Motion Planning (RBE550)
Programming Assignment 5: Informed-RRT* and D* Algorithm Implementation

Assignment By:
Swapneel Dhananjay Wagholikar (WPI ID: 257598983)

Question asked in Assignment:
Explain in your own words, how does D* replan a path by updating the cost?

Answer:
D* is a path planning algorithm that updates the cost of a path based on changes in the environment. In other words, it can replan a path in real-time as new information becomes available.

D* replans a path by updating the cost of each location based on changes in the environment, and recalculating the cost of the path from the current position to the goal location. If the cost of the path has increased, it finds a new, cheaper path to the goal location.

If a new obstacle is discovered in the path, D* implements a dynamic procedure where it updates the obstacle field. It adds the node to the open list and sets the status to RAISE if k(G, X) is less than h(G, X) and LOWER if k(G, X) is equal to h(G, X). It also redesigns a new walkway and changes the pricing information provided to the neighbors.

Question asked in Assignment:
Why does D* can replan faster than A* or Dijkstra?

Answer:
D* employs incremental search rather than starting the search from scratch every time it has to replan like in graph-based A* and Dijkstra, which allows it to replan more quickly than A* or Dijkstra.

D* does not re-search the whole graph; it just updates the cost of the path from the current place to the desired location. This implies that if the cost estimate changes, it just needs to go through a small percentage of the search area to discover a new path.

In addition, like A*, D* makes use of a heuristic function to calculate the cost of getting to the desired place. The heuristic function employed in D*, however, is more cautious and does not overstate the cost of traveling to the desired location. In the event that the cost estimate changes, D* will be able to swiftly locate a new, best path rather than wasting time exploring the search space.

Question asked in Assignment:
What is the key differences between regular RRT* and informed RRT*?

Answer:
We take into account a random sample from anywhere in the configuration space in the RRT* rewiring stage. In contrast, in informed RRT*, we fit an ellipse around the start and target locations using the optimal path as a parameter and select a random sample inside that sphere.

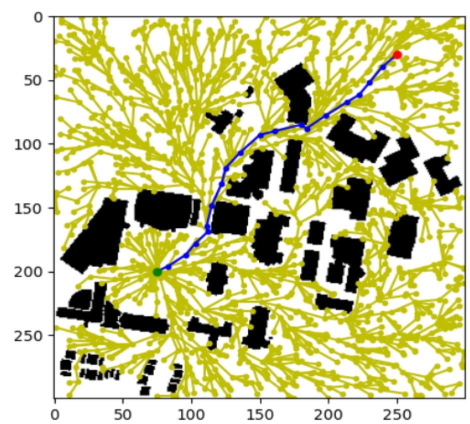
Additionally, there are some key differences that are as follows:

1. Exploration Strategy: Informed RRT* employs extra information, such as a heuristic function or a roadmap, to direct the exploration toward the objective location in contrast to regular RRT*, which explores the search space using a random sampling technique.
2. Convergence Rate: Since informed RRT* employs extra information to direct the search space's exploration in the direction of the objective location, it can converge more quickly than ordinary RRT*. This may result in a quicker convergence to an ideal path and more effective exploration of the search space.
3. Complexity: Because informed RRT* requires additional data, such as a heuristic function or a roadmap, to direct the exploration of the search space, it might be more difficult to build than standard RRT*.
4. Performance: In some circumstances, such as high-dimensional search spaces or surroundings with barriers, informed RRT* can outperform conventional RRT*. The performance disparity between the two methods may be less pronounced in other circumstances, such as low-dimensional search areas with few barriers.

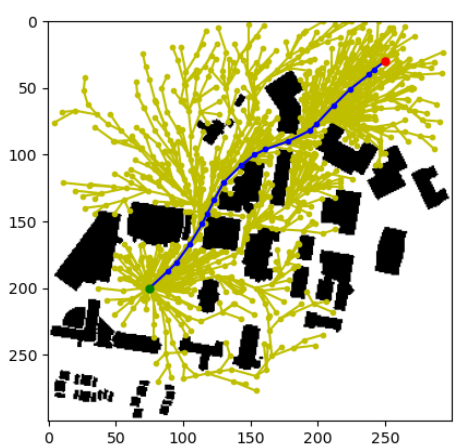
Question asked in Assignment:
By showing and comparing the results of RRT* and informed RRT*, what is the advantages of using the latter?

