Learning to the Rescue of Verification and Synthesis for Cyber-Physical Systems

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DBLP

ConVeY

Reachability for Uncountable MDPs [1]

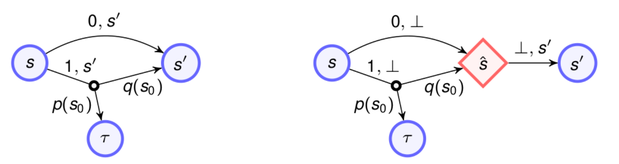
- Extend Value Iteration (VI) and Bounded Real-Time Dynamic Programming (BRTDP) to solve reachability in this setting.
- Use learning to improve the performance.

Reachability in Partially-Observable MDPs*

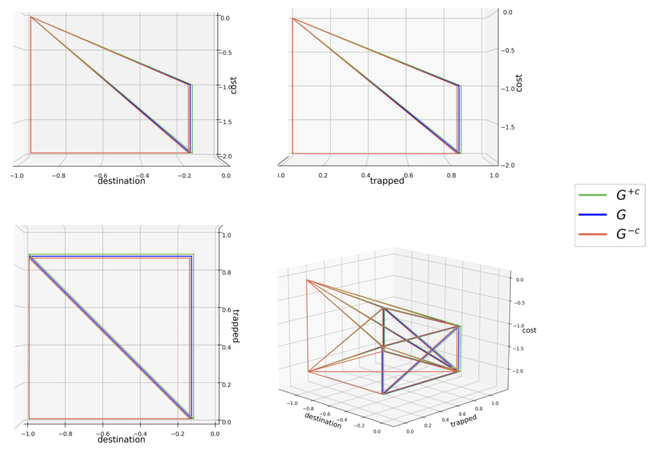
- Optimal solution requires infinite memory.
- STORM can compute a sub-optimal strategy which is huge.
- Use automata learning to synthesize small controllers which yields better results.

Applying Probabilistic Verification

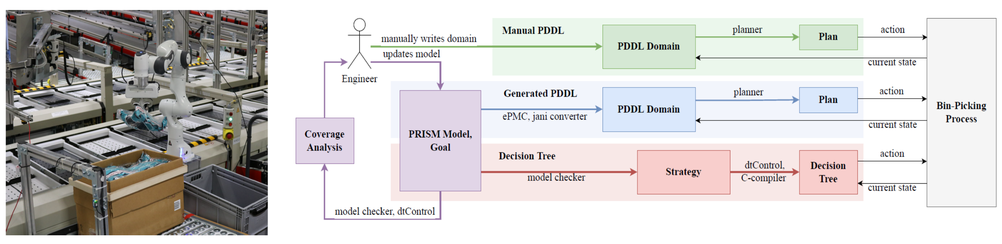
1. **Dynamic Information Flow Tracking Games** [5]
   - Advanced Persistent Threats vs DIFT as a concurrent SG.
   - Convert the single reward concurrent SG into a multi-reward turn-based SG.



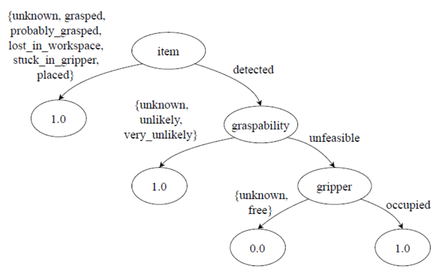
   - Learn the probabilities with PAC guarantees.
   - Solve this game to get the trade-off curves.



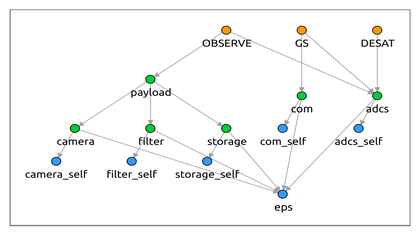
2. **Planning via Model Checking With Decision Tree Controllers** [4]



   - Model a robotic arm as an MDP.
   - Solve the MDP and generate strategy as a decision tree.
   - Improve the model by looking at which states do not have a recovery action.

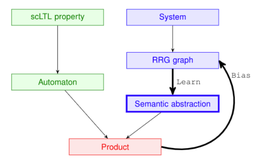


3. **Fault Isolation for satellites** [3]
   - Model the system architecture with fault probabilities of components as an MDP.
   - Reduce the size of the MDP using Monte Carlo tree search.
   - Solve the smaller MDP for a sub-optimal strategy.

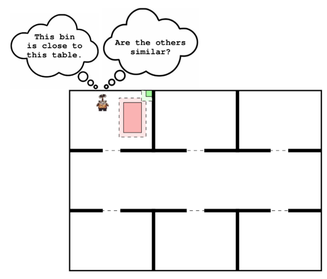


Motion Planning in Unknown Environments

- Gave an algorithm to synthesize a path satisfying sc-LTL [2]

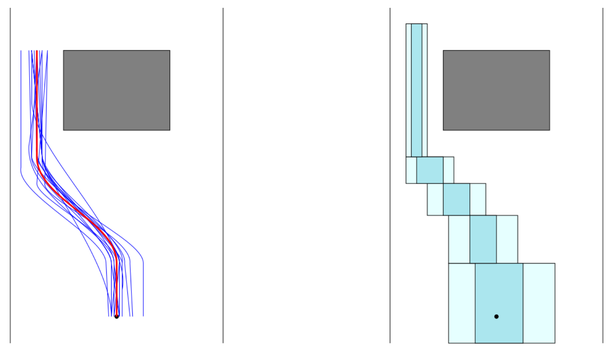


- Learn from the known environment and use it to guide the future exploration.



Fuzzy Logic for Motion Planning*

- STL has the problem of "boxing" and we want to come up with a logic where it is more natural to express motion planning specifications.
- Learn this logic using samples.



References

[1] K. Grover et al. "Anytime Guarantees for Reachability in Uncountable Markov Decision Processes". In: *33rd International Conference on Concurrency Theory, **CONCUR 2022**, September 12-16, 2022, Warsaw, Poland*. 2022, 11:1–11:20.

[2] K. Grover et al. "Semantic Abstraction-Guided Motion Planning for scLTL Missions in Unknown Environments". In: *Robotics: Science and Systems XVII, **RSS 2021***. Virtual, 2021.

[3] J. Kiesbye et al. "Model Checking for Proving and Improving Fault Tolerance of Satellites". In: *IEEE Aerospace Conference, **AeroConf 2023***. 2023, (preprint).

[4] J. Kiesbye et al. "Planning via model checking with decision-tree controllers". In: *2022 International Conference on Robotics and Automation, **ICRA 2022**, Philadelphia, PA, USA, May 23-27, 2022*. 2022, pp. 4347–4354.

[5] M. Weininger et al. "Guaranteed Trade-Offs in Dynamic Information Flow Tracking Games". In: *2021 60th IEEE Conference on Decision and Control, **CDC 2021***. IEEE, 2021, pp. 3786–3793.