

## Term Projects

This year, each student in 6.852 is required to carry out a term project related to distributed algorithms. This handout describes what we would like you to do.

Students can work alone, or in teams of two or three. You are required to write a report, due on the final day of classes, which is Thursday, December 10. Your report should be no more than 15 pages long (in 11 pt font). We will have presentations based on the reports on the following day.

### 1 Kinds of projects

There are three kinds of projects that are acceptable. Keep in mind that this is a theory course, so anything you do should have substantial theory content.

**Reading project:** In this type of project, you choose a topic of current interest in the distributed algorithms research community, learn about it, and write a report to explain it to others. That is, read and understand several key papers on your topic and write an expository report explaining the important theoretical ideas. You should write for an audience at the level of the students in our class. If you do this well, your explanations will be easier for the class to understand than the original papers, which are generally written for specialists on the research topic.

**Theoretical research project:** In this type of project, you find a theoretical research problem you are interested in, and devise your own new algorithms or prove your own new lower bound results (or both). Write a theoretical research report about it. The style should be like that of the conference papers you have seen in this course, but you should aim your presentation at students in our class. We suggest that you consider a currently-active research topic, since it's harder to get new results about older, well-studied problems. To work on a new problem, you will need to do background reading on the topic. That will provide you with a convenient fall-back: in case your attempts at new results don't work out as you intended, you can simply turn the project into a reading project.

**Experimental research project:** In this type of project, you select known distributed algorithms from the literature, or perhaps devise some variations. Think of clear questions to ask about the algorithms that might be answered by means of experiments. For example, you might ask how the algorithms behave under a variety of assumptions about parameter values, about inputs, etc. Simulate the algorithms to answer your questions. (We don't recommend trying to run your algorithms in real distributed settings, but talk to us if you really want to do that.) Write an experimental research report to describe the questions, experiments, and results. The report should contain clear questions that your experiments are designed to answer, clear descriptions of your experiments and their results, and clear conclusions.

### 2 Sources

Typical sources for current research on distributed computing theory are various conferences devoted to this area, such as the Principles of Distributed Computing conference (PODC), the International Symposium on Distributed Computing (DISC), the Symposium on Parallelism in Algorithms and Architectures (SPAA), the International Conference on Principles of Distributed Systems (OPODIS), etc.

Other conferences, such as ICDCS, have special “tracks” for distributed algorithms papers. More general theoretical conferences, such as FOCS, STOC, and SODA, publish distributed algorithms papers.

You can also find ideas in journal papers. The journal Distributed Computing is entirely devoted to distributed computing theory papers. Many broader journals such as JACM, Information and Computation, etc., also publish papers on distributed computing theory. The Morgan Claypool Synthesis series of monographs on distributed computing theory can also provide ideas.

Finally, you are welcome to extract ideas related to distributed computing from your own research.

### 3 Suggestions for topics

We will be placing a list of some specific topics suggested by distributed computing theory researchers at MIT, on the course web site. Some general areas of current research interest in the field are as follows, but you can come up with your own.

- **Synchronous graph network algorithms:** The LOCAL and CONGEST models. Algorithms for solving fundamental graph problems such as computing colorings, clusters, connected dominating sets, connectivity, etc. Algorithms for information dissemination and data aggregation. Software for simulating such algorithms, written by 6.852 students last year, should be available. Contact us if interested.
- **Asynchronous distributed algorithms:** Quorum-based distributed data-management algorithms. Coding techniques for data storage. Failure detectors. Randomized consensus algorithms. Topological approaches to computability. Resource allocation algorithms, for shared memory or network models.
- **Timing-based algorithms:** Using Paxos to implement reliable data storage in a distributed system. Gradient clock synchronization.
- **Flexible, robust, adaptable distributed algorithms:** Computing functions in dynamic graph networks. Self-stabilizing algorithms. Reconfigurable atomic memory algorithms (like RAMBO).
- **Wireless network algorithms:** Communication and computation in Radio Network models, in Signal-to-Noise-Ratio (SINR) models, or in networks with channels that support coding. Robot or vehicle or aircraft coordination algorithms. Virtual Nodes and their applications.
- **Biologically-inspired distributed algorithms:** Insect colony algorithms for problems such as foraging, task allocation, nest-finding, or cooperative construction. Algorithms for patterning among cells in developing embryos. Distributed algorithms for learning and memory in brains.

### 4 Requirements

**Project proposal:** A one-page project proposal is due on Thursday, October 29. This will give us a chance to consider your project idea and make suggestions. State clearly what you are planning to do, and which type of project (of the three listed above) you are carrying out. Include relevant references.

**Final report:** Your final report is due at the last regular class, on Thursday, Dec. 10. It should be at most 15 pages long (in 11 point font). It should include references. We suggest that, before handing your paper in, you ask at least one other student in the class to read your paper and suggest improvements.

**Presentations:** Students will present short summaries of their projects at an extra class meeting starting at 10AM on Friday, December 11 and continuing until we are done. We will provide a nice lunch.

Participation in the extra class meeting is optional, and if you cannot attend it will not affect your grade. The main purpose of the presentations is to give you a chance to tell everyone what you worked on and to get some feedback. Of course, it will also make it easier for us to understand your work.