Computational Data Mining

Part 1: Course Introduction

Instructor: Fatemeh Mansoori

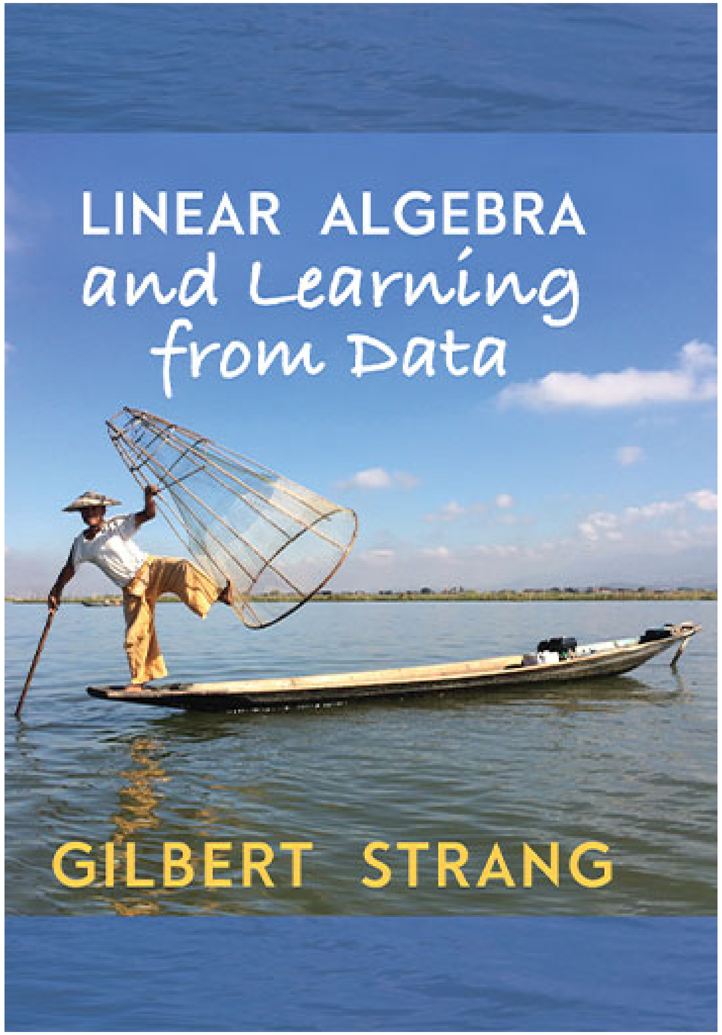
Reference Book

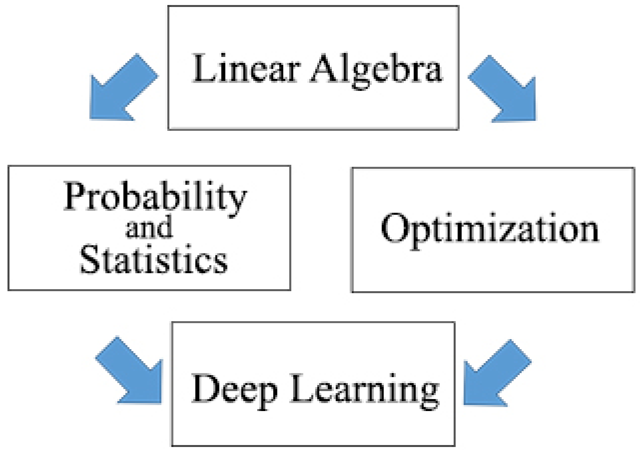
Main reference:

