Course Information

Instructor: Yannis Paschalidis, 8 St. Mary's St., Room 429, tel: 617-353-0434, yannisp@bu.edu, `http://sites.bu.edu/paschalidis/`. Office hours: Thursday 1pm-2pm or by appointment. The best way to reach Prof. Paschalidis is via e-mail.

Lectures: Tuesday and Thursday, 2:00-4:00, PHO 205.

Teaching Assistant: Ruidi Chen, rchen15@bu.edu.

Recitation and TA Office hours: Friday 4:00-6:00, PHO 404/428.

Topics: This course is an introduction to optimization problems and algorithms emphasizing problem formulation, basic methodologies and the underlying mathematical structures. We will cover the classical theory as well as the state of the art. The major topics we will cover are:

1. Theory and algorithms for linear programming.
2. Introduction to combinatorial problems and methods for handling intractable problems.
3. Introduction to nonlinear programming.
4. Introduction to network optimization.

Optimization techniques have many applications in science and engineering. To name a few:

- Optimal routing in communication networks.
- Transmission scheduling and resource allocation in sensor networks.
- Production planning and scheduling in manufacturing systems.
- Fleet management.
- Air traffic flow management by airlines.
- Optimal resource allocation in manufacturing and communication systems.
- Optimal portfolio selection.
- Analysis and optimization of fluxes in metabolic networks.
- Protein docking.

Prerequisites: Working knowledge of Linear Algebra and some degree of mathematical maturity.

Textbook: There is a required textbook for the course:
[BT] D. Bertsimas and J.N. Tsitsiklis, *Introduction to Linear Optimization*, Athena Scientific, 1997. It covers all the material we will cover except nonlinear programming. It is available at the BU bookstore but also through other vendors.

For the nonlinear programming part of the course we will use the lecture notes and
[Ber] D.P. Bertsekas, *Nonlinear Programming*, 3rd Edition, Athena Scientific, 2016.
You don't have to buy this book for the course, however you may want to, since it will be the textbook for the more advanced optimization course SE 724/EC 724.

Other books on these topics are:
[PS] C.H. Papadimitriou and K. Steiglitz, *Combinatorial Optimization: Algorithms and Complexity*, Prentice-Hall, 1982.
[Lue] D.G. Luenberger, *Introduction to Linear and Nonlinear Programming, (2nd Ed.)*, Addison-Wesley, 1984.
[BSS] M.S. Bazaraa, H.D. Sherali, and C.M. Shetty, *Nonlinear Programming: Theory and Algorithms (2nd Ed.)*, Wiley, 1993.
[Mur] K.G. Murty, *Linear Programming*, Wiley, 1983.

Grading:

1. 15% Homework.
2. 40% Mid-term.
3. 45% Final.

Rules of Conduct: You *may* collaborate in study groups on the solution of homeworks. You *must*, however, write up solutions on your own. If you do collaborate you *should* acknowledge your collaborators in the write-up for each problem (This as essential ! Note that it is not hard to guess who is working with whom.) Also, if you used other material in obtaining a solution (e.g., other books and papers) you *should* reference your source. The due day on homeworks is *strict*.

Course Material: Most of the course material will be posted on the Web. The URL for the course is `http://sites.bu.edu/paschalidis/` (under Courses).

LP Solver: Throughout the semester you can use gurobi (`http://www.gurobi.com/`), a commercial and very powerful LP solver. We will provide details in class on how you can access gurobi. You can also install gurobi on your machine: there is both a free academic license for BU machines and a free license for online courses which can be used anywhere but has some problem size limitations. The manual of gurobi is available at `http://www.gurobi.com/documentation/`. You can use the "command-line interface" for simple problems but also gradually familiarize yourselves with the callable library – the method of choice for anything but toy problems.

Syllabus (tentative)

1. Introduction and linear programming (LP) formulations.
2. Continue LP Formulations; Linear Algebra review; Polyhedra and convex sets.
3. Geometry of LP I.
4. Geometry of LP II.
5. Simplex method I.
6. Simplex method II.
7. Simplex method III.
8. LP Duality I.
9. LP Duality II.
10. LP Duality III.
11. Sensitivity analysis.
12. Parametric LP and a case study.
13. Mid-term exam.
14. Large Scale Optimization I.
15. Large Scale Optimization II and Nonlinear Programming (NLP) I.
16. NLP II.
17. NLP III.
18. Interior-point methods I.
19. Interior-point methods II.
20. Networks I.
21. Networks II.
22. Integer Programming (IP) I.
23. IP II.
24. A Case Study on the fleet assignment problem.