Stevens Institute of Technology
Syllabus

PEP 520: Computational Methods and Machine Learning

Semester taught: **Spring**	**Start and end date of the semester:** See Stevens web site
Name: Professor Knut Stamnes **Office address: 627 Burchard** **Office phone number: 201-216-8194** **E-mail address: kstamnes@stevens.edu**	Office Hours: By Appointment Course Web Address: To be assigned.

Overview

Course Description:
Mathematical preliminaries and error analysis. Solutions of equations in one variable. Interpolation and polynomial approximation. Numerical integration and differentiation. Numerical solution of initial-value problems. Methods for solving linear systems. Approximation theory. Solving the eigenvalue problem. Solutions of systems of nonlinear equations.
Introduction to machine learning in science and engineering.
Supervised learning and unsupervised learning.
Solving systems of non-linear equations, optimal estimation.
Text: Faires and Burden, *Numerical Methods*. Sivia and Skilling, *Data Analysis: A Bayesian Tutorial*.
The course is suitable for beginning graduate and upper-level undergraduate students.

Learning Goals

After taking this course, the student will be able to:

- Solve equations in one variable numerically
- Carry out numerical integration and differentiation
- Carry out numerical solutions to initial-value problems
- Solve systems of linear algebraic equations numerically
- Solve eigenvalue problems numerically
- Solve systems of nonlinear equations numerically
- Solve classification problems using supervised learning and unsupervised learning methods
- Solve function fitting problems using neural networks
- Solve inverse problems using optimal estimation
- Select suitable software tools for solving a variety of computational problems

Pedagogy

The course will employ lectures, in-class discussion, e-mail exchange, homework assignments, and tests. Students will do weekly assignments, a mid-term exam plus a final exam.

Useful Text(s)

Faires and Burden, *Numerical Methods, Thomson, Brooks/Cole, 2003*.

ISBN 0-534-40761-7.
Sivia and Skilling, *Data analysis: A Bayesian Tutorial, Oxford University Press, 2006*.

Required Readings

Readings will be assigned for each week.

Assignments

The course will emphasize homework, a midterm exam, and a final exam with equal weight.

1. Homework – Homework must be completed by the required date and submitted in class.
2. A mid-term exam must be completed when due.
3. A final exam must be completed when due.

The assignments and their weights are as shown below:

1. Homework	33%
2. Mid-term	33%
3. Final exam	34%
TOTAL	**100%**

Course Schedule (Sample)

Week	Subject	Assignment Due
1	Mathematical preliminaries and error analysis. Introduction to the Matlab tool.	Beginning of next class
2	Solutions of equations in one variable.	Beginning of next class
3	Interpolation and polynomial approximation.	Beginning of next class
4	Numerical integration and differentiation.	Beginning of next class
5	Numerical solution of initial-value problems.	Beginning of next class
6	Methods for solving linear systems.	Beginning of next class
7	Approximation theory.	Beginning of next class

Week	Subject	Assignment Due
8	Introduction of Machine Learning and Matlab NN toolbox (linear and nonlinear model, cost function, learning methods)	Beginning of next class
9	Supervised Learning – Classification problem (Logistic regression, SVM, decision trees, random forests)	Beginning of next class
10	Supervised Learning – Classification problem (Backpropagation NN, Convolutional NN)	Beginning of next class
11	Unsupervised Learning – clustering (kmean, SOM, etc)	Beginning of next class
12	Supervised Learning – Function fitting problems (Radial based-NN, MLNN, forward and inverse)	Beginning of next class
13	Solutions of systems of nonlinear equations, optimal estimation.	Beginning of next class
14	Final Exam Preparation	Final exam.