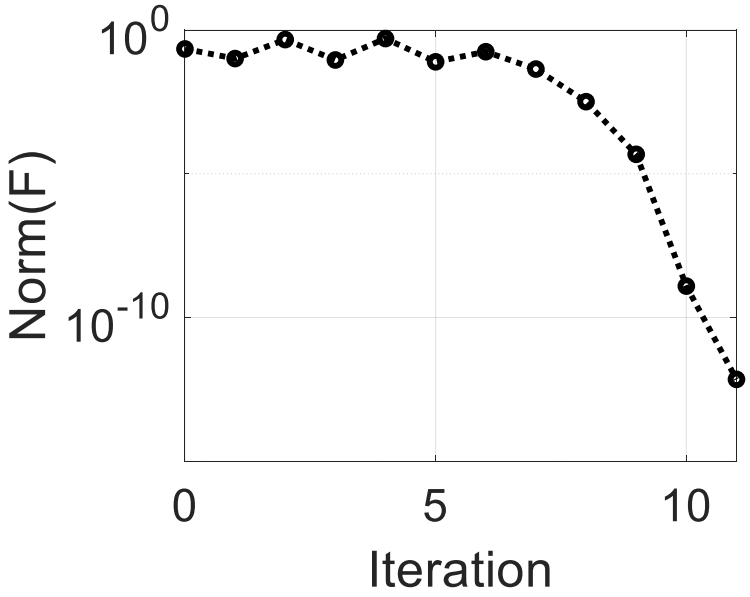
ASEN 6060
ADVANCED ASTRODYNAMICS
Week 7 Discussion, Part 1

Objectives:

- Gain intuition that will be useful for creating, debugging, and assessing implementation of numerical corrections algorithms

Example 1: Computing an L_2 Lyapunov Orbit

Your colleague has created a script to numerically compute an L_2 Lyapunov orbit via a single-shooting corrections scheme



Note: use more labels on the vertical and horizontal axes in your homework!

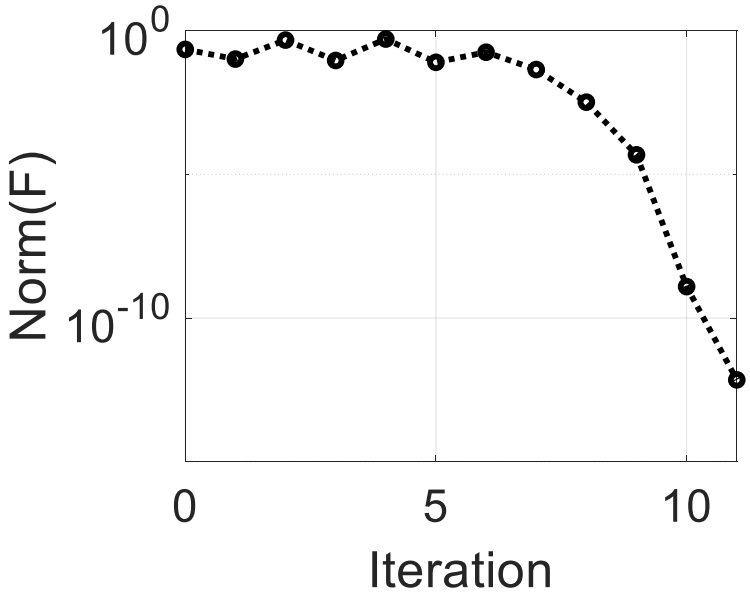
Question 1: Do you think that their corrections scheme could be implemented correctly? What information would you ask for to assess this further or help them identify any issues, if applicable, and why?

Question 1

Group Brainstorming:

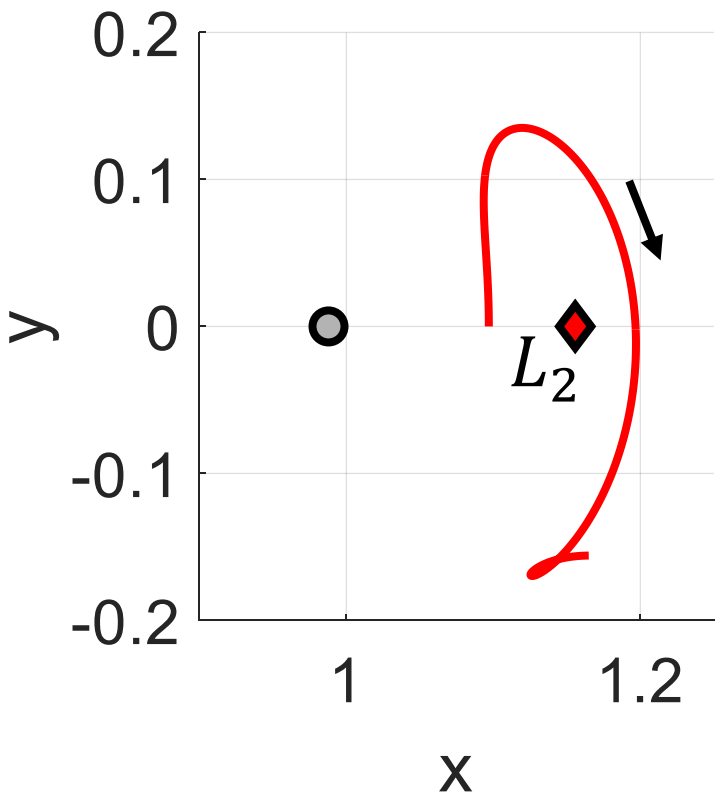
- Implemented correctly (likely)
- Qs:
  - What is the initial guess?
  - Error in the DF matrix?
  - What is the corrected solution? (Does it converge to a very different periodic orbit?)

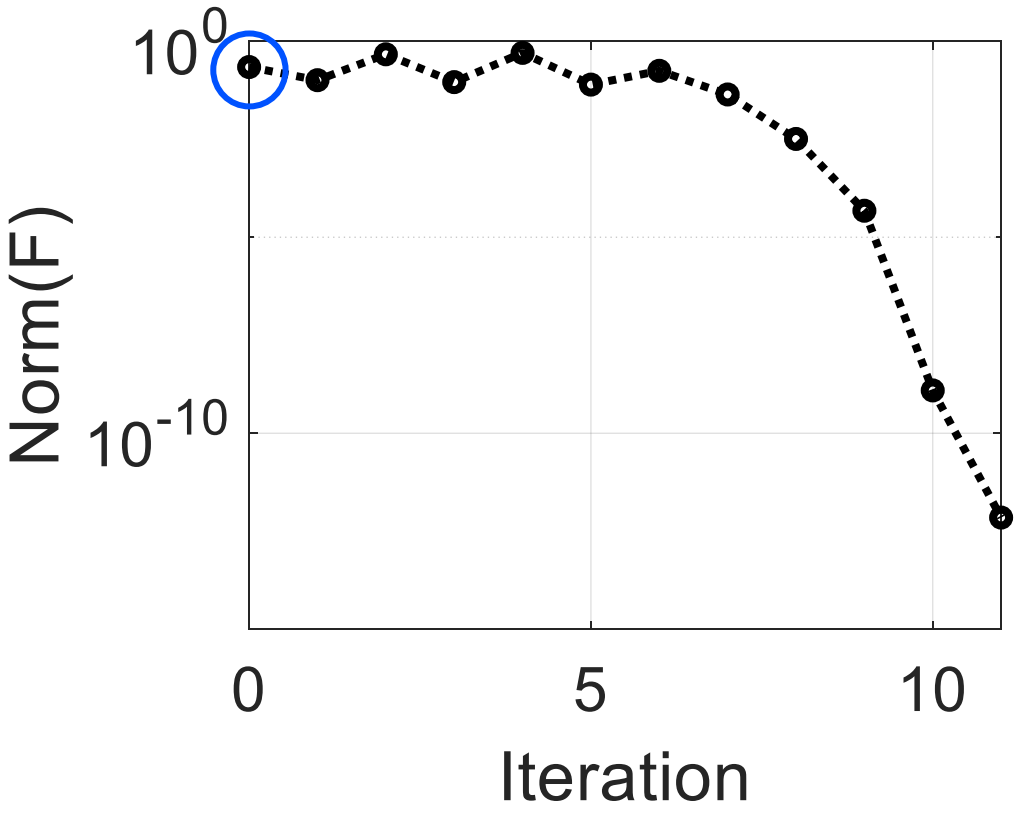
- The corrections scheme requires a few iteration to reduce norm(F) enough before quadratic(-ish) convergence observed. A better initial guess can reduce the number of iterations required



