A comparison of Timed Games and Time Optimal Supervisor Synthesis

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Introduction

Nowadays it becomes increasingly difficult to develop high-tech manufacturing systems. The system control software consists often of millions of lines of code. Several approaches exist that can be used for controller synthesis. Synthesized controllers guarantee that the controlled system behavior is nonblocking and that the requirements are satisfied. Recently, two approaches were proposed for synthesizing controllers that additionally take care of optimality with respect to time:

- Time Optimal Supervisor Synthesis (TOSS) [1]
- Timed Games (TiGa) [2]

Objective

The objective of this project is to compare the two different approaches for the synthesis of time-optimal supervisors. Both approaches are used to find a time-optimal supervisor for a U-shaped manufacturing line.

Time-optimal supervisors

TOSS uses supervisory control theory to synthesize supervisors from time-weighted system components and requirements. The makespan of each sequence from the synthesized supervisor is calculated by using Heaps-of-Pieces. This information is used to deliver a controllable, time-optimal supervisor.

Problems in TiGa are modeled as automata with clocks. These automata consist of controllable actions which can be taken by the player and uncontrollable actions which can be taken by the opponent. Within these automata losing and winning states can be defined. A search algorithm is used for finding controllable strategies for reaching the winning state within a certain makespan and avoiding the losing states, i.e. to win the game.

Results

- Both approaches can be used for synthesizing time-optimal supervisors for the U-shaped manufacturing line.
- When more sequences are possible, TOSS retains all the sequences, where TiGa gives only one sequence.
- TOSS always synthesize nonblocking time-optimal supervisors. In some cases TiGa synthesizes possibly blocking or nonblocking sub-optimal supervisors.

Conclusions

Time-optimal supervisors which are synthesized using TOSS do not result in deadlock. For TiGa this is not always the case. Supervisors derived using TiGa can be, in some cases, blocking or sub-optimal.

References
