Shooting and matrix method - Problem I, II, III, IV

Harsh Solanki, Pietro Dalbosco, Rakhshanda Naureen Ansari

January 30, 2025

1 Problem I

Code structure: linear case

- Function
  - for the ODE system
  - performing one "RK4 step" (vectorial form)
  - performing all the RK4 steps and saving the values of the function evaluated at the x_2 (second condition)
  - implementing the linear interpolation method (I used chat GPT to convert my fortran code in python)
  - combining the previous functions to find the correct value of the slope s. s is varying and for each value the system of ODEs is solved.
- I define the starting points (two values of s) for interpolation by setting two indeces.
- Plot the solution for each slope found during the iteration process performed by the linear interpolation method.

Code structure: nonlinear case

- Same as before.

In the linear case, the linear interpolation method finds the root in just one iteration because the system of ODEs is linear.

In the nonlinear case, in order to achieve the accuracy of 10^{-4} 81 iterations are needed.

2 Problem II and III

Code structure: Shooting method

- Same structure of the solutions described previously.

Code structure: matrix method

- Function
  - implementing Gaussian elimination (I used chat GPT to convert my fortran code in python)
  - building the proper matrix and solving the linear system making use of Gaussian elimination.

Then I plot the solution found by the shooting method along with the solution found by the matrix method for comparison.

3 Problem IV

Code structure

- Same structure and functions of solution I and II.