Example 1: Computing an L_2 Lyapunov Orbit

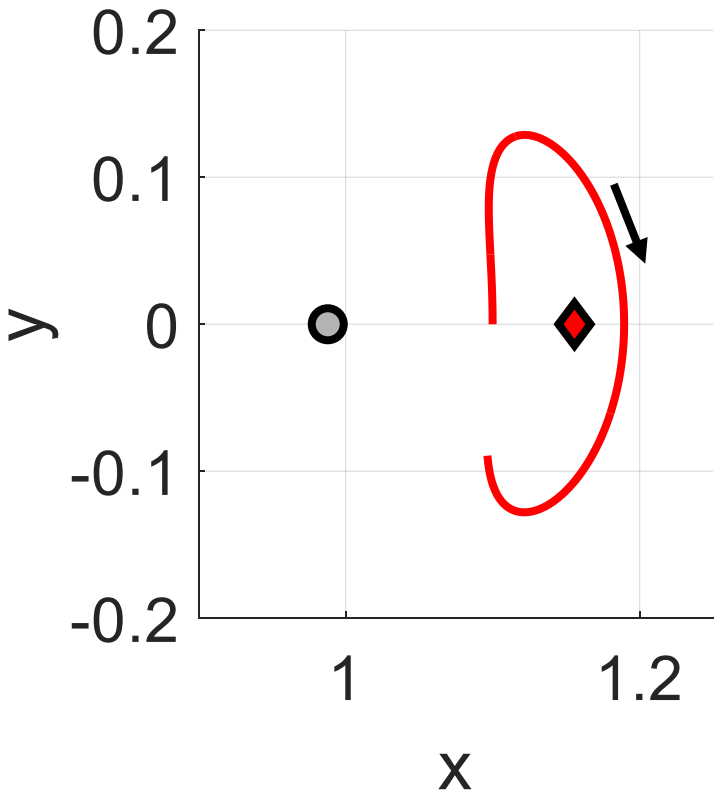
Using a poor initial guess

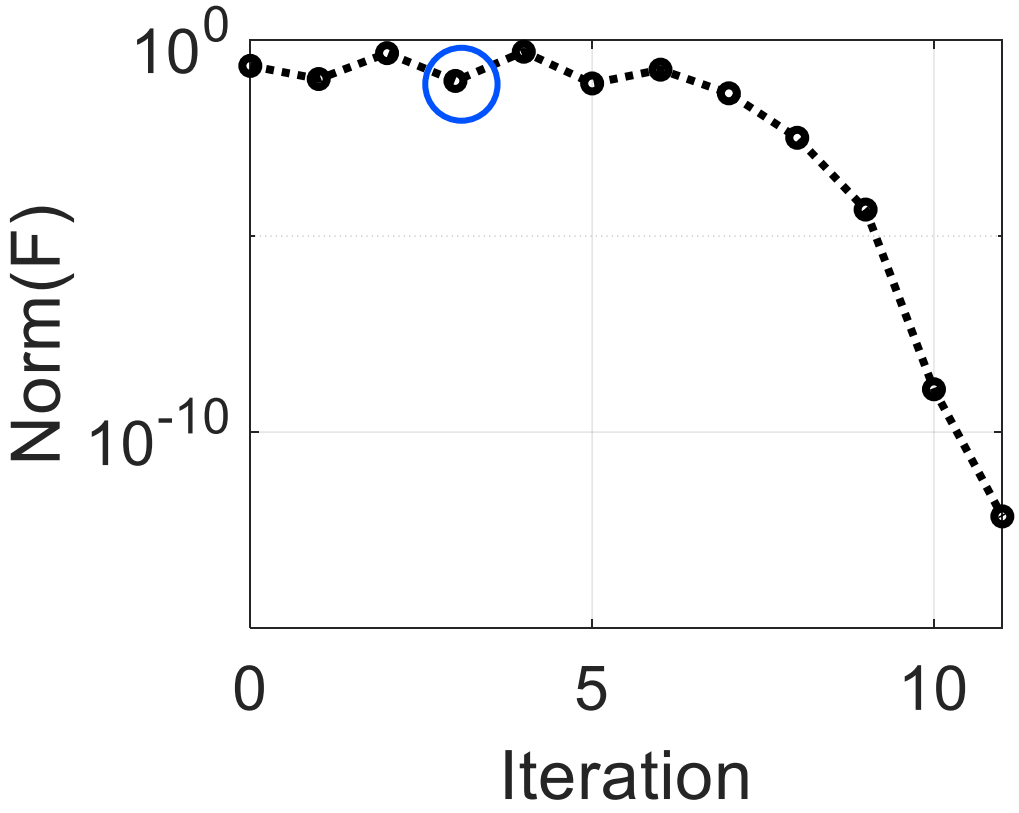




Example 1: Computing an L_2 Lyapunov Orbit

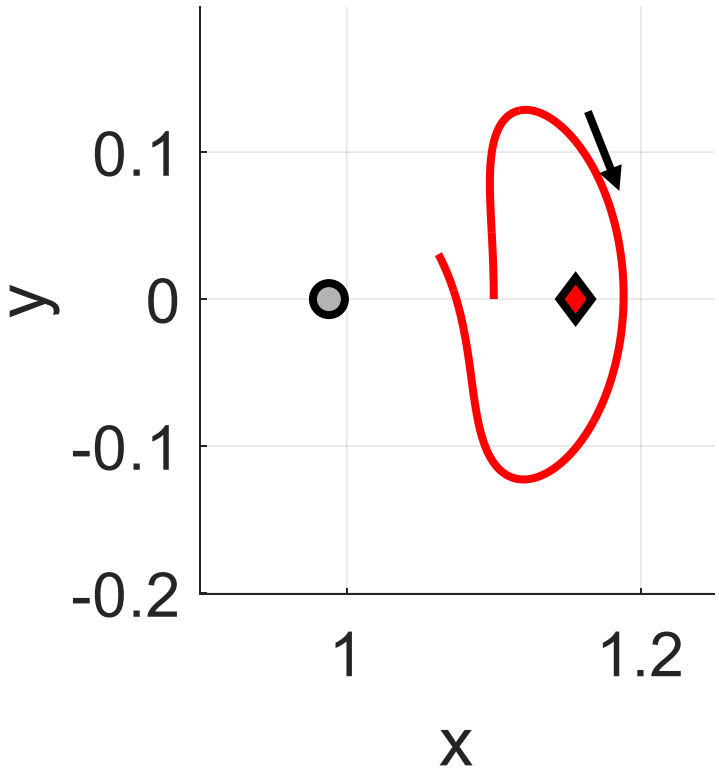
After 3 iterations

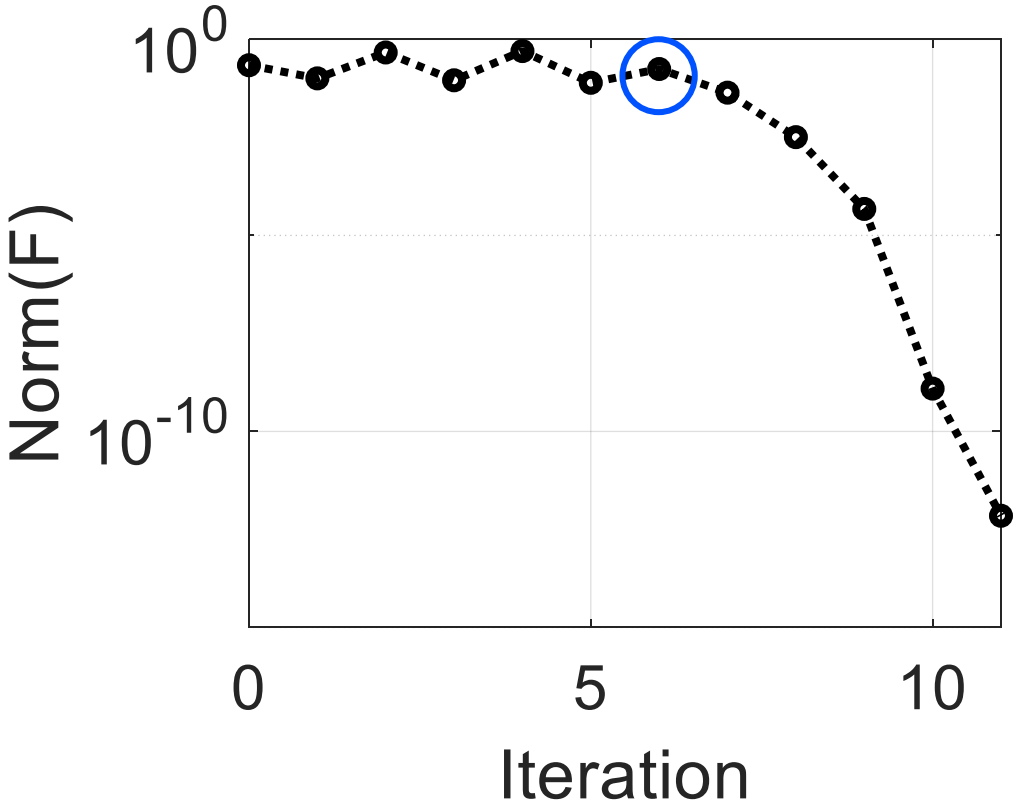




