COURSE DESCRIPTION

We introduce basic concepts and tools in nonlinear optimization such as convexity, the Karush-Kuhn-Tucker optimality conditions, and duality. We then discuss various algorithms in the context of machine learning. These include gradient- and descent-based methods. Also, we touch on topics such as online and stochastic gradient methods.

COURSE MATERIALS (texts to be referenced)


Check Blackboard ([blackboard.rutgers.edu](http://blackboard.rutgers.edu)) and your official Rutgers email account regularly.

LEARNING GOALS AND OBJECTIVES

This course is designed to help students develop skills and knowledge in the areas of mathematical programming and nonlinear optimization. These are acquired through in-class learning, homework exercises, and projects. Students who complete this course will demonstrate abilities to formulate real-life problems into optimization problems and apply optimization techniques to solve the problems.

PREQUISITES

Students need to have basic knowledge about calculus and linear algebra.

ACADEMIC INTEGRITY


I will strongly enforce this Policy and pursue all violations. On all examinations and assignments, students must sign the RU Honor Pledge, which states, “On my honor, I have neither received nor given
any unauthorized assistance on this examination or assignment.” Don’t let cheating destroy your hard-
earned opportunity to learn. See business.rutgers.edu/ai for more details.

ATTENDANCE AND PREPARATION POLICY

Expect me to attend all class sessions. I expect the same of you. If I am to be absent, my department
chair or I will send you notice via email and Blackboard as far in advance as possible. If you are to be
absent, report your absence in advance at https://sims.rutgers.edu/ssra/. If your absence is due to religious
observance, a Rutgers-approved activity, illness, or family emergency/death and you seek makeup work,
also send me an email with full details and supporting documentation one week ahead of the occurrence.

For weather emergencies, consult the campus home page. If the campus is open, class will be held.
Expect me to arrive on time for each class session. I expect the same of you. Expect me to remain for the
entirety of each class session. I expect the same of you. Expect me to prepare properly for each class
session. I expect the same of you. Complete all background reading and assignments. You cannot learn
if you are not prepared. Expect me to participate fully in each class session. I expect the same of you.
Stay focused and involved. You cannot learn if you are not paying attention.

CLASSROOM CONDUCT

Cell phones or any other course-unrelated electronic devices are banned from class.

EXAM DATES AND POLICIES

There are two exams in this course:
- Final Exam: December 13, closed book.

During exams, the following rules apply:
- You are allowed a one-page cram sheet (letter size, front and back) of your own handwriting.
- If you have a disability that influences testing procedures, provide me an official letter from the
  Office of Disability Services at the start of the semester.
- No cell phones or other electronics are allowed in the testing room.
- Alternate seating; do not sit next to another student or in your usual seat.

GRADING POLICY

Two homework assignments at 20 points each (40 points in total)
- One mid-term exam at 30 points
- One final exam at 30 points

The proposed letter grade assignment is as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>0—29.999</td>
</tr>
<tr>
<td>D</td>
<td>30—49.999</td>
</tr>
<tr>
<td>C</td>
<td>50—64.999</td>
</tr>
<tr>
<td>C*</td>
<td>65—69.999</td>
</tr>
</tbody>
</table>
B  70—84.999
B’  85—89.999
A  90—100

Please submit a pdf file of your HW answers to the Blackboard System. Late assignments will be penalized 20 points (on the 100 point scale) if turned in up to ONE week late. Assignments in excess of ONE week late will not be accepted. There will be no makeup exam, nor extra credit. Your final grade is not subject to negotiation.

If you feel I have made an error, submit your written argument to me within one week of receiving your final grade. Clarify the precise error I made and provide all due supporting documentation. If I have made an error, I will gladly correct it. But I will adjust grades only if I have made an error. I cannot and will not adjust grades based on consequences, such as hurt pride, lost scholarships, lost tuition reimbursement, lost job opportunities, or dismissals. Do not ask me to do so. It is dishonest to attempt to influence faculty in an effort to obtain a grade that you did not earn, and it will not work.

COURSE SCHEDULE (Tentative Course Progress)

<table>
<thead>
<tr>
<th>Date</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 6</td>
<td>1: Linear Algebra and Unconstrained Optimization</td>
</tr>
<tr>
<td>September 13</td>
<td>2: Optimality Conditions for Linear Constraints</td>
</tr>
<tr>
<td>September 20</td>
<td>3: General KKT Optimality Conditions</td>
</tr>
<tr>
<td>September 27</td>
<td>4: Zero-sum Game, Geometry, and Duality</td>
</tr>
<tr>
<td>October 4</td>
<td>5: Various Nonlinear Programming Methods</td>
</tr>
<tr>
<td>October 11</td>
<td>Problems and Review; <strong>HW1</strong> due</td>
</tr>
<tr>
<td>October 18</td>
<td>6: Support Vector Machine</td>
</tr>
<tr>
<td>October 25</td>
<td><strong>MID-TERM EXAM</strong></td>
</tr>
<tr>
<td>November 1</td>
<td>7: Convexity and Related Properties</td>
</tr>
<tr>
<td>November 8</td>
<td>8: Conjugate and Convex Duality</td>
</tr>
<tr>
<td>November 15</td>
<td>9: Machine Learning and Convex Optimization</td>
</tr>
<tr>
<td>November 22</td>
<td><strong>No Class; Friday schedule due to Thanksgiving</strong></td>
</tr>
<tr>
<td>November 29</td>
<td>10: Online and Stochastic Gradient Methods</td>
</tr>
<tr>
<td>December 6</td>
<td>Problems and Review; <strong>HW2</strong> due</td>
</tr>
<tr>
<td>December 13</td>
<td><strong>FINAL EXAM</strong></td>
</tr>
</tbody>
</table>
SUPPORT SERVICES


If you are a military veteran or are on active military duty, you can obtain support through the Office of Veteran and Military Programs and Services. http://veterans.rutgers.edu/

If you are in need of mental health services, please use our readily available services. Rutgers University-Newark Counseling Center: http://counseling.newark.rutgers.edu/
[Rutgers Counseling and Psychological Services – New Brunswick: http://rhscaps.rutgers.edu/]

If you are in need of physical health services, please use our readily available services. Rutgers Health Services – Newark: http://health.newark.rutgers.edu/
[Rutgers Health Services – New Brunswick: http://health.rutgers.edu/]

If you are in need of legal services, please use our readily available services: http://rusls.rutgers.edu/

If you are in need of additional academic assistance, please use our readily available services. Rutgers University-Newark Learning Center: http://www.ncas.rutgers.edu/rlc
Rutgers University-Newark Writing Center: http://www.ncas.rutgers.edu/writingcenter
[Rutgers University-New Brunswick Learning Center: https://rlc.rutgers.edu/]