Objective: This course introduces the students to mathematical models and computational methods for static and dynamic optimization problems occurring in finance. We shall discuss linear and non-linear optimization models of finance, dynamic (sequential) optimization, optimization under uncertainty, mathematical models of risk and their application. Additionally, duality theory and its use in economics and finance will be stresses. The students will be familiarized with concept of risk and risk-aversion. The models involve knowledge of probability, optimality conditions, duality, and basic numerical methods. Special attention will be paid to portfolio optimization and to risk management problems.

Prerequisites: Ma 230 Multivariate analysis and Optimization, Ma 222 Probability and statistics, or equivalent.

Main reference: Lecture Notes distributed in class.

Supplementary references (not required)

Time
Mondays 1:00 pm—2:40 pm. in Babbio 304
Thursdays 12:00 pm.—12:50 pm. in Babbio 221.

Place: Peirce 116.

Office hours:
In Peirce 302, Mondays 3—5pm. or by appointment.
Tel: (201) 216-8640.

Graded work: Eight homework assignments; two in-class examinations, a project, and a final exam. The final grade will be base on the following score:

0.25Homework + 0.2Tests + 0.15Project + 0.4Final Exam
### Plan of lectures

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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<tr>
<td>Aug 25</td>
<td>Review of linear programming optimality conditions and duality.</td>
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<tr>
<td>Aug 28</td>
<td>The economic meaning of Lagrange multipliers</td>
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<td>Sep 4</td>
<td>Non-arbitrage and state probabilities</td>
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<td>Sep 8</td>
<td>Matrix games</td>
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<td>Sep 11</td>
<td>Cash matching (dedication)</td>
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<td>Sep 15</td>
<td>Logical bounds; knapsack constraints; combinatorial optimization</td>
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<td>Sep 18</td>
<td>Bond portfolio duration and immunization</td>
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<tr>
<td>Sep 22</td>
<td>Non-linear optimization. Review of optimality conditions and duality</td>
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<td>Sep 25</td>
<td>Index funds (index tracking) and the use of combinatorial techniques</td>
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<tr>
<td>Sep 29</td>
<td>Examples</td>
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<td>Oct 2</td>
<td>Test 1</td>
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<tr>
<td>Oct 6</td>
<td>The concept of risk. Utility models</td>
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<td>Oct 9</td>
<td>Mean-variance portfolio models</td>
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<td>Oct 14&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Two-fund and one-fund theorems</td>
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<td>Oct 16</td>
<td>Value at risk</td>
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<td>Oct 20</td>
<td>Conditional value at risk</td>
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<td>Oct 23</td>
<td>Coherent measures of risk</td>
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<td>Oct 27</td>
<td>Duality for coherent measures of risk</td>
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<td>Oct 30</td>
<td>Optimization with coherent measures of risk</td>
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<td>Nov 3</td>
<td>Stochastic dominance relation</td>
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<td>Nov 6</td>
<td>Relations to utility theories and measures of risk</td>
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<td>Nov 10</td>
<td>Test 2</td>
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<td>Nov 13</td>
<td>Dynamic optimization problems; sequential decision making</td>
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<td>Nov 17</td>
<td>Belman principle and dynamic programming equation</td>
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<td>Nov 20</td>
<td>Dynamic programming algorithms</td>
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<td>Nov 24</td>
<td>Discounted and undiscounted models</td>
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<td>Dec 1</td>
<td>Risk-neutral option pricing as optimal stopping problem</td>
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<tr>
<td>Dec 4</td>
<td>Asset-liability management.</td>
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<sup>1</sup> Tuesday with Monday-class schedule