CS 691 - Optimization Methods in Finance

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1 General Information

(a) Instructor: K. Subramani.

(b) Meeting Times: Tuesday, 5:00 pm - 7:30 pm.
Location: 401 ESB-E.

(c) Contact Information: 749 ESB, k.subramani@mail.wvu.edu

(d) Office Hours: By appointment.

(e) Textbook - [CT07] is the main textbook. [IC93] is an excellent resource for linear programming.

(f) URL - http://www.csee.wvu.edu/~ksmani/courses/sp15/optfin/optfin.html.

(g) Assessment:

(a) Homework Assignments - You will be handed teo homework assignments. These assignments constitute 60% of your grade. Table (1) details the homework schedule.

Assignment Date	Submission Date
03/02	03/09
04/02	04/09

Table 1: Homework Schedule

(b) Presentations - You will be required to present allotted material. The presentations will be graded on the basis of clarity, comprehensiveness and effectiveness. The presentations will be worth 40% of your grade.

(c) Critique - You are required to critique a topic of your choice. The critique will be worth 20% of your grade.

(d) Additionally, students are encouraged to work on research projects. Research which results in publishable work will be credited with an **A**, regardless of the performance on homework assignments and presentation.

A maximum of 5 bonus points will be awarded for class performance.

(h) Grade Boundaries:

Grade	Boundary
A	80 and up
B	$65 - 79$
C	$50 - 64$
D	$45 - 49$
F	$0 - 44$

Table 2: Grade Boundaries

(i) Grading policy - If you have any questions about the grading, you must contact the instructor within two days of your paper being returned.

(j) Makeup Policy - If for some reason, you are unable to attend a test or an exam, please meet me at the earliest and I will set an alternate date.

(k) **Course Objectives** - The objectives of this course are as follows:

(a) To introduce rigorous models for financial analysis.

(b) To analyze models in linear programming, non-linear programming, quadratic programming, conic optimization, integer programming, dynamic programming, stochastic programming and robust optimization.

(c) To use and develop software that embodies the above techniques.

(l) **Learning Outcomes** - Upon successful completion of this course, students will be able to:

(i) Perform simple financial mathematics and analysis.

(ii) Rigorously analyze problems in various financial domains.

(iii) Use software to solve large-scale problems.

2 Syllabus

2.1 Mathematical Preliminaries

Vector algebra, Matrix algebra, Simultaneous equations, Convexity, Cones, Probability. This material will be covered from the appendix of [IC93] and Appendices A, B and C of [CT07].

2.2 Introduction

Optimization problems, Optimization with data uncertainty, Financial Mathematics. This material will be covered from Chapter 1 of [CT07].

2.3 Linear Programming - Theory and Models

The theory of linear programming, The Simplex Method, asset/liability cash-flow matching, asset pricing and arbitrage. This material will be covered from Chapters 2, 3 and 4 of [CT07].

2.4 Non-linear Programming - Theory and Models

Introduction, univariate optimization, unconstrained optimization, constrained optimization, volatility estimation. This material will be covered from Chapters 5 and 6 of [CT07].

2.5 Quadratic Programming - Theory and Models

The quadratic programming problem, optimality conditions, interior-point methods, portfolio optimization. This material will be covered from Chapters 7 and 8 of [CT07].

2.6 Conic Optimization - Theory and Models

Second-order cone programming, Semidefinite programming, tracking error and volatility constraints, arbitrage bounds for forward start options. This material will be covered from Chapters 9 and 10 of [CT07].

2.7 Integer Programming - Theory and Models

Modeling logical conditions, Solving mixed integer linear programs, constructing an index fund. This material will be covered from Chapters 11 and 12 of [CT07].

2.8 Dynamic Programming - Theory and Models

Introduction, The knapsack problem, Stochastic dynamic programming, option pricing, structuring asset-backed securities. This material will be covered from Chapters 13, 14 and 15 of [CT07].

2.9 Stochastic Programming - Theory and Models

Two-stage problems with recourse, Multi-stage problems, Decomposition, Scenario generation, Value-at-Risk and Conditional Value-at-Risk, asset/liability management. This material will be covered from Chapters 16, 17 and 18 of [CT07].

2.10 Robust Optimization - Theory and Models

Introduction, Uncertainty sets, Different flavors of robustness, multi-period portfolio selection, profit opportunities in risky portfolios, moment bound for option prices. This maerial will be covered from Chapters 19 and 20 of [CT07].

I would like to reiterate that this is a sketch of the topics that we will be covering. For various reasons, I may choose to drop a mentioned topic or cover a new topic. In such cases, advance notice will be given.

3 Academic Integrity Statement

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code at http://www.arc.wvu.edu/admissions/integrity.html. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me before the assignment is due to discuss the matter.

4 Inclusivity Statement

West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Accessibility Services (293-6700). For more information on West Virginia Universitys Diversity, Equity, and Inclusion initiatives, please see http://diversity.wvu.edu.

References

[CT07] Gerard Corneujols and Reha Tutuncu. *Optimization Methods in Finance*. Cambridge University Press, 1^{st} edition, 2007.

[IC93] James P. Ignizio and Tom P. Cavalier. *Linear Programming*. Prentice Hall, 1993.