COSC 302 — **Algorithm Write-up** — Spring 2018
Prof. Darren Strash
Colgate University

Goals

The goal of this write-up assignment is to give you the opportunity to exercise critical thinking and to use formal mathematical writing to express in-depth understanding of a topic not discussed in class. At the end of this project, you will have an deep understanding of your chosen topic and will be able to effectively communicate information about the topic.

See the last page of this document for a list of topics from which to select. If you do not find one that interests you, you are welcome to suggest your own topic for approval by Friday, April 20, 2018.

Due date: The write-up must be submitted on Moodle by Friday May 4, 2018 by 4:30pm.

Collaboration and sources: It is critical to cite your sources for this project. Unsubstantiated claims must be accompanied by a citation. Allowable resource materials for citations only include published sources (i.e., books, journals, or conference proceedings)[1]. Collaborative discussion with fellow students is allowed, but write-up artifacts must not be shared—all written work must be your own. Furthermore, any other content in the paper (such as figures, plots, or tables, but excluding short quotes) must be created by yourself[2].

Write-up

You must submit a pdf write-up written in LaTeX. Use the article document class, 11pt font with single spacing, the geometry package (with 1-inch margins), and use BibTeX for references. (Here is an example citation: Akiba et al. [1] show experimentally that the branch-and-reduce paradigm can be used to quickly solve the minimum vertex cover problem on medium-scale social networks.) I include the source of this document, which can be used as a template. The text body of the write-up must be 1 to 2 pages in length (this excludes tables, figures, plots tables, and references), and should address the following:

- Formally define and describe the topic in detail, and discuss its significance.
- For an algorithm, data structure, or technique:
  - Discuss its advantages, and what it accomplishes.
  - Are there other related algorithms/data structures/techniques that accomplish something similar? If so, mention them, and compare and contrast them with your topic.
  - Mention running time, space used with a brief analysis; and give support/evidence for its correctness.
  - Discuss optimality.
  - Describe two applications of the algorithm/data structure/technique.

[1] Note that Wikipedia and similar websites do not meet this criteria. However, these materials often provide excellent information for starting research.

[2] Inkscape (`http://www.inkscape.org`) and the Ipe Drawing Editor (`http://ipe.otfried.org`) are excellent (free) programs for creating publishable-quality pdf figures for algorithms-related topics. Such pdfs can be included in LaTeX with the graphicx package and the \includegraphics command.

- For a model:
  - Mention fundamental techniques that are used to make algorithms efficient in the model.
  - Briefly describe two algorithms in the model of computation, and analyze them.
  - Compare and contrast this model to other models. Which ones are most similar?
- For a class of problems:
  - How do you show a problem is in the class?
  - Which are representative or classic problems in this class?
  - How does this class compare to other classes?
  - What techniques are used to solve problems in this class?
- For a subject area, select two algorithms/data structures/techniques and follow the instructions for techniques/data structures/techniques, but only discuss these points more briefly, and targeted within your topic.

Formatting and text length will be strictly enforced. Students should avoid the "standard" 5-paragraph format, which is rarely used in real-world writing. Every sentence should be clear and purposeful. Points will be removed for "filler" text—text that simply exists without a meaningful purpose. Succinctness is always preferred.

Grading

This project is worth 5% of the overall course grade.

- 20% precision, formality, succinctness, and clarity of writing
- 30& thoroughness of treatment of the topic
- 50% correctness of content

Topics

Algorithms / Data structures / Techniques

- Distribution sort
- Fortune's algorithm
- Chan's algorithm (for convex hulls)
- The Rabin-Karp algorithm
- B-trees
- Range trees
- Splay trees
- Van Emde Boas trees
- Cuckoo hashing
- The sweep-line technique
- Fractional cascading

Models and problems / problem classes

- The External Memory (or I/O) Model
- The PRAM Model
- Graph Isomorphism
- PSPACE (the class of problems)
- #P-Complete (the class of problems)

Subject areas

- Collision detection in video games
- Hidden surface removal in rendering
- Path finding in robotics
- 3D Modeling / CAD
- Vehicle routing

Roll your own

- Suggest your own topic for approval by Friday, April 20, 2018.

References

[1] T. Akiba, Y. Iwata, and Y. Kawata. An exact algorithm for diameters of large real directed graphs. In E. Bampis, editor, *SEA 2015*, pages 56–67. Springer, 2015.