Course Overview

The course introduces practitioners of sustainability management to the data analysis techniques and statistical methods which are indispensable to their work. The class teaches how to build statistical substantiation and to critically evaluate it in the context of sustainability problems. The statistics topics and examples have been chosen for their special relevance to sustainability problems, including applications in environmental monitoring, impact assessment, and econometric analyses of sustainable development. Students are assumed to have had no previous exposure to statistics.

Course Objectives

This course demonstrates how to conduct a quantitative analysis of an organization’s work processes and operations, resource utilization, and environmental impact necessary to create a rationale for implementing sustainability initiatives. Statistical topics, including probability and random variables, will be discussed in both theory and in their practical applications for sustainability managers. This course will provide students with the skills to conduct regression analysis, to conduct hypothesis and estimation testing, to design surveys, and to prepare statistics packages. These quantitative skills are necessary for a professional manager responsible for the management of people, finances and operations toward sustainability goals.

Course Content

Session 1 Introduction

Readings: Leekley, Chapter 1 and Chapter 2.

Session 2 Describing Data: Tables and Graphs
Measures of Central Tendency: Mean, Median, Mode, Advantages and Disadvantages; Measures of Dispersion: Mean Absolute Deviation, Variance and Standard Deviation, Quantiles and Inter-Quartile Range; Skewness and Kurtosis; Plots: Histogram, Q-Q, ECDF, Box, Scatterplot, Smoothers
Readings: Leekley, Chapter 2

Assessing social responsibility: A quantitative analysis of Appraisal in BP’s and IKEA’s social reports
http://dcm.sagepub.com/content/6/1/55.full.pdf+html

Session 3 Describing Data: Summary Statistics
Measures of Central Tendency: Mean, Median, Mode, Advantages and Disadvantages; Measures of Dispersion: Mean Absolute Deviation, Variance and Standard Deviation, Quantiles and Inter-Quartile Range; Skewness and Kurtosis; Plots: Histogram, Q-Q, ECDF, Box, Scatterplot, Smoothers

Readings: Leekley, Chapters 3,
Homework 1: Exercises from Leekley Chapters 2

Corporate Management, Industry Competition and the Sustainability of Firm Abnormal Profitability
http://link.springer.com/content/pdf/10.1023%2FA%3A1022489324208

Session 4 Basic Probability
The Origins of Probability Theory; Events; The Laws of Probability; Probability of A or B; Conditional Probability; Joint Probability; Bayes' Rule; Permutations and Combinations, Discrete vs. Continuous, Category vs. Ordered vs. Quantitative; Expected Value, Variance; Discrete Random Variables: Binomial, Poisson, Hypergeometrics; Continuous Random Variables: Normal, Chi-Squared, Exponential

Readings: Leekley, Chapter 4
Homework 2: Exercises from Leekley Chapters 3.


Session 5 Probability Distributions
The Origins of Probability Theory; Events; The Laws of Probability; Probability of A or B; Conditional Probability; Joint Probability; Bayes' Rule; Permutations and Combinations, Discrete vs. Continuous, Category vs. Ordered vs. Quantitative; Expected Value, Variance; Discrete Random Variables: Binomial, Poisson, Hypergeometrics; Continuous Random Variables: Normal, Chi-Squared, Exponential
Readings: Leekley, Chapter 5.
Homework 3: Exercises from Leekley Chapter 4

Session 6 Sampling and Sampling Distributions
Random sampling, stratified sampling, cluster sampling, the t-table, Environmental Sampling, Surveys and experiments; Experimental design; Constructing Samples; Constructing indices and scales; Examples of bad survey questions; Replication in natural vs social sciences.

