Georgia Institute of Technology/School of Industrial and Systems Engineering

**ISyE 4034 Decision and Data Analytics**

**3-0-3**

**Instructor - Professor Jye-Chyi Lu**

E-mail: JCLU@isye.gatech.edu; Office: Groseclose #312

Class days: MWF/time: 10:05 – 10:55 am MWF/place: MRDC #2404

Office hours: 11:10 am – 12:30 pm, MWF or by appointment

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

# Prerequisites: ISyE 3133: Engineering Optimization; CS 4400 – Introduction to Database Systems; Prerequisites with concurrency: ISyE 4031: Regression and Forecasting.

# Course Outcomes: By the end of this course, the students are 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 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 excellent semester project reports and presentation slides.

# Recommended Textbook: Business Analytics by J. R. Evans (2012)

# Additional sources: Competing on Analysis: New Science of Winning by T. H. Davenport and J. E. Harris (2007); Course materials posted on T-square.

**Grading:**

All exams and assignments will follow the honor codes developed in Georgia Tech. For examples,

Georgia Tech Honor Code and Student-Faculty Expectations

Georgia Tech student developed Honor Code: http://osi.gatech.edu/content/honor-code

Georgia Tech student and faculty developed Student-Faculty Expectations: http://www.catalog.gatech.edu/rules/22/

Homework and project policy: Students should not work with people outside of their own group. It will be considered as cheating.

1. *Two exams,* 22% each. Subjects include data analytics and decision/optimization analytics.

Absence of Exam(s): We only accept notifications from Dean’s office or Institute Approved Absences <http://www.registrar.gatech.edu/students/formlanding/iaabsences.phpor>. Since it is difficult to create a different but fair test, the solution is typically not a makeup test but with other arrangement such as working on a separate project without other student’s involvement.

Regrade Policy: no regrades are considered after one week beyond the grades are published.

1. *Four team homework assignments,* 5% each. Subjects include

(1) Statistics/Data-Mining procedures/Tools (due the third week of a semester),

(2) Optimization procedures/Tools (due the sixth week of a semester),

(3) Dynamic Decision-Analytics Modeling (due the ninth week of a semester), and

(4) Integration of Decision-and Data-Analytics (due the twelfth week of a semester).

1. O*ne semester team project*, 33%. 26% for quality and report and 7% for presentation. Guidelines will be provided in T-square. There are about nine milestones for submitting partial project results.
2. *Eight* *attendance checks* 0.5%. Two missing attendance can be dropped for total of 3%.

**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

# Georgia Tech Honor Code and Student-Faculty Expectations: Georgia Tech Academic Honor Code and Student Code of Conduct are available online at www.honor.gatech.edu.

**Schedule of Topics:**

There are 15 full weeks for lecture and project studies.

1. **Block-1 (4 weeks): Basic Decision- and Data-Analytics; Project Problem and Model Formulations**

**Week-1:** (1) Course introduction, Lecture outline and project assignments;

(2) Review of past projects focusing on goal formulation and DDA system architecture;

(3) Overview of data analytics methods and tools.

**Week-2:** (1)Statistical modeling techniques, e.g., multiple linear regression, nonlinear regression and generalized linear model, EWMA and time-series forecasting;

(2) Link data-analytics goal(s) to specific statistical modeling and analysis procedures.

**Week-**3: (1) Decision optimization modeling techniques, e.g., linear programming, integer and mixed-integer programming, nonlinear programming;

(2) Link decision-analytic goal(s) to specific optimization modeling and solution procedures.

**Week-**4: Real-world examples focusing on (1) problem and goal formulations; (2) step-by-step guidelines for constructing decision- and data-analytic models; (3) linkage between decision- and data-analytics.

1. **Block-2 (6 weeks): In-depth Decision- and Data-Analytics; Project Execution Details**

**Week-5:** (1) Discussion of data sources and data collection methods;

(2) Classification and additive models including decision trees.

**Week-6:** (1) Cluster analysis, dimension reduction, association rules and link analysis;

(2) Support vector machine.

**Week-7:** (1) Economic decision models for logistics, supply chain management, health system and other applications;

(2) Game theory based supply-chain contract decision models.

**Week-8:** (1) Multi-objective optimization, decision in uncertain environments;

(2) Nonlinear, dynamic and stochastic optimizations.

**Week-9:** (1) Continuation of Week-8 subjects;

(2) Problem and issues in decision- and data-analytics integration;

(3) Solution methods for integrated decision-data-analytics.

**Week-10:** (1) Practical issues (e.g., data extraction, organization, manipulation, validation and software usage for modeling) in decision-data-analytics;

(2) Analytics problems from student projects.

1. **Block-3 (5 weeks): Advanced Decision- and Data-Analytics; Project Completion Details**

**Week-11:** (1) Business analytics system integration and system dynamics (e.g., model assumption validation and remedies);

(2) Model assessment and averaging (e.g., bagging, boosting and random forest).

**Week-12:** (1)Step-by-step guidelines for projectreport and presentation slide preparation; Lesson learned from past project studies;

(2) Non-standard real-world problems for decision- and data-analytics, e.g., pop-up store procurement with advanced-information-forecasting and sequential decision-analytics.

**Week-13:** (1)More on dimension-reduction focusing on recent advance on variable-selection for a huge number of explanatory variables.

(2) Monitoring progress on project studies

**Week-14:** (1)More on decision-data-analytics focusing on large-scale computing issues for dynamic optimization with updates of information forecast

(2) Provide guidance for semester-project report writing starting with planning outlines of presentation slides. Illustration with past reports and slides.

**Week 15:** (1)Look into future of business analytics. Provide real-world examples on novel initiatives and link them to course contents, especially technical DDA procedures.

(2) Two 50-minute lectures will be devoted to student project presentation for sharing course-learning experience.