Analysing and Combining Static Pruning Techniques for Classical Planning Tasks

Master Thesis
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I. Introduction
Planning Task

- Variables
- Operators \( \text{drive}_{A \rightarrow B}, \text{drive}_{B \rightarrow A}, \text{load}_A, \text{unload}_A, \text{load}_B, \text{unload}_B \)
- Initial state \( \text{A A} \)
- Goal state \( \text{B B} \)

1. Introduction
Plan: \( \text{load}_A \) \( \text{drive}_{A \rightarrow B} \) \( \text{unload}_B \)
I. Introduction

State Explosion Problem
Dynamic Pruning

Static Pruning

- Variables
- Operators
- Initial state
- Goal state

1. Introduction
2. Pruning Techniques

- Safe Abstraction
- Redundant Operator Reduction
- Dominance Pruning
Safe Abstraction

- Original version by Helmert (2006)
- Variant by Haslum (2007)

General idea:

1. Abstract safe variables
2. Solve abstract task
3. Refine plan
2. Pruning Techniques

### Safe Abstraction

**Abstract Planning Task**

- **Variables**
- **Operators** $\text{drive}_{A\rightarrow B}, \text{drive}_{B\rightarrow A}, \text{load}_A, \text{unload}_A, \text{load}_B, \text{unload}_B$
- **Initial state**
- **Goal state**
2. Pruning Techniques

Safe Abstraction

Original Planning Task

Plan: $load_A \ drive_{A \rightarrow B} \ unload_B$
Redundant Operator Reduction

- Researched by Haslum and Jonsson (2000)

**General idea:**

- More operators than necessary
- Remove *redundant* operators
Redundant Operator Reduction

2. Pruning Techniques
Dominance Pruning

- Optimality-preserving

Torralba and Hoffmann (2015)
- Compute state simulation

Kissmann and Torralba (2015)
- Identify *subsumed* transitions
- Remove „bad“ operators
Dominance Pruning

- Operators: \( \text{drive}_{A \rightarrow B}, \text{drive}_{B \rightarrow A}, \text{load}_A, \text{unload}_A, \text{load}_B, \text{unload}_B \)
3. Synergies
Which synergies exist?
→ Proven theorems

3. Synergies
3. Synergies

Synergy Effects

- Safe Abstraction
- Redundant Operators
- Dominance Pruning
4. Experiments

- Implementation in Fast Downward
- IPC Benchmarks
Roadmap Experiments

1. Techniques separately
   - Configurations
   - Best performance

2. Combinations and Synergies
   - Synergies separately
   - Synergies compared

4. Experiments
Safe Abstraction

Expanded States

Planning Time

4. Experiments
Redundant Operator Reduction

4. Experiments
Dominance Pruning

4. Experiments

Expanding States

Planning Time

Baseline (A* + LMCut)

Dominance Pruning

Powerful, up to 50–80% operators pruned, but comparatively slow.
Synergies separately

Pruned Operators

4. Experiments
4. Experiments

**Synergies compared**

- ROR+SA vs SA+ROR
- Combination vs Combination
- No coverage increase

**Operators left**

**Planning Time**
5. Conclusion

- Static Pruning can improve coverage
- Synergies exist & occur on IPC domains

Further research:
- less strict Safe Abstraction
- more fine-grained ROR
- satisficing Dominance Pruning

Thank you!