Statement of Interest for Workshop on Integrating Planning Into Scheduling: Temporal Contingency Planning

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In classical planning assumptions are made that ignore important aspects of the real world. As a result, many planners have been written that extend classical planning in various ways. Often times these extensions to classical planning incorporate aspects of scheduling such as optimization and reasoning about resources and time. For example, there has been considerable research with planners that allow durative actions (Smith & Weld 1999). Uncertainty is an aspect of the real world that is being studied in both planning and scheduling communities. (Dearden *et al.* 2003) lists a classification of planners that deal with uncertainty. Most of the research in uncertainty has dealt with uncertain action effects. However we are interested in actions with uncertain durations. The work in planners that assume action duration is uncertain has focused on finding conservative plans that are safe regardless of how long the actions in the plan take (e.g., (Tsamardinos, Pollack, & Horty 2000)). The main disadvantage of the conservative approach is that opportunities are often missed. To help resolve this issue, we are writing a planner that takes a different approach by generating temporally contingent plans. These plans include branches that are based on the duration of actions at execution time. The advantage to this approach is that the conservative plan still exists, but only as a contingency branch, allowing a more vigorous plan to be executed when time allows.

Specifically, we consider problems that exhibit the following characteristics:

- multiple solution plans exist
- solution plans are ranked by a nontemporal metric
- actions have uncertain durations
- execution time of some actions is constrained
- plans that are ranked highly by the metric are only valid when actions complete quickly.

One example problem is planning to attending a conference across the country. When plans are ranked by monetary cost, the best plan is to go to the airport, fly to the conference city, and take a bus to the conference. However, if the flight arrives too late there may not be enough time to take a bus and a more expensive option, like a taking a taxi, would have to be substituted.

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We define uncertainty in action duration by assigning each action an interval duration [*min-d*, *max-d*], where *min-d* and *max-d* are minimum and maximum reasonable durations, respectively ($min\text{-}d > 0$ and $max\text{-}d < \infty$). In our planner, uncertainty is dealt with iteratively using a Just-In-Case (Drummond, Bresina, & Swanson 1994) style algorithm. First an optimistic seed plan is generated by assuming actions will require only their minimum durations. By making this assumption, all uncertainty is removed from the problem at planning time. Once obtained, the seed plan is converted to a simple temporal network (STN) (Dechter, Meiri, & Pearl 1991) which factors back in the durational uncertainty. The STN is analyzed to locate time points where the seed plan may fail (e.g. if flight time > 100 minutes, there is not enough time to take a bus). At each such time point, a temporal contingency branch is created and inserted (e.g. if flight time ≤ 100 minutes take a bus, otherwise take a taxi).

Preliminary experiments show that we are able to create temporally contingent plans where branches that are ranked highest by the metric are always taken when time constraints allow. In this way, the plans include more opportunities over conservative approaches. Our future work will include design and testing of non-iterative algorithms, more investigations into improvements for parallel plans, consideration of resources, and determining how to locate missed opportunities and exploit them.

References

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