Course Name and Number: DATA 609 – Mathematical Modeling Techniques for Data Analytics
Credits: 3 cr.
Prerequisite(s): DATA 600 – Information and Systems;
DATA 605 – Fundamentals of Computational Mathematics;
DATA 606 – Statistics and Probability for Data Analytics.

Course Description: In this course students will learn mathematical methods for understanding data relationships and for system optimization. Mathematical modeling techniques for representing a complex system will be presented. Topics to be covered include difference, system of differential equations, linear (LP) and non-linear programming (NLP); algorithmic search methods for optimization; integer programming (IP), branch and bound, and their uses. Use of modeling packages will be stressed. Examples will be used from actual systems. In addition, students will be expected to explain their models, reports, and analyses in plain and easy-to-understand language.

Course Learning Outcomes:

By then end of the course, students should be able to:

- Learn linear programming models and theory; understand simplex method and apply to LP models; understand duality; be able to perform sensitivity analysis;
- Be able to formulate integer programming models; understand and apply branch and bound technique;
- Learn quadratic and nonlinear program models; know 2nd order condition and apply to QP; learn steepest descent method;
- Learn how to use commercial and free optimization tools.

Program Learning Outcomes addressed by the course*:*

- Business Understanding. Apply frameworks and processes to build out data analytics solutions from understanding of business goals.
- Solid foundational data programming skills, using industry standard tools, essential algorithms, and design patterns for working with structured data, unstructured data and big data.
- Solid foundational math and statistics skills, with emphasis on linear algebra, probability, Bayesian statistics, and numerical methods.
- Data understanding. Collect, describe, model, explore and verify data.
- Data preparation. Selecting, cleaning, constructing, integrating, and formatting data.
- Optimization Modeling. Selecting optimization modeling techniques, generating test designs, building and assessing models.
- Model implementation and deployment. Machine learning
- Presentation. Evaluating and communicating results.

How is this course relevant for IS professionals?

Math modeling and optimization technics are essential for data analytics problems. It is the foundation for some problems that we will come across in linear regression, machine learning, and data mining fields. With understanding of math modeling techniques, IS and Data Analytics professionals would be able to solve many more real problems more efficiently and effectively.

Assignments and Grading:

Participation (online discussion forums and communication with fellow students)*	**14%**
Assignments (seven, equally weighted)**	**56%**
Course Project (one project, team of 1/2)**	**30%**
TOTAL	**100%**

* Please actively participate in the online discussion at least once every two weeks about the homework, or some discussion topics that the instructor provided, or projects. Please have at least **one substantial discussion every week** (10 discussions are expected. week 0 (getting to know you, finish by end of week 1) + week 1 – 9, express your views on the topic in discussion extensively) post in the discussion forum in order to get full mark. It can be a continuation of a stream that other students started, i.e., encouraging you to have more interaction, communication, and discussion through the forums.
** Note that please do not submit your homework by email, please submit through the blackboard system. For each of the homework, only need to finish **four (or two)** selected problems of your own choice on the assigned list (**two from each week's list (1 from week 14 and week 15's lists)**). Extra credits will be awarded to students who solved more problems (up to 20% for each homework). There will be seven homework. Note that only **three homework** will be selected randomly to be graded. **The non-graded homework will be given a 100% grades** if you submit on time. Solutions will be provided for all homework.

*** **Project description** is attached in the syllabus as well as in the blackboard system.

- Project proposal by end of week 11 (<1 page) (worth **10%** of project grade)
- Project presentation slides due in week 16th by the EOD of the presentation day (worth **10%** of project grade)
- Project presentation starts in week 16th class (worth 30% of project grade)
- Final project report (end of week 16th, 11:59pm EST, worth **50%** of project grade)

Quality of Performance	Letter Grade	Range %	GPA/ Quality Pts.
Excellent - work is of exceptional quality	A	93 - 100	4.0
	A-	90 - 92.9	3.7
Good - work is above average	B+	87 - 89.9	3.3
Satisfactory	B	83 - 86.9	3.0
Below Average	B-	80 - 82.9	2.7
Poor	C+	77 - 79.9	2.3
	C	70 - 76.9	2.0
Failure	F	< 70	0.0

Required Texts and Materials:

A First Course in Mathematical Modeling, 5th Edition. Frank R. Giordano, William P. Fox, Steven B. Horton. ISBN-13: 9781285050904

Supplemental Texts and Materials:

Practical Optimization: A Gentle Introduction
http://www.sce.carleton.ca/faculty/chinneck/po.html
Online book by Professor John W. Chinneck

Relevant Software, Hardware, or Other Tools:

Course will be using R for some of the computational homework and projects.
Please download and install R from here:
http://cran.r-project.org/

My Contact Information:

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You are encouraged to ask me questions on the "Ask Your Instructor" forum on the course discussion board where other students will be able to benefit from your inquiries. I am available by email (haiyuan.wang@sps.cuny.edu). We can also set up a Skype session for screen share. For the most part, you can expect me to respond to questions by email within 24 to 48 hours. If you do not hear back from me within 48 hours of sending an email, please resend your message.

