# ME455 Active Learning HW4

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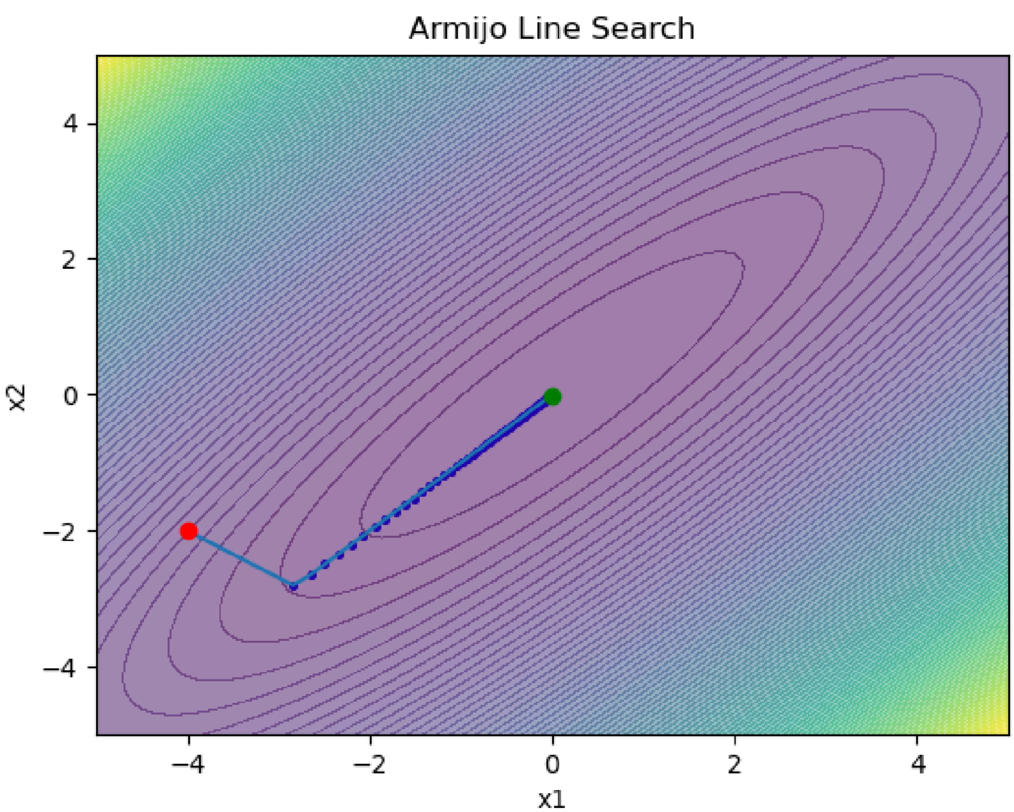
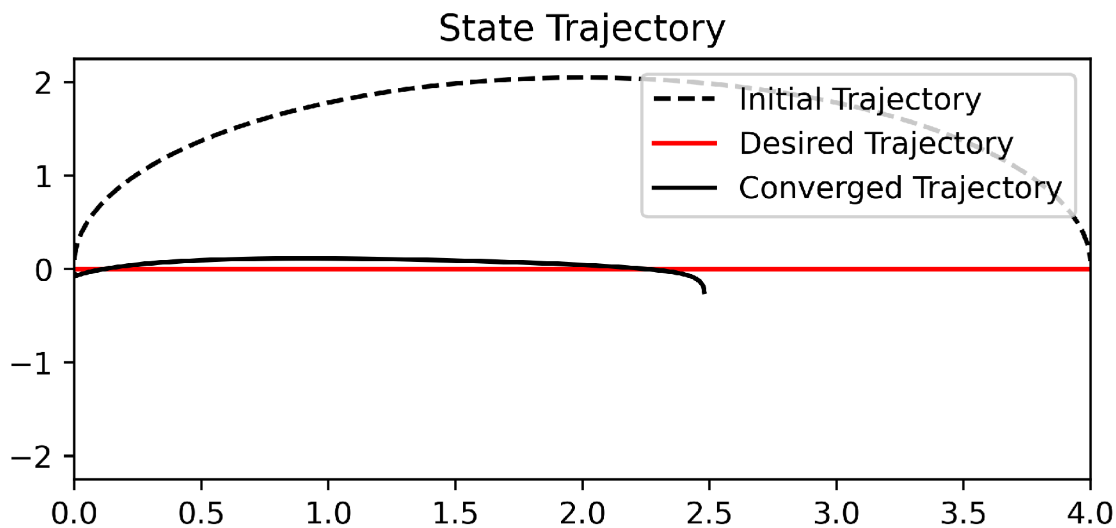
## Problem 1

