LTL_f Synthesis as AND-OR Graph Search: Knowledge Compilation at Work

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LTL_f Synthesis

- Autonomy, one of the grand objectives AI
  - Autonomous system, react to environment changes

- LTL_f synthesis [De Giacomo & Vardi, 2015]
  - Linear Temporal Logic on finite traces [De Giacomo & Vardi, 2013]
  - **Obtain** a system **From** a declarative specification
  - System interacting with the environment, generated executions satisfy the specification

LTL_f Synthesis and FOND Planning

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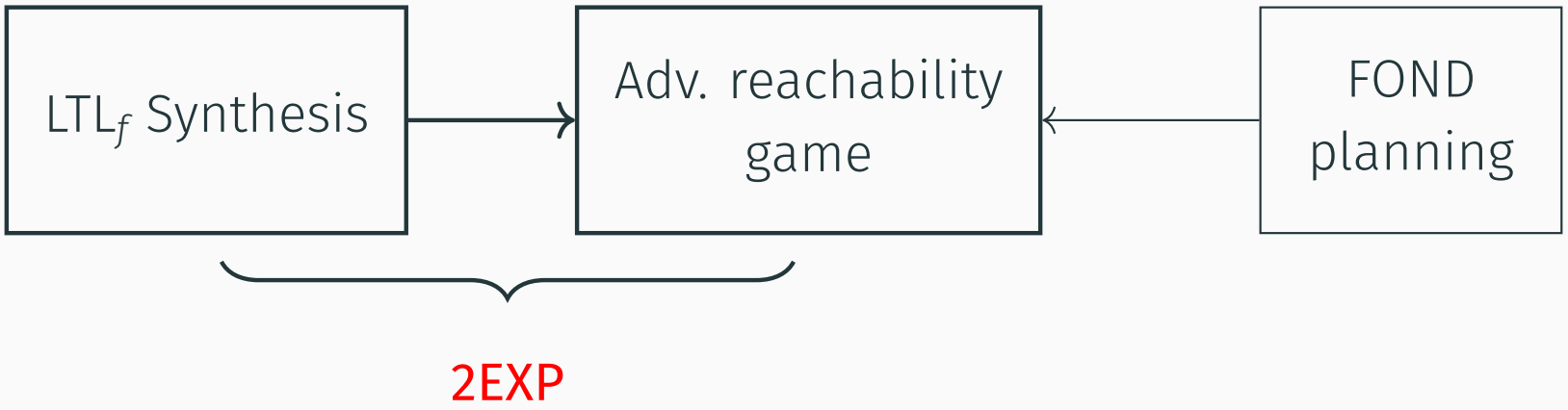
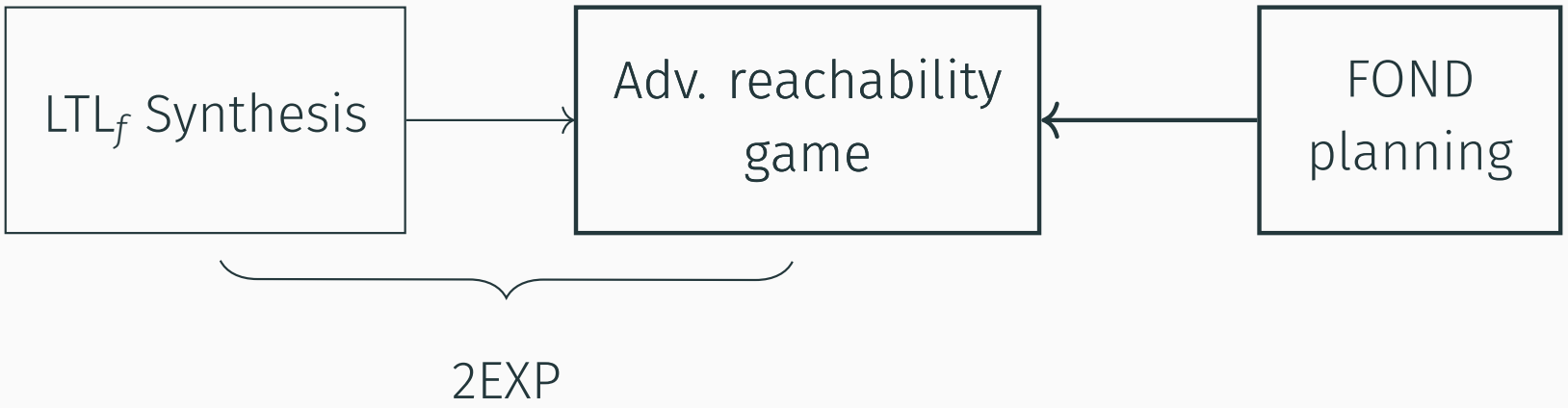
- Fixpoint computation on constructed DFA, e.g., Model Checking

