# Time-Based Decision Trees in Interaction Design (proposal)

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## INTRODUCTION

Time aspects are an important element in the design of interactive systems. However, the explicit consideration of time issues and their effects on the interaction flow today often is neglected by software developers during the design process due to the absence of appropriate tools. Often used software modeling techniques like UML diagrams [5] concentrate on the visualization of internal processes and architecture, the general focus of development environments is on spatial layout and system time. Thus they all disregard user interface (UI) time constraints.

In this work, I will therefore exemplary design a UI incorporating time-based decision trees in order to explicitly model time constraints. In general, decision trees are graph representations of hierarchical systems of decision rules and are very common in domains such as decision analysis and artificial intelligence. I will extend this notion by including time. Decisions made by the tree now depend additionally on time constraints and time flow, i.e. the time needed for making a decision could affect the resulting decision and certain decisions can only be made at certain points in time, as the system reaches different states in the course of time.

This work will be done in cooperation with the Klinik für Psychiatrie und Psychtherapie at Universitätsklinikum Aachen. This department uses an application called Presentation for which I will develop a new UI. Presentation is a stimulus delivery and experimental control software system for neuroscience used for programming, performing, and analyzing psychological experiments. One reason that makes designing experiments a tedious and laborious work in this software is that the underlying programming languages, SDL (Scenario Description Language) and PCL (Presentation Control Language), needed for specifying the course of events, are based on traditional software techniques, whereas time aspects are of great importance in experiments. Thus the special demands of this domain were not taken into account when designing the program. This makes Presentation an excellent application area for taking advantage of time-based decision trees and therewith improving the interaction. Therefore, I will use the application Presentation for evaluating my thesis.

## RESEARCH QUESTION

I want to show that the use of time-based decision trees is beneficial in interaction design by creating design metaphors for using time-based decisions and applying them in the design of a user interface to the highly specialized application Presentation.

## RELATED WORK

Card et al. [2] introduced the basic concepts of human cognition and information processing to the field of HCI with their “Model Human Processor”. They describe, amongst others, reaction times and time constraints in human memory performance that are of great importance when designing systems that adhere to human capabilities. But apart from pure performance issues these concepts also give valuable insights for general UI time constraints that should be respected throughout the design.

In order to be able to differentiate a design including time-based decision trees from common techniques used today, I will look at current design processes and software development processes, in particular at visualization methods such as UML [5].

When considering SDL, the language used to specify stimuli and sequences of stimuli and their timing and layout properties in Presentation, it could be beneficial to have a closer look at SMIL [6]. This is an XML-based markup language used to integrate and control multimedia contents in web pages that specifies timing, layout and synchronization. Therefore SMIL is related in some way to SDL and could give some ideas for improvements.

To the best of my knowledge, time-based decision trees have not been applied in the context of interaction design, yet. Eisenstein et al. [4] use decision trees to support automated UI design by providing an adaptive algorithm that recommends an ordered list of interactors to the designer; but without considering time. An interesting work including time-based decision trees is the one of Console et al. [3]. They introduce the notion of temporal decision trees as a model for on-board diagnosis in dynamic embedded systems. They show that diagnostic decision trees are an efficient model for reasoning about appropriate recovery actions in response to system faults and that they can be generated automatically. Then they are extended to temporal decision trees to exploit temporal information about observations and to preserve time constraints.

An alternative model including time constraints is the theoretical concept of timed automata [1], an extension to state-transition graphs to model the behavior of real-time systems. However, state automata are more formal than decision trees as they are closely related to formal language theory and are based on a mathematical model. Thus their focus is different from that of decision trees. They concentrate on the classification of abstract problems according to their solvability. But as this model covers a topic similar to time-based decision trees, I will look into it in order to test whether it would also make sense in the context of my thesis.

## PROJECT SCHEDULE

### Phase 1: Literature Review (1 month)

Initially, I will familiarize myself with Presentation and time-based decision trees and try to find more relevant contributions in the areas stated in the Related Work section.

### Phase 2: Initial Study (1 month)

After being sure that I have read everything that is relevant to my work, I will design and conduct a contextual inquiry to identify current work practices and occurring problems at the psychological clinic and to get a deep understanding of the domain. My goal is to identify the actual needs of the users.

### Phase 3: Prototypes (1 1/2 months)

Using the results of the study I will construct several prototypes to demonstrate different approaches. I will start with paper prototypes and after evaluating them with users I will proceed with interactive prototypes and their evaluation.

### Phase 4: Implementation (1 1/2 months)

Based on the conclusions of the prototypes, I then will implement the new UI to Presentation incorporating the users' demands. Afterwards it will be tested in user studies to compare it with the original UI.

### Phase 5: Writing (1 month)

Finally, I will write down the process and the findings of my work when composing my thesis.

## REFERENCES


1. Rajeev Alur, David L. Dill. *A Theory of Timed Automata*. Theoretical Computer Science Journal, Volume 126, pp. 183-235, 1994.
2. Stuart K. Card, Thomas P. Moran, Allen Newell. *The Psychology of Human-Computer Interaction.* Lawrence Erlbaum Associates, Inc. Mahwah, NJ, USA, 1983.
3. Luca Console, Claudia Picardi, Daniele Theseider Dupré. *Temporal Decision Trees: Model-based Diagnosis of Dynamic Systems On-Board.* Journal of Artificial Intelligence Research 19 (2003), pp. 469-512, October 2003.
4. Jacob Eisenstein, Angel Puerta. *Adaptation in Automated User-Interface Design.* Proceedings of the International Conference on Intelligent User Interfaces (IUI) 2000, pp. 74-81, New Orleans, LA, USA, 2000.
5. OMG – Object Management Group. *Unified Modeling Language: Superstructure - version 2.1.1.* February 2007.
6. W3C. *Synchronized Multimedia Integration Language (SMIL 2.1).* http://www.w3.org/TR/2005/REC-SMIL2-20051213/, December 2005.