CSU33061 Artificial Intelligence

Submit to Blackboard by Mon, 21 Feb (23:59)

This assignment asks you to apply the A* search algorithm to the processing of propositional Prolog knowledge bases such as

```
q:- a.
q:- b,c.
a:- d,e.
a:- c,e,f.
b:- c.
c:- e,f.
e.
f:- e.
```

which we can represent as the list

```
[[q,a],[q,b,c],[a,d,e],[a,c,e,f],[b,c],[c,e,f],[e],[f,e]]
```

and use as `KB` in the clauses

```
arc([H|T],Node,Cost,KB) :- member([H|B],KB), append(B,T,Node),
                           length(B,L), Cost is 1+ L/(L+1).

heuristic(Node,H) :- length(Node,H).

goal([]).
```

Your task is to define the predicate

```
astar(+Node,?Path,?Cost,+KB)
```

that implements A*, returning a path from `Node` to the goal node `[]` with minimal cost, given `KB`. Test your code with queries such as

```
?- astar([q],Path,Cost,
   [[q,a],[q,b,c],[a,d,e],[a,c,e,f],[b,c],[c,e,f],[e],[f,e]]).
Cost = 11.916666666666668,
Path = [[q], [a], [c, e, f], [e, f, e, f], [f, e, f], [e, e, f],
             [e, f], [f], [e], []] ;
Cost = 13.499999999999998,
Path = [[q], [b, c], [c, c], [e, f, c], [f, c], [e, c], [c],
             [e, f], [f], [e], []] ;
```

```
false

?- astar([q],Path,Cost,[[q,a],[q,b,c],[a],[b],[c]]).
Cost = 2.5,
Path = [[q], [a], []] ;
Cost = 3.6666666666666665,
Path = [[q], [b, c], [c], []] ;
false
```

Hint Modify the skeletal search algorithm

```
search([Node|_]) :-  goal(Node).
search([Node|More]) :-  findall(X,arc(Node,X),Children),
                        add2frontier(Children,More,New),
                        search(New).
```

so that the head of the list `New` obtained in `add2frontier` has f-value no larger than any in `New`'s tail, where

$$f(\text{node}) = \text{cost}(\text{node}) + h(\text{node}).$$

Let the frontier be a list of path-cost pairs (instead of just nodes), being careful to update path cost, and to bring in the heuristic function in forming the frontier `New`.

```
less-than([[Node1|_],Cost1],[[Node2|_],Cost2]) :-
   heuristic(Node1,Hvalue1), heuristic(Node2,Hvalue2),
   F1 is Cost1+Hvalue1, F2 is Cost2+Hvalue2,
   F1 =< F2.
```