LTL_f Synthesis and FOND Planning



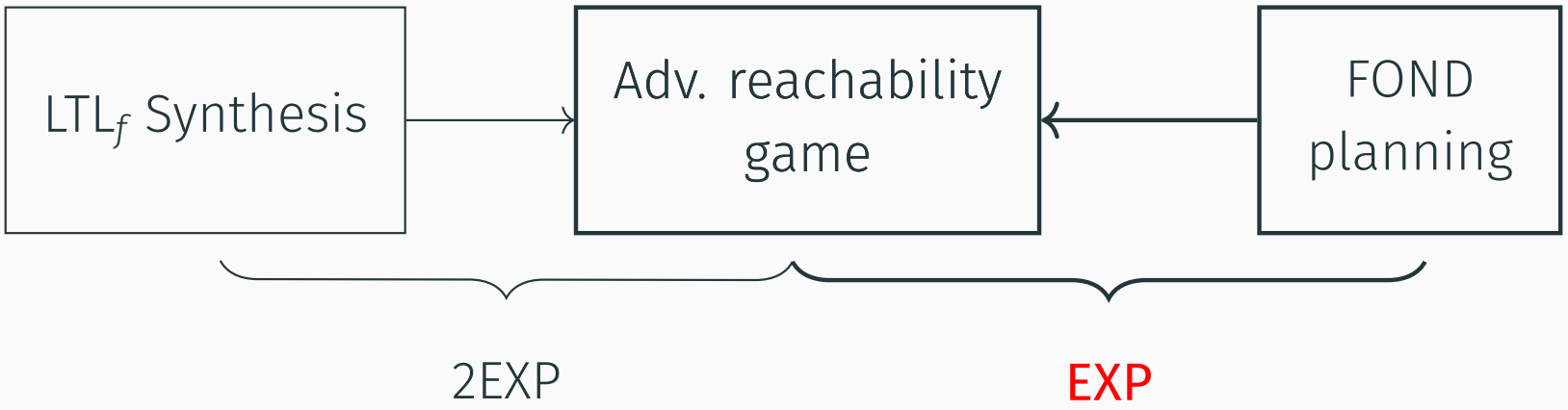
- Fixpoint computation on constructed DFA, e.g., Model Checking
- Problem: DFA can be double-exponential

LTL_f Synthesis and FOND Planning



- Forward search while expanding the space, e.g., FOND planning

LTL_f Synthesis and FOND Planning



- Forward search while expanding the space, e.g., FOND planning
- However, State space in FOND, only single-exponential

LTL_f Synthesis as AND-OR Graph Search

- Forward LTL_f synthesis approach
  - Adopting AND-OR graph search, as in FOND planning
  - Over double-exponential search space

LTL_f Synthesis as AND-OR Graph Search

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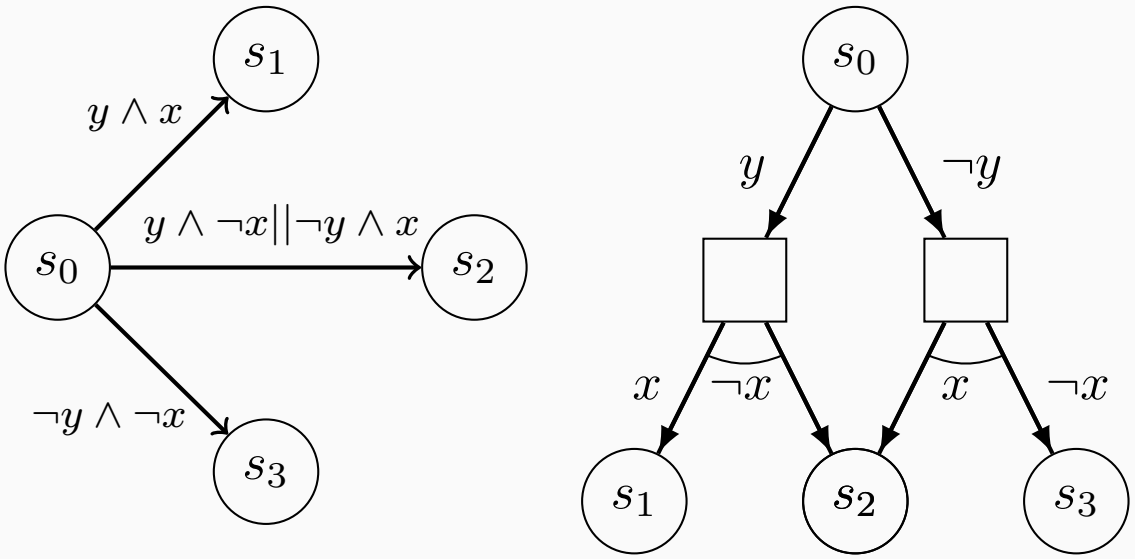
2. Adversarial reachability game on DFA as AND-OR graph search



