**ADS 521**

**COURSE SYLLABUS**

**(2022-2023, Fall Semester**)

**Numerical Methods**

**Instructors: Assoc. Prof.** Yıldırım Akbal

**Catalog Data:**

**Textbook:** Since this course is amalgamation of a couple of courses, there is no designated course book. however the following books will be fruitful and mostly be used.

**References:**

1. First Semester in Numerical Analysis with Julia Giray Ökten (Excellent introduction to numerical methods in Julia, neither solely to Julia nor numerical methods but both)
2. Shashi Kant Mishra Bhagwat Ram Introduction to Unconstrained Optimization with R
3. An introduction to Optimization by Chong and Zak (4th ed.)

**Prerequisite:** None

**Goals: The main goal of this course is to introduce simple optimization techniques as well as simple curve fitting techniques. The main focus will be the applied point of view. The main language to be used is Julia which is practically the best language for numerical analysis and optimization.**

**Requirements:**

1. **Students are free to do their own analysis in the language they like, however assignments will bence submitted in Julia (unless you use pretty advanced methods).**
2. **Students are advised to strengthen their mathematical background, in particular Linear Algebra and Differential Calculus will be used intensively. The topics to be used will be announced in adva.**

**Upon successful completion of this course: students**

1. **Will be acquainted with mathematics of model fitting**
2. **Will be acquainted with Julia Programming Language, construct statistical models in Julia from scratch.**
3. **Solve simple optimization problems**
4. **Will have a better grasp to construct more advanced models like deep neural networks.**

**Grading Policy:** HW’s will be assigned on a regular basis (each worth 10%). At the end of the semester students will have a take home exam (remaining 40%).

| **COURSE CHART**   | **WEEK** |  | **Course Topics** |  | | --- | --- | --- | --- | | 1 | 26-09-  30-09 | A Crash Course on Julia Programming Language –  Data Types, Syntax and Some Important Packages  Welcome Quiz |  | | 2 | 03-10 – 07-10 | Recalling Some Math,  Some Simple Problems in Numerical Analysis – Warming up with Julia. | HW1 | | 3 | 10-10 – 14-10 | Curve Fitting – Least Squares Method : Linear Regression, Polynomial Regression, Harmonic Regression |  | | 4 | 17-10 – 21-10 | Curve Fitting – Cubic Splines,  Numerical Differentiation – Automatic Differentiation | HW2 | | 5 | 24-10 - 28-10 | Optimization Techniques: Gradient Descent |  | | 6 | 31-11 4-11 | Optimization Techniques: Steepest Descent | HW3 | | 7 | 7-11 11-11 | Optimization Techniques: Newton’s Method. |  | | 8 | 14-11 18-11 | Optimization Techniques: Quasi Newton Methods.  Some Regression and Classification Methods | HW4 | | 9 | 21-11 25-11 | Optimization Techniques - (Application: Support Vector Machines) |  | | 10 | 28-11 2-12 | Applications - Neural Networks | HW5 | | 11 | * 1. -12 | Penalty Methods |  | | 12 | **12-12 16-12** | Matrix Factorizations |  | | 13 | 19-12 23-12 | PCA | HW6 | | 14 | 26-12 30-12 | Final Exam |  | |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |