ISyE 4034-A (Decision and Data Analytics (DDA))

1. Instructor: Dr. Jye-Chyi (JC) Lu
2. Lecture Hours and Location: Tu, Th 9:30 – 10:45 am
3. **Location: MRDC (Manufacturing Related Disciplines Complex) #2404 (to be confirmed)**
4. **Course CRN: to be posted on oscar.gatech.edu every semester**
5. Pre-requisites: Introductory Statistics, Introductory Regression, and Introductory Database background.
6. **Catalog Description**: Integrate decision and data analytics together to solve real-world business problems. Hands-on system modeling, data collection, analysis and interpretation, and **writing project reports.**

7. Recommended Books for Self-Reading (not the textbook): This course will *train* students to find relevant and creditable materials from possible sources in textbooks, past lecture notes, publications, and online searches, etc. Many *examples* are given in our *Canvas web pages*. However, the following few books provide some basics: Business Analytics by J. R. Evans (2012), Competing on Analysis: New Science of Winning by T. H. Davenport and J. E. Harris (2007), An Introduction to Statistical Learning with Applications in R (or Python) by James, G. Witten, D., Hastie, T. and Tibshirani, R., Data, Models, and Decisions by Bertsimas, D. and Freund, R.

8. Office hours: 10:55 am – 11:55 am (and by appointments) Tu, Th. At Groseclose #333.
9. Email: jclu@isye.gatech.edu (JCLU) – This is the main contact.
10. Software package: Any software including Minitab (available in the ISyE undergraduate lab) and R (free) package -can be downloaded at http://cran.r-project.org/ Students need to find optimization software themselves.
11. **Course description**: Class materials will be divided into the following five components:

    1) Problem Formulation (Business Goal(s) and Analytics Goal(s))
        a) Linking Business Analytics Goals to Decision-Data-Analytics (DDA) Processes
    2) Data Analytics Methods and Tools
        a) Descriptive Analytics (Statistical Procedures, Data Mining Tools)
        b) Predictive Analytics (Regression Modeling, Forecasting, Simulation)
        c) Statistical and Data Mining Software Packages
    3) Decision Analytics – Prescriptive Analytics Procedures
        a) Various Optimization Techniques
        b) Formulation of Optimization Model Supporting Real-world Applications
        c) Optimization Algorithms and Software Packages
    4) Data Preparation and Application Examples of DDA
        a) Guidelines for Dealing with Various (Unstructured) Data Types
        b) Data Extraction, Cleaning, Segmentation and Summary
        c) Application of DDA Tools, Interpretation and Assessment
    5) DDA Process Integration, System Dynamics and Automation

12. Topical Outline:

Topics	Weeks
Basic decision and data analytics 1. Introduction, DDA project problem and goal formulations with real-world examples, step-by-step guidelines for constructing decision and data analytic models, linkage between decision and data analytics. 2. Statistical modeling techniques, multiple linear regression, computing techniques in nonlinear regressions, generalized linear model. 3. Decision optimization modeling, nonlinear programming, multi-objective optimization and optimization in an uncertain environment. 4. Formulation of a statistical learning problem as an optimization/decision problem	5
In-depth decision and data analytics, project execution details 5. Data sourcing APIs and data collection methods; classification methods including discriminant analysis, support vector machine and decision trees 6. Unsupervised learning including cluster analysis, Gaussian mixture model, dimension reduction and principal component analysis, regression with regularizations, association rules and link analysis 7. Economic decision and game theoretic models for logistics, supply chain, health systems and other applications. 8. Practical issues, analytic problems from student projects.	6.5
Advanced decision and data analytics, project completion 9. Artificial neural network, boosting, random forest, reinforcement learning, deep learning, and generalized additive models 10. Big data analytics with high dimensional variable selections 11. AI oriented business analytics, real world examples on novel DDA initiatives, especially technical DDA procedures, project presentations	3.5
Total	15

13. Exams: There will be a total of 60% credits for ***two in-class exams*** **each with 30%** course grades. Subjects include: (1) data analytics and computing and (2) decision and optimization modeling/analytics.

14. In-Class Random Quizzes: Past exam grades were shown to be highly correlated with the #attendances for lectures. To encourage students to attend lectures, we will conduct in-class quizzes randomly and discuss their solutions in lectures. Ten percent of "extra-credit" exam grades will be allocated to quizzes.

