Welcome to COMP4121: Advanced Algorithms
Trimester 3, 2021

Lecturer: Aleks Ignjatovic (ignjat@cse.unsw.edu.au; office: 504 in K-17)

Office hours: Wednesday 5-6 via Zoom

Lectures: Wednesday 3:00 – 5:00 and Fridays 2:00 – 4:00 on Zoom

Lecture recordings: TBA

This course is a continuation of our introductory algorithms courses COMP3121/3821/9101/9801. We will cover some of the basic randomised algorithms and data structures, such as randomised hashing, skip-lists, order statistics and Karger's randomised Min Cut algorithm. We will then look at the Markov chains and the Google PageRank algorithm, the Hidden Markov Models and the Viterbi Algorithm, and then cover in quite a detail a variety of other algorithms important to the present day practice, such as the recommender systems as well as some of the algorithms used in Data Science. We will cover parts of three books: our COMP3121/3821/9101/9801 textbook *Algorithm Design* by Kleinberg and Tardosh, *Networked Life* by Mung Chiang and *Foundations of Data Science* by Blum, Hopcroft and Kannan. The first two books are available in the bookstore. A preprint of the third book is available for free at *https://www.cs.cornell.edu/jeh/book.pdf*

The grade will be based on a final (50%) and a major project (50%).

The learning outcomes are: (1) understanding and mastering more advanced algorithm design techniques and (2) familiarising with some of the most important present day algorithms, such as those used in Data Science, which is, nowadays, one of the most important fields of Computer Science, presently in high demand by industry employers.

Review Material:

Probability refresher

Linear Programming refresher - slides Linear Programming refresher - Lecture Notes

Suggestions for topics for the Major Project

Practice Problems, part I NEW VERSION!

SOLUTIONS to Practice Problems, part I

Practice Problems, part II

SOLUTIONS to Practice Problems, part II

Practice Problems, part III

SOLUTIONS to Practice Problems, part III

FINAL EXAM

MAJOR PROJECT examples from past years

DUE DATE TO SUBMIT YOUR MAJOR PROJECT : TBA

Lecture Notes (subject to updates, please make sure you download the version after the class when the material has been covered)

Introduction

Order statistics short version

Skip lists short version

Database access short version

Karger's Min Cut algorithm short version

- COMP3121 Lecture slides on MaxFlow/MinCut for those who have not studied this

Google PageRank and Markov Chains (lecture notes with more details)

Google PageRank and Markov Chains SLIDES short version

Security application of the PageRank (a paper from the major project by former 4121 students)

Hidden Markov Models and the Viterbi Algorithm (lecture notes with more details)

Hidden Markov Models and the Viterbi Algorithm slides short version

Universal and perfect hashing short version

Examples for the flexi week short version

Gaussian Annulus, Random projection and Johnson – Lindenstrauss lemmas short version

-- please also read pages 12-26 in **BHK** (*https://www.cs.cornell.edu/jeh/book.pdf*)

A brief sketch of the Singular Value Decomposition (SVD) short version

A Mathematica depiction of a SVD transformation

Low rank approximations of the Lena image

Clustering algorithms

Recommender Systems short version

Voting and Customer Feedback Aggregation short version

Voting Algorithms (lecture notes with more details)

A Mathematica implementation of the adaptive voting algorithm (Mathematica is free for UNSW students and available at the UNSW IT website)

Iterative Filtering (lecture notes with more details)

Transmit power control in cellular networks short version

DFT, DCT and convolution short version

DFT, DCT and convolution (lecture notes with more details)

A Mathematica implementation of Gaussian smoothing (Mathematica is free for UNSW students and available at the UNSW IT website)

A Mathematica implementation of DFT and DCT (Mathematica is free for UNSW students and available at the UNSW IT website)

A (slow) Mathematica implementation of JPEG

Introduction to signal processing and MP3 sound compression short version

A paper on MP3

Recap of Fourier series and integrals short version

Intro to signal processing (lecture notes with more details)

Every term, student feedback is requested in a survey using UNSW myExperience online survey system where the feedback will be used to make improvements to the course. Students are also encouraged to provide informal feedback during the session, and to let course staff know of any problems as soon as they arise. Other possible contacts including the School Grievance officer or one of the student representatives. Suggestions will be listened to openly, positively, constructively, and thankfully, and every reasonable effort will be made to address them. Feedback from last offering indicated students were quite happy with updated content which included algorithms for Data Science and Machine Learning. Consequently, such material will be emphasised in the subsequent deliveries of this course.

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