Approximation Algorithms, Act 2: Overview

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The second part of this course will be focused on *geometric* approximation algorithms. Geometric problems arise in various natural contexts such as robotics, databases, optimization, computer graphics and vision and machine learning. Our focus will be on the following eight problems, and the combination of eight techniques that we use to solve them.

1 Problems

The course will follow a problem-oriented structure, where we will learn techniques by devising algorithms for the following problems. All of them are very simple-to-state, easy-to-visualize geometric problems. I will not assume any familiarity with geometric algorithms on part of the students, so you are encouraged to ask questions, especially whenever you feel that something you don't know about is being used.

1. Art gallery problem
2. Clustering
3. Finding closest pair
4. k-enclosing minimum disk
5. Minimum covering disks
6. Voronoi diagrams (exact and approximate)
7. Approximate nearest neighbor search in high dimensions
8. Approximating minimum volume bounding box

2 Techniques

If all goes well, by the end of the course you should have a good idea about the following techniques for devising approximation algorithms.

1. Integer programming, LP rounding
2. Lower bounds for geometric problems (comparison model only)
3. The grid technique
4. Hashing (simple and locality sensitive)

5. Johnson Lindenstrauss lemma
6. Duality
7. Tail inequalities
8. VC dimension, ϵ-nets and ϵ-approximation.

3 Literature

The book we will be following mainly is "Geometric Approximation Algorithms" by Sariel Har-Peled.

We will also be using some parts of Jeff Erickson's lecture notes available at `http://jeffe.cs.illinois.edu/teaching/algorithms/`. If you are into algorithms, I would highly recommend reading through these very well-written notes.

A good (but not necessary for this course) textbook for an introduction to computational geometry is "Computational Geometry: Algorithms and Applications" by Mark de Berg, Otfried Cheong, Marc van Kreveld and Mark Overmars. Whenever you feel like you are forgetting the basics, go here.

4 Availability

I will be holding office hours (Room 311B) for this course every Thursday from $14:00 - 16:00$. You should feel free to drop by outside of these hours too, but in case I am not there, send me an email at `gmayank@mpi-inf.mpg.de` to schedule a meeting.