Review for the Midterm Exam

Dana S. Nau

University of Maryland
The Chapters We’ve Covered

- Chapter 1: Introduction
- Chapter 2: Representations for Classical Planning
- Chapter 3: Complexity of Classical Planning
- Chapter 4: State-Space Planning
- Chapter 5: Plan-Space Planning
- Chapter 6: Planning-Graph Techniques
- Chapter 7: Propositional Satisfiability Techniques
- Chapter 16: Planning based on MDPs
- Chapter 17: Planning based on Model Checking
- Chapter 9: Heuristics in Planning
Chapter 1: Introduction and Overview

- 1.1: First Intuitions on Planning
- 1.2: Forms of planning
- 1.3: Domain-Independent Planning
- 1.4: Conceptual Model for Planning
- 1.5: Restricted Model
- 1.6: Extended Models
- 1.7: A Running Example: Dock-Worker Robots

No questions on Chapter 1
2: Representations for Classical Planning

- 2.1: Introduction
- 2.2: Set-Theoretic Representation
  - 2.2.1: Planning Domains, Problems, and Solutions
  - 2.2.2: State Reachability
  - 2.2.3: Stating a Planning Problem
  - 2.2.4: Properties of the Set-theoretic Representation
- 2.3: Classical Representation
  - 2.3.1: States
  - 2.3.2: Operators and Actions
  - 2.3.3: Plans, Problems, & Solutions
  - 2.3.4: Semantics of Classical Representations
- 2.4: Extending the Classical Rep.
  - 2.4.1: Simple Syntactical Extensions
  - 2.4.2: Conditional Planning Operators
  - 2.4.3: Quantified Expressions
  - 2.4.4: Disjunctive Preconditions
  - 2.4.5: Axiomatic Inference
  - 2.4.6: Function Symbols
  - 2.4.7: Attached Procedures
  - 2.4.8: Extended Goals
- 2.5: State-Variable Representation
  - 2.5.1: State Variables
  - 2.5.2: Operators and Actions
  - 2.5.3: Domains and Problems
  - 2.5.4: Properties
- 2.6: Comparisons

Didn’t cover these, so no questions on them
Chapter 3: Complexity of Classical Planning

● 3.1: Introduction
● 3.2: Preliminaries
● 3.3: Decidability and Undecidability Results
● 3.4: Complexity Results
  ◆ 3.4.1: Binary Counters
  ◆ 3.4.2: Unrestricted Classical Planning
  ◆ 3.4.3: Other results
● 3.5: Limitations

No questions on this chapter
Chapter 4: State-Space Planning

- 4.1: Introduction
- 4.2: Forward Search
  - 4.2.1: Formal Properties
  - 4.2.2: Deterministic Implementations
- 4.3: Backward Search
- 4.4: The STRIPS Algorithm
- 4.5: Domain-Specific State-Space Planning
  - 4.5.1: The Container-Stacking Domain
  - 4.5.2: Planning Algorithm

No questions on these
Chapter 5: Plan-Space Planning

- 5.1: Introduction
- 5.2: The Search Space of Partial Plans
- 5.3: Solution Plans
- 5.4: Algorithms for Plan Space Planning
  - 5.4.1: The PSP Procedure
  - 5.4.2: The PoP Procedure
- 5.5: Extensions
- 5.6: Plan Space Versus State Space Planning

Didn’t cover these, so no questions on them
Chapter 6: Planning-Graph Techniques

- 6.1: Introduction
- 6.2: Planning Graphs
  - 6.2.1: Reachability Trees
  - 6.2.2: Reachability with Planning Graphs
  - 6.2.3: Independent Actions and Layered Plans
  - 6.2.4: Mutual Exclusion Relations
- 6.3: The Graphplan Planner
  - 6.3.1: Expanding the Planning Graph
  - 6.3.2: Searching the Planning Graph
  - 6.3.3: Analysis of Graphplan
- 6.4: Extensions and Improvements of Graphplan
  - 6.4.1: Extending the Language
  - 6.4.2: Improving the Planner
  - 6.4.3: Extending the Independence Relation

use my lecture notes

Didn’t cover this, so no questions on it
7: Propositional Satisfiability Techniques

- 7.1: Introduction
- 7.2: Planning problems as Satisfiability problems
  - 7.2.1: States as propositional formulas
  - 7.2.2: State transitions as propositional formulas
  - 7.2.3: Planning problems as propositional formulas
- 7.3: Planning by Satisfiability
  - 7.3.1: Davis-Putnam
  - 7.3.2: Stochastic Procedures
- 7.4: Different Encodings
  - 7.4.1: Action Representation
  - 7.4.2: Frame axioms

No questions on the satisfiability algorithms

Didn’t cover this, so no questions on it
Chapter 16: Planning Based on MDPs

- 16.1: Introduction
- 16.2: Planning in Fully Observable Domains
  - 16.2.1: Domains, Plans, and Planning Problems
  - 16.2.2: Planning Algorithms
- 16.3: Planning under Partial Observability
  - 16.3.1: Domains, Plans, and Planning Problems
  - 16.3.2: Planning Algorithms
- 16.4: Reachability and Extended Goals

Didn’t cover these, so no questions on them
17: Planning based on Model Checking

- 17.1: Introduction
- 17.2: Planning for Reachability Goals
  - 17.2.1: Domains, Plans, and Planning Problems
  - 17.2.2: Planning Algorithms
- 17.3: Planning for Extended Goals
  - 17.3.1: Domains, Plans, and Planning Problems
  - 17.3.2: Planning Algorithms
  - 17.3.3: Beyond Temporal Logics
- 17.4: Planning under Partial Observability
  - 17.4.1: Domains, Plans, and Planning Problems
  - 17.4.2: Planning Algorithms
- 17.5: Planning as Model Checking vs. MDPs

Didn’t cover these, so no questions on them
Chapter 9: Heuristics in Planning

- 9.1: Introduction
- 9.2: Design Principle for Heuristics: Relaxation
- 9.3: Heuristics for State-Space Planning
  - 9.3.1: State Reachability Relaxation
  - 9.3.2: Heuristically Guided Backward Search
  - 9.3.3: Admissible State-Space Heuristics
  - 9.3.4: Graphplan as a Heuristic-Search Planner

No questions on this

- 9.4: Heuristics for Plan-Space Planning
  - 9.4.1: Flaw-Selection Heuristics
  - 9.4.2: Resolver-Selection Heuristics

Didn’t cover this, so no questions on it
The Exam

- Open book, open notes (closed neighbor)

- My exams are usually quite hard, **but**
  - I grade on a curve
  - Recall from the syllabus that during the final exam, you can choose how to weight each exam

- Statistics from some previous times I taught the course:

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm exam average:</td>
<td>72</td>
<td>60</td>
<td>75</td>
<td>72.5</td>
<td>75</td>
</tr>
<tr>
<td>Average final grade:</td>
<td>3.4</td>
<td>3.6</td>
<td>3.6</td>
<td>3.1</td>
<td>3.7</td>
</tr>
</tbody>
</table>
Miscellaneous

● If you have questions, please post them to the discussion forum rather than emailing me
  ◆ Others might like to see the answers too!

● Sample exams: go to the “schedule and lecture notes” page, click on “private materials”
  ◆ Send me email if you’ve forgotten the name/password
  ◆ Midterm and final exams for three semesters
    » The ones from 2007 and 2008 include answers
    » No answers for the 2005 ones
      • Also, I covered the chapters in a different order that time