Advanced Modelling for Business Applications

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Aims and Objectives

Modelling is the process of building simplified representations of reality to explore the potentially ill-structured problems that modern organizations frequently face. Models give insights into complex trade-offs, help identify relevant data for the problem at hand, allow the evaluation of possible alternatives, make sensible recommendations and serve as the basis for communicating findings and influencing decisions. The skills needed to be a successful modeller include the ability to recognize the key problem(s) in a situation, the capacity to develop a structure for analyzing the problem, an aptitude for carrying out cogent analysis, and the mental flexibility to present the analysis and insights to interested parties in a convincing, non-technical manner. The primary objective of this course is to develop your ability to generate insights via modelling in a wide range of realistic situations. The skills developed here are vital for anyone working with today's organizations to navigate a course through uncertain and uncharted territory.

Topics Covered

The first part of the course will cover the basic tools of modelling. We will discuss how to frame ill-structured problems, present the main tools of model building, such as influence diagrams, spreadsheet engineering (Excel), sensitivity analysis, simulation and optimisation, and how to use models to generate insights. Emphasis will be placed on the communication of main findings, including coaching on the effective presentation of quantitative analysis. We will illustrate these techniques with a workshop drawn from the hospitality industry.

The second part of the course applies the modelling techniques discussed in the first part of the course to project valuation and operational problems. We will start with single project valuation models from the Pharmaceutical and Venture Capital industries and estimate the value of options such as abandonment, expansion and postponement using Real Options valuation techniques. The focus is not only on estimating the value of these options but also on how and when to use these options. We will continue with the Venture Capital case to discuss how to aggregate individual project valuations, both in the risk and the return dimensions, in order to build portfolios of real projects. We will construct company-wide efficient frontiers, see the benefits of diversification and illustrate how correlations can prevent or amplify the effect of diversification. The course will finish with a primer on more general stochastic systems that are subject to congestion. We will examine the impact of

variability on system efficiency and see how one can optimise the performance of such stochastic systems using both analytical and simulation based methods. We will illustrate these ideas in the context of queuing systems and we will apply the tools and methodologies developed on a hospital reorganisation case study.

Format and Teaching Methods

The course is divided into five days, each consisting of two sessions. Each day can be viewed as a 6 hour long workshop with short lectures that deliver a modelling framework, followed by breakout exercises and in-class real-time development of models drawn from a real business case. While each day is conceptually independent of one another, we will use and build upon modelling frameworks and concepts developed in previous days. At the end of each day participants will need to work on a short modelling exercise that builds on the day's case study and prepare a 10-minute presentation in groups on the models developed and the insights generated on that day. While all groups need to hand in a presentation, only two-three groups will get to give their presentation in class the following week. Where possible industry guests will also listen to the participants' presentations and give feedback, as well as share their experiences of modelling work within their organisations.

Participants are expected to play an active role in their learning by making appropriate contributions in class as well as answering and asking questions. Participants are also expected to work in groups for all modelling cases, exercises and presentations. Through discussions and through group work we aim to create a supportive environment that facilitates learning and utilizes the participants' diverse experiences and modelling skills to advance the knowledge of everyone.

Requirements & Pre-requisites

Participants are required to bring a laptop with **Excel 2010** to each class. Excel add-ins such as @Risk can be downloaded from the portal before the course commences (but are not necessary). The spreadsheet modelling techniques developed in the core MBA course *Decision and Risk Analysis* (or equivalent course in other schools) will be used throughout the course. Elementary knowledge of finance and quantitative methods, as provided in core courses, is assumed.

Recommended readings

Title	Year	Authors	Publisher
Modeling for Insight	2008	Powell & Batt	John Wiley & Sons
Excel 2010 Tips & Tricks	2010	Walkenbach	Thomson Publishing
Competing on Analytics: The New Science of Winning	2007	Davenport & Harris	Harvard Business School Press
Matching Supply & Demand	2009	Cachon & Terwiesch	McGrow Hill

Assignments and Assessments

Three modelling exercises and group presentations on the analysis of a case study (25% group-based) due on day 2, 3 and 4. Take home modelling project (75% individual) handed out at the end of the last lecture due back on Monday, Dec 10.

Course Material

A binder containing cases, journal articles and book chapters will be distributed in the first session. Additional material, including the lecture notes, will be distributed in class.

A note on the instructor

Nicos Savva is an Assistant Professor at the Management Science and Operations department of the London Business School. Nicos has a PhD in Management Science, an MPhil in Finance (Financial Engineering) and a BA in Physics, all from the University of Cambridge. In addition to Advanced Modelling, Nicos also teaches Decision and Risk Analysis for the London MBA and Executive MBA programmes and he is the recipient of the 2008-09 Outstanding Core Course Teaching Award. Besides LBS he has also taught at The Wharton School, University of Pennsylvania and at the Judge Business School, University of Cambridge.

