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Value Iteration (Double Integrator)

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0.0/30.0 points (graded)

In this problem, we'll consider the optimal control problem for the double integrator (unit mass brick on ice), described by

$$\ddot{q}=u,\ |u|\leq 1$$

using the Value Iteration algorithm. An implementation of that algorithm is available for you in Drake (see the runValueIteration function in examples/DoubleIntegrator.m). This is a complete implementation of the algorithm with discrete actions and volumetric interpolation over state.

- (a) Run the value iteration code for the double integrator to compute the optimal policy and optimal cost-to-go for the minimum-time problem. Compare the result to the analytical solution we found in lecture (also available in Example 9.2 in the course notes) by answering the following questions.
- 1) Find an initial condition of the form $(2, \dot{q}_0)$ such that the value iteration policy takes an action in exactly the wrong direction from the true optimal policy. Type in your value of \dot{q}_0 below:

2) What is the true optimal time-to-go from this state (i.e., for the optimal bang-bang
controller derived in class)?

3) What is the time-to-go from this state estimated by value iteration?

4) When implementing value iteration, one needs to be wary of several implementation details. Find a setting of the discretization (i.e., the variable xbins in DoubleIntegrator.m) that causes the code to NOT converge. The maximum distance between points in the \boldsymbol{q} and $\boldsymbol{\dot{q}}$ directions should still be at most 0.2, and the grid must still contain the square with sides of length 2 centered about the origin. (Hint: it might help to see how the minimum-time cost function is implemented).

```
1 q_bins =
2 qdot_bins =
3 xbins = {q_bins,qdot_bins};
4
```

Unanswered

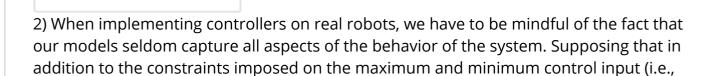
Run Code

(b) Change the cost-to-go function to a combination of the quadratic regulator problem and the minimum-time problem:

$$g\left(q,\dot{q},u
ight) =c\left(q,\dot{q}
ight) +Q_{p}q^{2}+Q_{d}\dot{q}^{2}+Ru^{2},$$

where $c\left(q,\dot{q}
ight)$ is 0 when $\left(q,\dot{q}
ight)=\left(0,0
ight)$ and 1 otherwise. Use $Q_p=Q_d=1, R=10$.

1) What is the cost-to-go from the point (1.0, 1.0) estimated by the value iteration?



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$ u \leq 1$), our real physical brick "robot" also had constraints on the derivative of the control input (let's say $ \dot{u} \leq 1$). Assuming that you only cared about stabilizing the system to the origin, which controller would you prefer to implement?		
Minimum-time (cost from part (a))		
Quadratic cost + minimum-time (cost from part (b))		
Submit	You have used 0 of 3 attempts	

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