

**ISE 533: Integrative Analytics**  
**Spring 2023 (Jan. 10 – April 27)**  
**Class Schedule: T, Th: 9:30 am – 10:50 am**  
**Location: SOS B4**

**Instructor: Suvrajeet Sen**  
**Office: Zoom**  
**Office Hours: T, Th: 11:30 am – 12:30 am**  
**Contact Info: s.sen@usc.edu**

**TA: Di Zhang (dzhang22@usc.edu)**  
**Office Hours:**  
**Course Producer: Wanning Li**

## Course Description

This course is intended to bring the three pillars of analytics (descriptive/predictive, prescriptive, and validation) together under one integrated framework. This will be achieved via projects from several application areas such as energy, communications, finance, supply-chain and inventory, and others.

## Learning Objectives

As the name suggests, this course has two objectives. It is principally devoted to “Analytics” and its scope is “Integrative”. What this means is that we will present several seemingly disparate tools, such as programming concepts from *Python*, data analysis concepts such as *Regression*, and decision models based on *Optimization* with the intent of building models which will help students understand the “workflow” necessary for a project requiring a spectrum of methods. This one-of-a-kind course is intended to highlight the integrative features within the lifecycle of an analytics project. A week-by-week plan appears next.

Week	Topics	Sources	Due Dates
1.1 (1/10)	<b>Overview and Optimization for Decisions</b>	<b>Emphasis on Projects</b> Reading: Jeff Camm Paper “How to Influence and Improve Decisions Through Optimization Models”	
1.2 (1/12)	Stochastic Optimization as Linear Programming	Examples in Nested Inventory: Transition from Deterministic to Stochastic Optimization Models	HW1 Assigned (Camm18 Problems)
2.1 (1/17)	Julia-Based Optimization Modeling	Yihang’s version of SLP code using Julia	
2.2 (1/19)	Stochastic Programming for Nested Inventory	Nested Inventory Paper, <i>Operations Research 1999</i> (BAA99)	<b>HW1 Due (Camm18 Problems)</b> HW2 Assigned (BAA99 With a Few Outcomes )
3.1 (1/24)	Decision Science Model	Two-stage Formulations for SP using Decomposed Setup And Implementation of Decomposed SP using Julia	

3.2 (1/26) (Di Zhang Lecture)	The Traditional Diet Problem and Meal Planning Problem	Diet Problems, see Garrille-Gass, 2001 <i>Operations Research</i> , and <i>INFORMS Tutorials 2018</i> (DengLiuSen18)	Portfolio Project 1 Introduction
4.1 (1/31)	Recipe- Selection for Meal Planning	a) Recommender Systems b) Discussion of Individual Creativity: Data, Methods, Applications	<b>HW 2. Due (BAA99 With a Few Outcomes )</b> HW3 Assign- ed (BAA 99 with Discretized Normal)
4.2 (2/2)	Data Science Technology	Data Sources and Web Scraping see <a href="https://core.isrd.isi.edu/">https://core.isrd.isi.edu/</a>	
5.1 (2/7)	Decision Science with Simulation- Optimization (Concepts)	Simulation Optimization and Transshipment Yale T. Herer, M. Tzur, E. Yucesan, "The Multi- location Transshipment Problem," <i>IIE Transactions</i> , 38:3, pp. 185-200.	Portfolio Project 2 Introduction
5.2 (2/9)	Decision Science with Simulation- Optimization (Concepts)	Stochastic Approximation (aka Stochastic Gradient Descent) Implementing Stochastic Subgradient "Descent" for Transshipment and Related Problems <a href="https://core.isrd.isi.edu/">https://core.isrd.isi.edu/</a>	<b>HW 3. Due on 2/9 (BAA 99 with Discretized Normal)</b>
6.1 (2/14)	Simulation and Stochastic Optimization (Methods)	Stochastic Decomposition for Transshipment and Related Problems <a href="https://core.isrd.isi.edu/">https://core.isrd.isi.edu/</a>	
6.2 (2/16)	Team Presentations	Progress with Meal Planning Problem. Each group will have 15 mins. to present Odd numbered groups	<b><u>Presentations and Presentations Due</u></b>
7.1 (2/21)	Team Presentations	Progress with Meal Planning. Each group will have 15 mins. to present Odd numbered Groups	<u>Presentations</u>
7.2 (2/23)	Team Presentations	Progress with Transshipment and Related Problems. Even numbered Groups.	<u>Presentations</u>
8.1 (2/28)	Team Presentations	Progress with Transshipment and Related Problems. Each group will have 15 mins. to present. Even numbered Groups.	<u>Presentations</u>
8.2 (3/2)	Data Science	Support Vector Machines with Stochastic Linear Programming (SP)	<u>HW 4 Assigned (SVM with SP and SGD)</u>
9.1 (3/7)	Data Science	Linear Regression and Stochastic Quadratic Programming	
9.2 (3/9)	Data and Decision Science	Advertising-Marketing Coordination (Notes by Sen, Xu, and Y.Zhang)	<b>HW 4. Due on 3/9 (SVM with SP and SGD)</b>
<b><u>Spring Break 3/12-3/19</u></b>			
10.1	Data and	Data-Driven Predictive Stochastic Programming:	Project 4 Assigned: Papers for Reading