To clarify, if a student attended **two quizzes** before Exam-1, he/she only needs to work on 90% of the exam problems. If this student scores perfectly in these two quizzes and 90% exam problems, he/she will get 100% grades. During the exam, this student can work on all exam problems, but make mistakes for losing 10% points, or work on 90% problems and score all grades from these 90% problems. In either case, this student will get a 100% grade for this exam.

15. **Two Mini-Projects** (**reading assignments** with teammates): MP-1 (**5%**) and MP-2 (**3%**).

16. **Two TEAM Computer Projects: CP-1 (7%) and CP-2 (6%).**

17. **Semester Projects:** There will be ***ONE semester project*** with **16**% credits (13% for the report and 3% for PPT and presentation). Students will form their own **teams**, and work with the instructor on pre-structured projects.

    Note that this semester, our semester project will emphasize instilling **entrepreneurial confidence** in students and encourage them to launch *successful* startups. This is aligned with the mission in Georgia Tech's CREATE-X projects. The projects will include formulations of "business" and DDA goals, data analysis strategies, illustrative examples of data analysis procedures, optimization models and solutions, and finally DDA system's workflow architectures and Web information collection and posting (see MP-1 for details). Guidelines will be provided on Canvas. Milestones for submitting partial project results will be planned.

18. **Class Attendance and Instructional Survey: *Nine* attendance checks with a total of 2% credits (students are allowed to miss up to *three* attendance checks without providing any reason to Dr. Lu); 1% is allocated for the instructional survey.**

19. **Letter Grade Decisions: A for (100, 92], B for (92, 85], C for (85, 75], D for (75, 60]**, F for below 60 semester scores. If a student's semester score falls into a border of two letter-grade regions (e.g., [92.500 – 92.999], attendance records will be used to decide student's letter grade.

20. **Outcomes and their Relationships to ISyE Program Outcomes:**

At the end of this course, students will be able to:

1. Formulate real life problems into business and analytics goals using business analytics procedures.
2. Construct decision and optimization mathematical models to meet the business and analytics goals formulated. Understand the assumptions and limitations of the decision models.
3. Establish data-analytic models to meet the needs of decision and optimization models. Understand the assumptions and limitations of data-analytic models.
4. Collect appropriate data to estimate data-models and understand which data are useful in solving the problem. Use statistical software to estimate models from real-life data.
5. Employ decision and optimization software to solve decision problems.
6. Understand issues involved in system dynamics and tool-integration for making the developed system sustainable.
7. Experience how to work in a team environment efficiently and effectively to prepare semester project reports and presentation slides.

Course outcome \ Program Outcomes	1. identify, formulate solve engg prob by engg, sci & Math	2. produce solutions consider public health, safety, welfare, global, cultural, social, environ & economic	3 communicate with a range of audience	4 recognize ethical & professional responsibilities, make informed judgement consider resolutions in global, economic, environ and societal	5. effective on a team provide leadership, collaborative and inclusive envirn, plan tasks & meet objectives	6. develop and conduct experiment, analyze and interpret data & use engineering judgement to draw conclusions	7. acquire and apply new knowledge using appropriate learning strategies
1. Formulate real life problems into business and analytics goals	H						
2. Construct decision and optimization models to meet business and analytics goals. Understand assumption and limitations.	H						
3. Establish data analytic models to meet needs of decision and optimization models.	H						
4. Collect appropriate data to estimate parameters in data models, use statistical software to build and validate models.						H	
5. Employ decision and optimization software to solve decision problems.							
6. Understand issues in system dynamics and process integration for sustainable systems							

7. Experience how to work in teams efficiently and effectively in developing report and presentation.			H		H		

Evaluation of the important outcomes

Course outcomes 1, 2, 3, 7 will be assessed from the term project.

21. Information on services from the Office of Disability Services**:**

    The Office of Disability Services collaborates with students, faculty, and staff to create a campus environment that is usable, equitable, sustainable, and inclusive of all members of the Georgia Tech community. The Disability Services Testing Center is a proctoring resource for faculty and students connected with Disability Services.

    Prior to scheduling any exams with the Testing Center, the student must:

    - Email Dr. Lu the Faculty Notification Letter
    - Meet with and discuss the provision of accommodation with the instructor

22. Please review the reference for the Georgia Tech Honor Code and Student-Faculty Expectations Agreement **by clicking on the documents underlined here.**

23. **Changes after the first week should be made before the last day to withdraw with a W grade.**

24. **Incomplete grade:** For the incomplete grade, the student must finish most of the assignments and tests and having a passing grade but unable to complete the final part of the class due to NON-ACADEMIC reasons can be assigned an "I".