Nicos' research interests include modelling and designing contracts for collaborative new product development and optimization of flexible systems under uncertainty with applications to healthcare. His research has been published in MSOM, Journal of Economic Dynamics & Control and in Nature Biotechnology. Nicos has acted as a consultant to high-tech start-up companies, retail firms, hospitals and hedge funds.

Day 1, Sessions 1 & 2: Introduction to Modelling

Main case: EasyBeds

Concepts covered

- The four stages of modelling
- Effective presentations of modelling work

Modelling techniques discussed

1. Modelling uncertainty: How to choose a distribution
2. Regression Analysis
3. Sensitivity Analysis
4. Monte Carlo simulation

Preparation – pre-class reading

- Prepare Part I of EasyBeds (course binder)
- Read and practice using *Excel 2010 Tips & Tricks* (course binder)

Post-class reading & groupwork

- Powell & Batt: Chapter 2 (course binder)
- Powell & Batt: Chapter 4 (optional)
- Prepare a presentation for the board of EasyBeds

Day 2, Sessions 3 & 4: Valuation of flexible systems

Main case: NSR: modelling codevelopment contracts in the biotech/pharma industry

Presentations

- 2-3 group presentations to the board of EasyBeds
- Industry speaker (Chief Marketing Officer of Travelport, TBC)

Concepts covered

- Modelling flexible systems (Real Options)
- Using models for contract design and negotiation

Modelling techniques discussed

5. Representing uncertainties with lattice trees
6. Backwards induction (Real Options valuation)
7. Game Theory

Preparation – pre-class reading

- Prepare Part I of NSR case (course binder)

Post-class reading & groupwork

- Articles (course binder)

    - Leslie K. J. and M. P. Michaels, 1997, The Real Power of Real Options, McKinsey Quarterly, 3
    - Scientific Management at Merk: An Interview with CFO Judy Lewent, HBR, 1994
- Powell & Batt: Chapters 6 & 11 (optional)
- Prepare a presentation for the board of NSR

Day 3, Sessions 5 & 6: Portfolios of real projects

Main case: Advance Nanotech

Presentations
- 2-3 group presentations to the board of NSR

Concepts covered
- Risk Management: Diversification vs. Hedging
- Modelling portfolios of projects: Allocating Shell's exploration budget

Modelling techniques discussed
8. Measuring risk in projects
9. Efficient frontiers
10. Non-linear/stochastic optimization
11. Stochastic optimization with integer constraints

Preparation – pre-class reading
- Prepare Part I of Advance Nanotech (course binder)

Post-class reading & groupwork
- Articles (course binder)
    - Savage S.L., Scholtes S. and Zweidler D., 2006, Probability Management, Parts I & II, ORMS today
    - Ray Kavanaugh Uses Math to Make Movies, Esquire feature article, Dec 2009
- Prepare a presentation for the investors or the project managers of Advance Nanotech

Day 4, Sessions 7 and 8: The impact of variability on system performance

Main case: Call centre queues

Presentations
- 1-2 group presentations to Advance Nanotech investors
- 1-2 group presentations to Advance Nanotech project managers
- Industry speaker (Tesco's mathematician, TBC)

Concepts covered
- Modelling systems with variability – queue theory

Modelling techniques discussed

12. Modelling durations and the exponential distribution
13. Modelling queues using Monte Carlo simulation
14. Markov chain analysis - steady state distributions for queues

Preparation – pre-class reading

- Nothing for this week

Post-class reading

- Journal articles (course binder)
    - Larson, R. C. 1987, Perspectives on Queues: Social Justice and the Psychology of Queueing, Operations Research, 35 (6)
    - Donald A.N, 2009, Designing waits that work, Sloan Management Review, 50 (4)
- Cachon & Terwiesch, Chapter 7 (course binder)

Day 5: Sessions 9 and 10: Capstone modelling case

Main case: Queue Management at Al-Ain Hospital

Presentations

- Industry speaker (Chief Operating Officer, Al-Ain Hospital, TBC)

Concepts covered

- Modelling new patient diffusion
- Course conclusions: Competing on analytics

Modelling techniques discussed

15. Analysing large scale datasets (Pivot tables)
16. Data driven modelling of diffusion processes

Preparation – pre-class reading

- Read the case Queue Management at Al-Ain Hospital (course binder) and prepare the first question

After class reading & individual assignment

- Journal article (course binder)
    - Davenport T.H. 2006, Competing on Analytics, Harvard Business Review
- Individual assignment handed out