UNIVERSITY OF INNSBRUCK
MASTERSTUDIUM INFORMATIK VERTIEFUNGSMODUL (WM 9)
Automatic Planning
Lecturer: Jörg Hoffmann
Tutor: Adina Sirbu
Exercises Nr. 6. **To be returned on Tuesday, Nov 20**

Exercise 1. (4 points)

Prove the proposition ("The Monotonicity Relaxation", slide 16) showing that any real plan is also a relaxed plan. Tip: the proof goes by induction over the length of the action sequence, and compares the state after executing the sequence $\langle a_1, \dots, a_i \rangle$ of real actions to the state after executing the sequence $\langle a_1^+, \dots, a_i^+ \rangle$ of the respective relaxed actions.

Exercise 2. (4 points)

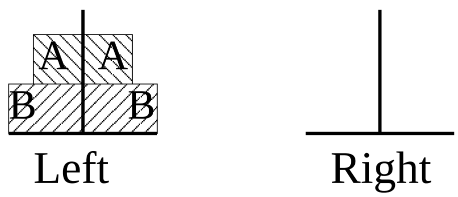
Construct an example, i.e., an artificial example STRIPS task, where, for some fact p, the value $r^{add}(\{p\})$ is updated twice during the computation of r^{add} ("The Monotonicity Relaxation", slide 32). In your example, what is the (final) value of $r^{add}(\{p\})$, and what is the value of $r^1(\{p\})$? Tip: in the example, there are different ways to achieve p; one appears in an early iteration and has many preconditions; the other appears in a later iteration but has fewer preconditions. Tip: there is an example that uses the fact set $\{p, q_1, \dots, q_{10}, x, y\}$.

Exercise 3. (3=0.5+2.5 points)

Consider a Towers-of-Hanoi problem with only two discs A and B, and two pegs $Left$ and $Right$. The facts are $clear(A)$, $clear(B)$, $clear(Left)$, $clear(Right)$, $on(A,B)$, $on(A,Left)$, $on(A,Right)$, $on(B,Left)$, and $on(B,Right)$. The initial state is $I = \{clear(A), on(A,B), on(B,Left), clear(Right)\}$. The goal state is $G = \{on(A,B), on(B,Right)\}$. The actions take the form $move(x, from, to) =$

$$(\{clear(x), on(x, from), clear(to)\}, \{on(x, to), clear(from)\}, \{on(x, from), clear(to)\}).$$

The "smaller(x,from)" and "smaller(x,to)" constraints are encoded in the action *set*, i.e., we have (only) the actions $move(A,B,Left)$, $move(A,B,Right)$, $move(A,Left,B)$ $move(A,Left,Right)$, $move(A,Right,B)$ $move(A,Right,Left)$, $move(B,Left,Right)$, and $move(B,Right,Left)$. Illustration:



1. Build a relaxed planning graph for this task, i.e., write up the sets F_t and A_t until the algorithm ("The Monotonicity Relaxation", slide 36) terminates. Leave out the NOOP actions. Use F_t in the write-up of F_{t+1}, and A_t in the write-up of A_{t+1}.

2. Extract a relaxed plan ("The Monotonicity Relaxation", slide 39). Write up the contents of the sets $G_0, \dots, G_{maxlevel}$, before the 2nd **for**-loop ($t := maxlevel, \dots, 1$) starts, and at the end of every iteration of that loop; say what actions are selected in each iteration. What is the value of h^{FF}?