Example 1: Computing an L_2 Lyapunov Orbit

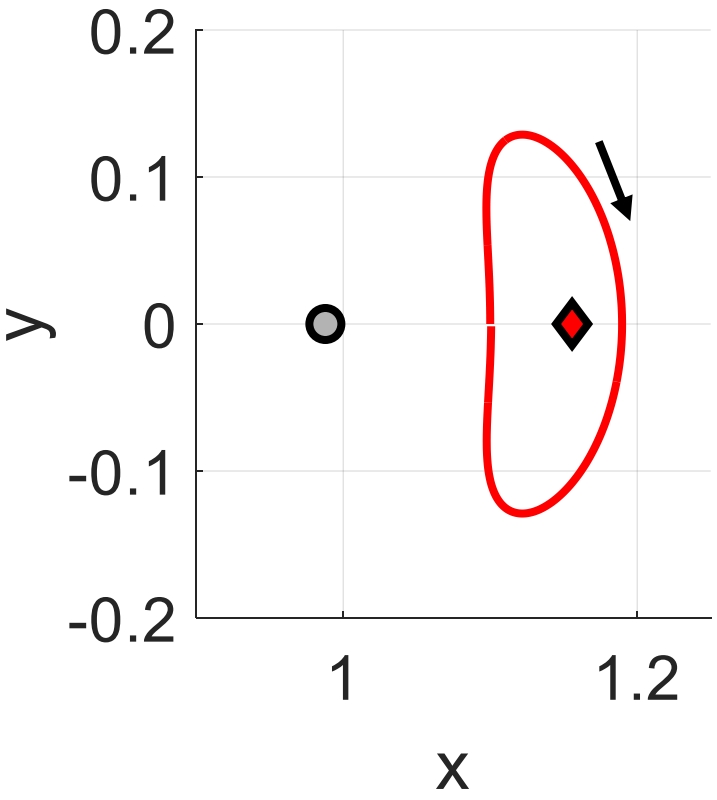
After 6 iterations

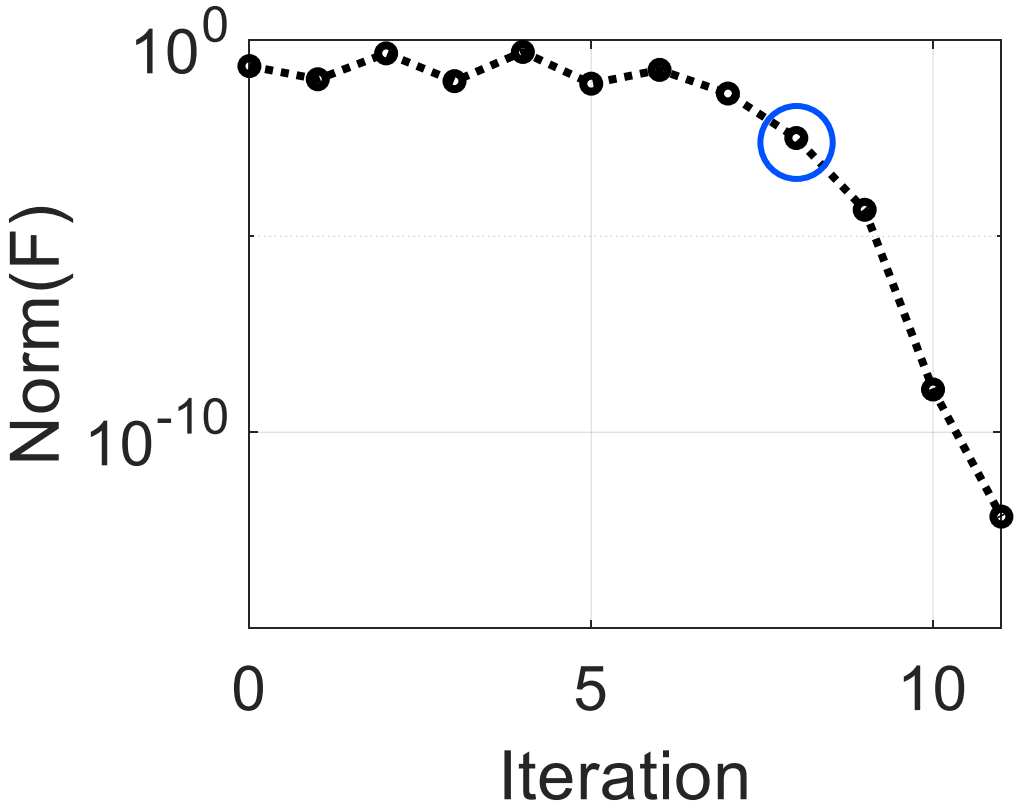




Example 1: Computing an L_2 Lyapunov Orbit

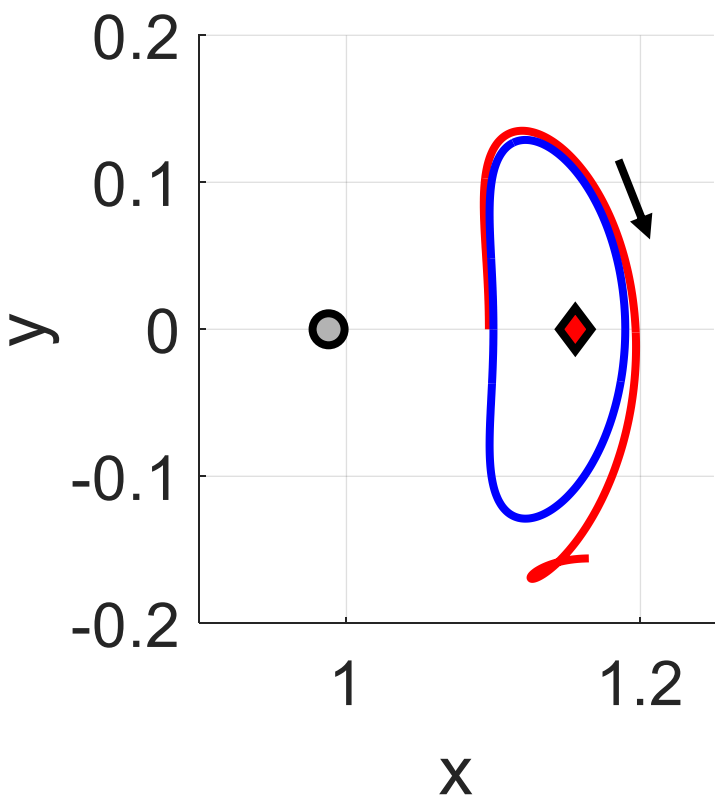
After 8 iterations

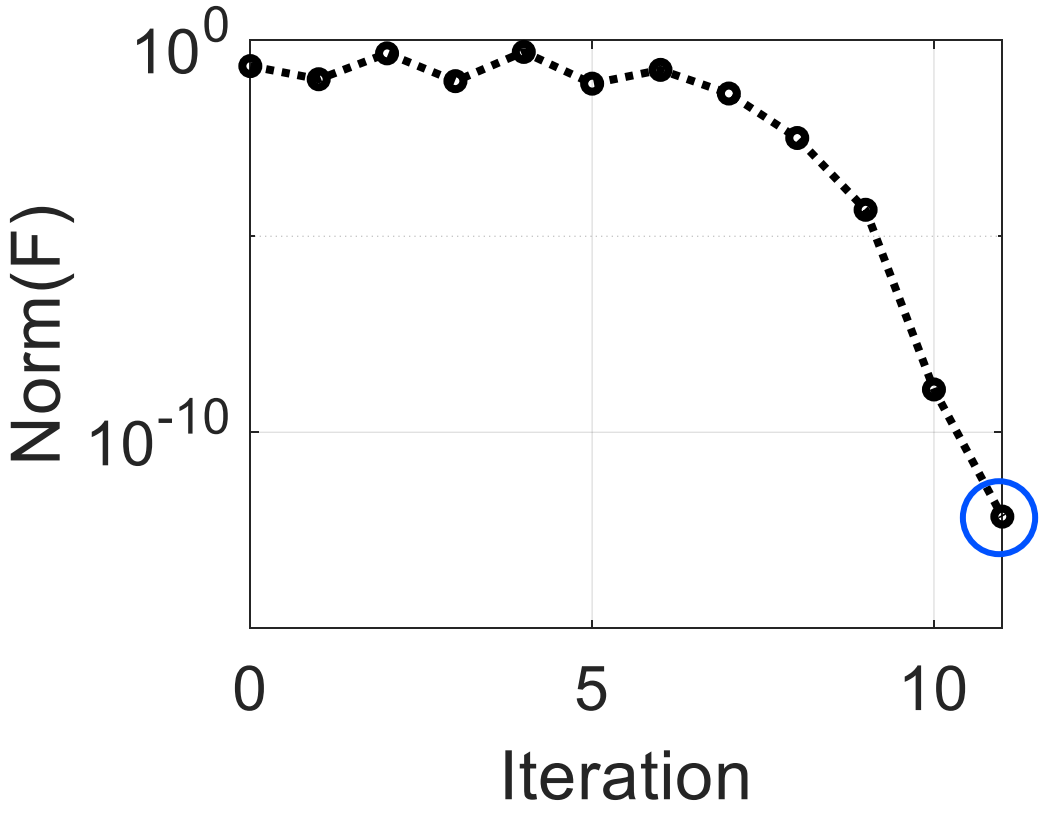




