COMPUTATIONAL MATHEMATICS OF EVOLUTIONARY EQUATIONS
(MATEMATYKA OBLICZENIOWA RÓWNAŃ EWOLUCYJNYCH)

Cele kształcenia

Evolutionary equations typically model phenomena in biology, medicine, chemistry and of physics to mention just a few. These equations are usually unsolvable analytically (that is just with pen, paper and mathematical formulas) but can be approximated with the aid of algorithms and computers. Computational mathematics of evolutionary equations finds its important role in this field, as it is devoted to methods (algorithms), which after implementation (programming) visualise the solutions or some of their features. Needless to say such algorithms must satisfy several features, and the most important ones are: accuracy, efficiency, robustness and stability.

Wymagania

The course Foundations of Computational Mathematics is not obligatory for students attending Computational Mathematics of Evolutionary Equations, but recommend. It would help in better understanding of the current material and for skilful calculations (both theoretical and practical). In other words, students may join the current course without going through Foundations of Computational Mathematics, but it may take them a little bit more time and effort to adopt to the present material.

Students undertaking the course are supposed to be at least a little bit familiar with Python and to communicate in English at a basic level. While Paul Bergold speaks both German and English, Karolina Kropielnicka speaks both Polish and English, so she will be able to help you with translation to Polish or in understanding some problems in Polish. For this reason the fact that the course will be taught in English should be understood as an advantage rather than a threat.

Treści programowe

- This course is devoted to numerical methods of equations, which evolve in time and space. Firstly mathematical models need to undergo spacial and temporal discretisation and secondly they are to be solved by numerical algorithms. We will be investigating such algorithms and their features. We will also become familiar with discretisation methods like finite differences, finite elements and spectral methods. We will have a closer look at methods devoted to phenomena modelled by wave, heat or Schroedinger equations.
- We will be learning computational mathematics both theoretically and practically. For the practical part we will use Python. Lectures and exercises will be taught in English.
- After this course students will be able to chose suitable algorithms and implement them in order to solve numerous mathematical models.

Wykaz literatury

This course will be based on lecture notes prepared by prof. Caroline Lasser (Technical University of Munich, Germany) and dr Paul Bergold (currently at University of Surrey) and on bibliography:

- [DB] Peter Deuflhard, Folkmar Bornemann, Scientific computing with ordinary differential equations, Springer, 2002.
- [DW] Peter Deuflhard, Martin Weiser, Adaptive numerical solution of pdes, DeGruyter, 2012.
- [HW] Ernst Hairer, Gerhard Wanner, Solving ordinary differential equations II, 2nd edition, Springer, 1996.
- [I] A. Iserles, A First Course in the Numerical Analysis of Differential Equations, CUP, 2009.
- [LR] Ben Leimkuhler, Sebastian Reich, Simulating Hamiltonian dynamics, CUP, 2004
- [Lu] C. Lubich, From Quantum to Classical Molecular Dynamics: Reduced Models and Numerical Analysis, EMS, 2008.