

Multidimensional Data Analysis

CSC 790

Course Syllabus

Fall 2023

Instructor: Dr. Grey Ballard

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Office: Manchester 237

Office Hours: 2:00–4:00 Th, or by drop-in or appointment

Class: 9:30–10:45 WF, Manchester 017

Course Schedule: <http://users.wfu.edu/ballard/teaching/CSC790/>

1 Course Description

This course focuses on tensor decompositions as a tool to analyze multidimensional data sets. After taking the course, students will be able to describe tensor notation and various tensor decompositions, apply the decompositions to different types of data using existing software, evaluate results and interpret them when appropriate, analyze and evaluate existing algorithms for computing tensor decompositions, and design new algorithms for related problems. Students will program in MATLAB and/or Python. Background in numerical linear algebra, numerical optimization, or basic statistical analysis (e.g., principle component analysis) will be helpful but not required.

2 Learning Outcomes

By the end of this course, students will be able to

1. *understand* tensor notation and how tensor decompositions express full tensors
2. use existing libraries to *apply* tensor decompositions to multidimensional data and understand the structure of solutions
3. *analyze* various tensor decompositions and differentiate among their utility across data analytic problems

4. *analyze* the computational costs of algorithms for computing tensor decompositions
5. *evaluate* tensor decomposition approximations to select among approximation variants and ranks, and appraise how confidently results can be interpreted
6. *evaluate* the tradeoffs among accuracy, efficiency, and robustness of different algorithms for computing tensor decompositions
7. *create* algorithms for tensor decomposition variants with nonstandard constraints, regularization, or tensor structure

3 Homework

Homework assignments will be assigned weekly (typically). I encourage you to discuss and work on these assignments with me and with other students, and you may use any helpful online resources. However, the work submitted must be your own and reflect your understanding of the material, so final solutions and code should be written independently. Be sure to cite your sources.

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. Projects must include the use of a real multidimensional data set. They may focus on tensor decomposition pedagogy, along with some artifact (such as a lesson plan, assignment scaffolding, and/or demonstration), with the intent of being useful in future versions of the class.

5 Assessment and Grading

Course grades are determined using the following weightings:

- 70% homework
- 30% project

Letter grades are assigned based on the following categorization:

A	93 or above	C	73–76.99
A⁻	90–92.99	C⁻	70–72.99
B⁺	87–89.99	D⁺	67–69.99
B	83–86.99	D	63–66.99
B⁻	80–82.99	D⁻	60–62.99
C⁺	77–79.99	F	below 60

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 CLASS

Wake Forest University provides reasonable accommodations to students with disabilities. If you are in need of an accommodation, then please contact me privately as early in the term as possible. Retroactive accommodations will not be provided. Students requiring accommodations must also consult the Center for Learning, Access, and Student Success (118 Reynolda Hall, 336-758-5929, class.wfu.edu).

8 Emergency Preparedness Policy

In the event of a major disruption of normal university activities, 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, Canvas, 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.

9 Grievance Procedure

For complaints in the academic (i.e., classroom) setting, the student should talk personally with or send a written complaint explaining the concern directly to the instructor. Should the student and instructor be unable to resolve the conflict, the student may then turn to the chair of the involved department for assistance. The chair will communicate with both parties, seek to understand their individual perspectives, and within a reasonable time, reach a conclusion and share it with both parties. If the student's complaint is not resolved by these procedures, the student should consult with the Office of Academic Advising for assistance. The Associate Dean for Academic Advising will consult with the

parties to obtain a resolution. Finally, a student may appeal to the Committee on Academic Affairs which will study the matter, taking input from all parties, and reach a final decision concerning resolution. <https://bulletin.wfu.edu/undergraduate/wake-forest-college/student-complaints/>