Example 1: Computing an L_2 Lyapunov Orbit

After 11 iterations

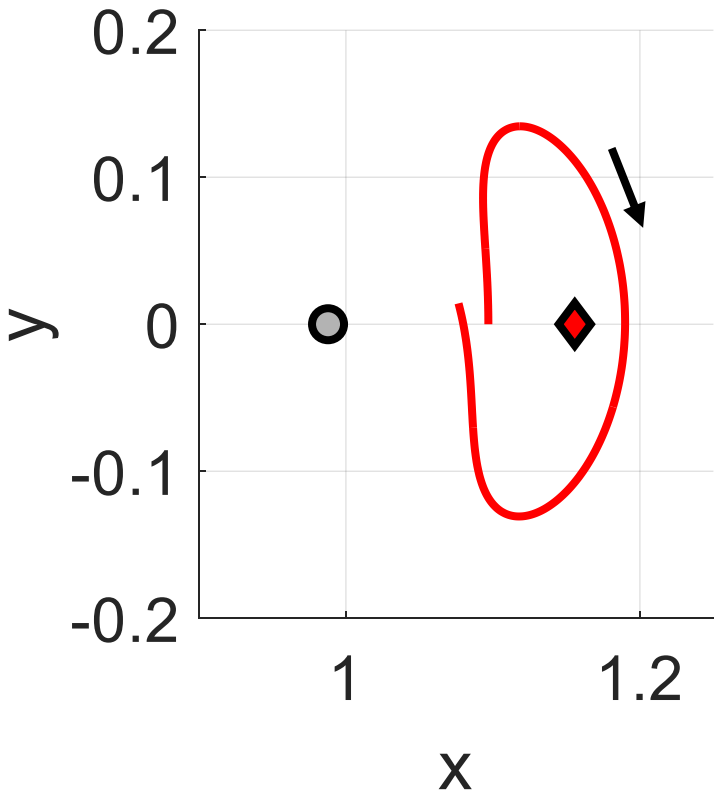


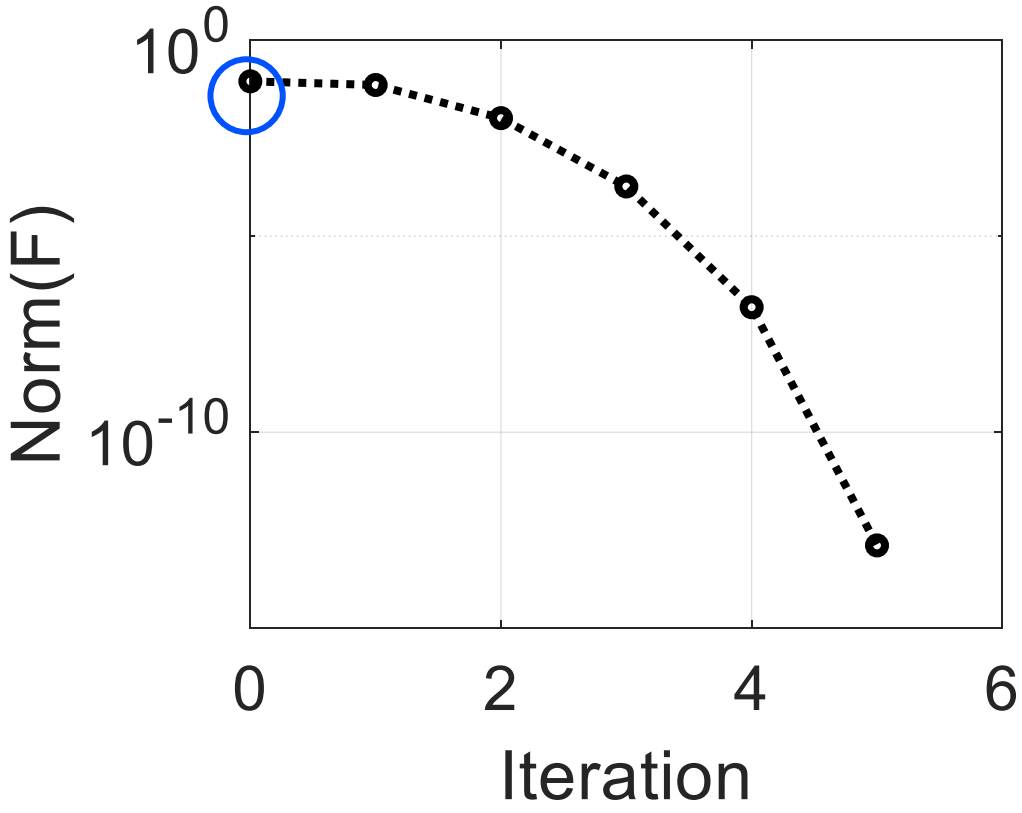


Initial Guess Solution

Example 1: Computing an L_2 Lyapunov Orbit

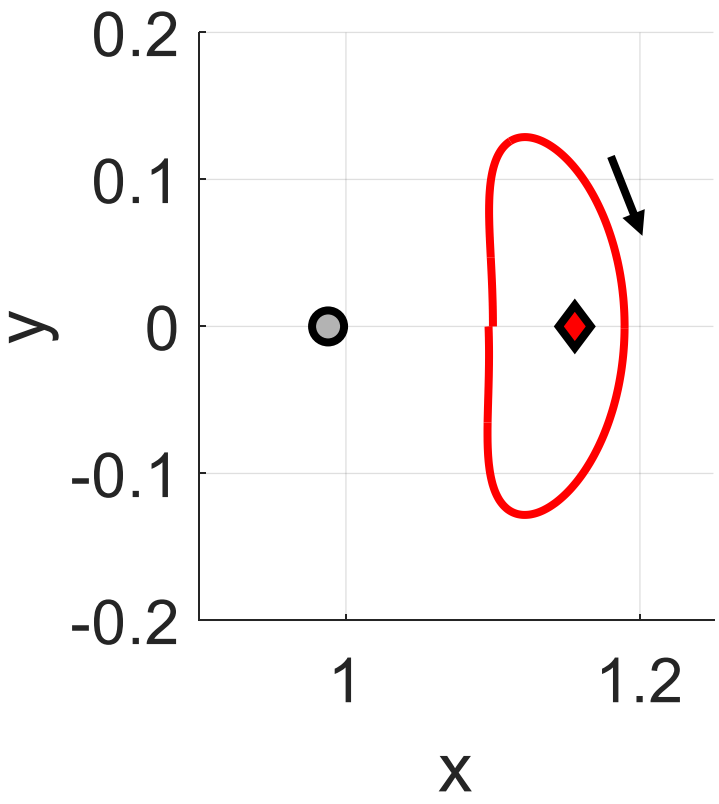
Using a better initial guess but the same implementation