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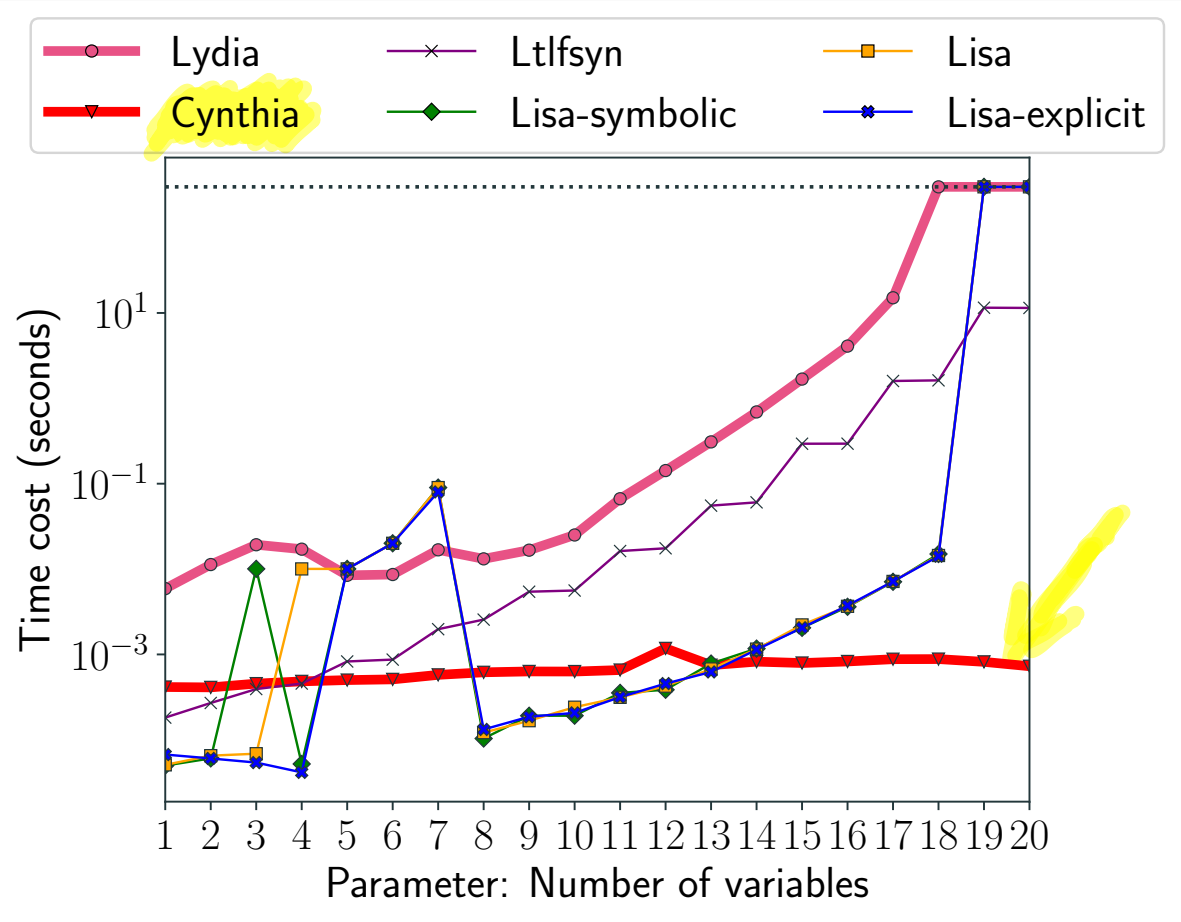
   - Compress labels leading to the same nodes, reduce the branching factor

Empirical Evaluation

- LTL_f Synthesis as AND-OR Graph Search, Cynthia
  - Uninformed search

- Baseline tools
  - Lisa [Bansal et al., 2020], Lydia [De Giacomo & Favorito., 2021], and Ltlfsyn [Xiao et al., 2021]

Experimental Results on Until-Patterns



$$U(n) = p_1 U(p_2 U(\ldots p_{n-1} U p_n))$$

Conclusions and Future Research

- Forward LTL_f synthesis adopting AND-OR graph search
  - Direct LTL_f-to-DFA construction
  - Expand the search space while performing AND-OR graph search
  - SDD to reduce branching factor
- Uninformed search, promising synthesis performance

- Move from uninformed search to informed search exploiting heuristics

Poster: Slot 200 at Row 6