Combinatorial Optimization

Final Project Proposal, Report, and Posters
Due on the last days of final exams

In preparation for the final project (which will include a full implementation, with empirical results on timing and accuracy), you will concentrate on a real combinatorial optimization problem of your choice. A real problem is one whose specific goal is related to a real life application, such as one that might be inspired from your own research area. You need to work in teams and you need to get approval by email from me before starting on the project. So please email me a brief paragraph outlining the problem and methods you plan to investigate.

You should be in teams of *two or less*, and you should include the following information in your final report (**use the indicated section titles**). Make the answer for each question a separate clearly identified *section* of your typed document.

1. **Introduction:** Introduce your problem informally, and include a brief survey of any literature on previous efforts to solve this problem in tabular format as follows

Reference	Name of Algorithm	Category (as in question 8 below)	Known complexity
…			
…			

2. **Optimization Problem:** Formulate the problem as an optimization problem, making sure to state the cost function(s), variables, parameters, constraints, … etc.
3. **Search Space:** Discuss the search space: structure? Size?
4. **Difficulties:** Discuss any difficulties expected to solve this problem
5. **Related Problems:** Identify, if any, the closest classical problem(s) (e.g. TSP, SAT, LP, NLP, MST, ... etc) to your problem, and if possible derive a transformation between them? Can you specify the time complexity class of your problem as P, NP, NP-Complete, NP-Hard? Support your claims carefully!
6. **Optimization Methods:** Select **two** different optimization methods to explore and compare:
   - A **simple or classical method (like local greedy, backtracking, A* or dynamic programming,** …etc) can be used for comparison (as 1 of the techniques)
   - **However, you MUST also include as one of the 2 methods, a meta-heuristic** in your project like Genetic algorithms, swarms, ants, or simulated annealing... or trying hybrids between the simple heuristics (like Greedy) and the meta-heuristics like GA,…,etc

7. **Algorithms' Pseudocode:** Write a detailed outline for the algorithm that will attempt to solve your specific problem for each of the optimization methods above (specify all inputs, outputs, assumptions, …etc)

8. **Algorithms relation to existing methods:** Classify your algorithm with respect to the variety of methods studied in class: total or partial evaluation? Exact or approximate? If possible, specify the type of heuristic used (Greedy, Dynamic Programming, … etc)?

	Total/Partial Evaluation	**Exact/ Approximate**	**Type of Heuristic**
IDP	Complete solution to reduced problem	Approximate	breaking down the problem into simpler subproblems and utilizing the fact that the optimal solution to the overall problem depends upon the optimal solution to its subproblems.
DC	Complete	Approximate	This algorithm is inspired by natural evolution but modifies it to select candidate solutions that are not too similar this encourages population diversity and helps prevent premature convergence to a less optimal solution solutions that are too similar;

9. **Complexity:** Analyze the time complexity of the above algorithms, making sure to specify your definition of the problem/input size.
10. **Time plan and Team Plan (*see Table below*):** List the tasks needed to complete the entire project in the order in which they must be performed, indicate WHEN and WHO (if team) will you perform each planned task, and whether it has been completed or is to be completed

Task	**Who**	**When**	**Completed?**
…			
…			

Project Proposal

Each team should email me with a brief description (less than 1/2 page) and get approval from me before starting on their project.

Each team should inform the rest of the class about their final proposal AFTER approval by filling the table on slide 4 of the google slide link below and adding a maximum of 3 slides **at the end** of the following final project proposal slides summarizing your proposal in the following slides.

See SLIDE # 3 for the information you need to add to your 3 slides: I have copied the info below for your convenience:

- *Name of team members*
- *Title of project*

- Describe the problem and include diagrams to illustrate the problem
- Describe the problem instances you will solve
- Describe the methods you plan to investigate and your rationale for choosing them
- Show flowchart
- What are the parameters required to vary?
- What metrics will you report for evaluation purposes?
- Which experiment will you perform?

PROPOSAL SLIDE DECK: https://docs.google.com/presentation/d/1-k0HYsLbO53cPKkfzofDYS4uiApQzriw_xPDj9CIP5U/edit

Final Report

Your FINAL REPORT will be an integration of

1. **Complete Proposal Sections** (**include all the above sections**)
2. **Experimental Methodology** (elaborately organized, planned and explained)
3. **Experimental Analysis** (plots, tables, etc and their interpretation)
4. **Conclusions** (including critical analysis of the strengths and limitations of the studied approaches, and how they can be improved).

Project Poster (for OFFLINE course only on the Final Exam Day and Time: see https://louisville.edu/registrar/registration-information/final-exam-schedules)

You should also prepare a poster that summarizes all the above sections' information and present it to a poster session that will be held on the final exam date (in lieu of a written final).
The poster should be based on about 16 slides in large font (at least Arial size 20)
Your poster's quality of presentation and your preparation to answer questions will be part of your project grade.

Final Submission Information

You must follow the above guidelines to write your final report, then submit
- For OFFLINE class only:
- a "PRINTOUT" of your project report
(slip them under my office door in Duthie 206 (or bring with you to poster session) or put in my mailbox in the CSE department office in Speed Bldg by the scheduled final exam date)
- a poster to present on the final exam date (check academic calendars or announcement in class)

- **For OFFLINE and ONLINE course:** Your final report must include a link to a folder on google drive containing:
- **your final report as PDF or google Doc file** (first part must be your proposal + added updates from your final report).

- your project presentation in powerpoint slides (as google slides, for **offline**, this can be your poster slides; for **online** these are **slides reporting your project details up to 16 slides, font size of at least 20 for Arial font**)
- a directory with your source code, professionally commented and organized
- a ReadMe file explaining all the steps needed to compile and run you code, as well as all the input files, parameters, pre-conditions, and outputs of your programs.
- input files, data sets, and input parameters to your programs with comments and descriptions
- sample outputs of your programs with comments and descriptions