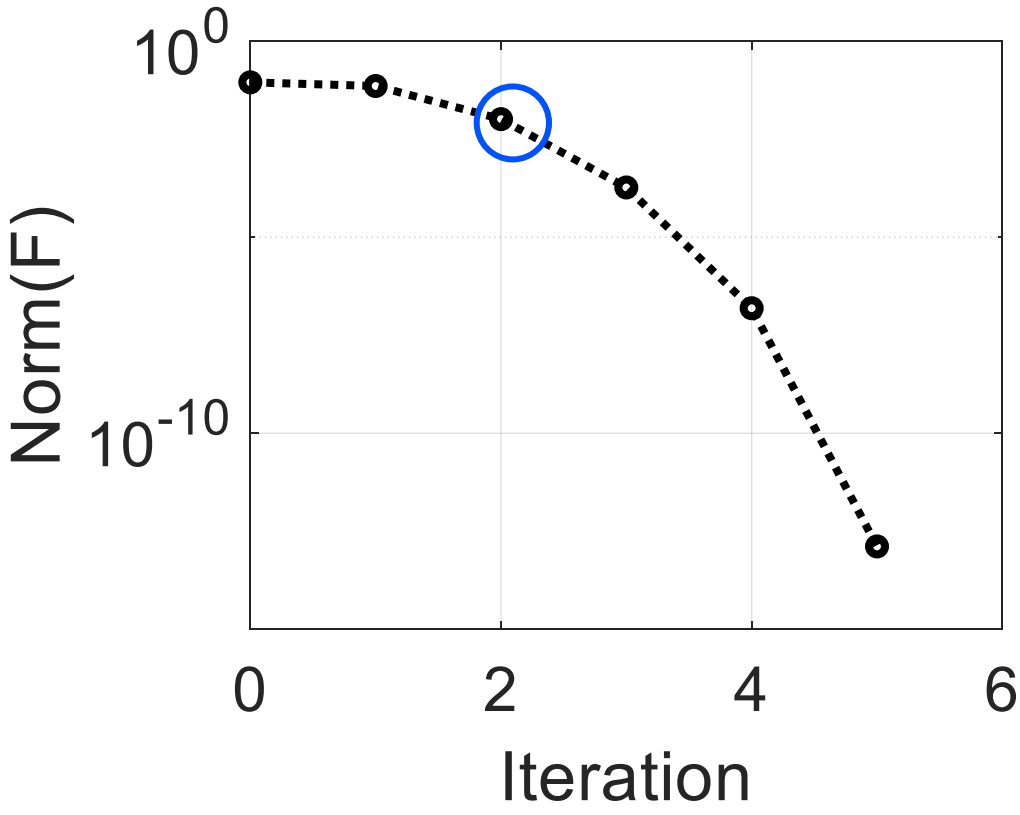




Example 1: Computing an L_2 Lyapunov Orbit

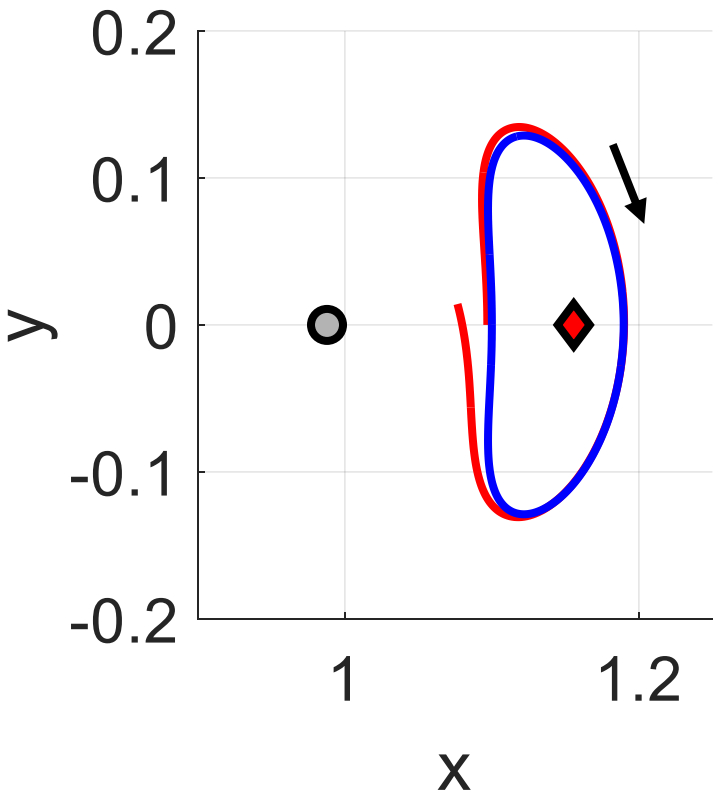
After 2 iterations

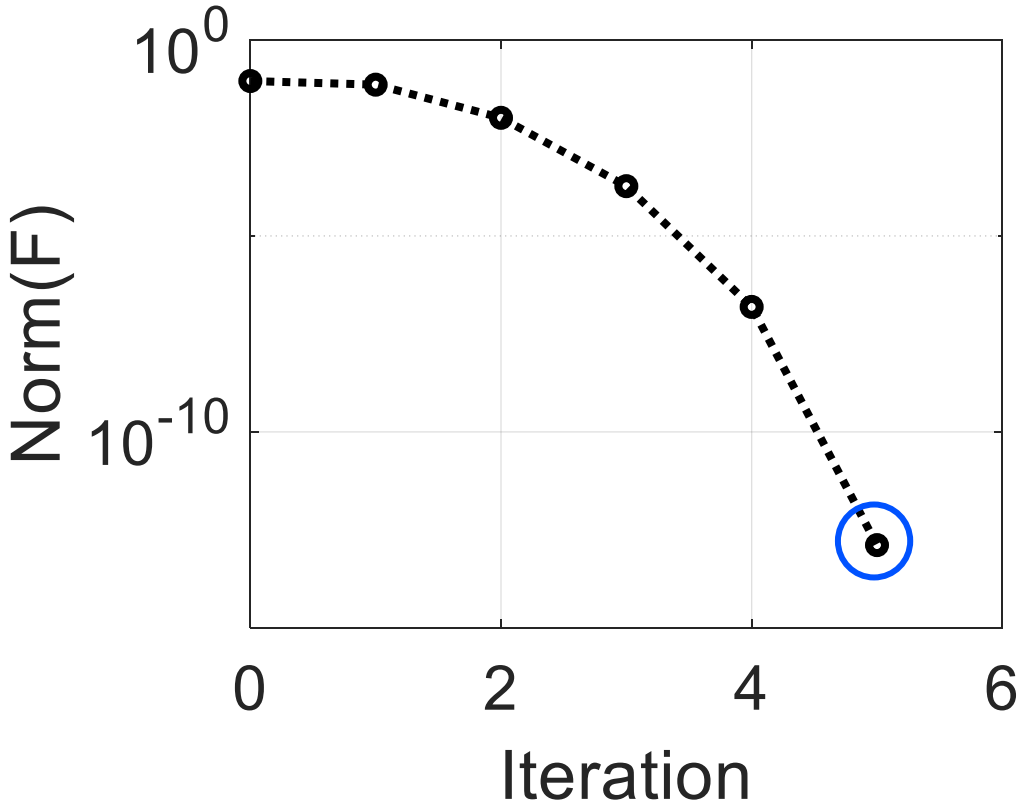




Example 1: Computing an L_2 Lyapunov Orbit

After 5 iterations

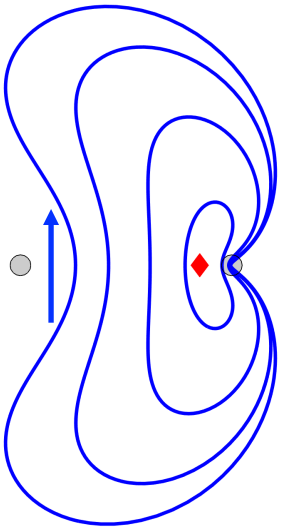


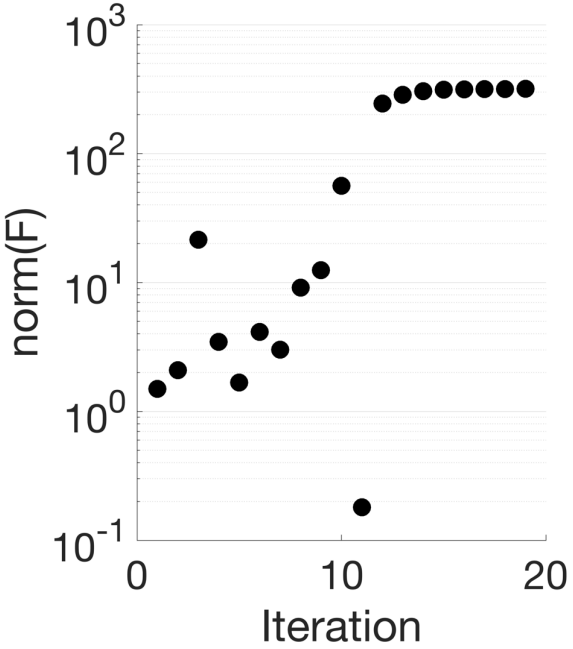


Initial Guess Solution

Example 2: Computing an L_1 Lyapunov Orbit

Your colleague has created a script to numerically compute an L_1 Lyapunov orbit via single-shooting





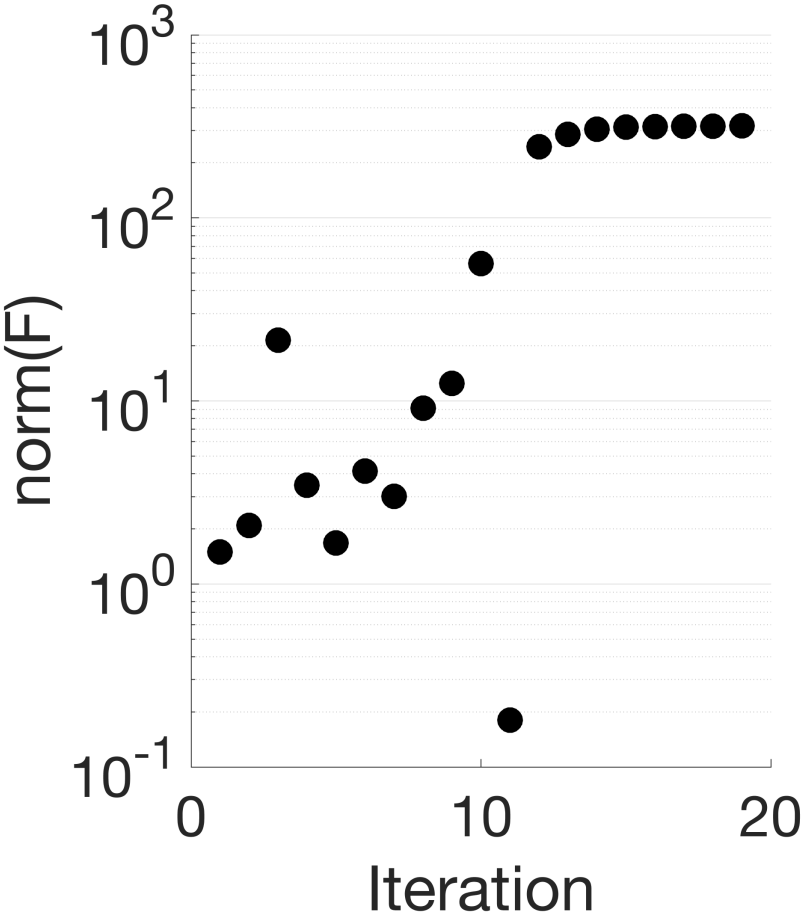
