BANA4095: Decision Models – Spring 2021
Course Introduction

Dr. Charles R. Sox
Associate Dean - Impact & Partnerships
Professor of Operations and Business Analytics

Introductions

- Dr. Charles Sox
  - » Professor of Operations and Business Analytics
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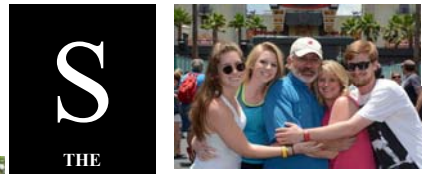
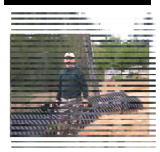
- Teaching Assistant
  - » Matt Baryluk
  - » barylump@mail.uc.edu

Dr. Sox

- B.S. Mathematics, Furman University
- M.S. & Ph.D. Operations Research, Cornell University
- 10 years at Auburn Univ. in Industrial Engineering
- 15 years at the University of Alabama
  - » Professor of Operations Management
  - » University Chair of Manufacturing Management
  - » Department Head for Information Systems, Statistics, and Management Science, 2011-2016
- University of Cincinnati
  - » Associate Dean - Impact & Partnerships, 2020 – present
  - » Professor of Operations and Business Analytics, 2017 - present

Dr. Sox

Advice

- This is a challenging course!
- Attendance, organization, and time management
- You cannot learn the material in this course by only sitting through lectures and reading the book.
- In order to learn the material covered in this course you will need to review it and use it outside of class . . . some people more than others.
- We will provide you with opportunities to apply/practice the material outside of class, but you may need more practice.
  - » Rework class examples, rework homework assignments, work additional problems, use these concepts and tools at work

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Course Delivery

- Tuesdays and Thursdays, 12:30 - 1:50 pm
- Office Hours after class or by appointment
- Online first two weeks of semester
  - » Webex link and recording in Canvas
- Hybrid format starting Jan. 25th
  - » Online **or** in person on campus
  - » Register for on campus attendance in Canvas
  - » Campus – Lindner Hall 0070

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Health & Safety Protocols

- Follow all UC health and safety guidelines while on campus
  - » uc.edu/publichealth/return-to-campus-guide
- Class Attendance
  - » Must show Green Pass on UC Covid Check App
  - » Face mask required
  - » Cleaning required
- Please behave responsibly while off campus

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Communications

- Canvas is extremely important!
  - » Post all course materials and announcements
  - » Submit assignments and tests
  - » Links to other resources
- When asking a question about your work always include an electronic copy of your spreadsheet or code!
- Call for urgent, time-sensitive questions and leave a voice message if I'm not available
  - » (513)556-1531

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Syllabus

- Objectives
  - Develop quantitative, analytical skills for effective business decision-making
  - Modeling decision problems
  - Optimization, Simulation
  - Coding and spreadsheet skills

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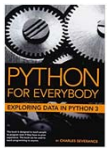
Syllabus

- Required Textbook(s)
  - Anderson *et al*., *Introduction to Management Science*: *Quantitative Approaches to Decision Making, 15th edition*. Cengage, 2019.
  - Severance, Charles R. *Python for Everybody: Exploring Data Using Python 3*. CreateSpace Independent Publishing Platform, 2016. (free open source, posted in Canvas)
- Optional Reference
  - Downey, Allen. *Think Python: How to Think Like a Computer Scientist*, 2nd edition (ver. 2.2.23). Green Tea Press, 2015. (free open source, posted in Canvas)
- How to "read"
  - » Build your own model/code as you read
  - » Modify and experiment with your model/code



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Syllabus

- Computer Usage
  - » Always bring your laptop to class
  - » Excel + Solver
  - » Anaconda Python Distribution
  - » Google Colaboratory (Colab)
  - » You are personally responsible for your own access to the necessary software both in and out of class

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Important Note for Apple/Mac Users

- Great news!!
- ALL of the course software will run on a Mac computer!!

