Operations Research Final Project Information

One of the main goals of this course is to prepare you to apply operations research (OR) methods to real-world tasks, or to leave you well-qualified to start research or work in optimization and decision sciences. The final project is intended to start you in these directions.

Please first have a look through the frequently asked questions.

Note: Only one group member is supposed to submit the assignment.

Project Topics

Choose a project type:

1. **Application:** Apply OR methods to a real-world problem (e.g., scheduling, logistics, resource allocation, network flows).
2. **Algorithmic:** Develop or improve an optimization algorithm for a specific problem.
3. **Theoretical:** Prove new or interesting properties of an OR method or algorithm.

Projects may combine these elements. Select a topic you find interesting and ambitious. For inspiration, review existing research (e.g., Google Scholar). You can also check find hints here.

Identify relevant datasets or problem instances early. If data requires significant preprocessing or collection, plan accordingly—methodology and results discussion are still expected.

A very good OR project will be a publishable or nearly-publishable piece of work.

Notes on a few specific types of projects

- **Optimization projects:** Since this course discusses many concepts in optimization, we ask that if you decide to work on a computational project, please make sure that you use other material you learned in the class as well. For example, you might set up linear programming and integer programming baselines, or do some analysis using network flow methods. We prioritize methodological and experimental rigor and standardize our grading, so note that pursuing (or not pursuing) a computational project will not itself impact your grade. Finally, solving large optimization problems can be very time consuming, so make sure you have the necessary computing resources. Ask me if you need additional resources.

- **Replicating results:** Replicating the results in a paper can be a good way to learn. However, we ask that instead of just replicating a paper, also try using the technique on another application, or do some analysis of how each component of the model or algorithm contributes to final performance.

In other words, your project does not need to be completely novel, but should not just duplicate previous work done by others.

Project Submission Phases

Your project will be submitted in three phases:

1. **Proposal:**
   Submit a brief (one page) proposal outlining your project topic, motivation, planned methods, and expected outcomes.

2. **Milestone:**
   Submit an intermediate, functional, and testable implementation of your code, along with a draft of your report. This should demonstrate progress and allow for feedback.

3. **Final Submission:**
   Submit the complete project, including all code, results, and the final report in the form of a scientific article.

Evaluation

Projects will be evaluated based on:

- **Technical quality:** Does the technical material make sense? Are the things tried reasonable? Are the proposed algorithms or applications clever and interesting? Do the authors convey novel insight about the problem and/or algorithms? Does the project have sufficient scope for the given team size?
- **Originality:** Did the authors add their own data processing, methods, or analysis? Does the final project avoid being a mirror image of existing papers/projects with no net new work?
- **Communication:** Are the authors able to clearly and effectively explain the work that they did, including context, methods, and results? Do the paper and poster balance clarity with rigor?

In order to highlight these components, it is important you present a solid discussion regarding the learnings from the development of your method, and summarizing how your work compares to existing approaches.

Project Proposals

In the project proposal, you'll pick a project idea to work on early and receive feedback from the TAs. In the proposal, below your project title, include the project category (which unit of the syllabus the project is linked to).

Format:
Your proposal should be a PDF document, giving the title of the project, the

project category, the full names of all of your team members, and a 300-500 word description of what you plan to do.

Your project proposal should include the following information:

- **Motivation:** What problem are you tackling? Is this an application or a theoretical result?
- **Method:** What OR techniques are you planning to apply or improve upon?
- **Intended experiments:** What experiments or computational studies are you planning to run? How do you plan to evaluate your OR method or algorithm?

Presenting pointers to one relevant dataset/problem instance and one example of prior research on the topic are a valuable (optional) addition.

- I suggest you use LaTeX as a good tool to produce a high quality report of your work. In particular, you can use any template you can find in overleaf (e.g., this one) to easily work in collaboration within the group to write the report.
- A github repository will be needed to submit the code. Ideally, the github repo should also contain the manuscript LaTeX files.

Grading:
The project proposal is mainly intended to make sure you decide on a project topic and get feedback from TAs early. As long as your proposal follows the instructions above and the project seems to have been thought out with a reasonable plan, you should do well on the proposal.

Milestone

The milestone will help you make sure you're on track, and should describe what you've accomplished so far, and very briefly say what else you plan to do. You should write it as if it's an "early draft" of what will turn into your final project. You can write it as if you're writing the first few pages of your final project report, so that you can re-use most of the milestone text in your final report.

Please write the milestone (and final report) keeping in mind that the intended audience are the instructors and the TAs. Thus, for example, you should not spend two pages explaining what linear programming is.

Your milestone should include the full names of all your team members and state the full title of your project.

> **Note:** We will expect your final writeup to be on the same topic as your milestone.

Contributions:
Please include a section that describes what each team member worked on and

contributed to the project. This is to make sure team members are carrying a fair share of the work for projects. If you have any concerns working with one of your project teammates, please create a private Ed post.

Grading:
The milestone is mostly intended to get feedback from TAs to make sure you're making reasonable progress. As long as your milestone follows the instructions above and you seem to have tested any assumptions which might prevent your team from completing the project, you should do well on the milestone.

Format:
Your milestone should be at most 3 pages, excluding references. Similar to the proposal, it should include:

- **Motivation:** What problem are you tackling, and what's the setting you're considering?
- **Method:** What OR techniques have you tried and why?
- **Preliminary experiments:** Describe the experiments or computational studies that you've run, the outcomes, and any error analysis that you've done. You should have tried at least one baseline.
- **Next steps:** Given your preliminary results, what are the next steps that you're considering?

Final Writeup

We know that most students work very hard on the final projects, and so we are extremely careful to give each writeup ample attention, and read and try very hard to understand everything you describe in it. After the class, we will also post all the final writeups online so that you can read about each other's work..

