Theory of Algorithms
CSC 721
Course Syllabus

Spring 2017

Instructor: Dr. Grey Ballard
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Office: Manchester 234
Office Hours: 3:30-4:30 TW, or by drop-in or appointment
Class: 2–3:15 TR, Manchester 17
Course Schedule: `http://users.wfu.edu/ballard/teaching/CSC721/`

1 Course Description

Design and analysis of algorithms. Topics may include time and space complexity analysis, divide-and-conquer algorithms, the fast Fourier transform, NP-complete problems, and efficient algorithms for operations on lists, trees, graphs, and matrices.

2 Learning Outcomes

By the end of this course, students should be able to:

1. evaluate algorithms using asymptotic computational complexity analysis,

2. reason about sequential and parallel models of computation,

3. analyze the data movement requirements of an algorithm,

4. read, critique, and present both classic and current research papers, and

5. write a research paper involving the design and/or analysis of algorithms.

This class is a graduate class, and there will be high demands of classroom preparedness and participation. I will assume that all students have taken an undergraduate algorithms course, an equivalent of CSC 222.

3 Class Participation

Most weeks we will discuss a research paper along with associated background material. Each student will present one paper from the list below. All students will read all papers and write one paragraph critiques, to be done before the session when each paper is presented. There may also be challenge problems and supplemental reading throughout the semester. Classroom participation includes engaging with lectures and paper presentations – I expect each student to add a comment or question to the discussion nearly every class session.

Paper list (all pdfs available on Sakai):

1. Karp. *Reducibility among combinatorial problems.* 1972.

2. The set of 3 papers:

   - Winograd. *A new algorithm for inner product.* 1968.
   - Strassen. *Gaussian Elimination is not optimal.* 1969.
   - Bini, Capovani, Romani, and Lotti. $O(n^{2.7799})$ *complexity for $n \times n$ approximate matrix multiplication.* 1979.

3. Frigo, Leiserson, Prokop, and Ramachandran. *Cache-oblivious algorithms.* 1999.

4. Park, Penner, and Prasanna. *Optimizing graph algorithms for improved cache performance.* 2004.

5. McColl and Tiskin. *Memory-efficient matrix multiplication in the BSP model.* 1999.

6. Chan, Heimlich, Purkayastha, and van de Geijn. *Collective communication: theory, practice, and experience.* 2007.

7. Irony, Toledo, and Tiskin. *Communication lower bounds for distributed-memory matrix multiplication.* 2004.

8. Ballard, Carson, Demmel, Hoemmen, Knight, and Schwartz. *Communication lower bounds and optimal algorithms for numerical linear algebra.* 2014. *Section 2 only!

9. Zhou, Wilkinson, Schreiber, and Pan. *Large-scale parallel collaborative filtering for the Netflix Prize.* 2008.

10. Andoni and Indyk. *Near-optimal hashing algorithms for approximate nearest neighbor in high dimensions.* 2008.

4 Projects

The project can be done individually or in groups of 2 and should either be connecting your research to topics in this class or digesting a topic of interest related to this class. The main output of the project is a report (in ACM format: `https://www.acm.org/publications/proceedings-template`) and a presentation to the class at the end of the semester.

5 Assessment and Grading

Course grades are determined using the following weightings:

- 50% participation
- 50% project

Letter grades are assigned based on the following categorization:

A	92 or above
A$^-$	90–91.99
B$^+$	88–89.99
B	82–87.99
B$^-$	80–81.99
C$^+$	78–79.99
C	70–77.99
F	below 70

6 Contacting Me

In general, email is the best way to reach me, and I'm happy to take questions over email. The easiest way to find me in person is to stop by my office during office hours, though please feel free to drop by any time. If you want to be sure to find me then you can also email ahead to schedule a time; it helps to propose a few times that work for you so that I can choose one that works for me too.

7 Learning Assistance Center

If you have a disability that may require an accommodation for taking this course, then please contact the Learning Assistance Center (758-5929) within the first two weeks of the semester and bring it to my attention as appropriate.

8 Emergency Preparedness Policy

In the unlikely event of a major disruption of normal university activities (such as might result from a health emergency or other disaster), a course continuation contingency plan will be enacted in order to allow completion of the course.

During this time, students should continue with the reading and other assignments listed on the syllabus and monitor email, Sakai, and the WFU website for information. If students have questions or are in doubt about how to proceed, they should contact the instructor by email if available, otherwise they should contact by phone.