Student project

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Abstract

The practical side of the course Advanced methods for ODEs and DAEs consists of two parts: small goal-oriented assignments and more detailed project. The main idea behind the second one is to involve the students in the numerical solving of an ordinary differential equation describing the real world phenomena, as well as to gain some practice in reading literature and writing short reports.

1 Project realisation

To successfully finish the project students have to do the following steps:

1. search and read the literature on the specific topic
2. understand and implement the model in Matlab
3. solve the model by given (in case not given then chosen) method
4. write report in a form of latex presentation with minimum 8 maximum 12 slides (title page - work split (who did what) - motivation - model problem - numerical methods (with pros/cons)- results (detailed discussion)- conclusion)
5. defend the work on the last tutorial

Note: The work is not specified in detail. The goal of the project is to see if the student is able to use the theory in a fully practical situation without the help of an advisor or supervisor. This means that only model and numerical procedures will be specified but not the technical details.

2 Topic: Simulation of cardiac cell

The simulation of the electrical activity in cardiac cells is known to require a large number of stiff ordinary differential equations (ODEs). In order to reduce the cost of developing new drugs these mathematical models are used instead of the experimental trials. Hence, the efficient solving of the proposed mathematical model is more than needed.

Work plan:

- To describe the system use the model of differential equations given by Luo and Rudy in 1991 (you can use Matlab code for the model)
- For adopted system implement:
  - ESDIRK method by your choice
  - Rosenbrock-Wanner ROS2 method
  - multistep BDF-3 method.

  Note that you have to choose the time step by yourself according to the accuracy criterion/stability of the system/the efficiency of the program. Solving linear and/or nonlinear system of equations is of free choice. However, the students have to be able to explain the reasons.

Initial reference:

[1] http://rudylab.wustl.edu/research/cell/lrd2.htm

[2] Justin Greniera, Youssef Belhamadiaa. Nested Implicit Runge-Kutta Method for Simulating Cardiac Cell Models.