

Practice Questions

This is a small sample of the types of questions you can expect on the exam. I am not putting these questions on the canvas quiz format. The structure of the exam will be identical to the midterm.

- 1) Clearly write down the dynamic programming (Bellman) Equation for the following problem. Do not forget to include the terminal conditions (boundary conditions). You don't have to solve it.

You have purchased a lease for an Oil well. This well has initial reserves of 50 thousand barrels of oil. In any year you have three choices of how to operate the well: (a) you can not pump, in which case there is no operating cost and no change in oil reserves; (b) you can pump normally, in which case the operating cost is \$50 thousand and you will pump out 20% of what the reserves were at the beginning of the year; or (c) you can use enhanced pumping using water pressure, in which case the operating cost is \$120 thousand and you will pump out 36% of what the reserves were at the beginning of the year. The price of oil is \$10 per barrel, and the interest rate is 10% / year. Assume that both your operating costs and the oil revenue come at the beginning of the year (through advance sales). Your lease is for a period of 3 years.

- 2) The number of barrels of oil produced over the previous 100 days at a well in rural west TX is included in the attached csv file. Tomorrow, you don't know how many barrels will be produced, but you think the past variation is representative of what could happen tomorrow. A refinery wants to buy your oil, but you must pay for transportation. You can hire trucks to haul the oil to the refinery, at a cost of \$1000 per truck. Each truck can hold 100 barrels of oil. If you hire too many trucks, you still must pay the drivers. If you hire too few trucks, you can send the oil to the refinery via a pipeline at a cost of \$20 / barrel. How many trucks should you hire to minimize the expectation of costs from sending oil to the refinery? Formulate this stochastic programming problem as a Mixed Integer Program (number of trucks must be an integer!) and solve it. HINT: If B is the (random) number of barrels you produce tomorrow and T is the number of trucks you hire, then your objective is to minimize $1000 \cdot T + E[20 \cdot (B - 100 \cdot T)^+]$. You must approximate this expectation as a sample average and reformulate the inside to be linear.
- 3) Suppose we are playing space invaders, instead of pong, but can use the exact same preprocessing function as we used for pong. For space invaders there are 6 possible buttons to push: NOOP, FIRE, LEFT, RIGHT, LEFTFIRE, RIGHTFIRE. We are doing deep Q learning and want to use the network structure suggested by the DeepMind folks. How many total parameters need to be trained for this model? How many vectors of 'truths' do we need? How many vectors of 'weights' do we need?