UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

CS440/ECE448 Artificial Intelligence

Practice Exam 3

Spring 2023

Exam 3 will be May 9, 2023

Your Name: ______________________________

Your NetID: ______________________________

Instructions

- Please write your name and NetID on the top of every page.
- This will be a CLOSED BOOK exam. You will be permitted to bring three 8.5x11 page of handwritten notes (front & back).
- Calculators are not permitted. You need not simplify explicit numerical expressions.

1. (10 points) Captain Marble is flying over a thick cloud bank. Her estimated velocity is v m/s northward, with a standard deviation of p m/s. Once per second, she uses her x-ray vision to scan the ground below, and recognizes landmarks that specity her lattitude, x, with a standard deviation of e meters. Based on all observations up through time t, her estimated lattitude at time t is y meters north of the equator, with a standard deviation of s meters. At time $t+1$ she is about to make another observatino, but just then she wonders: what are the expected value and standard deviation of her position at time $t+1$, on the basis of only the measurements up through and including time t?

Solution: The expected value is $y+v$, with a standard deviation of $\sqrt{s^2+p^2}$.

2. (10 points) Leira the merman is swimming eastward from Honolulu at a somewhat variable velocity: his velocity averages a m/s, but with a standard deviation of b m/s. Once every second, he checks his location usign sonar. Based on all of his observations up through time $t-1$, he believes that his longitude at time t is c meters east of Honolulu, with an uncertainty (standard deviation) of d meters. Since he's not sure, he takes another sonar measurement at time t; his sonar reading says that he is e meters east of Honolulu, but with a measurement uncertainty (standard deviation) of f meters. Based on all of his observations up through and including the observation at time t, what are the expected value and standard deviation of his longitude relative to Honolulu?

Solution: The Kalman gain is $k = d^2/(d^2+f^2)$. The expected value of his position at time t, given all observations up through and including time t, is $(1-k)c+ke$, with a standard deviation of $d\sqrt{1-k}$.