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Software Installation Instructions

- MS Excel should include the basic Solver add-in package
- Anaconda Python distribution
  - » Installation instructions in Canvas
  - » Includes Python Shell, Jupyter Notebook, and Spyder environments
- Google Colaboratory (Colab)
  - » Optional but recommended as a backup
  - » Cloud based environment to run Jupyter Notebooks
  - » Requires Google account

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Grading

Participation	5%	A	≥ 90.0
Homework	20%	B	80.0-89.99
Exam 1 (Feb. 11)	25%	C	70.0-79.99
Exam 2 (Mar. 18)	25%	D	60.0-69.99
Final Exam (Apr. 23)	25%	F	< 60.0

Last Day to Drop: Friday, April 2nd

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Individual & Team Assignments

- Homework assignments are a critical component of the learning process for this course
- Always provide a clear verbal explanation and interpretation of your analysis and recommendation
- Individual Assignments
  - » All submitted work must be your own
  - » You may discuss the general approach and solution with others only after you and they have already attempted to solve the problem

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Team Assignments

- Team Assignments
  - » Must be collaborative work with all team members
  - » All team members must make a substantial contribution to the assignment
  - » Every team member should work on the assignment individually before the group meets to work together
  - » Every member of the team must be prepared to present the team's work
  - » Team member assessments may be used to adjust individual grades on a team assignment
  - » No discussion of specific approaches or solutions between teams

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Academic Integrity

- University of Cincinnati *Student Code of Conduct* (SCOC)
  - » http://www.uc.edu/conduct/Code_of_Conduct.html
- Lindner College of Business "Two Strike" Policy
  - » https://business.uc.edu/academics/resources/advising/student-support.html
- Instructors are required to report any incident of academic misconduct. There will be a **ZERO** tolerance policy for academic misconduct in this class.

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Other Stuff

- Attendance
- Accessibility/Disability
- Inclement Weather
- Make-up policy
  - » Assignments
    - – Late submissions will be penalized and will not be accepted after the assignment solution has been reviewed in class
  - » Exams
    - – Must provide valid documented excuse before the exam or within 24 hours of the exam

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Expectations

- On-time, pay attention, ask questions
- Don't leave during class without permission
- Turn off all electronic devices (except your computer of course)
- Read the assigned material BEFORE class
- Keep thorough, organized class notes
- Do the homework assignments and learn from them

QUESTIONS?

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Business Analytics

- Data-enabled decision making

- "In God we trust . . . all others bring data."
  - W. Edwards Deming
- "The extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions."
  - -Davenport and Harris (2007)

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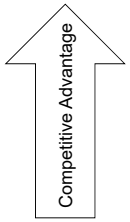
Levels of Business Analytics



- Prescriptive Analytics — What's the best decision?
  Decision Modeling
  Optimization & Simulation
- Predictive Analytics — Why is this happening? What will or could happen?
  Statistical Modeling
- Descriptive Analytics — What is happening?
  Reporting, Charting, and Summary Statistics

Examples

- Identifying profitable and loyal customers (current & potential)
- Determining the optimal price for a product or service
- Finding the lowest possible level of inventory without reducing availability to the customer
- Finding the best people to hire, retain and promote

- What are some examples from your own work experience?

Structured Decision Problems

- Objectives are clear
- Necessary assumptions are obvious
- All the necessary data are readily available
- Logical structure of the analysis is well understood

- Examples:
  - Textbook problems and test questions (usually!)
  - Routine work assignments
  - Others?

Unstructured Decision Problems

- Objectives are unclear
- Assumptions and problem structure are unclear
- Necessary data is not readily available
- Not clear what data is needed or useful

- Examples
  - What should Hoxworth do to increase blood donations?
  - Should an advertiser spend more money on the creative aspects of an ad campaign or on the delivery of the ad?
  - How much should a mid-career executive save toward retirement?

Example: UC Student Recruiting

The university administration has decided that one of its new strategic goals is to increase student enrollment at UC by 20%. As a student assistant you have been tasked with developing a decision model to help the university predict future enrollment and to help the university decide what actions it should take to increase enrollment.

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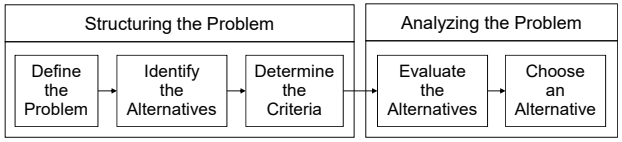
Decision Modeling & Analysis



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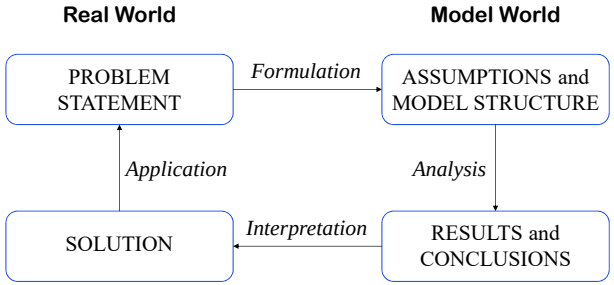
Decision Modeling



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What is a Model?

