

From approximation of the derivative to numerical methods for ODEs

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A. Information for lecturers

Unit description

Description: The aim of revise the concept of numerical approximation of the derivative (a prerequisite from previous courses) and apply to develop (basic) numerical methods for ODEs. Different numerical methods will be developed in this subject for half a semester in this subject. The structure is on slides with questions (and later solutions). For each question there is a discussion in small groups and then class-wide debate. The questions have a closed-form answer. The solution of each question is needed (or useful) for the next question.

Student and discipline level: This task is designed for students in year 3 of a Math. Engineering Bachelor's Degree.

Prior knowledge:

Expected student and teacher knowledge and skills are

- Theoretical and practical understanding of the derivative and Taylor series
- Finite-difference approximation of the derivative
- Basic knowledge of initial value problems for ODEs

Estimated duration: This task was developed for one hour, but experience suggests two hours are needed.

Learning objectives

At completion of the unit, students will be able to

- Have an intuitive understanding of how simple numerical methods for initial value problems work.

IBME character

The unit can be characterized as structured inquiry, meaning that students follow directions and hints in a structured teaching-learning based on a series of questions. For each question there is a discussion in small groups and then class-wide debate. The questions have a closed-form answer.

Mathematical content

The main mathematical content, within the context of biomedical sciences, is

- Geometric interpretation of the derivative as a tangent line
- Finite-difference approximations of the derivative as secants
- Combination of this fact with ODEs

Experiences

The unit was tested on an online class, during the COVID lockdown of 2019-2020. The students had some technical difficulties with forming small groups in the remote classroom software. Some of the groups came up with ingenious suggestions.

Student with identified needs

No special resources have been included for students with special needs. The activity in the present form has a strong visual and geometric component. Some information is colour-coded, but the choice of each colour does not have a meaning, so they can be changed for students with colour difficulties (colour blind, dyslexic...)

Assessment

The groups can be monitored, and the class-wide discussion should be guided. Since this activity is to create intuition, students should probably not be graded. As a suggestion, a “satisfaction” questionnaire should be given at the end of the activity, and at the end of the semester.

B. Student learning activities

Are attached in pdf and tex form.