Planning and Optimization

M. Helmert, G. Röger
T. Keller, M. Wehrle

University of Basel
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Exercise Sheet 3

Due: October 19, 2016

Exercise 3.1 (2+1+1+3 marks)

Consider the following propositional planning task $\Pi = \langle V, I, O, \gamma \rangle$.

- $V = \{$truck-A, truck-B, truck-C,
  package-A, package-B, package-C, package-truck,
  visited-A, visited-B, visited-C$\}$
- $I(v) = \mathbf{T}$ for $v \in \{$truck-A, visited-A, package-C$\}$, $I(v) = \mathbf{F}$ otherwise
- O contains the following operators, each with cost 1:
  - For $(X, Y) \in \{(A, B), (B, A), (B, C), (C, B)\}$:
    drive-X-Y = $\langle$truck-X, $\neg$truck-X $\wedge$ truck-Y $\wedge$ visited-Y, 1$\rangle$
  - For $X \in \{A, B, C\}$: load-X = $\langle$truck-X $\wedge$ package-X, $\neg$package-X $\wedge$ package-truck, 1$\rangle$
  - For $X \in \{A, B, C\}$: unload-X = $\langle$truck-X$\wedge$package-truck, $\neg$package-truck$\wedge$package-X, 1$\rangle$
- γ = package-B $\wedge$ visited-A $\wedge$ visited-B $\wedge$ visited-C

Informally, the task consists of a package that can be transported by a truck on a roadmap with three locations that are arranged on a line. The goal is to transport the package from location C to B, and having visited all locations at least once.

(a) We can find the mutex groups

$$\{\text{truck-A}, \text{truck-B}, \text{truck-C}\} \text{ and } \{\text{package-A}, \text{package-B}, \text{package-C}, \text{package-truck}\}$$

in Π. Use these mutex groups to derive an equivalent planning task Π' in finite-domain representation. Use reasonable variable names in Π'. For brevity, you are allowed to use the schematic operator notation used above to describe the operators in Π'.

(b) Compare and discuss the number of states in Π and Π'.

(c) Are there mutex groups $G \subseteq \{\text{visited-X} \mid X \in \{A, B, C\}\}$ with $|G| \geq 2$? Justify your answer.

(d) Transform Π' to transition normal form. For brevity, you are allowed to use the schematic operator notation used above to describe the operators.

Exercise 3.2 (1+4 marks)

Let s be a state, $\varphi = \varphi_1 \wedge \cdots \wedge \varphi_n$ be a conjunction of atoms, and o be a STRIPS operator which adds the atoms $a_1, \ldots, a_k$ and deletes the atoms $d_1, \ldots, d_l$ (w.l.o.g., $a_i \neq d_j$ for all i, j). Prove the correctness of STRIPS regression by showing the following claims:

(a) If o is *not* applicable in s, then $s \not\models \mathit{sregr}_o(\varphi)$.

(b) If o is applicable in s, then the following holds: $s \models \mathit{sregr}_o(\varphi)$ if and only if $s[\![o]\!] \models \varphi$.

The exercise sheets can be submitted in groups of two students. Please provide both student names on the submission.