GSM 511 Foundations of Quantitative Analysis
Fall, 2007
Professor Hand

Syllabus

Contact Information

Instructor:	Professor Michael L. "Call Me Mike" Hand
Office:	Atkinson 402
Hours:	Tu, Th 1:00 p.m. - 2:00 p.m., W 3:00 p.m. - 4:00 p.m., and by appointment
Phone:	503-370-6056
E-mail:	mhand@willamette.edu

Required Course Text

Bowerman, Bruce L. and Richard T. O'Connell. *Business Statistics in Practice, Fourth Edition.* McGraw Hill/Irwin, Burr Ridge, Illinois. 2007. (ISBN: 007344183X, includes Minitab Student Release 14.)

Course Philosophy and Learning Objectives

The techniques of quantitative analysis enjoy broad acceptance and wide-spread application in enterprises of all sizes and are deployed against problems in such diverse areas as – financial management, quality control, public budgeting, research and development, compensation analysis, and market research. Yet, powerful quantitative ideas and tools remain largely underexploited. We frequently hear ours described as an information economy, as if we were awash in the stuff (information) while in actuality high quality information remains a relatively scarce resource. Instead, we are merely up to our ears in data, facts and figures that are by themselves neither interpretable nor actionable. The challenge is to refine the mountains of raw data, to identify meaningful trends and patterns, to gain fundamental managerial insights, to extract the essential information that we require to effectively manage and control our enterprises. Our firm grasp of quantitative concepts, particularly as they relate to the commonly recurring requirements of management, is the critical link between the data that we have and the information that we need.

Upon successful completion of this course, you should –

- Be an intelligent user and interpreter of analytical models and statistical information.
- Be able to frame common managerial problems in analytical terms.
- Understand the importance of mathematical concepts for expressing and interpreting rates of change.
- Recognize opportunities to use available computing resources to implement, analyze, and optimize basic analytical models.

- Understand the nature of data and how it is obtained.
- Understand statistical processes for transforming data into useful information.
- Develop a working familiarity with basic computational tools of data summarization, analysis, modeling, and optimization along with a level of self-sufficiency in their use.
- Be able to effectively communicate the results of quantitative analyses and models, especially through the use of statistical graphics and other visualization tools.
- Recognize opportunities for strategic application of analytical thinking to advance your career and your enterprise.
- Build confidence in your ability to creatively and intelligently exploit analytical opportunities.

It would be easy to think of Foundations of Quantitative Analysis as merely a general review of selected tools in mathematics, management science, probability and statistics; in particular, as these tools relate to knowledge acquisition and to decision support in the context of management. On one level, we can and occasionally will resort to thinking of our course in this way. However, we are more interested in establishing and building the links between the quantitative tools we know and the managerial decisions that we face so that, when we do encounter an opportunity, we are prepared to frame it in analytical terms and to work toward an effective solution. This course is not just about mathematics and statistics, but rather it is about "a way of thinking."

To reinforce this point, consider the following simple mathematical task – find the equation of the line connecting the coordinate pairs (100, 13000) and (300, 23000). You may even scoff at the borderline-tedious simplicity of the question as posed in purely mathematical terms. What if instead, we reframe the situation to note that we have data relating production cost to the number of units produced. To further nourish our insight into the nature of the production/cost relationship, we might (no, we most certainly would) also construct an appropriate visual representation of the data and perhaps be led to develop (at least as a first approximation) a simple linear model to represent the relationship. From there, we would be positioned to address questions of how cost is related to production level. Can we quantitatively describe the fixed and marginal components of cost? For a given level of production, what is the projected cost? For a given proposed production budget, what level of production is supported?

Indeed, we are talking about a way of thinking; a way of thinking that applies not only when using simple linear models, but more generally to more complicated situations. As managers, we are interested in identifying, measuring and describing – the position of the enterprise, how that position is changing over time, what factors influence position, future projections of position, how might we control related factors to improve or even optimize position. The course is laid out to address these critical questions while identifying and developing the underlying mathematical and statistical concepts that support our fundamental information requirements.

