Operations Research, Spring 2025 (113-2)
Final Project

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In the final project, you are invited to conduct an OR study on a real problem. You are expected to find your own problem, formulate a model that describes the problem, collect relevant data, solve the model, and make interpretations and suggestions from your solutions. What we really want to see are (1) how you apply OR to solve real problems, (2) how you select a suitable topic and appropriate methods, and (3) how you present your ideas and results. Good luck and enjoy!

1 Groups

Please form a group of ***four or five*** enrolled students for this project. One student is not allowed to participate in two groups.

2 The study

In this project, each group needs to apply OR techniques to solve a real problem until helpful suggestions are made or insightful implications are found. The topic will be chosen by group members. While there is no restriction on the topic, it will be nice that the topic is (1) relevant to our daily life and (2) can be understood easily by everyone in class.

When you choose your own topic, you are welcome to discuss with the instructing team to ensure that the topic is fine. The instructing team will also read the proposals and give feedback accordingly. Below are some example topics that were studied by former students:

1. (Personnel scheduling for IM Week) Facing time-variant demands for the coming IM Week, how to schedule your classmates to complete all the tasks? Do not forget that your classmates still have classes and cannot work for too long. Moreover,

how would you model service level as a function of demand volume and personnel supply?

2. (Beer ordering and shipping for German beer festivals) Given the demand forecasts for three beer festivals and supply and transportation information in Germany, one needs to decide the order quantity and shipping routes. Should we minimize the expected total costs, minimize the risk of running out of beer, or do something else?

3. (The installment of ice cream machines in Family Mart) Given a chance to install ice cream machines to Family Mart stores, how to choose a few stores to maximize the total profit? Is it profit-maximizing not to install ice cream machines in all stores? Note that estimating demands is a big challenge!

As this is a project, most details should be left for you to decide. However, you are more than welcome to discuss your ideas with me. Please do not work on the above topics (or convince the instructing team why you need to work on the same topic); find your own!

3 Tasks

Each group needs to sign up, write a proposal, make a presentation by making a video, write a report, and give feedback to other groups and group members.

1. Sign up: Students should sign up by providing the names of group members to a given online form by ***23:59, March 22***.

2. Proposal: A proposal introduces the problem you want to study and the mathematical model that precisely describes the problem. The proposal is limited to ***at most six A4 pages*** (including everything) and should be submitted in the PDF format to NTU COOL by ***23:59, March 29***.

   The proposal may be written in English or Chinese. The first page of the proposal should include your group ID (which will be assigned to you after the sign-up process) and the student IDs and names of all group members.

3. Oral presentation in a video: Each group needs to make a video to present their works for ***15 to 20 minutes*** and uploads the video to YouTube. The link to the video must be submitted to NTU COOL by ***23:59, May 31***. You may set your

video to be viewable only by those with the link (called "unlisted" on YouTube). The slides of the presentation should also be submitted in the PDF format by the same due time. The first page of the slides should include your group ID and the student IDs and names of all group members.

You may decide the number of speakers by yourself (at least one, of course). Speakers are encouraged to present in English with some bonus points, though Chinese is still welcome with no penalty. However, please do not try to present in English if that is too difficult for you. The language used in the video is not required to be the same as that used in the proposal. It is up to the presenters for showing their faces or not. If one believes that showing her/his face makes the presentation more interesting, it is suggested to do so. The presentation must be done by human beings.

The submitted videos will be made public on NTU COOL for the entire class to watch and learn from each other. For the classmates to quickly understand the content of the video, each group should also provide a project summary up to 200 words. The summary should be written in the same language as that used in the oral presentation.

4. Written report: Each group needs to write a formal report to describe the details of their works. The report is limited to ***twelve pages***, including everything. The report should be submitted as a PDF file to NTU COOL by ***23:59, May 31***.

   You may write your report in English or Chinese as long as it is readable, and the language used in the report is not required to be the same as that used in the proposal and video. Using English to write a report does not make a group earn bonus points. The first page of the report should include your group ID and the student IDs and names of all group members.

5. Inter- and intra-group peer evaluation: Each student must select ***at least five*** other groups' works to watch their videos and give rates and feedback. The feedback for each group should be at least 100 words and may be written in English or Chinese. Each student should also give rates and feedback to each of her/his group members. The feedback for each group member should be at least ten words and may be written in English or Chinese. These rates and feedback should be submitted by ***23:59, June 7***.

