

ISYE 4034 DECISION AND DATA ANALYSIS

Concentration Depth elective for Analytics and Data Science

Credit: 3-0-3

Prepared Profs. Xiao Liu, JC Lu Fall 2025

Prerequisite(s): ISYE 3133 Engineering optimization, CS 4400 Intro to Data Base. ISyE 4031 Regression and Forecasting with concurrency.

Textbook

Business Analytics by J. R. Evans (2012)

Additional Reference Books:

An Introduction to Statistical Learning with Applications in R by James, G. Witten, D., Hastie, T. and Tibshirani, R.

An Introduction to Statistical Learning with Applications in Python by James, G. Witten, D., Hastie, T. and Tibshirani, R.

Data, Models, and Decisions by Bertsimas, D. and Freund, R.

Catalog Description:

Integrate decision and data analytics together to solve real-world business problems. Hands-on system modeling, data collection, analysis and interpretation, and reporting writing projects.

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

Topical Outline (can we shorten this? JC: I have done some shortening. Please review them.)

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	4
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	4.5
Total	15

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 technically;
2. Construct decision and optimization mathematical models to meet business and analytics goals. Understand assumption and limitations of decision models;
3. Establish data-analytic models to meet needs of decision and optimization models. Understand assumption and limitations of data-analytic models;
4. Collect appropriate data with APIs to estimate parameters in data-models. Use statistical software to build and validate models;
5. Employ decision and optimization software to solve decision problems;
6. Understand issues involved in system dynamics and process 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 context.	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						H	

software to build and validate models.							
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.