Hushmand Esmaeili
RBE 550 Motion Planning
Advanced Search Algorithms

Questions to Answer

Explain in your own words, how does D* replan a path by updating the cost?
As the robot moves toward an initial path plan from the start to the goal node, it updates the cost of each node in the path based on any changes in the environment (e.g. add/remove dynamic obstacles). Given the updated cost, if the new cost has increased significantly (like when an obstacle is added), the replan a path.

The replanning method uses a heuristic to the goal; in our case, Euclidean distance. We also estimate the cost of reaching the goal from each updated node. Finally, once the costs are updated at each step, we use the *get_backpointer_list* to find a new shortest path from the current node to the goal.

Why can D* replan faster than A* or Dijkstra?
D* can replan faster than A* and Dijkstra because it only considers the parts of the graph that have changed since the previous iteration. While A* and Dijkstra requires the entire graph to be recomputed whenever a change happens in the map, D* only updates the relevant portions. D* uses an approach called incremental search, which starts from the previous computed solution and updates it, instead of starting from scratch each time.

What is the key differences between regular RRT* and informed RRT*?
The key difference between regular RRT* and informed RRT* is in the way that the algorithms sample new nodes. In RRT*, new nodes are randomly generated, while in informed RRT* nodes are generated in a biased region that is most likely to lead to a solution. In the version that we implemented, this bias is the length of the current best path, and we use this to generate new samples only within an ellipsoid region defined by the start, end, and current bias (best path length). This can lead to a faster convergence to a feasible solution.

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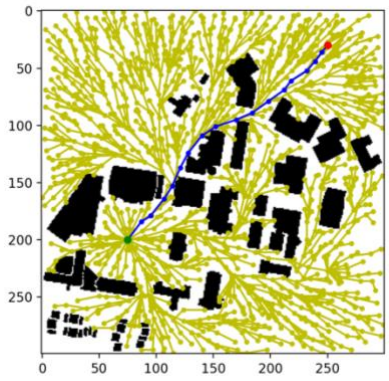
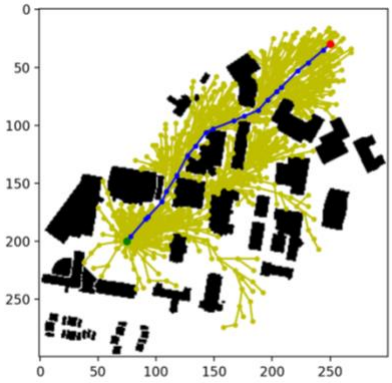
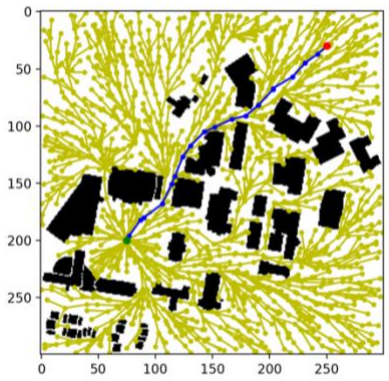
By showing and comparing the results of RRT* and informed RRT*, what is the advantages of using the latter?



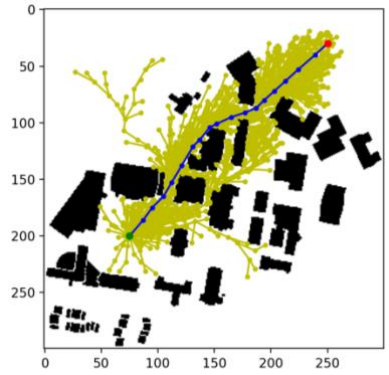
RRT* trial 1
It took 1430 nodes to find the current path
The path length is 251.24



Informed RRT* trial 1
It took 1166 nodes to find the current path
The path length is 249.97



RRT* trial 2
It took 1542 nodes to find the current path
The path length is 252.57



Informed RRT* trial 2
It took 1246 nodes to find the current path
The path length is 249.41

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Looking at the results from RRT* and informed RRT*, the main (obvious) difference between them is how they sample nodes in the search space. Regular RRT* nodes are definitely more random and spread all around the search space. However, the sampled nodes for informed RRT* consistently looks like an ellipsoid; it makes it's like an ellipsoid because that is the biased region we're sampling in, between start and goal nodes and the distance between them.

It usually took less nodes for informed RRT* to find an optimal solution than regular RRT*, although both are able to find optimal solutions about the same length. Therefore, faster convergence (and reduced computational cost) is an advantage of informed RRT* over regular RRT*.