Our work begins by considering the basic mathematical ideas behind elementary models. We continue by generalizing our ideas and tools for describing rates of change and optimization (OK, perhaps that might involve calculus.) Finally, we extend our thinking to systems of relationships (that would be matrix methods and linear programming.) You might notice that this initial work largely neglects the presence of variation and uncertainty. Managers and their enterprises regularly face uncertain conditions arising from a variety of sources and, though mathematical models serve well to a reasonable approximation, any responsible treatment of quantitative analysis (and I would argue that our treatment is eminently reasonable) must ultimately evolve to include the ideas of probability and statistics, a body of knowledge that provides the tools to assess, reduce, and control (to the extent that it is controllable) the impact of uncertain conditions.

Our quest to overcome the vagaries of an uncertain world is an odyssey that commences in the second half of our course and continues through the Spring Semester with GSM 512 Statistical Inference and Modeling. In the statistical portion of the current course, we address the description, summarization, and display of data (instruments of information extraction) as well as the fundamentals of probability and essential probability distributions. Our work lays the foundation for the continued study of statistical estimation, hypothesis testing (statistical decision making,) and statistical modeling in GSM 512.

Among our immediate, short-term objectives is to arm all entering Atkinson students with the fundamental analytical foundation essential to support their work in the required curriculum, in subsequent elective courses, and ultimately in their career. Of even more lasting, long-term significance is that we learn to recognize and appreciate the value of quantitative and analytic thought in managing and controlling organizations. In this course, we strive to identify and exploit the many opportunities for the effective application of essential quantitative tools.

An additional theme of the course is that quantitative techniques are not the exclusive domain of specialists and technicians. While it would be naïve to dispute the value (give it a shot, if you must) of mathematical tools in decision-making, it is far too common that managers (in particular, and people in general) are content to dismiss themselves as lacking the necessary academic preparation and aptitude. The single most significant objective of this course is to overcome any latent anxieties that we may have relating to quantitative analysis and to develop confidence in our abilities to wield the weapons of knowledge and good in the name of effective management.

Course Approach

The course is reasonably self-contained and assumes little at the outset, in the sense that we begin with the most fundamental of mathematical ideas and proceed systematically to build a foundation of increasingly sophisticated quantitative concepts. However, we will move rather briskly across the mathematical landscape in order to embrace a relatively broad range of ideas.

Our approach is a modern one, designed to exploit modern computing resources as essential tools of information extraction and presentation. Though much of our work is conceptual in nature and many of our modest computational objectives can be met using only paper and pencil (with perhaps a modicum of brain power,) we'll make frequent forays into the world of computing in search of the best ideas for extending our locus of control over "the numbers." Our principal software tools will be Microsoft Excel and occasionally a general-purpose statistical package, Minitab. In order to facilitate our computing objectives, I have ordered a special textbook bundle that includes the student release of Minitab. The complete text reference and ISBN is given on the first page of this syllabus and repeated below.

Course Materials

GSM 511 Foundations of Quantitative Analysis, along with GSM 512 Statistical Inference and Modeling, comprise a year-long sequence in quantitative methods. The quantitative content of the present course, GSM 511, divides fairly naturally into two parts, roughly equal in size – mathematics/ management science [though we agreed we wouldn't think of it as just math] and probability/ statistics. GSM 512 continues the development of statistical ideas with estimation, hypothesis testing, and statistical modeling. The statistical content of the required core, the latter half of 511 and all of 512, is supported by a fairly traditional text in business statistics – Bowerman and O'Connell.

Required Course Text

Bowerman, Bruce L. and Richard T. O'Connell. *Business Statistics in Practice, Fourth Edition.* McGraw Hill/Irwin, Burr Ridge, Illinois. 2007. (ISBN: 007344183X, includes Minitab Student Release 14.)

What about the first half of the course? The math book? Is there going to be a math book? The short answer is no. We've adopted and tried a number of Mathematics for Management texts over the years. All are good at what they do, but what they do is not really everything that we want. Perhaps not surprisingly, these books take a mathematics-first approach emphasizing mechanics and repetition. I love mathematics as much as anybody, but the traditional approach is not what I wish for you, since the managerial message is often lost in the mix. We should leave this course saying not that we did a little math, but that we are now equipped to meet a variety of managerial challenges through the power of analytical thought (and maybe, in the process, we did a little math.) Thus our decision is to boldly go (I can split an infinitive with the best of them) where few mathematics classes have gone before without the support and comfort of a textbook. Rest assured, that I have spent a lifetime thinking deeply about how we should best proceed and I will support you with liberal doses of course notes, examples, and other supplements to facilitate your journey and make it as pleasant and productive as I know how.

