Fundamentals of Computational Math IS 605 Spring 2016

The following are the recommended optional textbooks for the course. You don't need to purchase these text books but you may want to do so in order to get deeper into the material.

Linear Algebra: Introduction to Linear Algebra, Fourth Edition. by Gilbert Strang.
Probability & Statistics: The Art of Probability for Scientists & Engineers. by Richard W. Hamming.

The course will provide an overview of the commonly used mathematical techniques in Data Analytics & Statistics. A lot of emphasis will be given to computational techniques and implementing math in programs. Students will be expected to do a fair bit of hands-on programming. We'll be primarily using R as our programming environment. All assignments will need to be submitted in as R-Markdown documents. Students can expect to walk away with a good understanding of the kinds of math they'll need to be successful in the exciting area of Data Analytics.

By the end of the course, you'll be able to understand and compute:

Linear Algebra
. Trace, determinant, rank
. Factorization of matrices
. Linear systems of equations
. Eigenvalues and Eigenvectors

Probability
. Expectation of random variables
. Independence and dependence of random events
. Conditional probabilities
. Contingency tables and using them to calculate various probabilities
. Bayes theorem and applying it to real-life situations

Univariate and multivariate calculus
. Differentiation: chain rule, power rule
. Integration: by parts, uv substitution
. Gradients

Numerical linear algebra
. Solving Linear system of equations using Matlab
. Principles of Least squares
. Matrix inversion
. Singular value decomposition

Statistics
. Regression analysis
. Common Distributions
. Central limit theorem
. Maximum Likelihood

. Type I & Type II errors
. Bias-Variance trade-off
. Tests: student's t-test, chi^2
. Frequentist vs Bayesian viewpoints

Numerical methods
. Polynomial approximation
. Fourier approximation
. Root finding
. Integration
. Ordinary Differential Equation

Assignments & Grading:

Assignments	There will be weekly homework assignments. Each assignment will contribute about 4 points towards your final grade. The homework will be a combination of R programming & mathematical derivation work.	**60%**
Final Exam	There will be a final exam in this course and will contribute to roughly 40% of the grade. The final exam will feature a mini-project and several small & medium sized questions. The final exam will be a comprehensive review of the course.	**40%**
Forum participation	Forum participation is encouraged. Please reach out to discuss the assignments and topics with the class participants. This is where interesting related material will be posted that will help you deepen your understanding of the material	

The Course schedule will be as follows:

Week of	Meeting	Topics	Assignment (due Sunday)
Jan 29, 2016	**2/2**	**Vectors, Matrices & Systems of Equations**	
Feb 7, 2016		**Trace, Determinant, Factorization of Matrices**	Assignment 1 Due. Linear Systems of Equations in Octave
Feb 14, 2016	**2/16**	**Eigenvalues & Eigenvectors**	Assignment 2 Due. LU Decomposition
Feb 21, 2016		**Matrix Inversion & Singular Value Decomposition**	Assignment 3 Due. Eigenvectors
Feb 28, 2016	**3/1**	**Least Squares**	Assignment 4 Due. SVD
Mar 6, 2016		**Random variables & Probability**	Assignment 5 Due. Write Octave program to solve a regression problem
Mar 13, 2016	**3/15**	**Expectation, conditional probability**	Assignment 6 Due. Independent or Dependent variables?
Mar 20, 2016		**Bayes Theorem & Contigency tables**	Assignment 7 Due. Calculate the mean of an infinite stream of numbers
Mar 27, 2016	**3/29**	**Central Limit Theorem & Common Distributions**	Assignment 8 Due. Bayes Rule.
Apr 3, 2016		**Page Rank**	Assignment 9 Due. Simulate central limit theorem
Apr 10, 2016	**4/12**	**Regression Analysis, Maximumum Likelihood Estimate, Type I & Type II errors**	Assignment 10 Due: Page Rank
Apr 17, 2016		**Bias Variance Tradeoff**	Assignment 11 Due: Regression Analysis & Cross Validation
May 1, 2016		**Univariate & Multivariate Calculus**	Assignment 12 Due. K-Means (will examine bias-variance tradeoff)
May 8, 2016	**5/10**	**Taylor Series Approximations**	Assignment 13 Due. Numerical differentiation
May 15, 2016		**Gradient Descent & LBFGS**	Assignment 14 Due: Taylor Series
May 22, 2016	**5/24 (Opt)**	Final exam will be release on May 20th night.	Final exam posted (due May 29)

Quality of Performance	Letter Grade	Range %	GPA
Excellent - work is above and beyond class expectations	A	93-100	4
Excellent - work is above and beyond class expectations	A-	90-92.9	3.7
Good - work is above average	B+	87 - 89.9	3.3
Satisfactory	B	83 - 86.9	3
Below Average	B-	80 - 82.9	2.7
Poor	C+	77 - 79.9	2.3
Poor	C+	70 - 76.9	2
Failure	F	< 70	0

Relevant Software and Other Tools:

Students should have R Studio & R installed in their computers. Relevant libraries that are required will be posted in the assignments and course materials. Students are expected to submit R-Markdown files for their assignments.

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Meetup: We'll be meeting every other week. The date and time will be finalized shortly. Please watch the announcements and this Syllabus link for changes.