## Principles of AI Planning

Dr. J. Rintanen, M. Ragni
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University of Freiburg
Department of Computer Science

# Exercise Sheet 1

**To be submitted Monday, April 18**

In this exercise, you will familiarize yourself with the **FF** planning system and the **PDDL** language used for specifying planning problems. The software and problem definitions necessary for completing these assignments are available on the exercise web page[1].

**Exercise 1.1** (PDDL I – 5 credits)

The Tower of Hanoi[2] is a mathematical game. It consists of three pegs, and a number of discs of different sizes which can slot onto any peg. The puzzle starts with the discs neatly stacked in order of size on one peg, smallest at the top, thus making a conical shape.
The object of the game is to move the entire stack to another peg, obeying the following rules:

(a) Only one disc may be moved at a time.
(b) A disc can only be placed onto a larger disc (it doesn't have to be the adjacent size, though: the smallest disc may sit directly on the largest disc).

Since you are too intelligent to solve problems by hand you plan to let the computer do the hard stuff and use the **FF** planning system.

(a) Write the Tower of Hanoi domain in PDDL. Use 3 predicates: unary predicate *clear*, binary predicates *on* and *smaller*. One action *move* is sufficient.
(b) Specify the following problem consisting of 4 discs in PDDL: The disc $d4$ is smaller than $d3$, $d3$ is smaller than $d2$ and $d2$ is smaller than $d1$. All discs are on peg 1, whereby $d4$ is on $d3$, which is on $d2$, which is on $d1$. Your goal is to have $d4$ on $d3$, $d3$ on $d2$, $d2$ on $d1$ on peg 3.
(c) Solve this problem by using **FF**.

**Exercise 1.2** (PDDL II – 5 credits)

A friend of you, who has attended the theoretical computer science lecture last semester, shows you a 3-SAT problem and asks you to help him solve it. Since you are very busy and want to practize your new planning skills you decide to look if you can solve such problems by using planning algorithms. For this reason, you do the following:

[1] `http://www.informatik.uni-freiburg.de/~ki/teaching/ss05/aip/exercises.html`
[2] `http://en.wikipedia.org/wiki/Tower_of_Hanoi`

(a) Specify the 3-SAT domain in PDDL.
*Hint:* You need operators for assigning values to the variables. You can fix the set of variables to $p_1$, $p_2$, and $p_3$.
(b) Specify the following 3-SAT problem[3]
$(p1, \neg p2, p3) \wedge (p1, p2, \neg p3) \wedge (\neg p1, p2, p3)$.
(c) Solve this problem by using **FF**.

You may work on these assignments and submit your results **in groups of two students**. Make sure to clearly indicate both names on your work. **You may write your answers in English or German.** Please return your homework on monday **before** 14:15.
Exercise marks count towards your final grade for this course, which is calculated from exercise marks (**15%**) and exam marks (**85%**).

[3]You can use this formula: (and (or (p1) (not(p2)) (p3))) ... as the goal specification in PDDL.