Format:
Final project writeups can be at most 5 pages long (including appendices and figures). We will allow for extra pages containing only references. If you did this work in collaboration with someone else, or if someone else (such as another professor) had advised you on this work, your write-up must fully acknowledge their contributions. For shared projects, we also require that you submit the final report from the class you're sharing the project with.

Here's more detailed guidelines with a rough outline of what we expect to see in the final report: `final-report-guidelines.pdf`.

Contributions:
Please include a section that briefly describes what each team member worked on and contributed to the project. If you have any concerns working with one of your project teammates, please create a private Ed post. We may reach out and factor in contributions and evaluations when assigning project grades.

Code:
Please include a link to a Github repository or zip file with the code for your final project. You do not have to include the data or additional libraries (so if you submit a zip file, it should not exceed 5MB).

Grading:
The final report will be judged based off of the clarity of the report, the relevance of the project to topics taught in this course, the novelty of the problem, and the technical quality and significance of the work.

After the Course

After the course, if you want to submit your work to an operations research conference, the INFORMS and EURO deadlines are good places to start (INFORMS, EURO). Of course, depending on the topic of your project, other conferences may also be more appropriate.

Project FAQs

1. **What are the deliverables as part of the term project?**
   The project has four deliverables:

   a. Proposal

   b. Milestone

   c. Poster

   d. Final report
      Please see the Logistics doc on the home page for due dates and deadlines.

2. **Should the final project use only methods taught in the class?**
   No, we don't restrict you to only use methods/topics/problems taught in class. That said, you can always consult a TA if you are unsure about any method or problem statement.

3. **Is it okay to use a dataset or problem instance that is not public?**
   We don't mind you using a dataset or instance that is not public, as long as you have the required permissions to use it. We don't require you to share the dataset either as long as you can accurately describe it in the Final Report.

4. **Can I use datasets from public repositories?**
   Using datasets from public repositories is allowed. However, the project

needs to focus on model performance and achieve meaningful results to receive high grades. This is because a significant amount of work is needed to formulate the problem, obtain data and preprocess data, whereas public repositories provide you with well-defined problems and organized datasets at the start.

5. **Is it okay to combine the term project with that of another class?**
In general it is possible to combine your project for this course and another class, but with the following caveats:

- You should make sure that you follow all the guidelines and requirements for this project (in addition to the requirements of the other class). So, if you'd like to combine your project with a class X but class X's policies don't allow for it, you cannot do it.
- You cannot turn in an identical project for both classes, but you can share common infrastructure/code base/datasets across the two classes.
- In your milestone and final report, clearly indicate which part of the project is done for this course and which part is done for a class other than this one. For shared projects, we also require that you submit the final report from the class you're sharing the project with.

6. **Is it okay for the project to be part of my on-going research?**
The project has to be new, and you cannot use existing work or research for the project. However, the project can depend on existing research that you have done, as long as the project is new work that you are doing for the class and sufficiently self-contained, but in this case, you must clearly state in your milestone and final report what part of the project was done before and for this course. You can however, use the project for publications of your main research.

7. **Do all team members need to be enrolled in the course?**
No, but please explicitly state the work which was done by team members enrolled in the course in your milestone and final report. This extends to projects that were done in collaboration with research groups as well. We generally don't encourage you to collaborate with non-university people for the course project due to potential IP implications. If you choose to collaborate with a company, please understand you will need to follow the IP policy here.

8. **What are acceptable team sizes and how does grading differ as a function of the team size?**
We recommend teams of 3 students, while team sizes of 1 or 2 are also acceptable. The team size will be taken under consideration when evaluating the scope of the project in breadth and depth, meaning that a three-person team is expected to accomplish more than a one-person team would.

The reason we encourage students to form teams of 3 is that, in our experience, this size usually fits best the expectations for the projects. In

particular, we expect the team to submit a completed project (even for team of 1 or 2), so keep in mind that all projects require you to spend a decent minimum effort towards gathering data, and setting up the infrastructure to reach some form of result. In a three-person team this can be shared much better, allowing the team to focus a lot more on the interesting stuff, e.g. results and discussion.

In exceptional cases, we can allow a team of 4 people. If you plan to work on a project in a team of 4, please come talk to one of the TAs beforehand so we can ensure that the project has a large enough scope. You must submit a written proposal for a 4-person project to the head TA, which has to be approved.

9. **Do I have to be on campus to submit the final report?**
   No, the final report will be submitted via Gradescope.

10. **What fraction of the final grade is the project?**
    The term project is 40% of the final grade.

11. **What is the late day policy for group project?**
    Students can use late days for both the proposal and milestone (though note that these late days apply to each member of the group). Also note that while late days are allowed, we do not recommend using them since the assignments are more time consuming than writing up the proposal and milestone (and worth more points). Note that there are no late days for the final poster and paper to provide enough leeway for grading.

12. **Can we use optimization libraries such as CPLEX, Gurobi, or are we expected to implement them from scratch?**
    You can use any library for the project.

13. **Is it ok to use a public repository for version control?**
    We recommend that students keep their repo private while working on the project. After the class ends, we understand that many students may want to have their work be public, so that they can point to it for interviews, outside advisors, etc, which is acceptable.

14. **What if two teams end up working on the same project?**
    It is okay if two teams end up working on the same project as long as they don't coordinate to do so, in order to not be biased in the way they tackle the problem. Alternatively the teams can coordinate to make sure they work on different problems.

15. **Will we be provided any cloud compute resource credit?**
    We are looking into getting cloud credit for the projects. We will announce here once this is finalized.

16. **Are we required to use a specific programming language for the project?**
    Yes, exclusively Python.