   All inter-group rates and feedback will be provided anonymously to each group for reference. When a group receives feedback from other students, the personal infor-

mation of those students will not be disclosed. Similarly, all intra-group rates and feedback will be provided anonymously to each student. When one receives feedback from her/his group members, the personal information of the group members will not be disclosed.

Table 1 summarizes the major tasks regarding the restriction in languages and who will view the submission.

Task	Restriction in languages	Who will view it
Sign up	No restriction	Students and instructing team
Proposal	No restriction	Instructing team
Abstract	Identical to the video	Students and instructing team
Video	Identical to the abstract	Students and instructing team
Report	No restriction	Instructing team

Table 1: Summary of tasks

4 Useful examples

Before you start, please note that there are many examples for you to get more ideas about "a good project". First, there are videos in the Coursera courses talking about case studies, which are quite related to this project. They are in OR1-5 and OR2-5. Please do go through OR1-5 before you start to write your proposal and OR2-5 before you start to work on the videos and final report. Second, there are videos, slides, and reports from students taking this course in the past. The links to all of these materials are on NTU COOL. Going through them again can be quite useful.

5 Report writing and oral presentation

As always, you are required to ***type*** your work. Hand-written works are not accepted. You are responsible to make your work professional in mathematical writing with a text processor with a formula editor or LaTeX.

Beyond typesetting, a more important task is to make your report *a well-organized article* rather than a collection of unrelated information. If you have no prior experience

of documenting an OR study, you are suggested to include the follow sections in order in your report:

1. **Introduction.** You should always start by describing the background and motivation of your problem. Then the problem should be described at a high level.[1] If possible, you should explain why the problem is interesting, i.e., challenging and important. Real-world observations are good for motivating your study. The problem should have a decision maker dealing with a complicated environment with various types of operations. You should highlight the trade-offs faced by the decision maker when choosing among alternatives.

2. **Problem description.** Use words to describe the problem and construct your conceptual model. You will *conceptually* describe your decision variables, parameters, objective functions, and constraints. You will use texts rather than mathematical symbols; you will speak in business language rather than technical jargon. Make your problem description complete while concise.

3. **Model formulation.** Use compact formulation to describe the problem and construct your mathematical model. Make your mathematical model a precise description of your problem.

4. **Algorithm(s).** Describe your algorithm, which is typically a heuristic one, that you design to solve the optimization problem. If you have more than one algorithms, describe all of them. You may use words, flowcharts, and pseudocode to describe the algorithm(s). If useful, you may also provide examples.

   Note. Please note that a self-proposed algorithm is a must. Using only a solver to solve instances will not get good grades.

5. **Data collection and generation.** We expect both randomly generated instances and real-world instance(s), where the former demonstrate the applicability of your algorithm(s) and the latter demonstrate the practicality. For randomly generated instances, first describe how you generate random instances by describing the factors, levels, and scenarios designed by you. Then describe how you set the values or distributions for all parameters. For real-world instances, describe how you collect data (e.g., from some websites, through questionnaires, etc.), do estimation, and make assumptions to form instances, i.e., to generate values for all parameters in your instances.

[1] The problem needs not to be the same as that in the proposal.

Note. Please note that including both self-generated instances and at least one real-world instance is a must. Having only one of them will not get good grades.

6. **Performance evaluation.** Write down the results of using your algorithm(s) to solve your instance(s). You definitely need benchmarks to demonstrate the performance, and the best benchmark is (an upper/lower bound of) an optimal solution obtained through mathematical programming. Please use Gurobi Optimizer (or other solvers you prefer) to solve your instances and write down the optimality gaps. Another good benchmark is very simple heuristics, which should perform worse than your proposed algorithm(s). Ideally your proposed algorithm(s) should be close to (the upper/lower bound) of an optimal solution and far from those very simple heuristics. In solving those real-world instance(s), if you have an executable plan, write it down. Some visualization is typically a plus. It will be better if you have some performance evaluation (say, your proposed solution may save how much time/money compared with the current solution).

7. **Conclusions.** Say something to summarize the whole study and possible ways to improve it.

Obviously, the above order is also natural for your presentation.

Note. Not all examples proposed their own algorithm(s); they only used Gurobi optimizer to solve their instances. Also, not all examples included both randomly generated instances and real-world instance(s). This is in the past we did not specify the requirements clearly. In this project, please do remember to include both of them. This will maximize the chance to convince your readers (who may be your bosses, customers, clients, or users in the future) that your solution approach is good.

