Homework 5: Coverage

1. (50pts) Using whatever method you wish, compute a maximally ergodic trajectory for the system $\dot{x} = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$ with respect to the normal distribution

$$\phi(x) = \det(2\pi\Sigma)^{\frac{-1}{2}} \exp\left(-\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu)\right) = \mathcal{N}(x;\mu,\Sigma)$$

for $\mu = 0$, $\Sigma = Diag(2,2)$, $x(0) = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ and time horizon of $T = 10\ s$. **Turn In:** A plot of the maximally ergodic trajectory. (This plot should definitively show coverage with respect to the distribution, but given the freedom in this problem everyone's plot should look somewhat different.)

Do ONE of the following problems.

2. (50 pts) Choice 1: Using your ergodic control capability from 1), find a scenario within the infotaxis problem from Homework 3 where ergodic control is more reliable than infotaxis. For instance, having multiple doors in the environment, or distractions that look like doors but are not doors, could work. **Turn In:** Turn in the paths for infotaxis and paths for ergodic control that illustrate the scenario you found. Also write a few sentences about how to interpret the result.

3. (50 pts) Choice 2: Using a single integrator system in the configuration $q = (x, y)$ for control synthesis, use ergodic control to generate a Gaussian Process model of a topographic model. That is, find a topographic dataset online and "explore" it using your simple kinematic model and try to reconstruct the topography. Use a measurement model that makes sense (e.g., a bearing-only measurement model)—don't assume perfect measurements. **Turn In:** Plot the ergodic trajectory, the learned model and the original data set.

Please note that both the second and third problems are substantially under-specified, as they would be in any practical problem. Clarification of the goal will be provided in the online discussion forum, but students should be prepared to make algorithmic choices about everything from noise levels and discretization granularity, to time horizon of control.