APMTH 220 Geometric Methods for Machine Learning **Spring 2024**

Your Project Title

Name: [Your Name] *Submission Date: [Date]*

1 Content

As part of APMTH 220 you will conduct a course project, which should relate to one of the three main topics that we cover in the course, (1) Geometric Representation Learning, (2) Graph Neural Networks or (3) Machine Learning on Manifolds. The project is an integral part of the course, since it will give you the opportunity to explore the utility of geometric methods in machine learning first hand. A significant part of your course grade is based on the successful completion of the project.

Here are some suggestions for possible course projects:

- Describe a problem with geometric structure that arises in your research and how a method that you learned in this course could be used to solve it.
- Investigate applications of a geometric method that you learned in this course: Describe the geometric structure that arises in the application, how a geometric method could be used to solve it and how it compares to previous approaches that did not exploit geometry.
- Develop your own implementation of one or more methods that you learned in this course and perform numerical experiments that illustrate the utility of exploiting geometric structure in machine learning.
- Extend or generalize the results of a paper that you read as part of the course. Hint: You may find inspiration for project ideas by carefully reading the discussion or conclusion sections of papers on the reading list.

You are encouraged to discuss your course project ideas and progress with the instructor during office hours throughout the semester. You should start working on your project early and develop a project outline in the first half of the course.

Note on using generative writing tools. You are permitted to utilize generative writing tools, such as ChatGPT, for your course projects. If you decide to do so, it is mandatory that you add a section at the end of your submission (both for the proposal and the final report; not counting towards the page limit), where you disclose, which tool you used and how, e.g., "used ChatGPT for idea generation", "used ChatGPT to improve writing style" etc. Please also briefly reflect on your experience and what you liked/ disliked about the tool.

2 Deliverables

A project proposal is due on 03/06/2024, which should consist of a *one-page* outline (excluding references,) of your project idea and goals/ anticipated outcomes. *Please use this template for your submission.* Your proposal should be structured as follows:

- *Motivation*: Motivate the problem, task, model, or methodology you want to investigate.
- *Background*: Describe the context of your project, i.e., include references to related work and position your project in the context of that literature.
- *Proposed approach*: Describe the theoretical and/ or computational analysis that you are planning to conduct for your project.
- *Data availabilty and computational requirements (if applicable)*: Describe the data sets that you are planning to use and what computational resources are needed to conduct any experiments that you propose.

A project report is due on 05/03/2024, which should describe the problem that you are addressing, a summary of the related literature that you read as part of the project and your work towards its solution. The report is *limited to 8 pages (excluding references)*, which should be self-contained and describe all main theoretical and computational results. Technical proofs and/ or additional experiments may be deferred to an appendix. If you write code as part of your project, please include the code in your submission or provide a link to a code repository. *Please use this template for your submission.* Your project report should be structured as follows:

- *Abstract:* Summarize your project in a few sentences.
- *Introduction:* Describe the motivation for your project and position it in the context of the existing literature.
- *Background and Notation:* Give an overview of concepts and methods used in your project. Introduce key notation.
- *Proposed approach:* Describe the theoretical and/ or computational methodology that you developed during your project. If applicable, describe the data sets and computational resources that you used to conduct your project.
- *Results:* Describe the theoretical or computational results of your project.
- *Discussion and conclusion:* Reflect on the results of your project and suggest future directions.

To understand the expectations for the course project, here are the grading criteria:

1. Content
    - Motivation
    - Background
    - Approach
    - Results
2. Style and presentation
    - Overall Soundness
    - Novelty/ Originality
    - Scope
    - Clarity of writing

Project presentations will be done in form of a poster session on **April 29, 10am-1pm, in the Maxwell Dworkin Lobby**. Attendance of the poster session is mandatory. You have the option to have your poster printed by us (submission deadline: 04/21, 11.59pm; submission details tba) or to print it yourself.