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CSCI 3302

Professor Hayes
Homework 2

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1. *You want to find a driving route that minimizes the number of turns between two locations in Boulder*

   (a) I would rather employ a discrete algorithm. It will find a route with minimal turns. It will find the shortest path from where I am and where I'm going.

   (b)
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Cost(l,t)
int map
int start
int vertex
for vertex in map
   distance[vertex]=infinity
   previous[vertex]=undefined
distance[start]=0
Q=the set of street corners in map
while Q != empty
    l=street corner in Q with smallest distance[]
    remove l from Q
    for each neighbor t to l
        alt=distance[l] + distance between l and t
        if alt < distance[t]
            distance[t]=alt
            previous[t]=u
return previous[]
```

2. We are given the ratio, $\frac{\text{num points tree}}{\text{num points total}}$. Assume the numerator to be y and the denominator to be x, where $y = A_(free)$ to get the number of points in the tree and $x = A_{total}$ to get the number of points sampled. We are looking for $\lim_{x\to\infty} \frac{y}{x}$. Putting the values of x and y back in, we are looking at $\lim_{A_{total}\to\infty} \frac{y=A_(free)}{A_{total}}$. Solving this limit, we get 0. This means as the total area reaches infinity, there will be no more free space.

3. To insert a new point into a k-d tree, use the same method to insert an element in any other search tree. Traverse the tree starting from the root. Once you have reached the node under which the child should be located, add the point. Worse case, it will take $O(n)$ time complexity, on average the time complexity is $O(\log n)$.

4. Ultra-sound sensors send out a pulse and measure the time it takes for the signal to reflect off a surface and return. Bandwidth is how frequent it sends out a pulse. When the dynamic range is increased it takes even longer to send out a pulse, thus increasing the bandwidth.

   However, when it comes to a laser, the bandwidth is being sent out at a constant rate. So is the dynamic ranged is increased, the amount of signals sent out remains the same.

5. *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.*

   (a) To calculate the time it takes until we head back from the ultrasonic sensor we can use the equation Test distance = (high level time * velocity of sound)/2. Plugging in our known values we get, 15m = (high level time $*$ 300m/s)/2. From here we can solve for "high level time", and we get $\boxed{\frac{1}{10}\text{seconds}}$.

   (b) The laser turns off 10 times a second, since the frequency is 10Hz. It will take $\boxed{\frac{1}{10}\text{seconds}}$ for the laser to reach its max distance, 15m.

   Calculate the time it takes until you hear back from the laser scanner. Together with the speed of light (approx. 300,000 k/s) this leads to a wavelength of (Hint: You do not need the speed of light to answer this question)

6. *A GPS sensor provides position estimates within a circle of approximately 3m in diameter. Every now and then the satellites on the horizon change and the center of this circle moves elsewhere, approximately staying within a 30m radius of the true location of the receiver.*

   (a) 30m corresponds to accuracy. 3m corresponds to precision.

(b) With the sensor provides that 18000 readings per hour, we get $\boxed{\frac{1}{5}\text{seconds per reading}}$.

To get this, we need to convert the readings per hour to readings per second. We can do this by doing $\frac{18000}{1\text{hr}} * \frac{1\text{hr}}{60\text{min}} * \frac{1\text{min}}{60\text{sec}}$ to get 5 readings per second. After this, we just need to flip it to get seconds per reading.