Question 2: What information would you ask for to determine whether they have implemented their corrections algorithm correctly or help them identify any issues, if applicable, and why?

Question 2

Group Brainstorming:

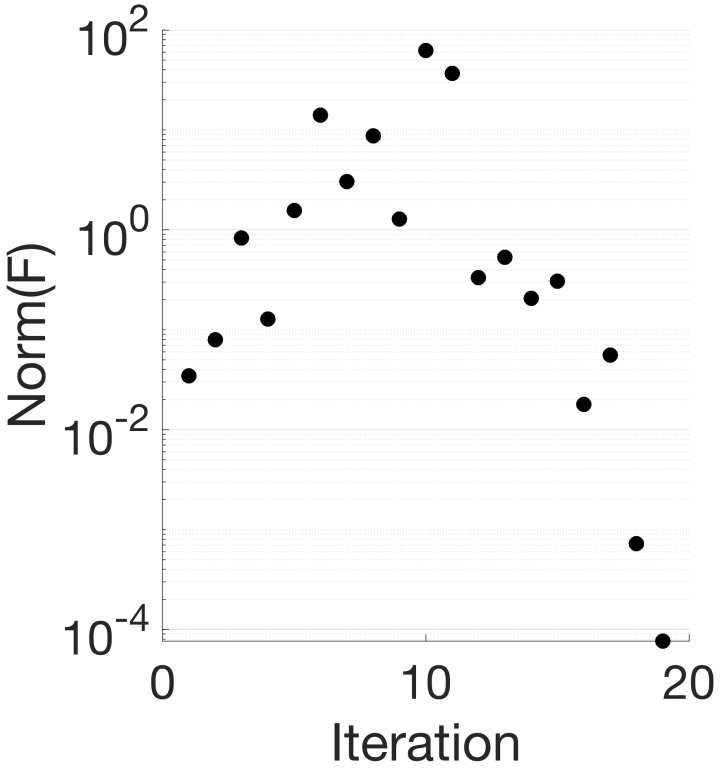
- What is the initial guess? Newton's method assumes that it is sufficiently close to the solution. In that case, divergence could occur
- Error in the DF matrix
- How is the STM/DF matrix being calculated?
- What is the formulation of the corrections problem? Are there any assumptions that influence quality of the initial guess?

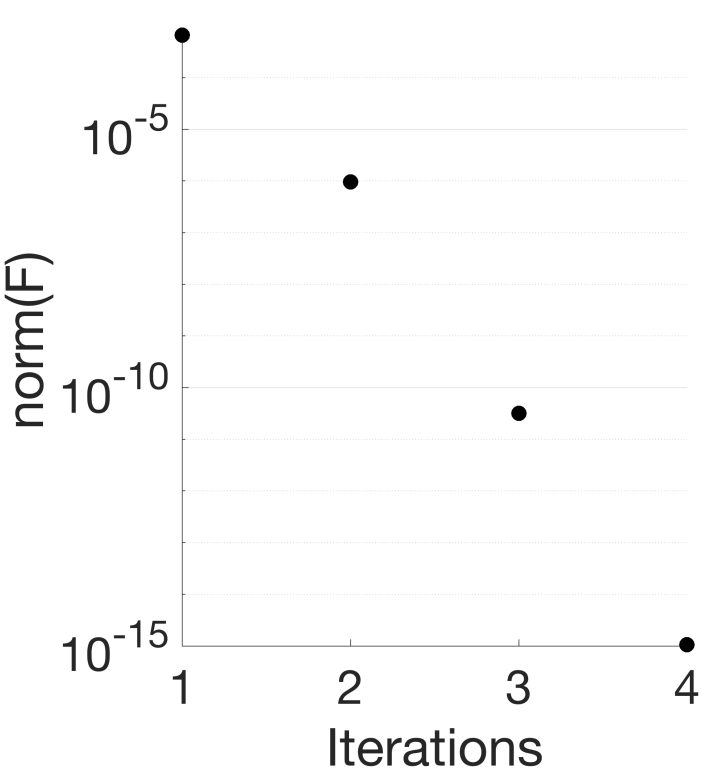
- Reason: poor initial guess, but correct implementation!