Readings: Leekley Chapter 6.
Homework 4: Exercises from Leekley Chapter 5

Modelling More Sustainable Aluminium

Session 7 Estimation and Confidence Intervals
Point and interval estimators, estimate of proportion, populations mean

Readings: Leekley, Chapter 7,
Homework 5: Exercises from Leekley Chapter 6
Dimson et al, 2012

Midterm Due: Distributed on March 9th. Review Eccles paper and develop research proposal

Session 8 Hypothesis Testing
Independence of Observations Central Limit Theorem Sampling Distributions Tests for distribution (Kolmogorov-Smirnov, Q-Q tests). The one-sample t-test for a population mean; One-sample Chi-squared test for population variance; Two-sample t and z tests for population mean; two-sample z test for population variance

Readings: Leekley, Chapter 8
Homework 6: Exercises from Leekley Chapter 7
Guenster et al., 2006

Session 9 Hypothesis Testing
Independence of Observations Central Limit Theorem Sampling Distributions Tests for distribution (Kolmogorov-Smirnov, Q-Q tests). The one-sample t-test for a population mean; One-sample Chi-squared test for population variance; Two-sample t and z tests for population mean; two-sample z test for population variance
Session 10 Hypothesis Testing
Independence of Observations Central Limit Theorem Sampling Distributions Tests for
distribution (Kolmogorov-Smirnov, Q-Q tests). The one-sample t-test for a population
mean; One-sample Chi-squared test for population variance; Two-sample t and z tests for
population mean; two-sample z test for population variance

Session 11 Hypothesis Testing
Independence of Observations Central Limit Theorem Sampling Distributions Tests for
distribution (Kolmogorov-Smirnov, Q-Q tests). The one-sample t-test for a population
mean; One-sample Chi-squared test for population variance; Two-sample t and z tests for
population mean; two-sample z test for population variance

Session 12 Regression Analysis
Covariance and Correlation, Spearman Rank Correlation, Correlation Tests; Scatterplot
and Univariate Regression. Regression Error, Coefficient of Determination; Assumptions
of the Linear Regression Model; Multivariate regression, Hypothesis Tests about
Coefficients and the Model; Specification; Missing Data; Heteroscedasticity; Discrete
Dependent Variables

Session 13: Climate Change and Statistics
Readings: Chapter 12 of The Signal and the noise, Nate Silver.
Session 14 Multiple Regression Analysis
Covariance and Correlation, Spearman Rank Correlation, Correlation Tests; Scatterplot and Univariate Regression. Regression Error, Coefficient of Determination; Assumptions of the Linear Regression Model; Multivariate regression, Hypothesis Tests about Coefficients and the Model; Specification; Missing Data; Heteroscedasticity; Discrete Dependent Variables

Readings: Leekley Chapter 13
Homework 11: Exercises from Leekley Chapter 12

Allouche and Larouche 2005,

Session 15 Time-Series Analysis
Exploiting patterns over time, basic components of a time series, seasonal variation, the long-term trends, the business cycles, forecasting.

Readings: Leekley Chapter 14
Homework 12: Exercises from Leekley Chapter 13

Amman et al. 2010.

Session 16: Final Exam Presentations

Homework 13: Exercises from Leekley Chapter 14
Method of Instruction and Evaluation

The course is based on 200 points.

Homework Assignments: There will be 13 weekly problem-solving assignments each worth 10 points for a total of 130 points.

Participation: Each student will make a presentation on the week's reading “sustainability” reading assignments plus their active participation in class worth 10 points.

Tests: There will be a take-home midterm exam and a take-home final, each worth 30 points.

The Midterm is due on March 23th.
The Final Exam is due on May 11th.

I will hold office hours on Thursday’s from 4:30-5:45 pm at 2929 Broadway, by appointment. Recitation Periods TBD

Text Books

All additional readings will be listed in Courseworks. Any readings whose full-text is not available through the links in Courseworks will be placed on reserve at the Library.

Additional Books of Interest on Reserve:

• The Black Swan: The Impact of the Highly Improbable Nassim Nicholas Taleb
• Moneyball: The Art of Winning an Unfair Game, Michael Lewis
• Freakonomics: A Rogue Economist Explores the Hidden Side of Everything, Steven Levitt and Stephen J. Dubner.
• How to Lie with Statistics, Darrell Huff
• The Signal and the Noise: Why So Many Predictions Fail — but Some Don’t, Nate Silver
Course Policies

Attendance
Students are expected to arrive on time, attend all classes, and to stay until the end of class unless they have notified the instructor at the beginning of the session that they will be leaving early. Each unexcused absence will result in a 1 point deduction from the participation grade.

