Syllabus

MATH1902: Numerical Solution of Differential Equations

http://people.sc.fsu.edu/~jburkardt/classes/math1902_2020/syllabus/syllabus.pdf

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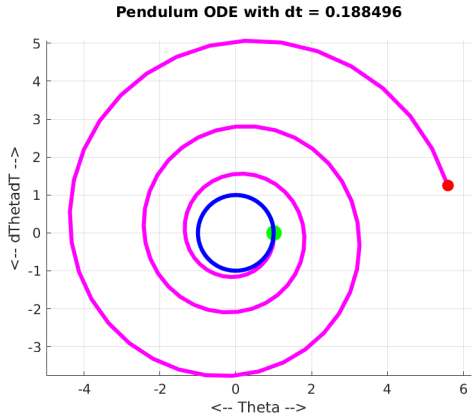

The blue circle represents the behavior of a simple pendulum; the magenta spiral shows how an attempt to compute this behavior spirals out of control.

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Prerequisites: Good undergraduate background in linear algebra and some familiarity with the theory of ordinary differential equations. Previous experience with MATLAB or programming is helpful, but not required.

Content: This course is an introduction to modern methods for the numerical solution of initial and boundary value problems for systems of differential equations. We will discuss the principal classes of numerical methods and of their theory, including convergence and stability considerations, consistency order, step size selection and adaptivity, the effects of stiffness, geometric integration, invariant and Hamiltonian dynamics. The focus will be on time-adaptive, second-order accurate, symplectic methods.

Textbook:
Numerical Methods for Ordinary Differential Equations: Initial Value Problems,
by David F. Griffiths and Desmond J. Higham.

Online discussion:
We plan to hold a weekly online ZOOM session, currently scheduled for 12:30pm on Tuesdays, to briefly discuss that week's new material. Questions and requests for help can always be submitted via email, and if necessary, a personal ZOOM session can be set up to talk over a problem.

Course website:
There is a course website at:
http://people.sc.fsu.edu/~jburkardt/classes/math1902_2020/math1902_2020.html

Each week, a new topic will be posted on this site, including a presentation of material to be studied, MATLAB scripts and images that illustrate the topic, and a homework problem. After reading the introductory material and running the example codes, you should have enough information to solve the homework problem, and then submit the result. Depending on the assignment, the solution to be submitted will be either a working MATLAB program, a short text file, or a graphical image (preferably in PNG format).

Topics to be covered:

- Euler's method;
- the backward Euler method; the midpoint method; the Runge-Kutta method
- Simple ODE models of the pendulum, a flame, an ecosystem of foxes and rabbits;
- Estimating error; measuring convergence
- Adaptive step size selection
- ODE's for systems with a conservation law or an invariant
- Long-term dynamics
- Boundary value problems
- Problems in space and time

References:

- http://www.springer.com/us/book/9783540566700 'Solving Ordinary Differential Equations I, Nonstiff Problems', by http://www.unige.ch/ hairer/Ernst Hairer, Syvert P. Nørsett, https://www.unige.ch/ wanner/Gerhard Wanner. Springer.
- http://link.springer.com/book/10.1007 'Solving Ordinary Differential Equations II, Stiff and Differential-Algebraic Problems', by Ernst Hairer, Gerhard Wanner. Springer.
- http://link.springer.com/book/10.1007 'Geometric Numerical Integration Structure-Preserving Algorithms for Ordinary Differential Equations', by Ernst Hairer, Christian Lubich, Gerhard Wanner. Springer.
- http://onlinelibrary.wiley.com/book/10.1002/9780470753767 'Numerical Methods for Ordinary Differential Equations', Second Edition, by http://jcbutcher.com/ J. C. Butcher. John Wiley & Sons.
- http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471929905.html 'Numerical Methods for Ordinary Differential Equations: The Initial Value Problem', by J. D. Lambert. John Wiley & Sons.
- http://bookstore.siam.org/ot61/ 'Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations', by Uri M. Ascher and Linda R. Petzold. SIAM.