6 More about the proposal and problem selection

The proposal should include four sections, which are introduction, problem description, mathematical model, and expected result. If one have no idea, following the example provided by the TAs can be a good idea. As choosing a topic is critical for the whole project (and the proposal as well), below we list some more suggestions for a group to choose a problem.

Though a student does not need to solve the model in the proposal, eventually she/he will do that. Therefore, one important thing is to ensure that in the model everything

is explicit. For example, if a student's problem is to set an airlines ticket price p to maximize the expected sales revenue, the model "maximizing $pf(p)$, where $f(\cdot)$ is the demand function" is not explicit because $f(\cdot)$ is not defined. People just cannot implement this and use solvers like Gurobi Optimizer to solve it. A better model is "maximizing $p(a - bp)$, where a and b are parameters whose values will be estimated later in this semester." Estimating a and b can be hard, but as estimation is not the core of this course, any reasonable estimation will be accepted. If a student is interested in a problem, but she/he does not know the explicit form of the formulation, I believe the problem is too difficult or inappropriate for OR. I would suggest her/him to change a topic.

If a student is quite worried about whether your problem/model will be too complicated to be solved, a safe way is to choose a problem that is similar to those introduced in class, such as facility location, production-inventory, personnel scheduling, job scheduling, resource allocation, portfolio optimization, etc.

Lastly, please be reminded that there are TA office hours (the dates are listed on the syllabus). All students are welcome to visit the TAs to get advises from them about problem selection, model formulation, and anything else. Asking the instructor during the breaks on Mondays is of course also welcome.

7 Grading policy

Below we describe how your works will be graded:

1. Sign-up (5 points): A group gets full credits once the group information are submitted by the due time.

   Note. The key is to find your group members!

2. Proposal (20 points): A group's proposal will be graded by the instructing team mainly according to the correctness and clearness of the conceptual and mathematical models. The appropriateness of the topic is not a big issue. If a group's topic is quite inappropriate (e.g., too hard, too simple, etc.), no points will be deducted, but the group will get feedback. The proposal is mainly for the instructing team to give comments and feedback to all groups before they really start the project.

   Note. The key is to start your discussion as soon as possible and describe your problem clearly, both in texts and mathematical formulas!

3. Video presentation (25 points): The video presentation grades will given to you by the instructing team and students. Grades from all students will be averaged and count for 50% of the grade. If a group gets fewer than five grades from the class, some TAs will given their grades to make the number of grades at least five. The grades from the instructing team count for 50%.

   Note. The key is to choose a good topic, give a clear and interesting talk, and generate useful conclusions!

4. Report (25 points): According to the quality of your written report, the instructing team will give you grades.

   Note. The key is to apply appropriate methods correctly and write a professional report.

5. Inter-group peer evaluation (10 points): If one gives an enough number of rates and feedback with not-too-bad quality, she/he earns all points in this item. Nevertheless, if one's feedback is poorly written and detected by the instructing team, she/he will lose points.

   Note. The key is to learn from other groups and write constructive feedback!

6. Intra-group peer evaluation (15 points): If one gives rates and feedback with not-too-bad quality to all her/his group members, she/he earns five points in this item. Nevertheless, if one's feedback is poorly written and detected by the instructing team, she/he may lose points. The other ten points in this item will be the average rates a student receives from her/his group members.

   Note. The key is to work hard and be responsible!

7. (Bonus) Oral presentation in English (5 points): Bonus points will be given to groups that use English to do their oral presentations (as long as the English is not terrible). Nevertheless, if the presentation is too hard to be understood or too boring, the presentation grades will be low.

8. (Bonus) Having both domestic and foreign students (5 points): If a group has at least one domestic student and one foreign student, the group will get these bonus points.

9. (Bonus) Additional inter-group peer evaluation: Beyond the required number of evaluations, one may earn two bonus point for giving rates and feedback to every three additional groups (with at least 100 words of feedback in a not-too-bad

quality). Nevertheless, if one's feedback is poorly written and detected by the instructing team, she/he will not earn bonus points.

For the proposal, video, and report, exactly one group member of a group should make the submission. The groups who fail to do so may get some penalties. For each task, the scores for that task will be discounted by 10% if it is submitted up to twelve hours late, by 20% if it is submitted between twelve and 24 hours late, and it will be counted as zero if it is submitted more than 24 hours late.