Course materials will be posted regularly on our Class Tools course site. You can navigate your way directly to the site through the link http://agsm.willamette.edu/courses/siteinfo/ . You will be prompted for your Willamette University login in order to gain access to course materials.

Course Activities

An outline of the course – with a projected schedule of lectures, resources, exercises, and examinations – follows. Background reading and problems are generally assigned for each class session. I suggest that you complete a first reading of all assigned material prior to class and make at least an earnest preliminary attempt at the assigned problems. This approach will help you to better identify learning objectives and areas of potential difficulty. When you prepare in this way, you will be primed to arrive for class full of questions, curiosity, and enthusiasm. Following class, reread the assigned material, this time for full comprehension, and complete (to your own satisfaction) any assigned problems. With the exception of the formal class exercises, described later and noted on the schedule, assigned problems are not to be submitted for grading. Rather, they are to serve as self-assessment tools to gauge comprehension and to pinpoint any difficulties that may require special attention.

In addition to informal, self-managed reading and problem assignments, there will be three required computing exercises. These exercises serve to reinforce the conceptual material of the course as well as to introduce useful software tools to support analytical work. Distribution and due dates for each of the three exercises are included in the course outline. As a vehicle for regular feedback and assessment, we will often have some kind of survey or mini-quiz during class meetings. The results of these in-class exercises will also serve as the basis for evaluating class participation, so be sure to bring your laptop computers to class.

A variety of resources are available to support and enhance your learning experience. The Atkinson School regularly retains the services of several talented and helpful returning students who serve as tutors for Atkinson quantitative core courses. The tutors will schedule, post, and conduct a number of sessions during which they will be available for consultation with individuals or groups of students. You are of course also welcome (and encouraged) to ask questions of me in class, during my office hours or whenever else you can corner me. Finally, don't overlook the resources that you have in each other (except for during examinations when it is expected that all your work will be your own.) You'll find that you can learn a lot from your classmates in this and every course. Even for those with strong quantitative backgrounds, who seemingly would be only on the giving end of a helping alliance, will be surprised at how much they can expand their own insights through collaboration with others.

Examinations and Grading

Course grades will be based upon the computing exercises [3 at 5% each,] class participation [10%, based on in-class, on-line surveys and mini-quizzes, bottom two scores discarded] two midterm examinations [20%] and a cumulative final examination [35%.] Consistent with the philosophy of emphasizing the application of fundamental analytical ideas, rather than formulas and computation, all examinations are open-book and open-notes. Sample examinations will be posted to our Class Tools course site in advance of scheduled exam dates. Scheduled dates for the midterm and final examinations are included in the course schedule that follows.

Laptop Computers in Class

You are advised to have your notebook computers with you in class and always at the ready, as we will be using them in a variety of ways. Our Class Tools course site essentially will be the sole means of distribution for all course materials. While I will generally display current examples on the class room screens, you may wish to have copies of the examples open on your screen so that you can better follow along, to linger on selected points and zoom in as necessary. You will occasionally have the opportunity to look in and work along with me on in-class Excel examples, but we won't do this often, as it tends to consume a lot of our precious time together. As noted previously, to collect timely feedback during class, I plan to give regular short-answer quizzes and surveys, where you will be asked to respond, using your laptop, through our Class Tools site. These in-class exercises will also be the basis for the class participation portion of your course grade. Finally, if you're comfortable doing so, you may wish to use your laptop as a tool for taking notes. In between the times that we are formally using our laptops, **please be considerate of your fellow class members and reserve Internet browsing, e-mail reading, and instant messaging for another time.** I know that we all fancy ourselves brilliant multi-taskers, but these activities are a distraction, not only to you, but to your fellow class members. You also risk damage to my tender feelings.

Waiver Policy

Is this course for you? There is generally considerable variation in the mathematical backgrounds and aptitudes of course participants. All are welcome, from the mathematically timid to Carl Friedrich Gauss reincarnate. A number of you may believe – finding yourself already sufficiently endowed with all the mathematical skills, statistical faculties, and managerial insights that you could otherwise hope to develop in this course – that your time could be better spent in other pursuits. Qualified students are welcome, at their option, to waive this course. Qualifications are assessed via a short waiver examination. The examination is a simple test of the essential course concepts, at a level more elementary than the actual course exams, and is designed to be taken without any recent review. So don't waste any time cramming for it. You are welcome to take the exam without risk. No one will be required to waive the course, even if they come out looking like they should be teaching it. Indeed, a number of mathematically well prepared students have made productive use of the course to redeploy their traditional formal mathematical thinking into the managerial domain. To reiterate a point made earlier, this course is about much more than mathematics, it is about developing a way of thinking. Please contact the course instructor if you are interested in taking the waiver examination.

