MAE 200 Final project

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Step 1

Step 2

Step 3

Step 4: State Estimation based on α-horizon

I began with constructing my model of my system based on the linearized model around equation 22.34 of Numerical Renaissance. This resulted in the following code:

```
E = [
    mc+m1+m2  -m1*l1       -m2*l1;
    -m1*l1   I1+m1*l1^2      0  ;
    -m2*l2    0          (I2 + m2*l2^2);
];

E = [
    eye(3) zeros(3)
    zeros(3) E
];

A_bar = [
    0   0       0
    0 m1*g*l2   0
    0   0      m2*g*l2
];

A_bar = [
    zeros(3)  eye(3)
    A_bar zeros(3)
];

B_bar = [
    0
    0
    0
    1
    0
    0
];
```

Since E is invertible around $\vec{q} = \vec{0}$, we can solve for the A and B matrices from the standard form,

$$\dot{q} = Aq + Bu,$$

by inverting the E matrix. Thus, we create the following code

```
A = inv(E)*A_bar;
B = inv(E)*B_bar;

C = eye(3, 6);
D = 0;

sys = ss(A,B,C,D);
```

After running this code, we are left with the following system

```
sys =
    A =
           x1      x2      x3      x4      x5      x6
    x1      0       0       0       1       0       0
    x2      0       0       0       0       1       0
    x3      0       0       0       0       0       1
    x4      0   0.491   0.982       0       0       0
    x5      0   5.175  0.9428       0       0       0
    x6      0  0.9428    20.7       0       0       0

    B =
           u1
    x1      0
    x2      0
    x3      0
    x4 0.1044
    x5 0.1002
    x6 0.2004

    C =
        x1  x2  x3  x4  x5  x6
    y1   1   0   0   0   0   0
    y2   0   1   0   0   0   0
    y3   0   0   1   0   0   0

    D =
        u1
    y1   0
    y2   0
    y3   0

    Continuous-time state-space model.
```

Step 5