MTMM — Correcting and Extending Time Map Management*

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Abstract

We present the concept of the deductive temporal data base MTMM, that corrects and extends Dean's [85] TMM in a number of aspects, allowing complete and consistent temporal inferences from a temporal model that may be given in a quantitative or qualitative way. The user is allowed to incorporate a certain form of inconsistency in the time map; we will demonstrate that this is a useful feature. Moreover, the user may withdraw any information at any time. The expressiveness of the temporal logic of the MTMM is equivalent to convex subsets of Allen's relations.

We present the basics of the MTMM, going into the concepts of persistence, persistence clipping, and validity in a bit more detail.

1 Background

In everyday life, few facts are timelessly true. This is, however, not mirrored in straightforward—or somewhat naive—representations of real world scenarios like predicate calculus or PROLOG, which, first of all, treat everything as eternal verities. Dealing with change over time lies at the heart of some classes of AI applications like planning or reasoning about processes. Consequently, there are approaches to capturing change in different frameworks:

- logical frameworks, e.g., situation calculus [McCarthy/Hayes 69] and possible models [Hanks/McDermott 85], [Ginsberg/Smith 88],
- planning, e.g., adding and deleting facts in STRIPS [Fikes/Nilsson 71], or
- qualitative reasoning with process oriented [Forbus 84], state oriented [deKleer/ Brown 84], and interval based [Voß/Linster 89] approaches.

In our work, we deal with Dean's [Dean 85, Dean/McDermott 87] time map management system (TMM), where a time map is a data base containing facts and temporal information about these facts. Dean has done pioneering work in that area; as far as can be judged from his publications, however, he seems to have come to a number of pragmatic decisions concerning

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Hans Voß co-authored a companion paper [Materne/Hertzberg/Voß 90] that shares some amount of work with this one. Thanks to Tom Gordon and Hans Werner Güsgen for reading earlier versions of this paper.
both his concept of time map management and its implementation in the TMM that make it not obvious how to generalize his ideas.

In [Materne 90], it is attempted to correct and to generalize some of Dean's ideas found wanting—or, at least, to make some hidden assumptions explicit—, resulting in another system for time map management: the MTMM. In this paper, we summarize its key issues, thereby presenting a constructive critique of TMM's reasoning. (In the following, we presume familiarity with Dean's work.)

We do not discuss here the question of how to integrate the MTMM into application systems, in particular into a planning system. Considering planning, there are two problems within a planner that can be solved by the MTMM:

- planning with time: a self-contained system for planning without quantitative time is extended by the MTMM for handling time; this results in a DEVISER-like [Vere 83] functionality with an EXCALIBUR-like [Drabble 88] architecture.
- managing goal achievement and conflict: the planner is based on the MTMM that has to take care of the (partial) task order in the plan.

These questions are discussed at length in [Materne 90].

The paper is organized as follows. In the next section, we will present the basic example problem used throughout the paper. Then, we will define the basic notions of time map management in a (moderately) formal style. After that, we go into the concepts of persistence clipping, persistence, and validity in a bit more detail. Finally, we summarize some MTMM features, resulting in a brief characterization of its expressiveness as compared to Allen's [83] temporal logics.

2 The example problem

Vacationer Timm, lying on the beach, is considering his program for tomorrow: he wants to water ski for 1 to 1.5 hours, depending on his physical condition then; he thinks he will arrive at the beach at 10:30; he has to be back at the hotel by 1:00 in order not to miss the lunch. There are two boatmen in question for hauling him:

- Miguel arrives every day between 11:00 and 11:30 at the beach and will stay between 3 and 6 hours, i.e., he is available until 2:00, at least. He has to leave by 5:30 as he has to cook in the local bodega.
- Pedro is available from 8:30; he is guaranteed to stay for 2 hours, at least. However, his mother-in-law Carmen may arrive wishing Pedro to drive her into town immediately, seizing him for at least 1 hour. All that is known about her arrival is that she likes to sleep long, and Pedro has asked his wife to keep her at home until 10:30. On the other hand, Carmen is not sure to arrive at any specific time; maybe she won't come at all, and Pedro may be on the beach until dusk. In addition to the Carmen problem, Pedro may decide by himself to go home at some time later than 10:30 for the rest of the day, independent of the possibility that Carmen might arrive later.