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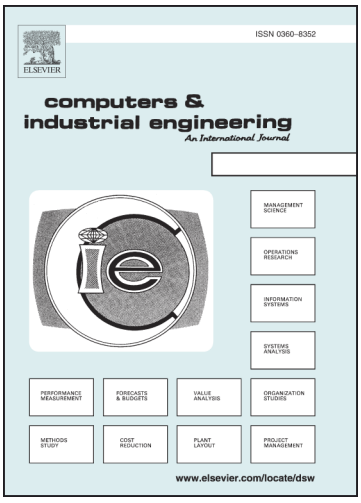

Using Dynamic Bayesian Networks as Simulation Metamodels Based on Bootstrapping

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Using Dynamic Bayesian Networks as Simulation Metamodels Based on Bootstrapping

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Abstract

Modeling and Simulation (M&S) is an ever growing field that utilizes increasingly complex and expensive simulations often requiring lots of time to run, can be difficult to maintain and analyze, but whose use continues to provide useful insight into leadership decisions. In a time critical decision situation, running such models may not be a practical approach to provide leadership the insights they need when they need those insights. Bayesian Networks (BN) are a useful analytical tool that offer understandable probabilistic relationships between variables, efficient computation, and quick analytical results. A BN indexed by time is a Dynamic Bayesian Network (DBN). A drawback to their use as a meta-model is the number of runs needed to train either the BN or DBN. This research introduces and demonstrates the use of bootstrapping techniques to reduce the number of actual simulation runs necessary to sufficiently train DBNs used as simulation meta-models. DBNs trained with independent simulation runs are compared to DBNs trained with bootstrapped-based samples developed on various sized subsets of actual simulation runs, the DBNs are compared statistically, and empirical examples are used to demonstrate the methodology. A method extending the DBN meta-model to multiple dimensions is presented and demonstrated. A case study using an actual combat simulation model completes the presentation.

Keywords: dynamic bayesian networks, bootstrapping, goodness of fit,

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