Modeling Personalized Treatment Decisions: Comparison of Timed Automata with Discrete Event Simulation

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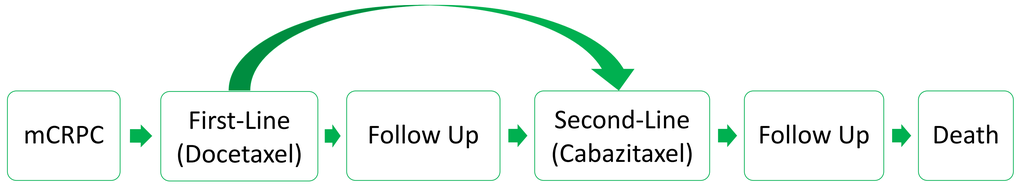
Introduction

The aim of this study is to compare the usefulness of two promising modeling techniques, Timed Automata (TA) originating from informatics, and Discrete Event Simulation (DES) known in operations research, for modeling complex and personalized treatment decisions involving multiple interacting processes and decisions over time.

Methods

The usefulness of both modeling techniques was assessed in a case study on the use of Circulating Tumor Cells as response marker in the personalized treatment process of metastatic Castration Resistant Prostate Cancer (mCRPC). The use of this marker for early therapy switching was modeled using TA in UPPAAL and DES in Tecnomatix Plant Simulation.



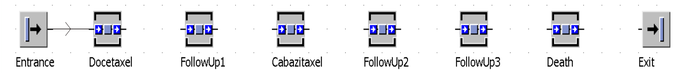
Parameters & Comparison

Input
- Costs & QoL
- Treatment Effectiveness
- Diagnostic Performance
- Physician's Behavior

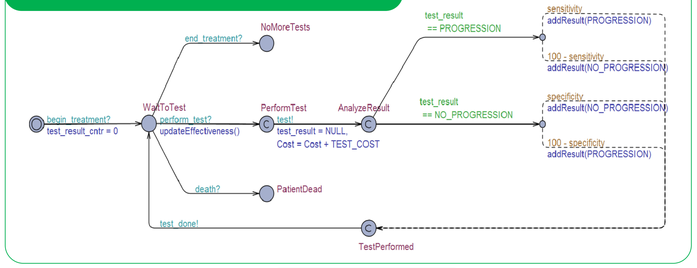
Output
- Cost-effectiveness (€/QALY)

Comparison
- Input Requirements
- Input Possibilities
- Model Checking
- Outcome values

Discrete Event Simulation Model

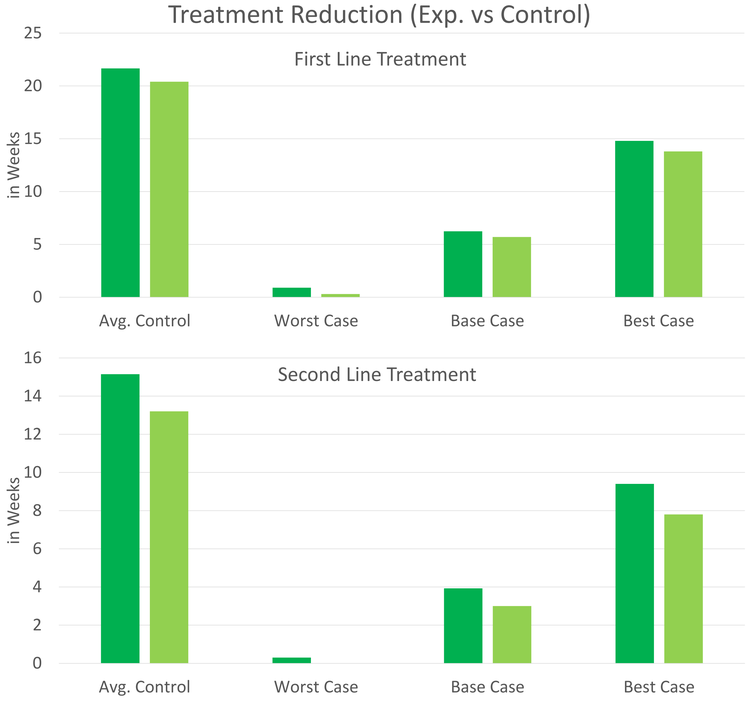


Timed Automata Model



Results

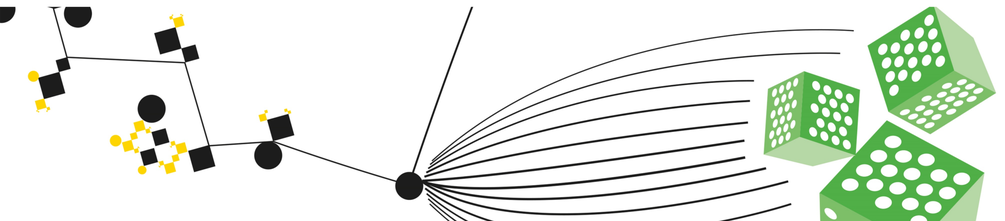
	Timed Automata	Discrete Event
Model Structure	Agents: Patient, Physician, Test & Guideline	Process: First-line, Follow Up and Second-line
Ease of modeling	Easy, several days (Experienced user) + independent agents, visual, debugging - input, experiments	Easy, several days (Experienced user) + input & output, experiments, debugging - interactions between actors in process
Cognitive ease	Good	More difficult
Additional	Model checking	-



Conclusion

Timed Automata is a new and interesting modeling technique, moving beyond standard health economic modeling methods, and allowing explicit separation of model components and statistical model checking to validate models.

Both Timed Automata and Discrete Event Simulation seem to be suitable for modeling complex and personalized treatment processes like that of metastatic Castration Resistant Prostate Cancer.



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