Search and Planning

Exercise 1 (8 points)

Consider the following game: a display shows 3 digits c_1, c_2 and c_3 with possible values in $\{0, 1, 2\}$. Under every digit there is a buttom, that, when pressed, replaces the value with the sum of the other two digits modulo 3. The player can play by pushing the buttons one at a time.

The display initially shows $\langle 0, 1, 2\rangle$ and the goal is to reach $\langle 2, 1, 0\rangle$.

(a) Represent the problem as a search in the state space and model the initial and final state.

(b) By applying "iterative deepening search" show the optimal solution; draw the search tree for each level of the search reporting the state in each of the nodes and the action on each of the arcs.

(c) Model the problem as local search and briefly discuss the execution of a basic algorithm for local search.

Exercise 2 (4 points)

Discuss the language PDDL and show an example of domain representation in PDDL

Exercise 3 (4 points)

Discuss the notion of conditional planning and the form of a conditional plan. Motivate the need for introducing conditional plans and discuss the difference in the representation of the state with respect to classical planning. Provide an example.

Knowledge Representation

Exercise 1 (8 points)

The packages stored in room1 are smaller than those stored in room 2.
A and B are packages; A is stored either in room1 or in room2, B is stored in room1.
B is not smaller than A.

(a) Define a vocabulary (i.e., constant, function and predicate symbols) and represent the above sentences in first order logic.

(b) translate the sentences in clausal form and tell whether the resulting KB is Horn.

(c) show, using resolution that package A is stored in *room1*.

Exercise 1d

For each pair of formulas tell whether or not the second one is a Skolem normal form of the first one; in the negative case, make an appropriate correction.

(a)
1. $\forall x \exists y (P(x, y) \wedge Q(y, x))$
2. $P(x, f(x)) \wedge Q(a, x)$

(b)
1. $\forall x \exists y \exists z (P(x, y) \wedge P(z, x) \wedge P(y, z))$
2. $P(x, f(x)) \wedge P(g(x), x) \wedge P(f(x), g(x))$

Exercise 2 (4 points)

Describe the unification algorithm, highlighting its case structure. Describe its step-by-step application on the following expressions where variables are denoted by upper case initial letters.

1. $p(X1, f(X1))$ and $p(g(X2), f(g(a)))$
2. $select(X, [X|Xs])$ and $select(Y, [a, b, c])$

For each case, show the most general unifier or justify why the two expressions do not unify.

Exercise 3 (4 points)

Write a PROLOG program that given a binary tree of with integer numbers stored in the nodes. Write a program that returns the maximum value stored in the tree. For example, given the input [4,[1,[],[]],[7,[],[]]] the algorithm should return 7. Write a modified version of the program so that it also counts the number of occurrences of the maximum value.