

**Syllabus**  
**Quantitative Models in Business**  
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**Goals**

This course introduces business students (MBAs) to quantitative techniques that are currently being used widely in business but are not taught in any current courses. The course will also look at topics that are qualitative but that are now amenable to quantitative treatment. The course would prepare students for more rigorous analysis across lines of business. There are many quantitative models that are feasible to teach to students with non-engineering backgrounds in a lighter way that are currently not being delivered because of the (incorrect) belief that these are not accessible to the average MBA student; the course aims to remedy this.

**Topics**

The following is a superset list of topics:

1. Mathematics and Statistics Primer.
2. Using Excel VBA for business problems. External data extraction from the web.
3. Diffusion models - the Bass (1969) model for product diffusion.
4. Bayesian Analysis - various applications - and for market microstructure.
5. Classifier models - Bayes theorem - for filtering, forecasting, market segmentation, spam. Sentiment Extraction from Stock Message Boards
6. Paradoxes in Option pricing - funny quirks in option technicalities - the principle of replication.
7. Brownian motion and stochastic calculus - simulate the stochastic Bass model.
8. Matrix Calculus - Markowitz optimal portfolio problem.
9. Continuous time dynamic programming by regression - for portfolio problems.
10. Monte Carlo Simulation - across all business areas.
11. Copulas - a new technique for modeling risks in portfolios.
12. Power Laws - almost all phenomena in the networked economy seem to be following power law statistical distributions.
13. Neural networks.
14. Graph Theory - being used widely in business to define communities on the web. (behind many of Yahoo's business models). Financial Communities.
15. Fuzzy Logic.
16. Genetic algorithms.
17. The Golden Ratio and its application in Marketing.
18. Cellular Automata - being used now for product diffusion modeling.

19. Factor Analysis - used across all business areas.
20. Discriminant Analysis - used in marketing and in finance for partitioning samples of consumers, firms, etc.
21. Probability generating functions - used in finance for modeling options.
22. Fourier Analysis - used widely for valuing derivative securities and in forecasting time series.
23. Auction models - Treasury auctions, click-through auctions, google stock auction.
24. Behavioral Economics - Utility functions, choices and paradoxes - - e.g. Robert Schwartz "The Paradox of Choice"
25. Randomized Algorithms - a new fast approximation approach developed in computer science that allows hard problems to be solved quickly with fair levels of accuracy. Example: distribution channel optimization.
26. Dynamic programming - solving multiperiod business problems.
27. Markov Chains - widely used to describe many financial phenomena, e.g. rating changes in firms.
28. Game Theory - the paradigm of co-opetition, a new look at cooperative game theory.
29. Strategies and Sampling - how to distill business information from diverse populations.
30. Fractals and Financial Markets - Mandelbrot's book and other work.
31. Shannon information theory - uses of entropy models in finance.
32. Extreme value theory - in insurance markets.

## **Motivation**

I have been keenly interested in these topics for some time, and have already spent time reading up on many. I built this list of topics from attending seminars in other fields and jotting them down on a list of "things to get around to when I have the time". Of course, one never ends up making the time. Therefore, I see the course as an indulgence, and a process that will lead to focus on these topics. As a tangential goal, this may lead to a book from the course.

From the student's point of view, I have discussed this idea with them in my classes, and many seem excited by the prospects of taking such a class. There is a body of our students that would like a quantitative modeling class that cuts across disciplines.

From an institutional viewpoint, there are benefits. One, it fosters interdisciplinary learning. Two, it enables teaching of state-of-the-art topics that are close to current practice, especially in a business environment that in the Valley that is becoming highly analytical (for instance, Google runs an entire business on a quantitative auction model). Three, there may be synergies with special programs like the MSIS.

## **Approach**

I plan to teach this course in the Spring of 2007. I will begin working on the course material in summer and hope to make much progress in terms of writing up brief notes, collecting relevant papers, and other materials such as models, figures, press articles, etc. There are more topics than

will fill out a 20 session class. I will probably have to edit the list down somewhat, but my goal is to stick to one topic per class, where the main ideas and mathematics are portrayed with a view to giving the student a sound idea of the modeling, and its application. I will then give selected students topic extensions as homework.