COGSCI 131 – Assignment 1
DUE: Jul 1 at class start

1a. [5pts] Suppose that an ant wandered randomly by taking steps (x,y), *one per second*, where at each ant step, x and y come from a normal distribution with a mean of 0 and a standard deviation of 1.0mm (assume this for all questions below). Plot a trace of the ant's path over the course of an hour.

1b. [10pts] Let's think about why ants need to perform path integration. Suppose that *instead* of path integration, when an ant found food, it just continued to wander with random steps until it got back to the nest. Using a simulation, find the probability that an ant who finds food after 1 hour will make its way back to within 10mm of the nest over the course of the next hour (note that if it comes within 10mm of a nest, it stops). Is this a good strategy? Why or why not?

1c. [10pts] If the ant searches for an hour, finds food, and then searches for the nest by continuing to walk at random, what is the average closest distance it will come to the nest over the course of the next hour? (Do <u>not</u> assume it stops if it comes within 10mm) Find this with a simulation.

2. [25pts] Now let's think about path integration. Assume that each step (x,y) is "remembered" (integrated) internally in the ant's brain with a standard deviation on each component of S. Thus, if we store the total X component, it gets updated with a new x step via $X \leftarrow X+x+e_x$ where $e_x \sim$ Gaussian(0,S) and similarly for Y ($Y \leftarrow Y+y+ e_y$ with $e_y \sim$ Gaussian(0,S)). Suppose that, upon finding food after an hour (as above, one step per second), the ant then heads straight back to where it thinks the nest is (e.g. it travels back via the vector (-X,-Y)). Thus, the outbound trip is noisy, but the return trip is noiseless. Run a simulation to see how far the ant will end from the nest for various S from 1.0mm down to 0.0001mm. Plot the mean distance the ant ends from the nest as a function of S. Be sure to show a range of S values that make it clear what's going on.

3a. [20pts] Next, let's just assume that it requires exp(0.1/S) energy units to run an integrator with a standard deviation of S for an hour. Suppose further that if you end up at a distance d from the nest after your return trip, it will take you d^2 energy units to find the nest. By using a simulation, plot the average energy expended while on a foraging trip (out for an hour and back) as a function of S. Be sure you have found a range of S to plot that shows the shape of the curve near its minimum.

3b. [10pts] What is the evolutionary significance of the minimum of the plot in 3a?