Graph-Based Factorization of Classical Planning Problems

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Setting

- Classical domain-independent planning
- Reformulation of planning problems

Motivation

- Many techniques rely on loosely coupled problems, e.g.:
  - Factored planning
  - Partial order reduction (e.g. strong stubborn sets, sleep sets)
- Problem formulation usually taken as given
- Automated problem reformulation is difficult (Haslum 2007)
- Equivalent reformulations with less coupling?

Outline
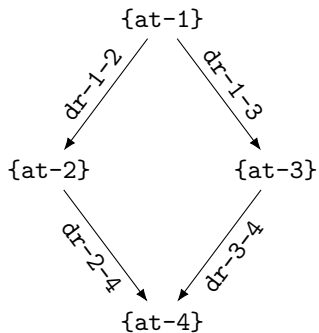
Example Formulations

- Simple example: 1 truck, 4 locations
- Drive from location 1 to 4

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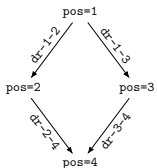- Drive from location 1 to 4

STRIPS

SAS$^+$

{at-1}

dr-1-2   dr-1-3

{at-2}   {at-3}

dr-2-4   dr-3-4

{at-4}

pos=1

dr-1-2   dr-1-3

pos=2   pos=3

dr-2-4   dr-3-4

pos=4
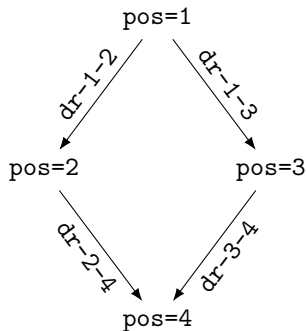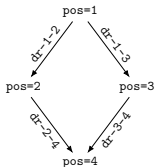
SAS$^+$ Variable Factorization
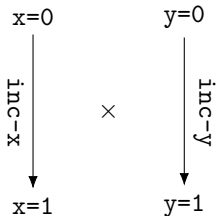
Original Variable

SAS$^+$ Variable Factorization

Original Variable

Factorized Variables

SAS$^+$ Variable Factorization

Original Variable

Factorized Variables

$x=0$ $\quad\times\quad$ $y=0$

$x=1$ $\qquad\qquad$ $y=1$
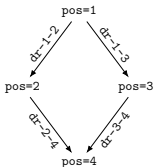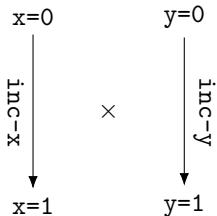
Factorized Product
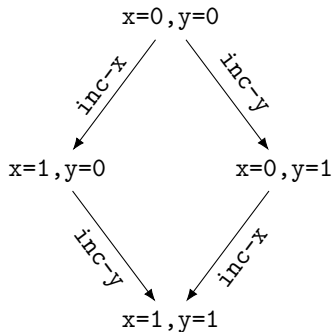
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Theorems

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- Runtime of factored planning can be exponentially smaller
- Partial order reduction can generate exponentially fewer nodes

And Practice?

- No automated implementation yet
- Analysis: IPC domains cannot be factorized
- Proof of concept: modified VisitAll

Conclusions

- Reformulation to obtain less coupled planning problems
- Exponential reductions possible
- Future work: make the approach practical
- More details: paper and poster