- A model is a purposeful representation of the key elements of an object or system and the relationships among those elements.
  - » Abstract representation of something real
  - » Enough detail so that key elements and relationships are accurately represented
  - » Omit unnecessary details

  "Everything should be made as simple as possible, but not simpler."
  - Albert Einstein
- Why model?
  - » Models provide insights and understanding that can ultimately lead to better decisions

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Key Elements of a Mathematical Model

- Inputs
  - » Quantities or factors that affect a decision
  - » Controllable Inputs (Decision Variables)
  - » Uncontrollable Inputs (Parameters)
- Variables
  - » Intermediate values that are calculated from some of the other elements
- Outputs
  - » Primary
  - » Secondary
- Mathematical relationships/structure

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Influence Chart

- A simple diagram that shows the relationships between inputs and outputs in a spreadsheet model
- Goal is to define the problem structure
- Ignores all available numerical data
- Identifies the main elements of a model
- Helps to define the assumptions of the model
- *InfluenceChartTemplate.xlsx*

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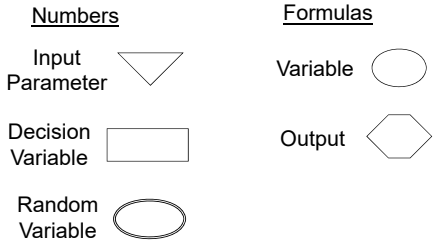
Building an Influence Chart

- Read from left to right; inputs on left and outputs on right
- An arrow represents a relationship between two elements
- Symbol/Shape for each type of element



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Decomposition Strategy

- An effective strategy for constructing decision models
- Breakdown large, complex problem or model into smaller, more manageable components
- Backward – start with the desired output/result and work backward to determine necessary inputs and intermediate calculations
- Forward – start with the available inputs and work forward calculating relevant intermediate values

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Armstrong Bike Co.

Armstrong Bike Co. produces two new lightweight bicycle frames, the Flyer and the Razor, that are made from special aluminum and steel alloys. The cost to produce a Flyer frame is $100, and the cost to produce a Razor frame is $120. As the selling price of each frame model, P_F and P_R, increases, the weekly quantity demanded for each model, F and R, goes down linearly.

$$F = 750 - 5P_F$$
$$R = 400 - 2P_R$$

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Armstrong Bike Co.

Construct an influence chart for the decision of what price to set for the Flyer bikes.

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Mathematical Relationships

- Mathematical formulas are used to model the relationships between the input parameters, decisions, variables and outputs.
- Each variable and output has a specific corresponding mathematical formula.
- The precise structure and parameters of each formula may be determined by definition, a logical relationship, historical data, assumption, or intuition.

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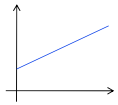
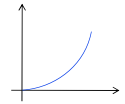
Types of Relationships

- Linear
  - » Constant rate of change (slope)
  - » $y = a + bx$



- Increasing Returns
  - » Increasing rate of change (slope)
  - » Power Function: $y = ax^b$ with $b > 1$
  - » Exponential: $y = ae^{bx}$ with $b > 0$



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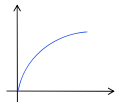
Types of Relationships

- Decreasing at a diminishing rate
  - » Exponential Decay
  - » Negative Exponential: $y = ae^{-bx}$ with $b > 0$

- Diminishing Returns
  - » Decreasing rate of change (slope)
  - » Power Function: $y = ax^b$ with $b < 1$
  - » Natural Logarithm: $y = a + b\ln(x)$
  - » Asymptotic Exponential: $y = a(1 - e^{-bx})$ with $b > 0$



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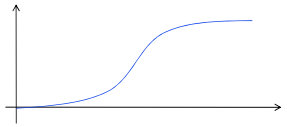
Types of Relationships

- S-curve
  - » Increasing then decreasing slope between two limits
  - » Power-S Curve: $y = b + (a - b)(x^c/(d + x^c))$
  - » Logistic Function: $y = \exp(a + bx)/[1 + \exp(a + bx)]$ used especially when y is a probability or proportion.



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Review

- Course Introduction
- Decision Modeling
- Influence Charts
- Common Mathematical Relationships

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