

# Homework 2

Introduction to Robotics  
ncorrell@colorado.edu

October 13, 2014

1. How does the computational complexity of Dijkstra's algorithm change when moving from 2D to 3D search spaces? (1pt)
2. A\* uses a "heuristic" to bias the search in the expected direction of the goal. Why can it only use a heuristic, not the actual length? (1pt)
3. Assuming points are sampled uniformly at random in a randomized planning algorithm. Calculate the limiting behaviour of the following ratio (number of points in tree)/(number of points sampled) as the number of points sampled goes to infinity. Assume the total area  $A_{total}$  and the area of free space  $A_{free}$  within are known. (1pt)
4. Assuming a kd-tree is used as a nearest-neighbour data structure, and points are sample uniformly at random, calculate the run-time of inserting a point into a tree of size  $N$ . Use "big-Oh" notation, e.g.  $\mathcal{O}(N)$ . (1pt)
5. Why does the bandwidth of a Ultra-sound based distance sensor decreases significantly when increasing its dynamic range, but that of a laser range scanner does not for typical operation? (1pt)
6. You are designing an autonomous electric car to transport goods on campus. As you are worried about cost, you are thinking about whether to use a laser scanner or an ultra-sound sensor for detecting obstacles. As you drive rather slow, you are required to sense up to 15 meters. The laser scanner you are considering can sense up to this range and has a bandwidth of 10Hz. Assume 300m/s for the speed of sound in the following.

- (a) Calculate the time it takes until you hear back from the US sensor when detecting an obstacle 15m away. Assume that the robot is not moving at this point. (1pt)
- (b) Calculate the time it takes until you hear back from the laser scanner. Hint: you don't need the speed of light for this, the answer is in the specs above. (1pt)
- (c) Assume now that you are moving toward the obstacle. Which sensor will give you a measurement that is closer to your real distance at the time of reading and why? (1pt)