Elden, L., Matrix Methods in Data Mining and Pattern Recognition, SIAM, 2007

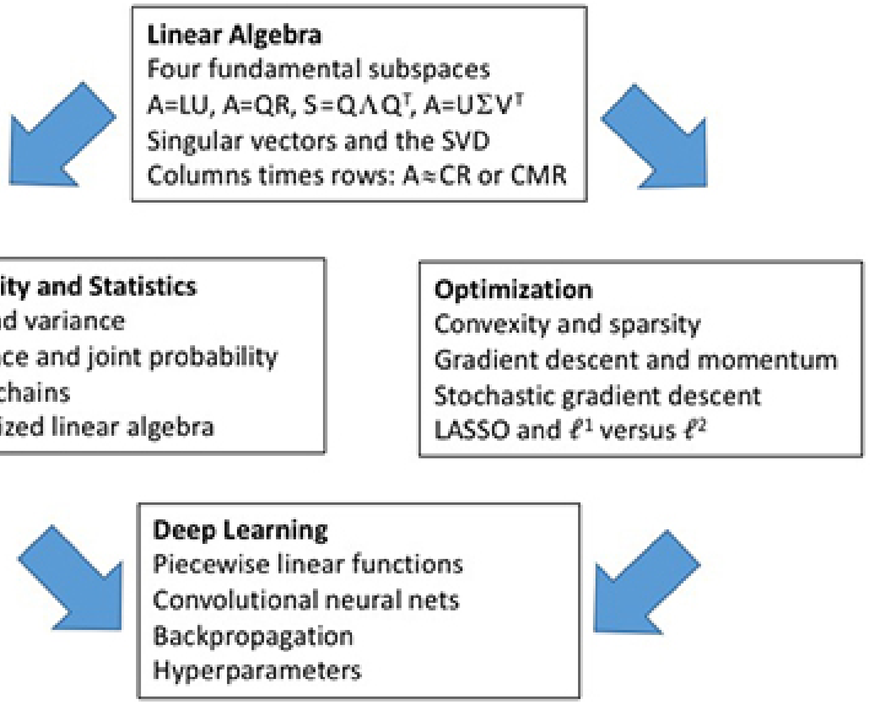
References book

Most of the this course and our slides are based on the book
linear algebra and learning form data And Based on the course :
[Matrix Methods In Data Analysis, Signal Processing, And Machine Learning]()





Matrix Methods In Data Analysis



Lectures of the course Matrix Methods in data analysis

Lecture 1: The Column Space of A Contains All Vectors Ax

Lecture 2: Multiplying and Factoring Matrices

Lecture 3: Orthonormal Columns in Q Give Q'Q = I

Lecture 4: Eigenvalues and Eigenvectors

Lecture 5: Positive Definite and Semidefinite Matrices

Lecture 6: Singular Value Decomposition (SVD)

Lecture 7: Eckart-Young: The Closest Rank k Matrix to A

Lecture 8: Norms of Vectors and Matrices

Lecture 9: Four Ways to Solve Least Squares Problems

Lecture 10: Survey of Difficulties with Ax = b

Lecture 11: Minimizing ‖x‖ Subject to Ax = b

Lecture 12: Computing Eigenvalues and Singular Values

Lecture 13: Randomized Matrix Multiplication

Lecture 14: Low Rank Changes in A and Its Inverse

Lecture 15: Matrices A(t) Depending on t, Derivative = dA/dt

Lecture 16: Derivatives of Inverse and Singular Values

Lecture 17: Rapidly Decreasing Singular Values

Lecture 18: Counting Parameters in SVD, LU, QR, Saddle Points

Lecture 19: Saddle Points Continued, Maxmin Principle

Lecture 20: Definitions and Inequalities

Lecture 21: Minimizing a Function Step by Step

Lecture 22: Gradient Descent: Downhill to a Minimum

Lecture 23: Accelerating Gradient Descent (Use Momentum)

Lecture 24: Linear Programming and Two-Person Games

Lecture 25: Stochastic Gradient Descent

Lecture 26: Structure of Neural Nets for Deep Learning

Lecture 27: Backpropagation: Find Partial Derivatives

Lecture 30: Completing a Rank-One Matrix, Circulants!