Course Outline:

Unit	Topic	Readings	"To Do"
Week #1 **Jan 27 – Feb 4**	**An introduction to modeling and review of integration techniques**	Course Site Features of Blackboard Giordano et al: Chapter 1 & Appendix D	**Blackboard discussion homework 1 is due by EOW (Sunday 11:59pm)**
Week #2 **Feb 5-11**	**Modeling process, proportionality, and geometric similarity**	Giordano et al: Chapter 2	
Week #3 **Feb 12-18**	**Model fitting and experiment modeling**	Giordano et al: Chapter 3 & 4	**Blackboard discussion homework 2 is due by EOW (Sunday 11:59pm)**
Week #4 **Feb 19-25**	**Simulation modeling**	Giordano et al: Chapter 5	
Week #5 **Feb 26-Mar 4**	**Discrete probabilistic modeling**	Giordano et al: Chapter 6	**Blackboard discussion homework 3 is due by EOW (Sunday 11:59pm)**
Week #6 **Mar 5-11**	**Linear programming (LP) - problems, formulations and geometric interpretation, simplex method and sensitivity analysis**	Giordano et al: Chapter 7	
Week #7 **Mar 12-18**	**Modeling using graph theory**	Giordano et al: Chapter 8	**Blackboard discussion homework 4 is due by EOW (Sunday 11:59pm)**
Week #8 **Mar 19-25**	**Modeling with decision theory**	Giordano et al: Chapter 9	
Week #9 **Mar 26-April 1**	**Game theory**	Giordano et al: Chapter 10	**Blackboard discussion homework 5 is due by EOW (Sunday 11:59pm)** **Project proposal by EOW of week 11 (Sunday 11:59pm)**
Week #10 **April 2-8**	**Spring Break**		
Week #11 **April 9-15**	**Modeling with a differential equation**	Giordano et al: Chapter 11	
Week #12 **April 16 - 22**	**Modeling with systems of differential equations**	Giordano et al: Chapter 12	**homework 6 is due by EOW (Sunday 11:59pm)**
Week #13 **April 23 – 29**	**Optimization of continuous models, nonlinear programming (NLP)**	Giordano et al: Chapter 13	
Week #14 **Apr 30 – May 6**	**Graphs of functions as models**	Giordano et al: Chapter 15	**homework 7 is due by EOW (Sunday 11:59pm)**
Week #15 **May 7 – 13**	**Integer programming (IP)**	Chinneck: Chapter 12	
Week #16 **May 14 - 20**	**Final Project**		**Project presentation slides due by EOD of the class on week 16th** **Project presentation in class on week 16th** **Final project report due by end of week 16th**

ACCESSIBILITY AND ACCOMMODATIONS

The CUNY School of Professional Studies is firmly committed to making higher education accessible to students with disabilities by removing architectural barriers and providing programs and support services necessary for them to benefit from the instruction and resources of the University. Early planning is essential for many of the resources and accommodations provided. Please see:
http://sps.cuny.edu/student_services/disabilityservices.html

ONLINE ETIQUETTE AND ANTI-HARASSMENT POLICY

The University strictly prohibits the use of University online resources or facilities, including Blackboard, for the purpose of harassment of any individual or for the posting of any material that is scandalous, libelous, offensive or otherwise against the University's policies. Please see:
http://media.sps.cuny.edu/filestore/8/4/9_d018dae29d76f89/849_3c7d075b32c268e.pdf

ACADEMIC INTEGRITY

Academic dishonesty is unacceptable and will not be tolerated. Cheating, forgery, plagiarism and collusion in dishonest acts undermine the educational mission of the City University of New York and the students' personal and intellectual growth. Please see: http://media.sps.cuny.edu/filestore/8/3/9_dea303d5822ab91/839_1753cee9c9d90e9.pdf

STUDENT SUPPORT SERVICES

If you need any additional help, please visit Student Support Services:
http://sps.cuny.edu/student_resources/

Course Name and Number: ISDA 609 - Mathematical Modeling Techniques for Data Analytics

Course project description

Select any phenomena or real world or a business problem of your choice, apply two mathematical modeling techniques to the problem, and present your findings clearly in your report. Compare the two methods, if possible.

Project team
Each team will consist of two members. You can also choose to work on the project by your own, or a team of three or four. Rule of thumb is if you are working by yourself, please try one method that we discussed in class. If you are a team of two, please try two methods that we discussed in class. If you are a team of three or more, you can try two methods discussed in class (hopefully more depth of analysis).

Project schedule

- Form team by end of week 11 and submit proposal bye end of week 11 (11:59pm EST) (worth 10% of project grade)
- Project presentation slides due by the EOD of class in week 16th (worth 10% of project grade)
- Project presentation starts in week 16th class (worth 30% of project grade)
- Final project report (end of week 16th, 11:59pm EST, worth 50% of project grade)

Project presentation
The presentation shall be less than 5-10 minutes for each team.

Project report
Feel free to explain the problems you are trying to solve in your project final report. It will be great if some of the following questions/issues will be addressed:

- Analysis of the problem.
- The methodology you used.
- Details of the methodology
- The findings from the project.
- Are they different from your initial expectation? If so, is there a suitable explanation?

Meeting time (8:00-8:50 PM EST on the following Wednesdays):

1/31/2018
2/14/2018
2/28/2018
3/14/2018
3/28/2018
4/11/2018
4/25/2018
5/16/2018 (project presentation)

Office Hours meeting **time (Please email for your questions, can also schedule one to one meetings online as needed)**

Please join my meeting from your computer, tablet or smartphone. (will update)
https://global.gotomeeting.com/join/464845685

You can also dial in using your phone.
United States: +1 (646) 749-3131
Access Code: 464-845-685