Optimization and Computational Linear Algebra for Data Science
Outline

1. 09/03: Logistics and Vector spaces
   1. General definitions
   2. Linear dependency
   3. Basis, dimension

2. 09/10: Linear transformations
   1. Linear transformations
   2. Matrix representation
   3. Kernel and image

3. 09/17: Rank
   1. Definition of the rank
   2. Properties of the rank
   3. Invertible matrices
   4. Transpose of a matrix, symmetric matrices

4. 09/24: Norm and inner product
   1. Norm
   2. Inner product
   3. Orthogonality
   4. Orthogonal projection and distance to a subspace

5. 10/01: Matrices and orthogonality
   1. Gram-Schmidt orthogonalization method
   2. Orthogonal matrices

6. 10/08: Eigenvalues, eigenvectors and Markov chains
   1. Eigenvalues and eigenvectors
   2. Diagonalizable matrices
   3. Application to Markov chains
   4. Example: Google's PageRank algorithm

7. 10/15: The spectral theorem and PCA
   1. The Spectral Theorem
   2. Application: Principal Component Analysis (PCA)
   3. Singular value decomposition
   4. Interpretations of the SVD

8. 10/22: Midterm

9. 10/29: Graphs and Linear Algebra
   1. Graphs
   2. Graph Laplacian
   3. Spectral clustering with the graph Laplacian
   4. Spectral clustering as a relaxation
   5. Spectral clustering beyond graphs

10. 11/05: Convex functions
   1. Convex sets
   2. Convex functions

11. 11/12: Linear regression
   1. Least squares
   2. Penalized least squares: Ridge regression and Lasso
   3. Norms for matrices, application to matrix completion

12. 11/19: Optimality conditions
   1. Local and global minimizers
   2. Constrained optimization
   3. The Lagrangian and the dual problem

4. Kuhn Tucker Theorem

13. 11/26: Thanksgiving

14. 12/03: GRADIENT DESCENT

1. Gradient descent
2. Newton's method
3. Stochastic gradient descent

15. 12/10: Rehearsal lecture

16. 12/17: Final exam