COSC 320 - Advanced Data Structures and Algorithm Analysis Project 3

Dr. Joe Anderson

Project Choice: 22 November 2019
Draft: 2 December 2019
Final Submission: 11 December 2019

1 Goals

During this project, you will

1. be exposed to the breadth of problem domains in graph theory and computer science

2. develop the skills needed to research a problem, understand its motivations and potential solutions,

3. be exposed to the genesis of a problem and its historical solutions,

4. practice communicating complicated material in computer science and applied mathematics.

2 Description

For this project you will work individually or with a partner to learn about, implement, and document one interesting graph algorithm or data structure that was not covered during the course lecture. You will prepare a full typed report to describe the motivation for the topic, theoretical properties with some justification, and the results of your own implementation.

For the purposes of grading, this project will carry the weight of one-and-a-half standard class projects.

Here is a list of pre-approved topic choices. If you'd like to use something not on this list, it must be approved by the instructor. Particularly challenging topics are marked with a ★. It is important to choose a topic or problem that interests you! This could be a starting point for you to conduct your own research as an undergraduate, or work with a faculty to help with their research!

1. Graphs for job scheduling

2. Map coloring, chromatic numbers

3. Graph min-cut/max-flow algorithm and theory

4. Graphs for managing disjoint set systems

5. Triangulation graphs (Delaunay, Voronoi, Ruppert's algorithm)

6. Graphs for image segmentation and image processing

7. Planar graphs and algorithms

8. ★ graphs and random walks (for sampling, generative models, etc.)

9. ★ graph isomorphism

10. ★ graph spanners

2.1 Deadlines

The timeline of this project will be as follows:

- Project Choice: 22 November 2019

  - Meet with the instructor before this date to declare 1) who is in the group and 2) what the topic and specific goals will be
  - Submit online a document with this information by the above date.

- Draft of report and software prototype: 2 December 2019

  - Submit a preliminary draft of the report. Submit the current version of the software you have written to implement the algorithms or study the problems; include any relevant datasets you plan to use. This should include a draft of the introduction, as well as an annotated bibliography (a list of references and at least 3-4 sentences summarizing the content relevant to your project).

- Final Submission: 11 December 2019

3 Specifications

If in a group, each member will receive the same grade for the project. A rough rubric is as follows:

1. (40%) Complete a written technical research report detailing your topic. This should be at least 3-4 pages of text and figures, not counting data tables or implementation code. You must use proper English grammar, punctuation, and spelling. Follow the standard research paper outline of:

   (a) Abstract: give a brief (3-4 sentence) summary of the project results.

   (b) Introduction: state the motivation of the topic, historical development, and review any non-standard mathematical preliminaries that will be used later.

   (c) Topic Details: provide a full description of the topic, its theoretical justifications, and practical applications. Use pseudocode, illustrations, and other tools to explain how your data structure or algorithm works. Tip: to get an idea of the audience and pacing, imagine you are writing a section for the course textbook.

   (d) Conclusion: summarize the results presented again, state any future development or open questions that arose during your research.

   (e) Bibliography: cite any sources you used to learn about the algorithm *and where future readers could also find that information*. **Use at least three** academic sources, **at least one scholarly journal article**; for instance, the majority of your content may come from a textbook, but then you should find some recent research developments that apply or improve the algorithm or data structure. On the other hand, your project may focus entirely on recent research developments around a particular algorithm and data structure, providing the relevant papers as references. Avoid citing websites and ephemeral data sources. Always find published, reputable, sources to provide reference.

   (f) Appendix: include the data you gathered to generate plots or tables, include source code used to perform experiments. Provide extra mathematical justification that may be needed but does not "fit" the flow of the main text.

2. (60%) Implement the algorithm or data structure, along with code to (*thoroughly*) test and demonstrate its effectiveness in different situations. Give a detailed report (with visual aids) of its efficiency in different situations. Follow any standard requirements for other programming projects in this course (e.g. it must compile and run on the COSC GNU/Linux environment). Include a `Makefile` and `README` with your code like normal.

4 Submission

Submit a `.zip` file called `Project3.zip` containing your report and source code, `Makefile`, and documentation, then upload it to the course MyClasses submission page.

Print out your code and documentation, to be turned in on the first lecture following the due date.

5 Bonus

(Up to 10 pts) Make your code generally available though a site like GitHub, GitLab, SourceForge, BitBucket, etc. Include a fully detailed README explaining the project, your approach, and any future goals you might have for it. Note that most of these sites will use your README file to display this information on the web, and you can use special formatting called "Markdown" to have it render with headers, lists, etc.

(5 pts) Take your draft of the write-up to the University Writing Center to have one of the consultants help you with the organization and presentation. Bring one of the signed forms as evidence that you completed this. You can find more information about the UWC at `http://www.salisbury.edu/uwc/` and `http://www.salisbury.edu/uwc/faq.html`.

(5 pts) Typeset your final report with the LATEX language. See `http://faculty.salisbury.edu/~jtanderson/teaching/latex.html` for some resources.

(Up to 10 pts) Complete the project with a particularly difficult/challenging topic (marked above).