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

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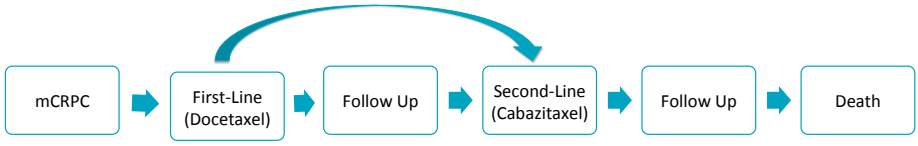
## Introduction

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 to decide when to switch from first-line to second-line treatment 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.




### Model Parameters and Comparison

**Input**
- Costs
- Prognosis
- Treatment Effectiveness
- Diagnostic Performance
- Physician's Behavior

**Output**
- Costs
- Survival
- Effectiveness

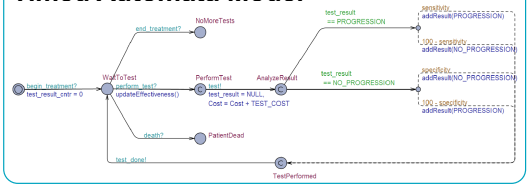
**Comparison**
- Input Requirements
- Input Possibilities
- Model Checking
- Outcome values

## Results

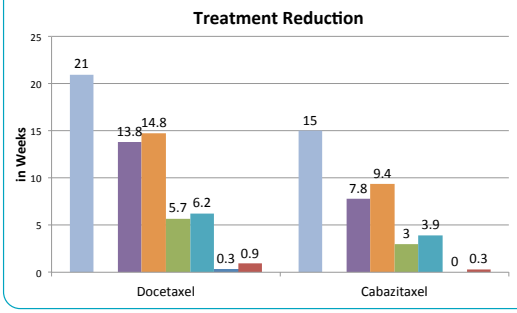
Both modeling approaches yield comparable results. While comparing the methods, it appeared that translating the process into a model was easier using TA, as this method allows independent modeling of the components comprising the treatment process such as patients, physicians, tests and treatments, whose mutual interaction and communication could be modeled easier and more extensively. Furthermore, the model checking feature of UPPAAL was found to be a powerful tool for internal validation of the model.

### Discrete Event Simulation Model


### Timed Automata Model




## Outcomes








## 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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