Atkinson School Expectation of Conduct for Students, Faculty and Staff

We are a community of learners. Our professional commitment is to create an environment that advances the science and practice of managing organizations. As individuals, we conduct ourselves with honor and integrity, treat everyone with respect, take responsibility for our actions, and fulfill our promises.

Examples of conduct consistent with this expectation include:

- Taking initiative
- Crafting solutions
- Completing assignments according to an agreed schedule
- Offering constructive criticism and accepting it appreciatively
- Taking responsibility for our own learning and that of others

We expect someone who observes or learns about behavior inconsistent with our expectations of conduct to initiate corrective action by clarifying the situation and encouraging the responsible party to act appropriately. In the case of a violation of School or University policies or the laws of relevant jurisdictions, notify the appropriate enforcement authorities.

Accommodations for Students with Disabilities

Students requesting accommodations for a disability must be registered and certified through the Willamette University Disability Services Office. Students seeking accommodations must contact the Disabilities Services Office in Bishop Health Center at 503-370-6471; or on the web at http://www.willamette.edu/dept/disability/. Atkinson students already approved for testing accommodations must notify Janet Jobes, Atkinson Recorder, at least two weeks prior to all scheduled tests for which they need accommodation.

COURSE OUTLINE/SCHEDULE

The course schedule is a well considered plan, but it is only that, a plan. We will deviate as necessary, but I will keep the class informed of any changes. Remember, this is only an exhibition. Please, no wagering.

Reading and problem assignments from the course text are designated by BO (for Bowerman and O'Connell.)

Unless otherwise designated, examples and course readings will be available for download from the course Class Tools site – ClassTools:GSM-511:HandOuts:Examples:<*subfolder*>.

Exercises will be available for downloading from the course Class Tools site – ClassTools:GSM-511:HandOuts:Exercises:<*subfolder*>.

Elementary Mathematical Models, Neglecting Uncertainty

I. Functions and Mathematical Models
Modeling the position of the enterprise, how the position is changing, future projections of position, how we might control related factors to optimize position

Tu 08/28 1. Course Overview and Introductory Examples
Reading and Problems:
Why Math Will Rock Your World, *Business Week*
Competing on Analytics, *Harvard Business Review*
Linear Models Notes
Example: LinFunCalc.xls

Th 08/30 2. Linear Mathematical Models and Applications
Reading and Problems: Linear Models Notes
Examples: LinFunCalc.xls, LinFunTax.xls

Tu 09/04 3. Quadratic Mathematical Models with Applications
Reading and Problems: Quadratic Models Notes
Examples:QuadFunGuit.xls, QuadFunPaCE.xls, QuadFunHam.xls
Exercise 1: Simple Functional Models: Visualization and Analysis
(Due Th 09/13)

Th 09/06 4. Exponential and Logarithmic Functions
Reading and Problems: Exponential-Logarithmic Models Notes
Examples: Exponential.xls, Logs.xls, Compound.xls, Reexpression.xls

II. Differential and Integral Calculus

Refining our notions on rate of change, how these ideas lead to determining optima, generalizing ideas of summation/accumulation: marginal analysis, consumer surplus, probability in continuous distributions

Tu 09/11 5. Differential Calculus: The Derivative and Applications
Reading and Problems: Derivative Notes
Example: ProfitDeriv.xls

Th 09/13 6. Differential Calculus: Optimization and Other Applications
Reading and Problems: Derivative Notes
Examples: TaylorDeriv.xls, GrassDeriv.xls
Exercise 1 Due

Tu 09/18 7. Differential Calculus: Functions of Several Variables and Partial Derivatives
Reading and Problems: Partial Derivative Notes

Th 09/19 8. Integral Calculus: The Antiderivative
Reading and Problems: Integration Notes

Tu 09/25 9. Integral Calculus: Applications
Reading and Problems: Integration Notes

III. Systems of Equations and Constrained Optimization

Simultaneous satisfaction of multiple conditions. Allocating resources to optimize an objective, subject to multiple constraints

Th 09/28 10. Systems of Equations: Matrix Methods
Matrix Operations and the Matrix Inverse
Reading and Problems: Systems Notes.pdf, Matrix Notes.pdf

