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A Monte Carlo simulation for the assessment of Bayesian updating in dynamic systems

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Abstract

The aim of this paper is to explore the effectiveness of Bayesian updating, especially in dynamic systems, where failure probability is variant in time. Through the use of Monte Carlo simulation it was tested whether (a) Bayesian updating and (b) dynamic behavior of failure probability lead to more risky behavior. The results indicate that Bayesian updating systematically lead to more risky behavior of the system, unless the prior failure probability estimates have been severely underestimated and that dynamic systems lead to more risky behavior only when Bayesian updating is applied.

The main explanation is that Bayesian updating involves a feedback mechanism that leads to more extreme deviations, especially when the complexity of the underlying system is important (non-linearity, feedback, inter-dependencies, loose coupling). Bayesian updating is an unavoidable process, which is especially helpful in cases of uncertain failure probability estimates. This paper indicates its deficiencies and the factors that intensify them.

Keywords

Bayesian updating; Monte Carlo; Failure probability; Complexity; Dynamic

Figures and tables from this article:

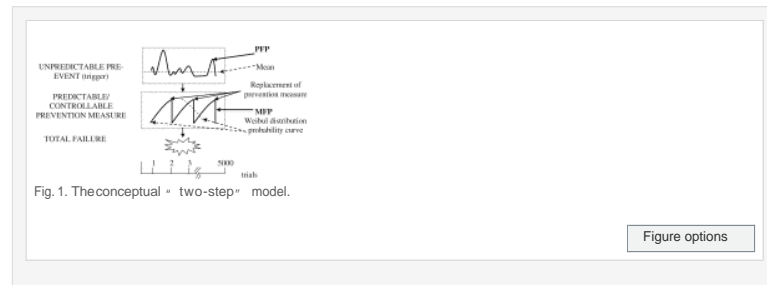


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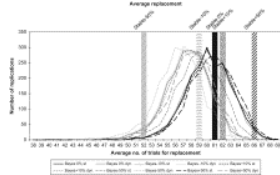


Fig. 3. Average number of replacements per scenario/tactic.

Figure options

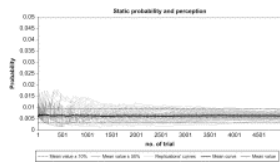


Fig. 4. Perceived PFP in Bayesian updating in static system.

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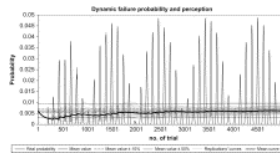


Fig. 5. Perceived and real PFP in Bayesian updating in dynamic system.

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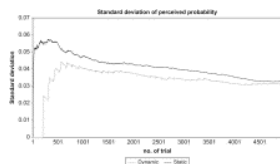


Fig. 6. Standard deviation of perceived probability from mean curve for Bayesian updating in static and dynamic system.

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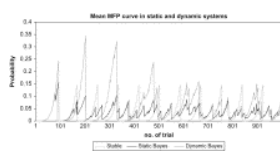


Fig. 7. Mean curve of MFP for "Stable" and for Bayesian tactic in static and dynamic system.

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Table 1. Simulation structure.

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Table 2. ANOVA for H1.

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Table 3. Mean hypothesis testing for H2.

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Table 4. ANOVA for H3.



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Table 5. ANOVA for H4.



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Table 6. Expected violations of maximum failure probability threshold.



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