EOAS 213 - Computational Methods for Geological Engineers

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1 Approximate Syllabus and learning goals

Week 1 Introduction to scientific computing and test cases.
Learning Goals

- Understand what is scientific computing and where is it used.
- Learn a little bit of python and write some simple programs.

Week 2 Differentiation - Finite difference in 1D.
Learning Goals

- Write code to approximate the derivative of any 1D function.
- Write vectorized code to approximate the derivative of any 1D function on a 1D grid.

Week 3 Differentiation - Finite difference in 2D
Learning Goals

- Write code to approximate the derivatives of any 2D function in every direction.
- Write vectorized code to approximate the derivative of any 2D function on a 2D grid.
- Use meshgrid and ndgrid for such approximations.

Week 4-6 Ordinary differential equations
Learning Goals

- Analytically integrate first order ODE's
- Analytically integrate second order ODE's
- Learn how to generate first order system of ODE's from a high order ODE
- Analyze the characteristics of an ODE of any order

Week 7 Interpolation
Learning Goals

- Write codes for radial basis interpolation.
- Fit noisy data.

Week 8-9 Numerical solutions of ODE's
Learning Goals

- Write codes for forward, backward and midpoint methods.
- Solve a number of model problems.

Week 10-12 Data fitting and optimization.
Learning Goals

- Understand the basic theory of parameter estimation.
- Use PyTorch to compute derivatives of functions.
- Write codes for parameter fitting.
- Solve some model problems

Week 13-14 Review and extra topics if time permits.

2 Resources

- Notes and Jupyter notebooks to be supplied
- A First Course in Numerical Methods, Ascher & Greif
- PyTorch

3 Examples and Codes

We will be using Jupyter notebooks through google colab. Please make sure you have a google account and that you can run a google colab notebook.

The notebooks are written in python and we will learn some basic python throughout the course.

It is highly recommended that you learn to work in an environment that is different that google colab and Jupyter notebook. I recommend VScode/PyCharm/Spyder. Most of you have used VScode in previous course and we will try to make it work throughout this course.

4 Assignments and Grading

Every week or two a homework assignment will be given. Some will be for you to practice (I will not grade then and they will be for completion only) and some will be graded (typically, the ones require more thought and work.)

There will be two midterms and a final. Gradient is as follows

- Homework - 30%
- Midterms - 30%
- Final 40%.

You must pass the final to pass the course!
The midterms are set to

- Midterm 1 - Feb 15th
- Midterm 2 - March 15th

5 Office hours

Lectures are given TT 12:30 PM to 2:00 on Zoom. I will stay online every time for questions or any problems you may have. If you need extra time we can communicate by email. Please email me to

eldadHaber@gmail.com