16-782 Fall'17
Planning & Decision-making in Robotics

Review of Exam Topics

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What You Should Know…

- Explicit vs. Implicit graphs
- What visibility graphs are
- What Voronoi diagram-based graphs are
- X-connected N-dimensional grids
- Lattice-based graphs

What You Should Know…

- A*
  - How it works
  - Theoretical properties
  - Proof for its optimality
- Weighted A*
- Backwards A*
- A* can be used to compute a policy and not just a single path

What You Should Know…

- Examples of heuristic functions
  - for X-connected grids
  - For higher dimensional planning problems derived by lower-dimensional search
- Be able to come up with a good heuristic function for a given problem
- Properties of heuristic functions
- How Multi-heuristic A* works

What You Should Know…

- The alternative formulation of A* that corresponds to a series of expansions of inconsistent states (states whose values are no longer consistent with their successors)
- How ARA* works
- What is an incremental search (D*/D* Lite) and when it is applicable and when it is not (i.e., its pros and cons)
- What is anytime incremental search (Anytime D*) and when it is applicable and when it is not (i.e., its pros and cons)

What You Should Know…

- What Freespace Assumption means
- Why we need to update heuristics in the context of Real-time Heuristic Search
- The operation of LRTA*
- Pros and cons of LRTA*
- What domains LRTA* is useful in and what domains it is not really applicable
- What RTAA* is

What You Should Know…

- Different types of planning for autonomous driving and how they interact
- What is multi-resolution lattice
- Different heuristic functions used in Motion Planning

What You Should Know…

- Pros and Cons of Resolution-complete approaches (like Grid-based or Lattice-based graphs) vs. Sampling-based approaches
- What domains are more suitable for each
- How PRM works

What You Should Know…

- Pros and Cons of RRT, PRM, RRT-Connect, RRT*
- How RRT, RRT-Connect and RRT* operate
- What guarantees RRT/RRT* provide
- Simple shortcutting algorithm

What You Should Know…

- General state machine for mobile manipulation
- The dimensionality when planning footsteps for quadrupedal (and bipedal) robots
- Appreciate the complexity of cost components when planning for quadrupedal (and bipedal) robots

What You Should Know…

- How to search for a path that is cost-minimal given multiple potential goals with different goalcosts (e.g., know how the graph transformation using "imaginary" goal)
- The operation of Iterative Deepening A* (IDA*)
- Pros and cons of IDA* as compared with A*

What You Should Know…

- What is coverage and what is mapping
- Frontier-based planning for coverage
- Frontier-based planning for mapping
- How to represent planning for surveyal as graph search

What You Should Know…

- Dependent vs. Independent variables.
- Definition of Markov Property
- The definition and the use of Dominance relationship

What You Should Know…

- How symbolic planning can be represented as a graph search and solved with heuristic searches (A*, weighted A*, etc.)
- Few ways for how domain-independent heuristics can be computed automatically
- Overall understanding of what Partial-order Planning is

What You Should Know…

- How to represent a particular planning problem using STRIPS language and how this translates into a graph
- The motivation behind creating domain-independent planning representations such as STRIPS

What You Should Know…

- What is Markov Decision Processes (MDP)
- Minimax formulation of planning under uncertainty
- The operation of Minimax backward A*
- Pros and cons of planning with Minimax formulation

What You Should Know…

- Pros and Cons of solving Expected Cost formulation (rather than Minimax formulation)
- The operation of Value Iteration
- The operation of RTDP
- Rewards formulation of MDPs and when it should be used

What You Should Know…

- What problems should be modeled as planning on Graphs vs. MDPs vs. POMDPs
- How POMDPs can be transformed into a Belief MDP
- How to plan in Belief MDP