CS:5360 Fall 2018 Projects

I see the following *types* of final projects for CS:5360:

(a) **Research-based and theoretical.** You will understand relevant literature, identify one or more open problems, and make some progress on at least one of the problems. The progress you report will typically include design and description of randomized algorithms and analysis of running time and correctness. Your final paper will be written in a theorem-proof style.

(b) **Research-based and experimental.** You will understand relevant literature and identify one or more questions about a randomized algorithm that can be best answered experimentally. You will then implement one or more algorithms, design careful experiments, report your experimental results, and draw conclusions.

(c) **Expository.** You will understand literature on a particular topic broadly and deeply and synthesize the highlights of your understanding into a paper and presentation.

It should go without saying, but I will say it: all projects need to have *randomization* in CS as their focus. Since original research takes significant time and preparation, for projects of type (a) and (b), you will be evaluated not just on your results, but on your understanding of relevant literature, and identification of interesting open problem(s).

Another way of categorizing your projects is by *topic*. Some projects might focus on the application of randomization to a CS area outside algorithms. For example, randomization is used in machine learning, data mining, social network analysis, sensor networks, etc. Some projects might stay within the broad area of algorithms and explore the use of randomization in data structures, graph algorithms, geometric algorithms, distributed and parallel algorithms, numerical algorithms, linear algebra algorithms, combinatorial optimization algorithms, approximate counting algorithms, etc. Finally, some projects might focus on more theoretical aspects of randomized algorithms such as Lovasz Local Lemma and the probabilistic method, martingales, communication complexity or information-theoretic lower bounds, etc. The list of topics in this paragraph is by no means comprehensive. If you are interested in a topic outside this list, please feel free to pursue it.

As a starting point, use the sources I mentioned in the syllabus.

1. *Lecture Notes on Randomized Algorithms* by James Aspnes:
   `http://cs.yale.edu/homes/aspnes/classes/469/notes-2016.pdf`

2. Michael Mitzenmacher and Eli Upfal, *Probability and Computing: Randomized Algorithms and Probabilistic Analysis*, Cambridge University Press, ISBN 0521835402.

3. Rajeev Motwani, Prabhakar Raghavan, *Randomized Algorithms*, Cambridge University Press.

4. David Williamson, David Shmoys, *The design of approximation algorithms*, Cambridge University Press.

5. Devdatt Dubhashi, Alessandro Panconesi, *Concentration of Measure for the analysis of randomized algorithms*, Cambridge University Press.

There are other, more specialized textbooks on distributed algorithms, parallel algorithms, social networks, random graphs, communication complexity, computational geometry, probabilistic methods in discrete math, probabilistic methods for graph coloring, stochastic processes, etc., that I can

point you to, if you are interested. Once you have made more progress in identifying your topic, I expect that you will be reading a number of research papers and these will form the bulk of your references.

For now, here is what you need to submit.

1. **Pre-proposal**. Due by by email by 5 pm, Fri, 10/19. This should contain (i) the type of project you plan to complete, (ii) the broad topic for your project, and (iii) at least two initial sources that you plan on studying. The sources should be specific – it is not enough to refer to a textbook, you need refer to specific sections of the textbook. The pre-proposal can be short, just a paragraph long, but it can be up to a page long if you feel confident about the details.

2. **Proposal**. Due by by email by 5 pm, Wed, 10/31. This should be 1-2 pages long, with specific references, and sufficient technical details that allow me to judge the viability of your project.

Final advice. I would strongly encourage you to meet with me and discuss your thoughts about your project, over the course of the next two weeks. You should also consider using other departmental resources, e.g., if you are planning a project on the use of randomization in sensor network protocols, you should consider chatting with Prof. Chipara and even presenting papers you are reading, in his research group meetings. If you are a PhD student, it makes sense to connect this project to your research area and aim to eventually turn this work into a research paper. If you are a Masters student with an interest in getting a PhD, the same advice applies. If you are Masters student aiming for a career in the technology industry, you might consider doing an experimental project that you can add to your portfolio.