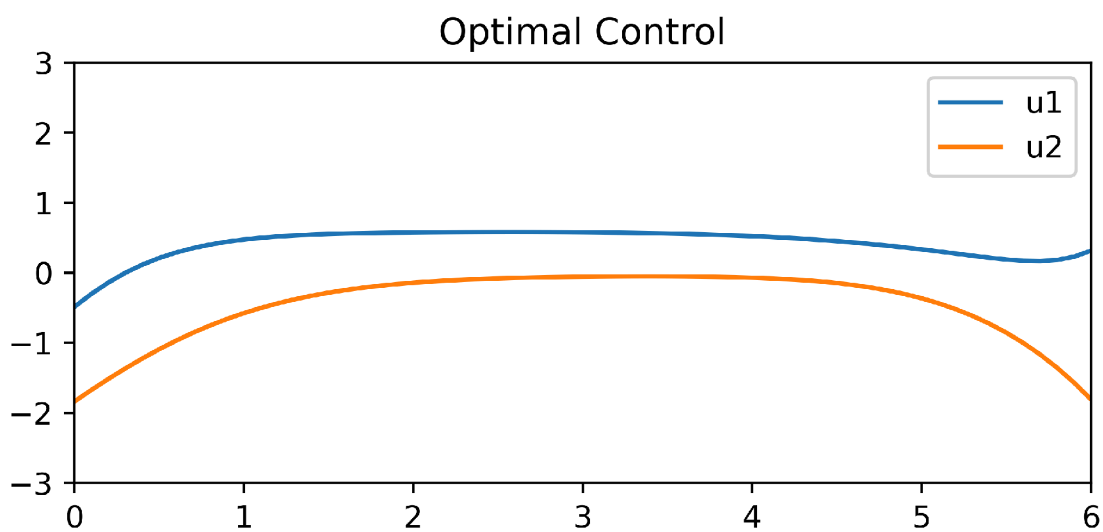
Please see handwritten pages for problem 1.