Tu 10/02 11. **Midterm Examination I**
(Covering Models through Integration, Class Sessions 1 - 9)

Th 10/04 12. Matrix Operations and the Matrix Inverse
Reading and Problems: Matrix Notes.pdf
Examples: System.xls

Tu 10/09 13. Linear Programming: Applications and the Simplex Method
Reading and Problems: Linear Programming Notes.pdf
Examples: Cars.xls
Exercise 2: Linear Programming and Constrained Optimization
(Due Tu 10/25)

Th 10/11 14. Linear Programming: Applications and the Simplex Method
Reading and Problems: Linear Programming Notes.pdf
Examples: Cars.xls

Tu 10/16 15. **IKEW Week** (no regular class meetings)

Th 10/18 16. **IKEW Week** (no regular class meetings)

Tu 10/23 17. Linear Programming: Applications and the Simplex Method
Reading and Problems: Linear Programming Notes.pdf
Examples: Cars.xls

Introduction to (Overview of) Probability and Statistics
Graphical Summarization of Data
Examples: Graphics Gallery, Bell Example, BellEx.xls, BellEx.mtw
Reading: Chapters 1, 2

Accounting for Uncertainty: Probability and Statistics

IV. Describing Data
Numerical and graphical description of the dimensions of position in the presence of uncertainly: location, dispersion and shape

Th 10/25 18. Graphical Summarization of Data
Examples: Graphics Gallery, Bell Example, BellEx.xls, BellEx.mtw
Reading: Chapters 1, 2
Problems: Chapter 2: 3, 10, 45 (WaitTime), 47
Exercise 2 Due

Tu 10/30 19. Numerical Summarization of Data
Examples: Describe, Court Award, Describe.xls, Describe.mtw,
Reading: Chapter 2
Problems: Chapter 2: 18, 26, 36, 38
Exercise 3: Describing, Visualizing, and Interpreting Data
(Due Th 11/08)

V. Probability, Random Variables, and Distributions
Tools for describing and assessing uncertain outcomes

Th 11/01 20. Fundamentals of Probability
Examples: Snack Food Example, PermComb, Combine.xls
Reading: Sections 3.1 – 3.3, Appendix C
Problems: Chapter 3: 6, 14, 15

Tu 11/06 21. Conditional Probability and Bayes Law
Examples: AppliedProb, DrugTest
Reading: Sections 3.4, 17.1
Problems: Chapter 3: 18, 31, 32; Chapter 17: 6, 8

Th 11/08 22. Discrete Random Variables and Mathematical Expectation
Examples: DiscreteRV, DiscreteRV.xls
Reading: Sections 4.1, 4.2
Problems: Chapter 4: 13, 15, 16, 19
Exercise 3 Due

Tu 11/13 23. The Binomial Distribution and Applications
Examples: BinomialEx, BinTab.xls
Reading: Section 4.3, Appendix C (Part 1)
Problems: Chapter 4: 25, 26, 28, 29

Th 11/15 24. **Midterm Examination II**
(Covering Systems through Probability, Class Sessions 10 - 22)

Tu 11/20 25. The Binomial Distribution and Applications
Examples: BinomialProblem, CaesarsGasp, CaesarsGasp.xls
Reading: Section 4.3, Appendix C (Part 1)
Problems: Chapter 4: 25, 26, 28, 29

Th 11/22 26. **Thanksgiving Break** (No Class Meeting)

Tu 11/27 27. The Normal Distribution and Applications
Examples: NormalProblem, NormalTable
Reading: Sections 5.1, 5.3
Problems: Chapter 5: 29, 32, 34

VI. Sampling Distributions and Statistical Inference
Putting it all together to describe and assess the error of estimation in statistical estimates

Th 11/29 28. The Normal Distribution and Sampling Distributions
Examples: SampDistStock, SampDistProb
Reading: Sections 5.3, 5.4, 6.1
Problems: Chapter 5: 38, 39; Chapter 6: 10, 11

Tu 12/04 29. Sampling Distributions and Statistical Decision Making
Examples: SampDistProb, CircuitCity
Reading: Sections 6.1, 6.2, 8.1, 8.2
Problems: Chapter 6: 13; Chapter 8: 31

Fr 12/14 30. **Final Examination, 10:00 am – 1:00 pm, KLH** (Comprehensive)