variable = NMC estimates
- Independent variables = estimates from other methods

Stratified by number of health states and treatment options (↑ = more complex models)

Performance metrics: R^2, slope, coverage probability, and scatter plots.

Figure 1: Method – Simulation model



Notes: * NMC estimates are estimated based on 100 outer samples and 1000 inter samples, sufficient to ensure reasonable precision and acceptable bias. All models were developed in R 4.4.1 and executed on the high-performance computing platform. All code are provided in a GitHub repository.

RESULTS

Table 1: Summary Results

variable	Method	Slope	R squared	Bias
Costs	GP	0.82	0.76	0.84
	MARS	1.03	0.93	-27.38
	BART	**0.96**	**0.97**	**19.91**
	MLMC	1.02	0.90	-39.18
Utilities	GP	0.71	0.65	56.53
	MARS	**1.02**	**0.97**	**-22.28**
	BART	**0.97**	**0.97**	**37.02**
	MLMC	**1.01**	**0.96**	**-35.67**
Transition probabilities	GP	1.08	0.91	-333.16
	MARS	1.12	0.71	-864.08
	BART	1.19	0.83	-727.17
	MLMC	**1.00**	**0.99**	**8.20**

Table 1 summarizes the results for each parameter and method across all performance measures:

- **BART** performed best for **cost**.
- **MLMC and BART** provided the most reliable estimates for **utility**.
- **MLMC** outperformed all others for **transition probabilities**.

Figure 2: Stratified Slope Results

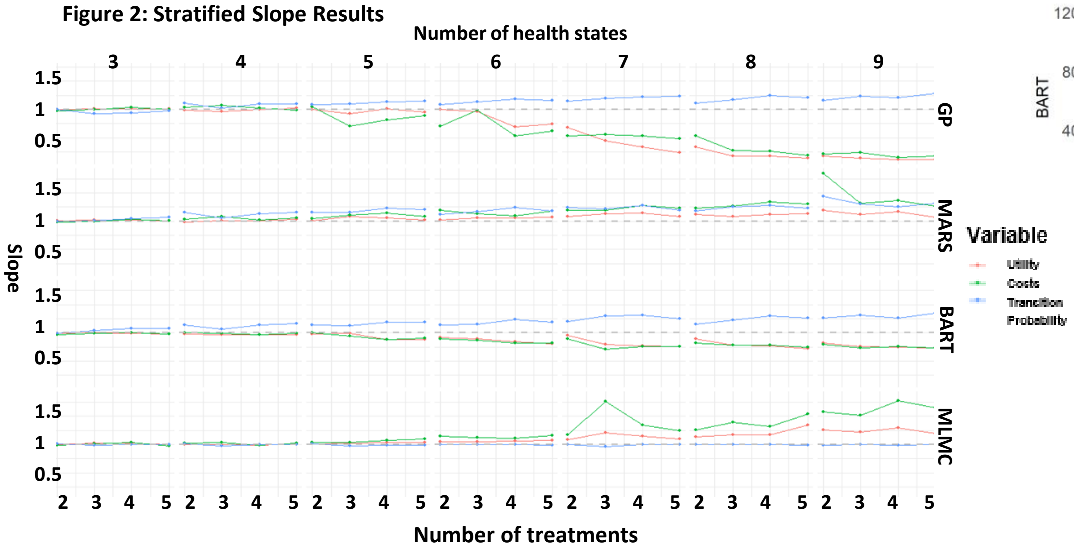


Figure 2 shows the stratified slope results, broken down by the number of health states and treatments.

Figure 3: Scatter plots – Transition probability

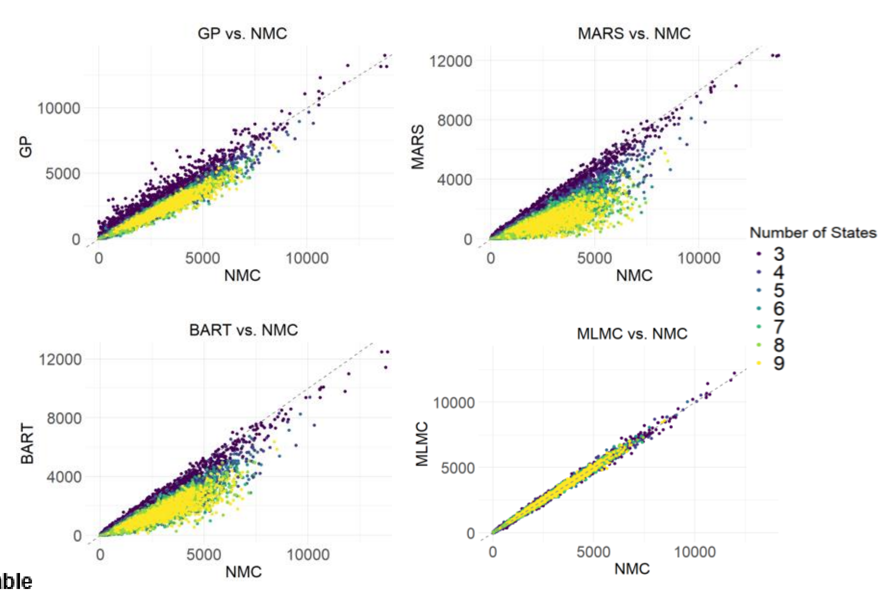


Figure 3 is the scatter plots show the results from each method compared against the gold-standard NMC estimates

When considering model complexity:

- **MLMC** maintained superior performance for **transition probabilities as complexity increased**.
- **BART** consistently produced the **most accurate** estimates for **cost and utility** in more complex models.

Conclusions:

- **BART** is preferred for simple models with uncorrelated parameters
- **MLMC** is recommended when parameters are correlated.

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Reference:

[1] Value of Information Analytical Methods: Report 2 of the ISPOR Value of Information Analysis Emerging Good Practices Task Force Rothery, Claire et al. Value in Health, Volume 23, Issue 3, 277 – 286

[2] Expected Value of Partially Perfect Information (EVPPI) [online]. (2016). York; York Health Economics Consortium; 2016. https://yhec.co.uk/glossary/expected-value-of-partially-perfect-information-evppi/

[3] Strong, Mark, Jeremy E. Oakley, and Alan Brennan. "Estimating multiparameter partial expected value of perfect information from a probabilistic sensitivity analysis sample: a nonparametric regression approach." Medical Decision Making 34.3 (2014): 311-326.

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