Suggestions for Project Topics

Here are some possible topics for projects. You can also suggest other topics if you have something you’re particularly interested in. You should start looking at these right away (start with Wikipedia or Google) to see what you’re most interested in, so you can answer the questions I’ve posted. (Answers to those questions are due on Tuesday, March 31.)

You and your team (we’ll talk about team composition in class) will develop a short presentation about your topic. The goal is to try to give your classmates an understanding of what the topic is about. I may give you some class time for team meetings on Zoom but you’ll have to arrange to work with each other outside of class time, by whatever communication channels you can use. But Cristian and I can meet with your team on Zoom to discuss things. The grade for the project will include a presentation and a written record of the project. (The written record should consist of at least a short (perhaps 5–6 page) paper and the slides or other materials from your presentation. The paper should probably include more detail than you can expect to fit into the presentation.)

When gathering information about these topics, remember that you only have a short time to present in class (probably about 20-25 min). Thus you will necessarily be giving a very high level overview of anything you study. This means you shouldn’t be intimidated by the depth of some of these topics; indeed, many lie at the forefront of research. Your task is to distill and synthesize information and present it to the class in a coherent and digestible form. For instance, don’t worry about proving a theorem; instead explain it to us and show us illustrative examples. Don’t try to blow us away with the full scope of a topic; instead try to find some nontrivial part that you can communicate to us. You’ll make the presentation in class time via Zoom (by sharing a screen to show the slides). We’ll talk more about the nuts and bolts of that later on.

Exploring topics in the book that we’re not covering: Note: You will want to further than what is in the book.

- Chromatic number and bounds (1.6.2)
- Chromatic polynomials (1.6.4)
- The four-color theorem (1.6.3) and coloring graphs on surfaces
- Perfect matchings on graphs (1.7.4)
- The stable marriage problem and variations on it (2.9)
- Ramsey Theory (1.8)
- Burnside’s lemma (2.7.2)
• Partitions (2.8.1) and Euler’s pentagonal number theorem
• Stirling numbers and Bell numbers (2.8.2-2.8.4)

Exploring theoretical topics that are not in the book
• Relating eigenvalues of adjacency matrices and Laplacians to properties of the graph
• The traveling salesman problem
• Turán’s theorem for clique-free graphs
• Expander graphs and applications to networks
• The max-flow min-cut theorem
• Matroids
• Cayley graphs
• Random graphs: Erdős Renyi, percolation

Exploring some applications related to topics we have covered
• Use of graph theory in social networks (e.g., Facebook, Twitter)
• Google’s PageRank algorithm
• Applications of graph theory in computational phylogenetics
• DebtRank of financial institutions
• Applications of random walks on graphs (e.g., in the context of BitTorrent file sharing or transmission of infectious diseases)
• Graph theory in scheduling problems
• Graph theory and different elimination systems in sports