UNIVERSITY OF INNSBRUCK
MASTERSTUDIUM INFORMATIK VERTIEFUNGSMODUL (WM 9)
Automatic Planning
Lecturer: Jörg Hoffmann
Tutor: Adina Sirbu
Exercises Nr. 4. **To be returned on Tuesday, Nov 6**

Exercise 1. (3 points)

Prove the proposition on "The k-Subsets Relaxation", slide 5). Tip: prove by induction over i, $0 \leq i \leq n$, that $result(s, \langle a_1, \dots, a_i \rangle)$ is defined, and equal to $(s \cup \bigcup_{j=1}^{i} add(a_j)) \setminus \bigcup_{j=1}^{i} del(a_j)$.

Exercise 2. (2=1+1 points)

Consider parallel regression in the parallel Blocksworld (see "The k-Subsets Relaxation", slide 13 for parallel regression, and slides 10 and 14 for the parallel Blocksworld operators and goal). Write up the fact sets $Regress(G, \{movefromtable(B, D), movefromtable(C, A)\})$ and $Regress(G, \{movefromtable(B, D), move(C, E, A)\})$.

Exercise 3. (5=2+3 points)

Prove the following propositions:

- **Proposition 1** Let (P, A, I, G) be a STRIPS task, let $s \subseteq P$, and let $\langle a_1, \dots, a_n \rangle$ be a sequence of actions so that $s \subseteq \mathit{result}(I, \langle a_1, \dots, a_n \rangle)$. Then, for $r(s)$ as defined on "The k-Subsets Relaxation" slide 18, we have that $r(s) \leq n$.
- **Proposition 2** Let (P, A, I, G) be a STRIPS task, let $s \subseteq P$, and let $\langle a_1, \dots, a_n \rangle$ be a sequence of actions so that $s \subseteq \mathit{result}(I, \langle a_1, \dots, a_n \rangle)$. Then, for $r^k(s)$ as defined on "The k-Subsets Relaxation" slide 19, we have that $r^k(s) \leq n$.

In both proofs, you may use without proof the property that, for any s, s' where $s \subseteq s'$, $r(s) \leq r(s')$. Tip: For the first proof, denote $s_i := \mathit{result}(I, \langle a_1, \dots, a_i \rangle)$; you can then prove by induction over i, $0 \leq i \leq n$, that $r(s_i) \leq i$. For the second proof, you can use a similar induction.

Note: For the first proof, use **only** the characterization of $r(s)$ on "The k-Subsets Relaxation" slide 18; do **not** use its definition as solution distance in sequential regression, as per slide 17!

Exercise 4. (5 extra points)

Prove the following proposition:

Proposition 3 Let (P, A, I, G) be a STRIPS task, let $s \subseteq P$, and let $\langle a_1, \dots, a_n \rangle$ be a shortest sequence of actions so that $s \subseteq \mathit{result}(I, \langle a_1, \dots, a_n \rangle)$. Then, for $r(s)$ as defined on "The k-Subsets Relaxation" slide 18, we have that $r(s) \geq n$.

This is a **voluntary** exercise, meaning that you can earn those 5 points, but the 5 points are **not** counted into the sum of achievable points. Tip: there is a relatively easy proof by contradiction.

Note: Use **only** the characterization of $r(s)$ on "The k-Subsets Relaxation" slide 18; do **not** use its definition as solution distance in sequential regression, as per slide 17!