16-782 HW3

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Planner results

Environment: Blocks

```
Goal found! Plan length: 3
Nodes expanded: 5
Time taken: 0.00542336 seconds

Plan:
MoveToTable(A,B)
Move(C,Table,A)
Move(B,Table,C)
```

Environment: BlocksTriangle

```

Goal found! Plan length: 6
Nodes expanded: 63
Time taken: 0.496869 seconds

Plan:
MoveToTable(T1,B3)
MoveToTable(T0,B0)
MoveToTable(B0,B1)
Move(B1,B4,B3)
Move(B0,Table,B1)
Move(T1,Table,B0)
```

Environment: FireExtinguisher

```
Goal found! Plan length: 21
Nodes expanded: 338
Time taken: 3.08593 seconds

Plan:
MoveToLoc(A,B)
LandOnRob(B)
MoveTogether(B,W)
FillWater(Q)
MoveTogether(W,F)
TakeOffFromRob(F)
PourOnce(F)
LandOnRob(F)
MoveTogether(F,W)
FillWater(Q)
Charge(Q)
MoveTogether(W,F)
TakeOffFromRob(F)
PourTwice(F)
LandOnRob(F)
Charge(Q)
MoveTogether(F,W)
FillWater(Q)
MoveTogether(W,F)
TakeOffFromRob(F)
PourThrice(F)
```

Implementation details

Running the code

All my code is in planner.cpp. It can be built and run like normal.
I defined a custom state called planner state, to hold the information so that it can behave like a node for A star search. It tracks: Current world state (conditions), Actions taken to reach this state, Path cost (g) and heuristic cost (h). The helper functions start with one that creates all possible groundings of an action, with all variations of symbols, once at the start. Then, is_applicable checks if a grounded action can be applied to the state, apply_action which applies an action to generate a successor state, and calculate_heuristic which estimates distance to goal. The main planner itself operates using a priority queue (open list) that is ordered by f-cost (g + h), along with a closed list to avoid revisiting states. It also employs a goal test to check for success and performs systematic state expansion using applicable actions.

The heuristic is the number of literals that are still unsatisfied
For the blocks environment, if I remove the heuristic, this is the below result

```
Goal found! Plan length: 3
Nodes expanded: 14
Time taken: 0.0146244 seconds

Plan:
MoveToTable(A,B)
Move(C,Table,A)
Move(B,Table,C)
```

The number of nodes expanded is 14 as compared to 5, and the time taken for the planner is 0.015 seconds as compared to 0.005 seconds.

Extra Credit

New environment created: Drill

Symbols: Drill, Bone, Joint, Support

Initial conditions: At(Drill, Support), Clear(Bone), Clear(Joint), Tool(Drill), Region(Bone), Region(Joint), Region(Support)

Goal conditions: Drilled(Bone), At(Drill, Joint)

Actions:

Move(tool, from, to)

Preconditions: At(tool, from), Clear(to), Tool(tool), Region(to)

Effects: At(tool, to), Clear(from), !At(tool, from)

Drill(tool, region)

Preconditions: At(tool, region), Tool(tool), Region(region), Clear(region)

Effects: Drilled(region), !Clear(region)

Results

```
Goal found! Plan length: 3
Nodes expanded: 5
Time taken: 0.00556906 seconds

Plan:
Move(Drill,Support,Bone)
Drill(Drill,Bone)
Move(Drill,Bone,Joint)
```