Homework 6 (Undergraduates only):

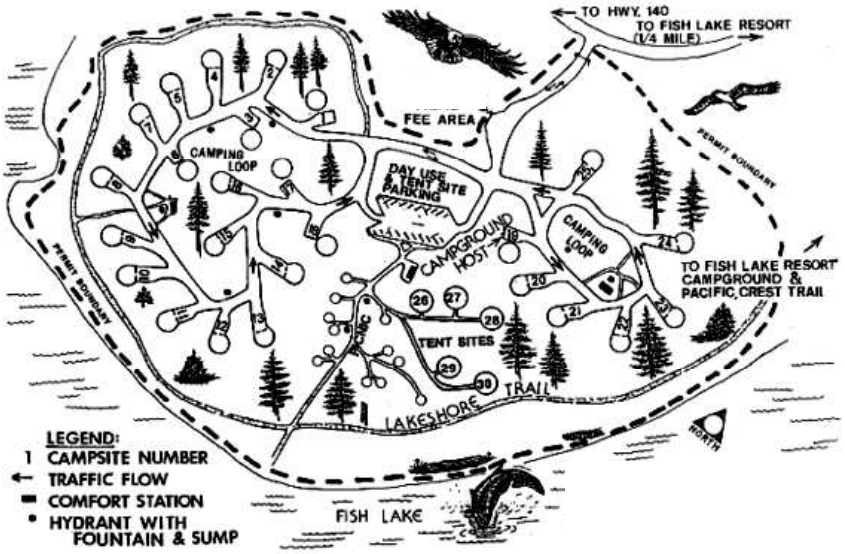
Evaluating Robot Behaviors and Algorithms

Assigned: Thursday, November 13, 2008
Due: Tuesday, November 25, 2008, at the beginning of class (no later than 5:10 PM)
(Hard copy is acceptable.)

---

1. Evaluation/Analysis of Robot Behavior

A series of late springtime freezes in the Hazy Mountain National Park have killed off all the nuts and berries in the park. As a result, in the summertime, the black bears have very little food, and are becoming aggressive, invading campgrounds for food. The National Park Service does not have enough human resources to protect the people in the campgrounds from the bears. Therefore, they have hired you to develop software for a team of robots that can perform *perimeter containment* for the Wades Nook campground, and sound the alert whenever a black bear is spotted entering the perimeter of the campground. For example, below is a picture of the campground – here, the perimeter is marked with the dashed line.



The job of your robots in the perimeter containment task is to make sure that no bear can cross into the campground without being seen by one of the robots. Let's say you have come up with a solution to this task, which we'll call your DetectTheBears (DTB) algorithm. Let's say your DTB algorithm is able to define a set of watch positions along the perimeter that can ensure complete visibility of all parts of the perimeter. Further, your algorithm enables the robots to move collaboratively and efficiently to these watch positions and scan for bears (assume you've installed the latest BearAlert sensor from Radio Shack on your robots for this purpose), sounding the alarm whenever a bear is detected crossing into the campground.

Answer the following questions about how you would evaluate your DTB approach:

a. Define three relevant metrics you would use to evaluate your DTB algorithm.

b. Describe a meaningful baseline algorithm that you would use to compare your DTB algorithm against.

c. Describe the experimental setup you would use for comparing your DTB algorithm with the baseline approach, including the parameters and experimental conditions you would vary, what data you would collect, etc.

2. Statistical Significance in Comparing Algorithms

We have collected data on 2 algorithms (doesn't matter what the algorithms are or what the data represent or what the units are) and we want to know whether our results show that the algorithms are significantly different (statistically) or not. Here is the data we have collected:

Algorithm #1	Algorithm #2
199	247
228	253
218	231
232	248
222	258
240	225

Answer the following questions by applying the Student's t-test to this data:

a. For a degree of confidence of 99.5%, are the two algorithms significantly different or not? Show your work and justify your answer.

(The following questions give away the answer to part 2a. That's OK; you still have to show your work and justify your answer for part 2a.)

b. If the algorithms are not significantly different to a confidence of 99.5%, are they significantly different to a lower degree of confidence? If so, to what degree of confidence can you say that they are different? Show your work and justify your answer.

c. Let's say you have collected more data, for a total of 20 samples of each algorithm. And, let's say that the mean and standard deviation of both data sets remains the same. How has this changed your degree of confidence in whether the algorithms are different? Show your work and justify your answer.

d. Let's say you want to achieve a degree of confidence of 99.5% that the algorithms are different, but you don't want to have to collect any more data than necessary. What is the minimum number of samples of each data set you need to collect in order to achieve this level of confidence (again, assuming the means and standard deviations don't change)? Show your work and justify your answer.