Answer:

RRT* result:



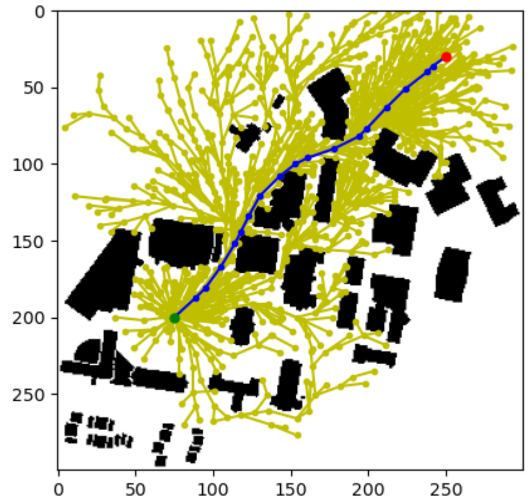
Informed RRT* result:



Informed RRT* is a more effective method since it requires fewer samples than RRT* while still providing the shortest path. The figures above demonstrate that the informed RRT* samples points between the start and target locations utilizing the ellipsoid to limit the points, as opposed to the RRT*, which samples points across C space.

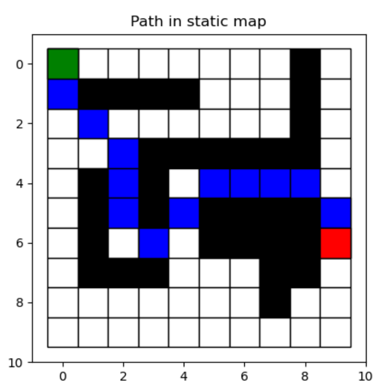
Algorithm Results and Explanation:

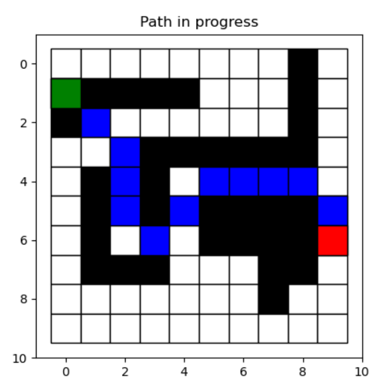
Informed RRT* Algorithm Result:

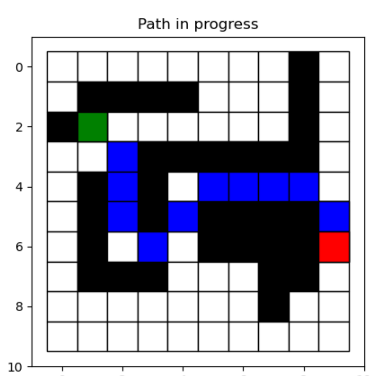


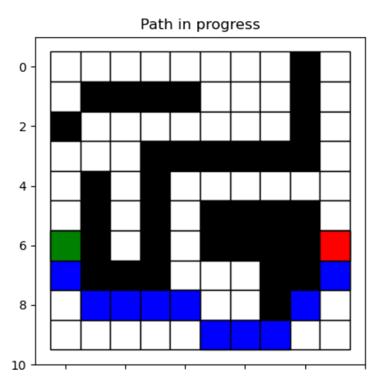
D* Algorithm Result:

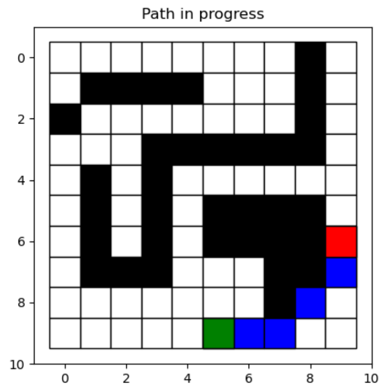
Many plots for path in-progress generated. Hereby, attaching few.

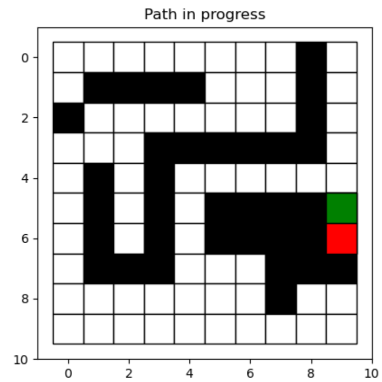












References:

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