CS 590 COMPUTATIONAL GEOMETRY

Final Research Project Specifications

NOTE: This is for the GRADUATE students.

Description

Your Computational Geometry Final Project is intended to give you an opportunity to independently explore an area of research in computational geometry that interests you. Therefore, the first key thing is to pick a computational geometry topic that you like and wish to explore (and which has not been entirely covered in class of course!). Once you have chosen a topic, which you will discuss and confirm with me by an appointed due date, you must pick at least three papers related to your topic of choice, at least one of which must contain an algorithm or experiment that you plan to implement and test. You will also turn in a “mini-proposal” of what you plan to accomplish and test. You will also turn in a “mini-proposal” of what you plan to accomplish with your implementation, including whether or not you will measure and/or compare algorithmic aspects such as time complexity, space complexity, heuristic improvements, relevant geometric aspects, or something else. If feasible and reasonable within the time frame, you may want to compare algorithms in two or more of your selected papers instead of just one. This is something that depends on the complexity of each algorithm, as well as how closely related they are to each other, and should be discussed beforehand with me. To sum it up, your project consists of three components: (i) A “mini-survey” of your topic that focuses around the three papers you have selected, with emphasis on the paper(s) that you choose to implement, and also including references to other literature on the topic to place your selected papers in perspective. (ii) An implementation of one or more algorithm(s) or experiment(s) based on at least one of your selected papers that should yield insight into something measurable or comparable. (iii) A presentation of your topic, focusing around the three papers you have selected, with particular emphasis on your implementation plan and any experimental results you have obtained until your presentation date. This is just the general description, so see below for details.
**Topic Selection**

As a starting point, Chapter 1 of the textbook gives a roadmap of the remaining chapters and how they relate to applications such as robotics, GIS, visualization, etc.. Those of you who are interested in applications to wireless networks in particular may start by skimming the survey paper by Li. If you are interested in more theoretical aspects of computational geometry or other areas of applications, the websites of Piotr Indyk (at MIT), Jeff Erickson (at UIUC), and David Eppstein (at UC Irvine) contain ample well-organized references. You are also always welcome to approach me with regards to topic or paper guidance, but please don't wait until the last minute to do that.

**Mini-proposal**

Your mini-proposal should include your topic, selected papers, which algorithm(s) from which paper(s) you plan to implement, your experimental setup regarding your implementation and what algorithmic and/or geometric parameters you plan to test, your planned implementation timeline with emphasis on any deliverables feasible by the presentation timeframe as well as your final deliverables, and what platforms and languages that you plan to use. Your mini-proposal deadline is Friday October 5, but you should have your topic selected and checked with me by Friday, September 21.

**Implementation**

As mentioned several times already, implementation of at least one algorithm from one of your selected papers is required. And, by “implementation”, simply programming the algorithm and displaying it visually is necessary but not sufficient in most situations. Usually, when an algorithm is proposed in the literature to handle a problem, it is done with certain algorithmic considerations (e.g. time complexity, space complexity, robustness, heuristic improvement, etc.), or in the domain of this course, geometric considerations (e.g. stretch factor, smoothness of triangle distributions, generalizability to higher dimensions, etc.) in mind. Therefore, thinking as computer scientists, you should perform meaningful measurements related to your implementation, that should hopefully confirm a hypothesis that you posed based on the research paper and/or your own ideas, as delineated in your mini-proposal. You are more than welcome to ask your own quantitative questions and go beyond that which was demonstrated already about the algorithm in the paper: In addition to experimentally supporting some quantitative claim made in the paper, also measure an aspect that the authors did not measure or make any claim about. Regarding the timeline and details, you are the one to delineate it in your mini-proposal. However, you should have something in the way of implementation to demonstrate (and turn into me) by Friday, November 2.
**Final Report**

Your final report should include all of the following tied up in a cohesive manner by you:

- A mini-survey of your topic, focused about your three selected papers, but also including the relationship of the papers to the existing literature on the topic in general, with ample appropriate references given.

- A detailed explanation of the algorithm(s) that you chose to implement, including what computational geometric problem it tackles, and what claims are made about the algorithm's superiority in the paper in which it is proposed.

- Regarding your implementation of the algorithm(s), your experimental setup, programming languages and platforms used, hypotheses, results, and analysis of your implementation, including how your implementation results relate to what is expected in the papers.

- Since this tends to be a visual subject, any figures or snapshots extracted from your experiments are welcome. Certainly, plots, tables, or best-fit curves related to your measurements may be invaluable as well.

- Although I do not expect you all to continue actually working in this field, I would like you to think about open questions related to your project (e.g. what further work on this you might consider to be interesting even if you will not actually pursue it yourself), and to of course include a section on that.

Your final reports and all source, object files, input, and output files related to your implementation are due on Monday, December 10. The length of the final report should be between 10 – 16 pages with references and figures.

**Presentations**

Prior to your final report, but significantly subsequent to your mini-proposal and subsequent to your first implementation milestone, you will give a one-hour presentation in class regarding your topic, selected papers, and implementation/experiments. As noted previously, you should have something demonstrable by way of implementation by the time of your presentation. However, that being said, I am obviously aware that those with later presentation slots will have more on the way of implementation than those with earlier slots. Therefore, we may all approach presentations with the implicit understanding that in the earlier presentations more time might be filled with elaborations on the topic and particular contributions of the selected papers as well as the experimental setup and hypotheses, whereas in the later presentations more time might be filled with something akin to actual results. Whatever may be the balance that you
choose, understand that everyone must include something on the way of elaboration on the topic selected, something in the way of a “mini-survey” of the papers selected and their contribution to the topic, something in the way of the implementation and experiments proposed, and something in the way of anything demonstrable with respect to the implementation. Finally, although on the tentative schedule the presentations are allotted for the last three weeks of class, they may take place in the last four weeks depending upon add/drops. In any case, the actual presentation schedule will have to be fixed shortly after I approve of the mini-proposals, which should occur sometime in Week 8, probably on Wednesday, October 10.

**Talking with me throughout**

Particularly surrounding the time of your mini-proposals, I may want to arrange office hour appointments to discuss your projects with you.

**SCHEDULE OF PROJECT MILESTONES**

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic selection and approval</td>
<td>Friday, September 21</td>
</tr>
<tr>
<td>Mini-proposal</td>
<td>Friday, October 5</td>
</tr>
<tr>
<td>Fixing Presentation Schedule</td>
<td>Wednesday, October 10</td>
</tr>
<tr>
<td>First Implementation Milestone</td>
<td>Friday, November 2</td>
</tr>
<tr>
<td>Presentations</td>
<td>November 5 through December 5</td>
</tr>
<tr>
<td>Final Project Due</td>
<td>Monday, December 10</td>
</tr>
</tbody>
</table>

**Grade Allocation**

The final project is worth 50% of your term grade. It is broken up as follows:

- Mini-proposal and topic selection: 5 % (guaranteed if deadline + requirements met)
- First implementation milestone: 2.5 % (guaranteed if deadline met with something)
- Presentation: 15 %
- Implementation: 12.5 %
- Final Report: 15 %