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# CST-305: Project 2 – Runge-Kutta-Fehlberg (RKF) for ODE

# Objective

The objective of this project is to use the Runge-Kutta-Fehlberg (RKF) method to solve an Ordinary Differential Equation (ODE), assess its accuracy, and evaluate the performance of the computing system used. The project involves solving the ODE manually and computationally using Python.

# System Performance Context

This program was tested on a standard consumer laptop with the following specifications:  
- Processor: Intel Core i7  
- RAM: 16 GB  
- OS: Windows 11  
- Python Version: 3.11  
Performance was measured by recording total computation steps and elapsed time, giving insight into numerical simulation efficiency.

# Specific Problem Solved

The differential equation solved is dy/dx = -y + ln(x), with initial values x0 = 2.0 and y0 = 1.0. The step size used was h = 0.3 and the RK4 method was applied for 5 steps.

# Mathematical Approach

The Runge-Kutta 4th order method (RK4) was used to compute numerical approximations of the ODE's solution. Each iteration calculates k1 through k4 values to estimate the next y value. This method balances performance with accuracy.

# Implementation in Code

The ODE was implemented in Python using a custom rk4\_step function that computes each RK4 step. A for-loop runs the steps, storing values for plotting. The matplotlib library was used for visualization. Performance was measured using Python's time module. Additional tests were conducted using two more ODEs.

# Responsibilities and Tasks

This was an individual project. All tasks including mathematical calculation, Python implementation, testing, documentation, and GitHub submission were completed by Christian Nshuti Manzi.

# References

- Burden, R. L., & Faires, J. D. (2011). Numerical Analysis (9th ed.). Cengage Learning.  
- Python Official Documentation: https://docs.python.org/3/  
- Matplotlib Documentation: https://matplotlib.org/