Lecture 31: Eigenvectors of Circulant Matrices: Fourier Matrix

Lecture 32: ImageNet is a Convolutional Neural Network (CNN), The Convolution Rule

Lecture 33: Neural Nets and the Learning Function

Lecture 34: Distance Matrices, Procrustes Problem

Lecture 35: Finding Clusters in Graphs

Lecture 36: Alan Edelman and Julia Language

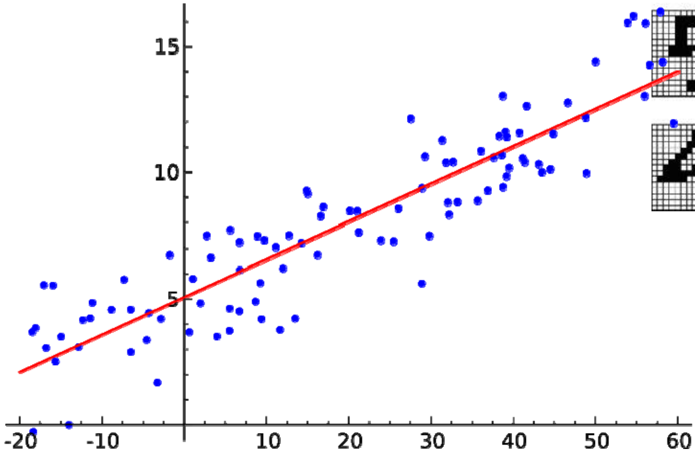
Grading policy

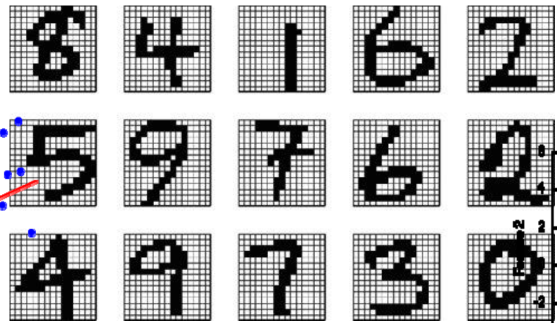
- Homework
- Project
- Presentation
- Midterm and Final Exam

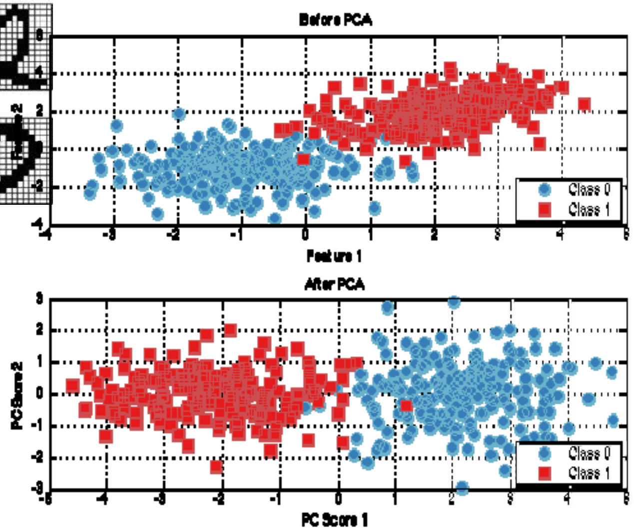
Data mining and pattern recognition

*The science of extracting useful information from large data sets

*The act of taking in raw data and making an action based on the 'category' of the pattern







Vectors and matrices

Document 1:	The **Google**$^{\mathrm{TM}}$ **matrix** P is a model of the **Internet**.
Document 2:	P_{ij} is nonzero if there is a **link** from **Web page** j to i.
Document 3:	The **Google matrix** is used to **rank** all **Web pages**.
Document 4:	The **ranking** is done by solving a **matrix eigenvalue** problem.
Document 5:	**England** dropped out of the top 10 in the **FIFA ranking**.

$$q = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \end{pmatrix} \in \mathbb{R}^{10}$$

Term	Doc 1	Doc 2	Doc 3	Doc 4	Doc 5
eigenvalue	0	0	0	1	0
England	0	0	0	0	1
FIFA	0	0	0	0	1
Google	1	0	1	0	0
Internet	1	0	0	0	0
link	0	1	0	0	0
matrix	1	0	1	1	0
page	0	1	1	0	0
rank	0	0	1	1	1
Web	0	1	1	0	0

$$A = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 \end{pmatrix}$$