Example 3: Computing an L_1 Lyapunov Orbit

Two colleagues have independently implemented single shooting schemes to compute an L_1 Lyapunov orbit. They used the same trajectory to generate an initial guess but get two different results:





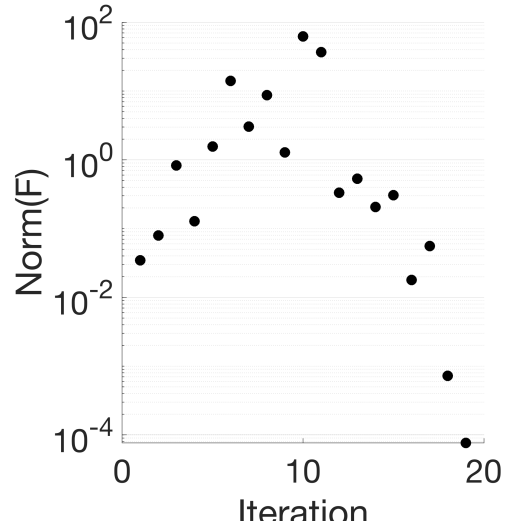
Question 3: Create a list of possible reasons that they are producing different results

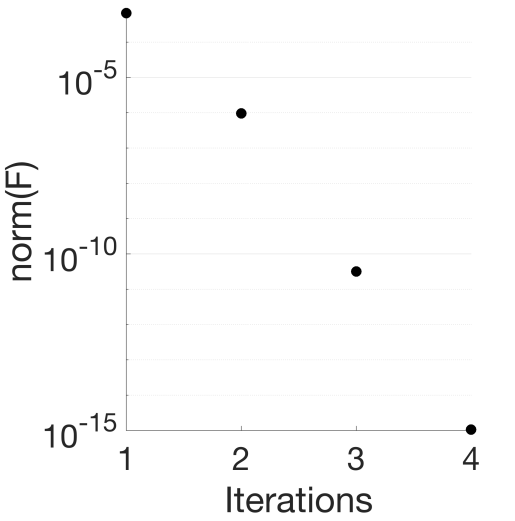
Question 3

Group Brainstorming:

- Initial guesses are different (look at norm(F)), producing different behavior
- Constraint formulations might be different. What specific constraints did they apply?
- Did they construct initial guesses in a manner that matches the corrections problem formulation?
- Did they numerically integrate the trajectory correctly/accurately?
- Did one person have an error?
- What is the tolerance and/or other termination conditions?

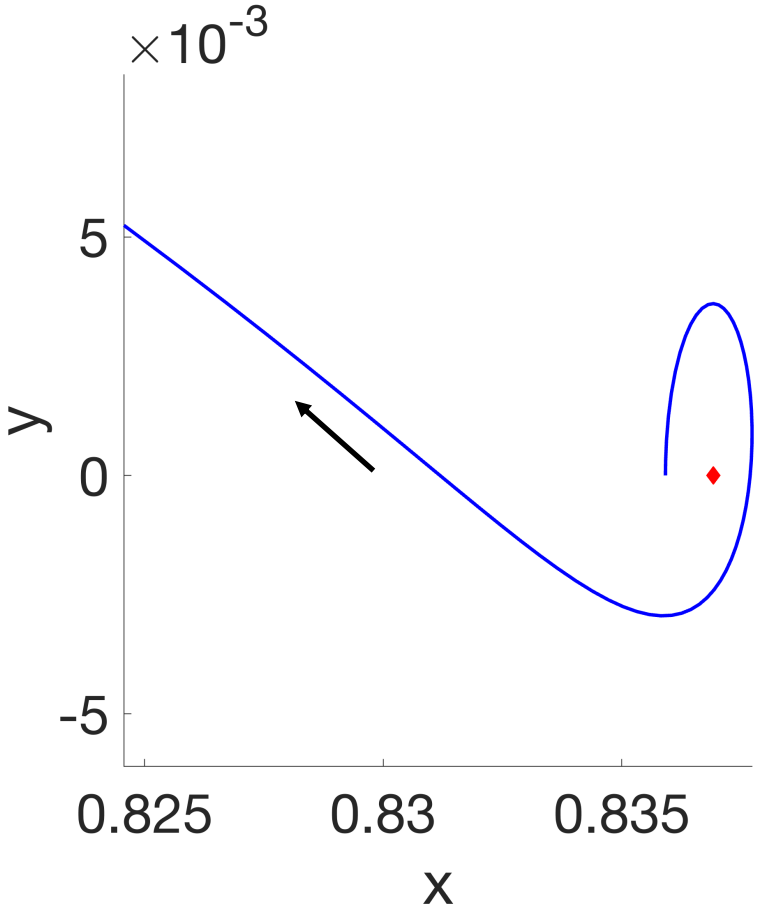
- Reason: different formulations of the corrections problem!