(3/21)	Decision Science	Regression + Stochastic Programming (Notes by Sen, Xu and Y. Zhang)	
10.2 3/23	Data+Decision Sciences: Marketing and Production Coordination	Confidence Intervals and Prediction Intervals for Predictive Stochastic Programming (Deng and Sen Paper)	
11.1 (3/28)	Data+Decision Sciences: Marketing and Production Coordination	Validation and Cross Validation in Predictive Stochastic Programming (Deng and Sen Paper)	
11.2 (3/30)	Data+Decision Sciences: Marketing and Production Coordination	Data-Driven Predictive SP: Prediction v Confidence Intervals (Deng and Sen Paper)	
12.1 (4/4)	Classical Inventory Model	Newsvendor Problem (Simple Recourse SP) <a href="https://multithreaded.stitchfix.com/blog/2019/11/21/newsvendor-model/#r1">https://multithreaded.stitchfix.com/blog/2019/11/21/newsvendor-model/#r1</a> <a href="https://multithreaded.stitchfix.com/blog/2019/09/10/stochastic-optimization/">https://multithreaded.stitchfix.com/blog/2019/09/10/stochastic-optimization/</a>	
12.2 (4/6)	Time Series Data	AWS Contest Problem <a href="https://www.otexts.org/fpp/4">https://www.otexts.org/fpp/4</a>	
13.1 (4/11)	Time Series Data	AWS Contest Problem <a href="https://www.otexts.org/fpp/4">https://www.otexts.org/fpp/4</a>	
13.2 (4/13)	a) Rolling Horizon Inventory b) Individual Creativity	a) Dynamic Inventory Models and b) Reiterate Individual Creativity	
14.1 (4/18)	Team Presentations	Production-Marketing Presentation Even numbered Groups (Reverse Order)	<u><a href="#">Presentations and Presentations Due</a></u>
14.2 (4/20)	Team Presentations	Production-Marketing Presentation Odd numbered Groups (Reverse Order)	<u><a href="#">Presentations</a></u>
15.1 (4/25)	Team Presentations	Summaries of Paper Reading Even numbered Groups (Reverse Order)	<u><a href="#">Presentations</a></u>
15.2 (4/27)	Team Presentations	Summaries of Paper Reading Odd numbered Groups (Reverse Order)	<u><a href="#">Presentations</a></u>
Last Day		<b>Portfolios are Due</b>	

**Prerequisite(s):** Basic courses in Computer Programming, Optimization and Statistics.

**Course Notes:**

The instructor will cover topics mentioned above, and students will learn from projects, rather than specific textbook assignments.

## Supplementary Materials

- For Python: <https://developers.google.com/edu/python/?hl=en>
- Statistical Primer (from NOAA, using Climate Data)
  - <http://www.nws.noaa.gov/om/csd/pds/PCU2/statistics/Stats/part2/SPrimer2.htm>
- Agriculture (USDA) <http://nassgeodata.gmu.edu/CropScape/>
  - Has crops, and other USDA data, and also includes all freeways as well.
- Midwest Study: <http://www.decision-innovation.com/spatial-time-series-analysis/case-study-multi-state-land-use-survey.aspx>
- Crime (FBI) <https://www.fbi.gov/stats-services/crimestats>
- Energy Information Administration
  - Total Energy: <https://www.eia.gov/totalenergy/>
  - Renewables: <https://www.eia.gov/renewable/data.cfm>
  - Electricity: <https://www.eia.gov/electricity/data.cfm>

## Grading Breakdown

This course is intended as a capstone experience, and there will be several assignments in which students will be working with data sets which can be used for optimization and statistical modeling. ALL DUE DATES ARE SHOWN IN RED ABOVE. At the end of the semester, each student will submit a portfolio of their work as the work towards their Final Grade. Homework assignments will account for 20% of the grade, 40% for the portfolio, 30% for class presentations, and 10% for participation/creativity/exploration. This last category will be recorded via new resources (data, model, methods) discovered by the student. Such discoveries do not have to be original, but something that the student discovers in the process of exploring the literature/web etc. It could be part of the projects, provided the student identifies the creative part within the project portfolio, or as a separate submission to the instructor outline the creative contribution in a separate submission, no more than 2-pages long. The deadline for this is April 15.

## Statement for Students with Disabilities<sup>2</sup>

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP: [http://sait.usc.edu/academicsupport/centerprograms/dsp/home\\_index.html](http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html), (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) [ability@usc.edu](mailto:ability@usc.edu).

## Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *SCampus*, the Student Guidebook, ([www.usc.edu/scampus](http://www.usc.edu/scampus) or <http://scampus.usc.edu>) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>. Information on intellectual property at USC is available at: <http://usc.edu/academe/acsen/issues/ipr/index.html>.

**Emergency Preparedness/Course Continuity in a Crisis**

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.

Please activate your course in Blackboard with access to the course syllabus. Whether or not you use Blackboard regularly, these preparations will be crucial in an emergency. USC's Blackboard learning management system and support information is available at [blackboard.usc.edu](http://blackboard.usc.edu).