AIND Planning Project: Research Review

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After completing the coding and analysis parts of the project, I felt that I couldn't imagine the full range of applications for planning. The main question I want to answer in this review is "What can planning be used for outside of solving logistics problems?" In short, not much. However, the logistics framework is surprisingly general. The three applications we will focus on are robotic motion planning, model-based reinforcement learning, and satellite scheduling.

Robotic Motion Planning

The Search-Based Planning Lab at Carnegie Mellon University conducts research in how search algorithms can be used to solve applied planning problems. A recent paper of theirs applies a search-based algorithm to plan robotic motion.[1] Their three main contributions include a novel data structure called a manipulation lattice graph, an anytime heuristic search called ARA*, and the use of multiple heuristics to guide ARA*. One insight from the paper was that solutions found in a lower-dimensional representation can serve as well-formed, guiding heuristics for the higher dimensional structures of motion planning problems.[1] They used this insight to help a robot navigate a kitchen-like environment.

Model-Based Reinforcement Learning

In his course on reinforcement learning, David Silver distinguishes between model-free and model-based reinforcement learning.[2] While the former attempts to learn a value function or policy from interaction with the environment, the latter directly learns a model of the environment and then uses that model to infer a value function or policy with which to choose actions. This inference is actually a (sometimes stochastic) planning problem. Tree search is often used for planning in this context. For example, Silver notes that model-based reinforcement learning, Monte Carlo tree search, and deep learning can be combined to achieve expert-level performance at playing Go.[2]

Satellite Scheduling

The Space Telescope Science Institute's SPIKE is a software designed to solve constrained scheduling and planning problems. Although designed in support of the Hubble Space Telescope, SPIKE is a general framework for scheduling and planning. It uses a technique called suitability functions "to represent the wide variety of strict and preferential constraints encountered in real scheduling problems."[3] It also uses constraint propagation and multistart stochastic repair technique for its scheduling algorithm. The software is used primarily for Ground Based Telescope scheduling and Orbiting Spacecraft scheduling, although it can potentially be used to solve a wide variety of scheduling and planning problems.

References

[1] Benjamin Cohen, Sachin Chitta and Maxim Likhachev, "Single- and dual-arm motion planning with heuristic search", International Journal of Robotics Research (IJRR), 2013.

[2] Silver, D. "Model-Based Reinforcement Learning", Internet, 2015.

[3] Space Telescope Science Institute. "Spike Planning and Scheduling System", Internet, 2016.