Instructions and Topics for Optimization Project (2023)

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Chapter 1

Instructions

A list of various topics for the optimization course project is included here. The following instructions are common across all topics:

1. Good understanding of the topic. This will include understanding the algorithm and how it has been derived.

2. Description of the problems to which the algorithm is applicable for.

3. A literature survey of the topic assigned to you. This will include variants of the algorithm available in literature. You are supposed to give only outline of the various other approaches that are similar to the basic algorithm assigned to you. Further, literature survey could include types of problems that have been solved using this algorithm (highlight if any major application is available in today's scenario, for example path planning, scheduling, etc.).

4. Implementation of the algorithm to a simple problem. You are supposed to submit codes for the same. Please right legible codes which can be understood by us. Please don't use any in-built function of specified algorithm in MATLAB/Python for coding. You are supposed to code it yourself. The code could be problem specific and need not be very general. Of course, you can use inbuilt tools to check correctness of your results/approach.
   Note: You are welcome to take initiative and compare the algorithm with other algorithms which are applicable on the problem at hand. You can compare them on the basis of computational time required, optimal solution obtained or not?

5. You are required to provide remarks and comments about the algorithm. For example, computation time required, software available for the implementation, strengths and weakness of the algorithm, any other improvement that could be included in the algorithm etc.

6. You are free to use various interactive tools to make your presentation interesting. Use of plots and figures is highly appreciated for easy understanding of the algorithm.

7. **Important**: Note that there is open-endedness in the project, and it is deliberate. Any group which takes more initiative and does more work will be rewarded for it.

Presentation Structure

The presentation should consist of slides in following sequence:

- First slide stating your group name, group members, roll number and a suitable project title such as 'Optimization using Genetic Algorithm'.
- One or two introductory slides stating importance/idea of the algorithm.
- About 2 or 3 slides stating the details of the algorithm given to you. Incase you are explaining some modified algorithm of similar type, specify these modifications here.
- About 2 or 3 slides that present literature survey of the algorithm. You can compare your algorithm with various other algorithms present in the existing field. You can discuss various variants available of the algorithm that you are studying.
- About 1 or 2 slides describing the problem on which algorithm has been implemented.
- Slides presenting the figures and the table obtained through comparison of various algorithms, if any.
- Slide(s) presenting conclusions reached by analysis of the simulation results.
  Note: Please do not cut and past algorithm equations from any source. Type them yourself. This will clarify the algorithm in your mind.
- About 1 or 2 slides regarding remarks and comments on the algorithm.

Note: (i) Each group will be assigned 20 minutes. The presentation should not exceed 15 minutes followed by 5 minutes questions and answers session. The instructor will be assessing each student in the group and hence it is possible that group members of same group would get different marks.
(ii) Ensure that plots, if any are well labeled and captioned and are legible. Also, choose the ranges on the axes in the plots so that space is not wasted (don't just rely on software to choose ranges).
(iii) The work done is important and a well made presentation helps in highlighting the good work. As the saying goes (in a lighter vein):
"*There is no idea so bad that it cannot be made to look brilliant with the proper application of fonts and color.*" — Scott Adams

Deadlines and Submission

Following are the deadlines:
Deadline for uploading **final ppt**: To be announced
Project **presentation** on: To be announced.
Submit your project as follows:
Uploading it on the Moodle page for CL 603. Upload two files:
(a) Your ppt (PDF version).
(b) Zipped file containing all Matlab/Python programs.
The file should be named as your GroupNumber_GroupName. Any one groupmember can upload the file.

Chapter 2

Topics for the Optimization Project

Ordinarily, one of the following topics would be assigned to each group by the instructor. Initial references for all the topics have been given in the next page to get you started. However, if you have some interesting ideas/problems in mind for the project, then get in touch with the instructor in the designated period.
The topics listed in this document are:

1. Genetic Algorithm for binary variables
2. Real valued Genetic Algorithm
3. Particle Swarm optimization
4. Pattern search optimization
5. Multiple objective optimization using Pareto front generation
6. Branch & bound with Cutting planes algorithm
7. Generalized reduced gradient method
8. Interior penalty function method
9. Dijkstra's algorithm
10. Chance constrained programming technique
11. Simulated annealing
12. Ant colony optimization
13. Equivalent weights for Lexicographic optimization
14. Optimal batch control
15. Multiparametric programming based explicit model predictive control
16. Dynamic programming (for example as used in dynamic time warping)
17. Geometric programming
18. Support vector machines (SVM)

References

For the first 12 topics, the references are either (1) or (2) (or both) below. For topic 13, basic idea is in reference (1) and (2) but details are in the paper in reference (3) below. Note that these are only initial references to get you started. You are expected to do a wider literature search.

1. Singiresu S. Rao; Engineering Optimization: Theory and Practice, John Wiley & Sons, Inc. 2009, 4^{th} edition.

2. Kalyanmoy Deb; Multi-Objective Optimization Using Evolutionary Algorithms, John Wiley & Sons, Inc. 2001.

3. Hanif D. Sherali; Equivalent weights for lexicographic multi-objective programs: Characterizations and computations, European Journal of Operational Research, 1982, 11(4), pp: 367-379.

There are many other sources of information for the listed topics. You can choose an appropriate one to get started. Get in touch with the instructor/TAs early in case of any issues.