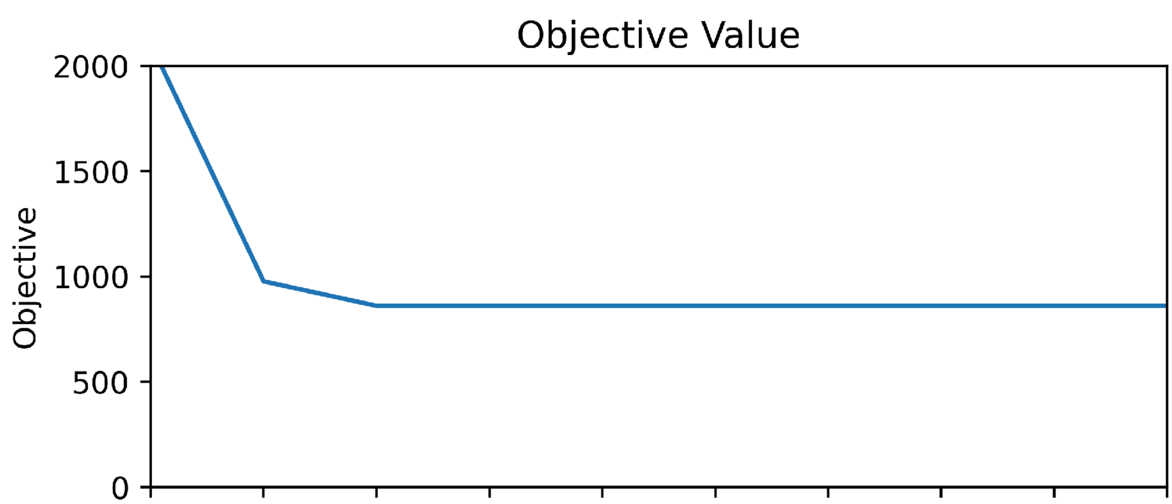
## Problem 2




## Problem 3


State Trajectory
Initial Trajectory
Desired Trajectory
Converged Trajectory
2
1
0
−1
−2
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0


Optimal Control
u1
u2
3
2
1
0
−1
−2
−3
0
1
2
3
4
5
6


Objective Value
Objective
2000
1500
1000
500
0


I’m not really sure why I couldn’t get my plots to look like the example plots, however I think there must be something wrong with either my iLQR algorithm or the way I calculate my loss. I’m doing my iLQR algorithm where I calculate the cumulative loss for the entire trajectory with the current control sequence, as well as the cumulative loss for the entire trajectory with the modified control sequence (u + alpha * gamma). Maybe this is wrong, but it seemed to me like the example code was encouraging this strategy. This leaves me with a loss that plateaus at 1000, which is kinda weird.

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## Problem #1:

$$v(t)^{[k]} = \underset{v(t)}{\arg\min} \int_0^T D_1 \ell(x(t)^{[k]}, u(t)^{[k]})\, z(t) + D_2 \ell(x(t)^{[k]}, u(t)^{[k]}) \cdot v(t)\, dt$$

$$+ D_m(x(T)^{[k]}) \cdot z(T)$$

$$+ \int_0^T z(t)^T Q_z z(t) + v(t)^T R_v v(t)\, dt$$

$$= \int_0^T D_1 \ell(x(t)^{[k]}, u(t)^{[k]})\, z(t) + z(t)^T Q_z z(t) + D_2 \ell(x(t)^{[k]}, u(t)^{[k]}) v(t) + v(t)^T R_v v(t)\, dt$$

$$+ D_m(x(T)^{[k]}) \cdot z(T)$$

$$= \int_0^T z(t) \underbrace{\left[ D_1 \ell(x(t)^{[k]}, u(t)^{[k]}) + z(t)^T Q_z \right]}_{a_z(t)^T} + v(t) \underbrace{\left[ D_2 \ell(x(t)^{[k]}, u(t)^{[k]}) + v(t)^T R_v \right]}_{b_v(t)^T} dt$$

$$+ D_m(x(T)^{[k]}) \cdot z(T)$$

now we can sub in $a_z(t)$ & $b_v(t)$...

$$0 = p(t)^T B(t) + v(t)^T R_v + D_2(\ell(x(t)^{[k]}, u(t)^{[k]}))$$

solve for $v(t)$

$$v(t) = -R_v^{-1}\left[ B(t)^T p(t) + D_2(\ell(x(t), u(t))) \right]$$

and sub in $v(t)$

$$\dot{z}(t) = A(t) z(t) - B(t) R^{-1}\left[ B(t)^T p(t) + D_2(\ell(x(t)^{[k]}, u(t)^{[k]})) \right]$$

$$\dot{p}(t) = -A(t)^T p(t) - Q_z z(t) - D_1(\ell(x(t)^{[k]}, u(t)^{[k]}))$$

$$\boxed{\begin{bmatrix} \dot{z} \\ \dot{p} \end{bmatrix} = \begin{bmatrix} A(t) & -B(t) R^{-1} B(t)^T \\ -Q_z & -A(t)^T \end{bmatrix} \begin{bmatrix} z \\ p \end{bmatrix} + \begin{bmatrix} -B(t) R^{-1} D_2(\ell(x(t)^{[k]}, u(t)^{[k]})) \\ -D_1(\ell(x(t)^{[k]}, u(t)^{[k]})) \end{bmatrix}}$$