MECHTRON 4AX3, Practice Questions
For final

Dr. M. v. Mohrenschildt

Make sure you review assignment 3 and the midterm !
The questions below are a bit larger/more open ended then final exam questions, but knowing these will make the final much simpler, so use it as a study guide.

1) Kalman

We can observe the position y of a car with a sensor that has a variance of σ_y^2. The car is moving at constant speed but due to wind there is a variance of σ_x^2. Initially we know for sure that the car is at $x(0) = 0$ with some speed v_0. Setup the Kalman Observer, make sure you understand each quantity.

2) Grid World

Given Grid World, this 4x3 maze with one +1 and one -1 cell. We have a deterministic robot that can move up-down, left-right depending on the cell. Compute the value function $V(s)$ by iterating the Bellman equation. (this is finite, perform a few steps by hand).

3) Controller-observer

Show that, given we choose the right K and L, if the observer error converges to 0, then the state will also converge to zero. So $||x||$ has to go to zero. Trick, use $u = -K\tilde{x} = K(x - \tilde{x}) - Kx$ the controller since $||x - \tilde{x}||$ is the observer error.

4) Optimal Control

Can you derive the matrix Ricatti equations for optimal control by minimizing the Bellman equation. (what i did on the blackboard for the matrix case, this is good practice in matrix algebra).

5) Linear Least Square

Given N points x_i, y_i, since a, b, R such that they fit the circle $(x - a)^2 + (x - b)^2 = R^2$. You have to manipulate the equation a bit to make it a LLS. (Don't google it immediately, try to figure it out how to make this a quadratic fitting).

6) Monte Carlo Simulation

How could we use a Monte Carlo Simulation to solve the equation:

$$Q^\pi(s, a) = \sum_{s'} \mathcal{P}_{ss'}^a \left[\mathcal{R}_{ss'}^a + \gamma \sum_{a'} \pi(s', a') Q^\pi(s', a') \right]$$