CS 374: Project Proposal

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1. **Root Finding Method :**
    a. **Finding roots** of certain physically significant function(s) using various numerical root-finding algorithms and analyzing the accuracy of their estimation in multiple cases. We shall further analyze the data points where a certain method faces shortcomings and try to provide accurate reasoning for the aforementioned.
2. **Gaussian Elimination** :
    a. **Time Complexity Analysis**: An analysis of the net time required to solve a particular system of linear equations by various methods of Gaussian Elimination is to be done by gradually varying the dimension of the N*N coefficient matrix. To give a more balanced approximation, for every value of N, multiple random matrices are to be generated and solved.
    b. **Effects of perturbing the solution**: An overall analysis of the impact of perturbation primarily with regards to the error incurred is to be done by adding varying amounts of noise to the coefficient matrix and comparing the current solution vector with the original solution vector.
    c. **Analyzing Ill-Conditioned Matrix**: Vandermonde Matrices are to be generated which are inherently ill-conditioned, and the above perturbation experiment is to be performed for varying dimensions of the N*N coefficient matrix. An overall distribution in terms of mean and the standard deviation of the multiple error vectors which are obtained for the same N is to be further analyzed.

3. **Double Pendulum:**
    a. **Solving** the nonlinear coupled ordinary differential equation model of a double pendulum using linear approximation with the Euler-Lagrange method. Observing the beating behaviour of the system.
    b. **Numerical model** using the Runge-Kutta method to solve the higher-order differential form of the system.

c. **Perturbing** the initial conditions and analysing the error and instability in the system and chaotic nature of the deterministic system by varying the initial angles slightly for both the pendulums and comparing the coordinate vectors obtained after a few iterations and finding the deviation.
d. **Numerical simulation** of the chaotic behaviour of the system of equations which will graphically represent the execution of our model for each iteration, thereby making it simple to understand the behaviour of the system with different parameters.

4. **Lagrange Interpolation:**
    a. Using the Lagrange Interpolation technique to obtain the system of equations for the double pendulum model by finding the position values using a few data points and then comparing it with the values found previously.