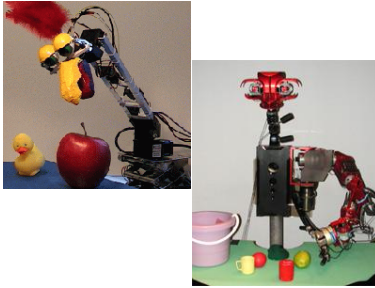


Artificial Intelligence



Lesson 7

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Planning

- Traditional search methods does not fit to a large, real world problem
- We want to use general knowledge
- We need general heuristic
- Problem decomposition

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STRIPS – Representation

- States and goal – sentences in FOL.
- Operators – are combined of 3 parts:
 - Operator name
 - Preconditions – a sentence describing the conditions that must occur so that the operator can be executed.
 - Effect – a sentence describing how the world has change as a result of executing the operator. Has 2 parts:
 - Add-list
 - Delete-list
 - Optionally, a set of (simple) variable constraints

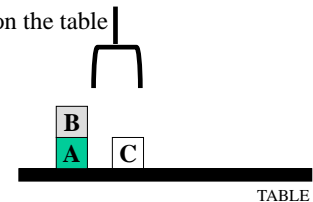
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Example – Blocks world

Basic operations

- stack(X,Y): put block X on block Y
- unstack(X,Y): remove block X from block Y
- pickup(X): pickup block X
- putdown(X): put block X on the table



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Example – Blocks world (Cont.)

```
operator(stack(X,Y),
  Precond [holding(X),clear(Y)],
  Add [handempty,on(X,Y),clear(X)],
  Delete [holding(X),clear(Y)],
  Constr [X\==Y,Y\==table,X\==table]).

operator(unstack(X,Y),
  [on(X,Y), clear(X), handempty],
  [holding(X),clear(Y)],
  [handempty,clear(X),on(X,Y)],
  [X\==Y,Y\==table,X\==table]).

operator(pickup(X),
  [ontable(X), clear(X), handempty],
  [holding(X)],
  [ontable(X),clear(X),handempty],
  [X\==table]).

operator(putdown(X),
  [holding(X)],
  [ontable(X),handempty,clear(X)],
  [holding(X)],
  [X\==table]).
```

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STRIPS Algorithm

- Strips – Stands for STanford Research Institute Problem Solver (1971).
- See example (pdf).
- See applet.

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STRIPS Pseudo code

STRIPS(stateList start, stateList goals)

1. Set state = start
2. Set plan = []
3. Set stack = goals
4. while stack is not empty do
 1. STRIPS-Step()
5. Return plan

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STRIPS Pseudo code – Cont.

STRIPS-Step()

switch top of stack t :

1. case t is a goal that matches state:
 1. pop stack
2. case t is an unsatisfied conjunctive-goal:
 1. select an ordering for the sub-goals
 2. push the sub-goals into stack

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STRIPS Pseudo code – Cont.

3. case t is a simple unsatisfied goal
 1. choose an operator op whose add-list matches t
 2. replace the t with op
 3. push preconditions of op to stack
4. case t is an operator
 1. pop stack
 2. $state = state + t.add-list - t.delete-list$
 3. $plan = [plan \mid t]$

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Versions and Decision points

- 3 decision points
 - How to order sub-goals?
 - Which operator to choose?
 - Which variable to instantiate?
- Different versions
 - Backtracking? (at each decision point)
 - Lifted Vs. grounded
- The original STRIPS
 - Backtrack only on the order of sub-goals
 - Lifted

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