Abteilung für
Angewandte Mathematik

JProf. Dr. Diyora Salimova
M.Sc. Mario Keller

Praktikum zur Vorlesung: Numerik für Differentialgleichungen – SoSe 2023

Sheet 5

Ausgabe: 05.07.2023, 12:00 Uhr — Abgabe: 12.07.2023, 12:00 Uhr

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Homepage to the lecture:

https://aam.uni-freiburg.de/agsa/lehre/ss23/ndgln

Remark: This is the last sheet.

Project 1 (8 points)**.** Implement the following explicit multistep method

$$y_{k+3} + \gamma(y_{k+2} - y_{k+1}) - y_k = \tau \frac{3+\gamma}{2}(f(t_{k+2}, y_{k+2}) + f(t_{k+1}, y_{k+1}))$$

with $\tau = 0.05$ for the initial value problem

$$y'(t) = -y(t), \quad y(0) = 1, t \in [0, 1].$$

Test your program by plotting the approximated solution and the exact solution for all values $\gamma \in \{-4, -3.1, -2.9, -1, 0.9, 1.1, 2, 9\}$. For which values of γ do you get reasonable approximations of the exact solution?

Project 2 (4 +4 points)**.** Consider the initial value problem

$$y'(t) = -\alpha(y(t) - cos(t)), \quad y(0) = 0, \quad t \in [0, 1]$$

and $\alpha = 50$, whose exact solution is given by

$$y(t) = \frac{\alpha}{1+\alpha^2}(\sin(t) + \alpha\cos(t) - \alpha e^{-\alpha t}).$$

(1) Solve the initial value problem with the explicit and implicit Euler method, the trapezoidal method and the classical Runge-Kutta method for step sizes $\tau = 2^l/10, l = 0, 1, 2, 3$. Compare the errors at time $T = 1$ in a table.

(2) Plot the approximations for the step sizes and the exact solution comparatively in a graph.