Late Assignment Policy
Assignments are due on the dates/times identified. One letter grade will be deducted from any assignment submitted after the due date/time. No assignment will be accepted after the deadline for submitting final grades.

Incompletes
As outlined in the School’s grading and academic starts policy, “A grade of ‘I’ (incomplete) is a temporary grade indicating failure to complete assigned work. The mark is given only upon the request of the student and at the discretion of the instructor. The student and faculty member must sign a completed ‘Request for Grade of Incomplete Form’ before the final class session. The ‘I’ must be removed within one year after the end of the semester in which the student received the grade. Students seeking an extension of this time limit must have the approval of the instruction and successfully petition of the director of their program. If no petition is made, or if the petition is unsuccessful, the grade is chanced to an N-Permanent Incomplete- which remains on the student’s permanent record.

Academic Integrity
The School of Continuing Education does not tolerate cheating and/or plagiarism in any form. Those students who violate the Code of Academic and Professional Conduct will be subject to the Dean’s Disciplinary Procedures. The Code of Academic and Professional Conduct can be viewed online:
http://ce.columbia.edu/node/217

Please familiarize yourself with the proper methods of citation and attribution. The School provides some useful resources online; we strongly encourage you to familiarize yourself with these various styles before conducting your research:
http://library.columbia.edu/help/howto/endnote.html
Violations of the Code of Academic and Professional Conduct will be reported to the Associate Dean for Student Affairs.

**Accessibility Statement**
Columbia is committed to providing equal access to qualified students with documented disabilities. A student’s disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University’s Health Services website: http://health.columbia.edu/services/ods/support
APPENDIX A

School Policies

Copyright Policy
Please note -- Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:
The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction.
One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity
Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SCE holds each member of its community responsible for understanding and abiding by the SCE Academic Integrity and Community Standards posted at http://ce.columbia.edu/node/217. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility
Columbia is committed to providing equal access to qualified students with documented disabilities. A student’s disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this
service, please visit the University's Health Services website:

**Accessibility Statement** – I want you to succeed in this course. Contact disability@columbia.edu for learning accommodations.

**Names/Pronouns** – You deserve to be addressed in a manner that reflects your identity. You are welcome to tell me your pronoun(s) and/or name (if different from University records) at any time, either in person or via email.

**Discrimination** – We embrace the diversity of gender, gender identity & expression, sex, sexual orientation, race, ethnicity, national origin, age, religion, disability status, family status, socioeconomic background, and other visible and non-visible identities. Columbia University does not tolerate unlawful discrimination, discriminatory harassment, sexual assault, domestic violence, dating violence, stalking, or sexual exploitation and all such conduct is forbidden by Columbia University Policy.

**Duty to Report** – You deserve a University community free from discrimination, harassment, and gender-based misconduct including sexual harassment, sexual assault, domestic and dating violence, stalking, and sexual exploitation. It is therefore University policy to require Columbia faculty and staff to report to EOAA any instance or allegation of prohibited conduct involving any undergraduate or any graduate student that is disclosed to, observed by, or otherwise known to that employee. This requirement to report is in place to help ensure that students are provided appropriate resources and to allow the University to mitigate harm to our community.

**Confidential Resources** - There are confidential resources on campus who do not have a Duty to Report, including:

- Sexual Violence Response & Rape Crisis/Anti-Violence Support Center (SVR)
- Ombuds Office
- Medical Services
- University Counseling and Psychological Services
- University Pastoral Counseling
- Columbia Office of Disability Services

University employees working in a confidential capacity will not report information shared with them.

**Inclusion** - In the M.S. in Sustainability Management program, faculty and staff are committed to the creation and maintenance of “inclusive learning” spaces – classrooms and other places of learning where you will be treated with respect and dignity, and where all individuals are provided equitable opportunity to participate, contribute, and succeed.
In our Sustainability Management K4100 classroom, all students are welcome regardless of race/ethnicity, gender identities, gender expressions, sexual orientation, socio-economic status, age, disabilities, religion, regional background, Veteran status, citizenship status, nationality and other diverse identities that we each bring to class.