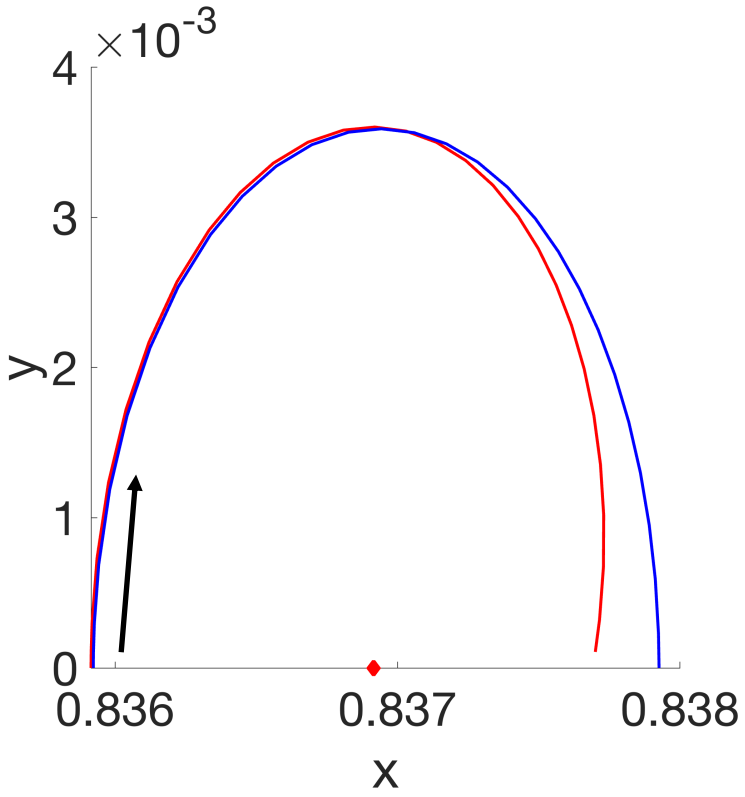


Question 3

Correcting for periodicity over full period

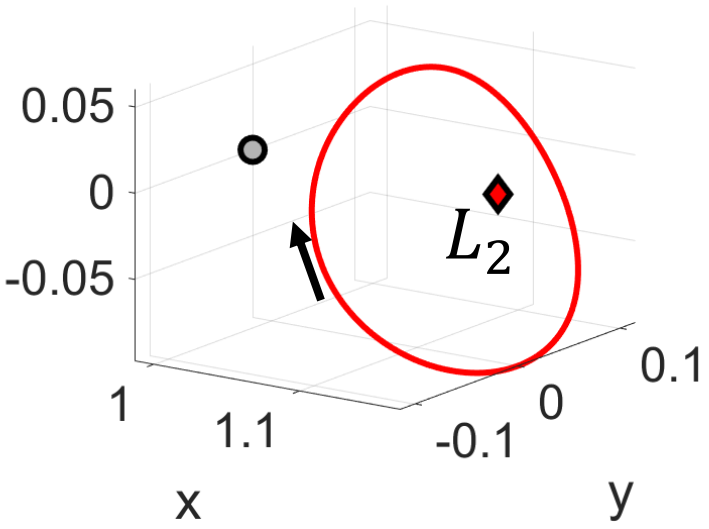


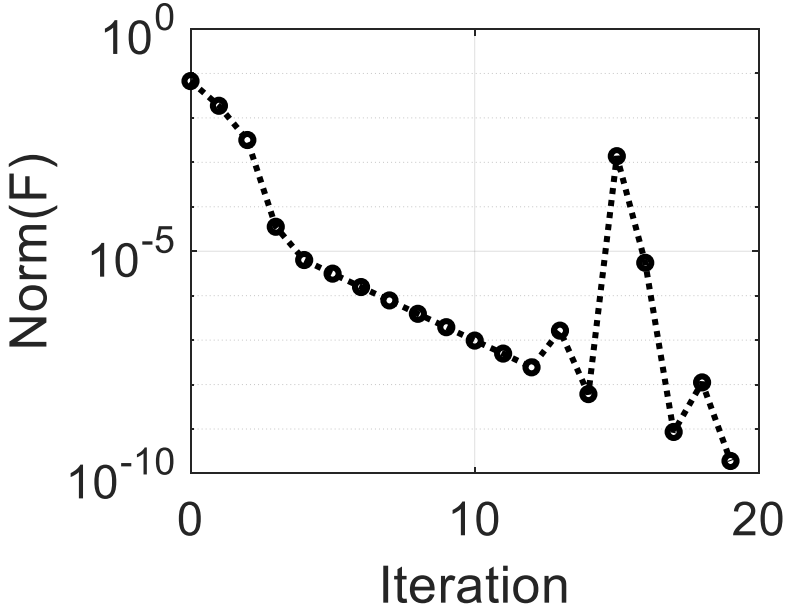
Correcting using mirror theorem



Example 4: Computing an L_2 Halo Orbit

Your colleague has created a script to numerically compute an L_2 halo orbit via single-shooting





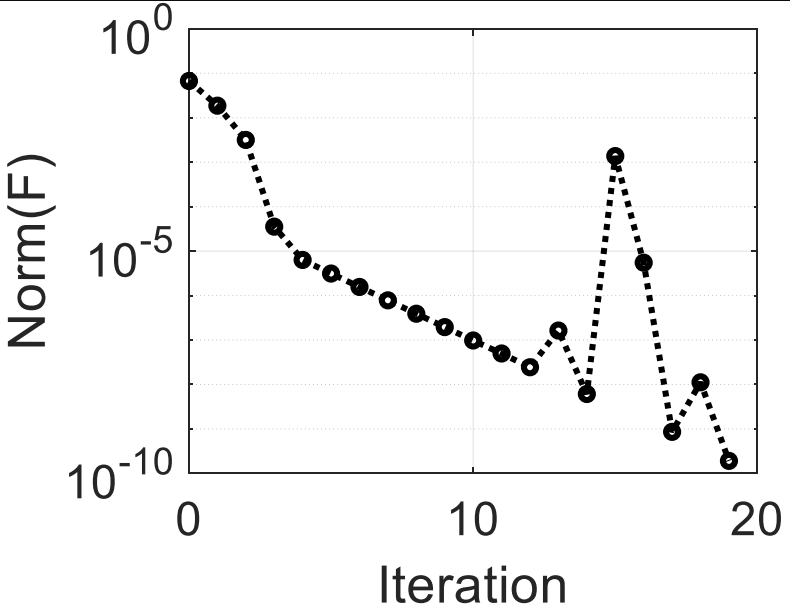
Question 4: What information would you ask for to determine whether they have implemented their corrections algorithm correctly or help them identify any issues, if applicable, and why?

Question 4

Group Brainstorming:

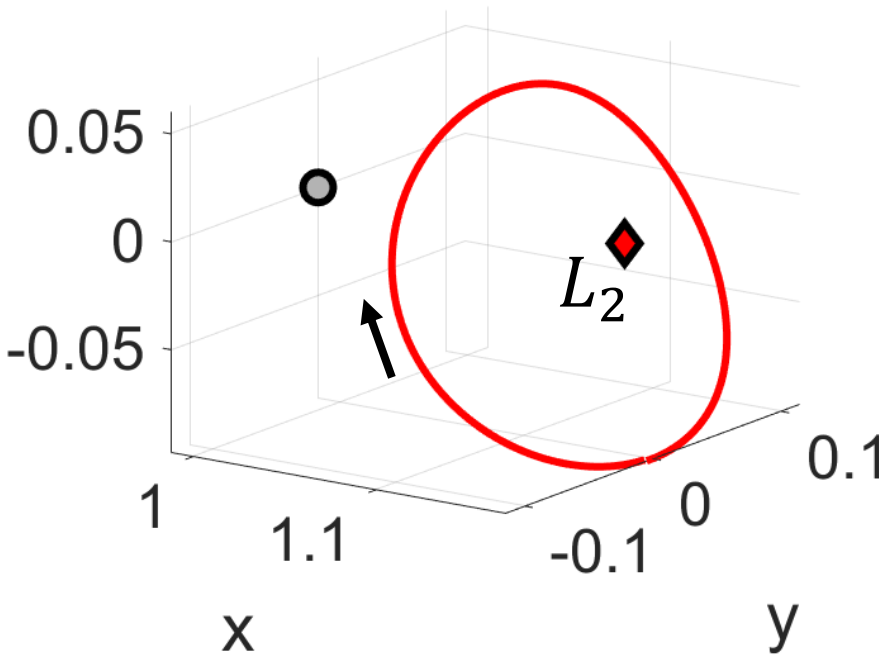
- Missing consistent quadratic convergence as norm(F) gets small
- Likely an error?
- Is there a bifurcation in this family, challenging corrections (we will cover this next week)
- How would we describe this convergence behavior?
- Look at properties of the DF matrix?

Reason: an error in the DF matrix!

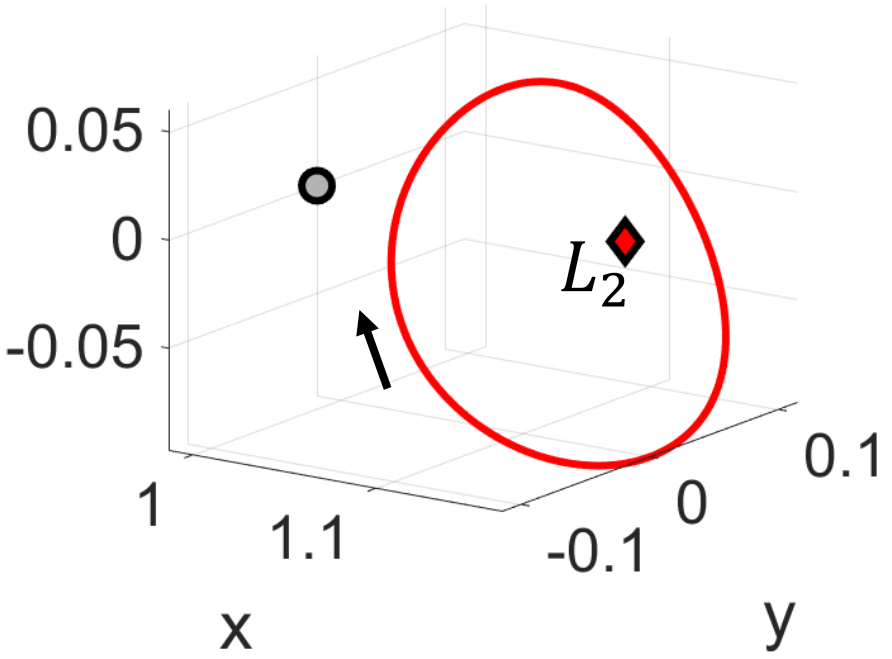


Example 4: Computing an L_2 Halo Orbit

After 2 iterations



After 11 iterations



Initial Guess Solution