Class Exercise 9

Exercise 1

Consider the monkey-banana problem:

A monkey is in a room at position A. Suspended from the ceiling above position B is a bunch of bananas, beyond the monkey's reach. In the corner of the room at position C is a box. How can the monkey get the bananas?

The monkey can perform the following operations:

- walk - Walk on the ground from one position to another.
- push - Push a box from one position to another.
- climb_up - Climb on top of the box.
- climb_down - Climb down to the ground.
- grasp - Grasp an object that is in reach.
- release - Release an object.

(a) Give a STRIPS specification of the initial state.

(b) Give a STRIPS specification of the operators.

(c) The monkey would like to stand on the ground and hold the bananas (and then sit down and eat the bananas). Give a STRIPS specification of this goal.

(d) Determine a plan solving this planning problem.

(e) In the room there is a second box which is too heavy to be pushed. Extend state descriptions and operator descriptions.

Exercise 2

Consider the Blocks World example presented in the lectures (the non-compact STRIPS model).

(a) Extend the model by describing with a predicate *covered*(x) whether box x has some other box on top.

Give a description for a state where a, b and c are in the same stack and extend the operators.

(b) Extend the model by describing with a predicate *over*(x, y) whether a box x is in a stack with bottom box y.

Give a description for a state where a, b and c are in the same stack and extend the operators.

Exercise 3

Consider the Blocks World example presented in the lectures (the non-compact STRIPS model).

Combine the two operators *pickup*(x) and *stack*(x, y) into one macro-operator *put*(x, y).

Describe a general procedure of creating macro-operators.

Exercise 4

Consider the following blocks world planning problem.

- Constants: a, b, c, d, *floor*
- Predicates: *on*(x, y), *clear*(x)
- Operators:

  operator : *move*(x, y, z)
  precond : *on*(x, y), *clear*(x), *clear*(z)
  effects : $\neg$*on*(x, y), $\neg$*clear*(z), *on*(x, z), *clear*(y), *clear*(*floor*)
- Initial state: {*on*(c, a), *on*$(a,$ *floor*$)$, *clear*(c), *on*(d, b), *on*$(b,$ *floor*$)$, *clear*(d), *clear*(*floor*)}
- Goal: {*on*(a, b)}

(a) Use Regression Planning to solve this planning problem.

(b) Determine the initial plan for Partial-Order Planning. Is the plan space finite? Apply Partial-Order Planning to solve this planning problem.

Exercise 5

We consider the following version of the Sussman Anomaly in Blocks World:

- Constants: a, b, c
- Predicates: *on*(x, y), *ontable*(x), *clear*(x)
- Operators:

  operator : *pickup_and_stack*(x, y)
  precond : *ontable*(x), *clear*(x), *clear*(y)
  effects : $\neg$*ontable*(x), $\neg$*clear*(y), *on*(x, y)

  operator : *unstack_and_putdown*(x, y)
  precond : *on*(x, y), *clear*(x)
  effects : $\neg$*on*(x, y), *ontable*(x), *clear*(y)

  operator : *unstack_and_stack*(x, y, z)
  precond : *on*(x, y), *clear*(x), *clear*(z)
  effects : $\neg$*on*(x, y), $\neg$*clear*(z), *on*(x, z), *clear*(y)
- Initial state: {*clear*(b), *clear*(c), *on*(c, a), *ontable*(a), *ontable*(b)}
- Goal: {*on*(b, c), *on*(a, b)}

(a) Is there an order of the goal literals such that linear planning is possible?

(b) Determine a plan using Forward Planning and give all intermediate states when executing this plan.