Randomness, Decisions, and Human Nature

SOM 797R - SYLLABUS

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PURPOSE (for Non PhD students):

- To gain familiarity with the role of luck in business, finance, society, other matters involving randomness.
- To understand problems with causation, inference, belief and knowledge formation.
- To identify the presence of situations where deterministic methods no longer apply.
- To make *true life* decisions under uncertainty –away from textbooks and formulae.
- To understand the various methods to capture and understand uncertainty –both protect yourself from the bad uncertainty and benefit from the beneficial one.
- To understand the relation between human nature & the perception of randomness.

Mathematics here is dealt with in a "literary" fashion, i.e., with plain simple reasoning examples. Some of the readings might include mathematical sections. Psychology is not seen as a standalone discipline, but part of information theory and information processing.

PURPOSE (Phd Students):

For PhD Students more emphasis is put on "fat tails", "stochastic volatility", and problems with the commonly used mathematics of randomness.

The aim is to understand a spate of problems neglected in the existing literature, many of them of them of clinical nature, such as:

- o off-model risks
- o fat tails and the quality of statistical inference
- o the inseparability of utility and probability

While contents are simple to explain in nontechnical language, PhD students are asked to go far deeper in the literature.

SYMPTOM	PROBLEM	DISCIPLINE
Distortions in the way uncertain events present themselves	Data mining, survivorship bias	Statistics, finance, econometrics, philosophy of science/inference
Distortions in the way the generator works (sampling attributes) – "fat tails"	Model error, model mismatch, model risk	Information theory, Probability theory, epistemology, extreme value theory, extreme economics, econophysics,
Distortions in the way we perceive uncertain events	Perceptional biases, cognitive distortions	Judgment and Decision making, heuristics and biases, cognitive science, behavioral economics

GRADING (non PhDs:

Class participation 25%
Class project 25%
Homework 25%
Exam with 4 brief essay questions 25%

+ Lecture 1, September 12, 2005

MODULE 1. INTRODUCTION; WHAT IS THIS COURSE ABOUT?

- A general review of the course
- The visible and the invisible
- Table of Confusion
- Noise v/s meaning

Homework: Read the article provided here and write three bullet points outlining what comes to mind when I say that the journalist thinks that he knows more than he actually does , i.e., "fooled by randomness". (I picked the Bloomberg report because the problems are most blatant there).

Results: the author is clearly making mistakes of overcausation but the most blatant mistake was that the information ratio was low (information ratio =noise/meaning). He was giving complicated explanations for a small change.

+ *Lecture 2, September 19, 2005*

MODULE 2. OVERCONFIDENCE ("EPISTEMIC ARROGANCE") & THE FALLACY OF PREDICTION (LONG MODULE)

- Epistemic arrogance: a.k.a. overconfidence.
- Relation between knowledge, accuracy, and confidence – How knowledge does not necessarily increase with information, but confidence does.
- Intrinsic limits in prediction.
- Forecastability and nonlinearities
- Understanding the predictability of complex systems

- Nonlinearities and the degradation of knowledge
- Strategy with dealing with uncertainty. Focus on the error in forecast, or the spread rather than the forecast itself.

Readings: NNT: The Scandal of Prediction (3 chapters); James Montier, *the Folly of Forecasting*, *The illusion of knowledge or Is more information better information*? Dresdner Kleinwort Wasserstein Paper (permission given).

PhD readings: segments of the overconfidence literature. Raiffa and Albert (1969,1982). See Lichtenstein, S., & Fischhoff, B.(1977). Do those who know more also know more about how much they know? The calibration of probability judgments. Organizational Behavior and Human Performance, 20, 159--183.

The skeptic should see "Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments." Kruger, J., Dunning, D., Journal of Personality and Social Psychology, 1999, 77(6), 1121-1134.

See also Plous (1993) for the relationship between overconfidence and difficulty. For the clinical biases literature, see the paper by Tiesska-Zielonka here on the difference between weather forecasters and stock analysts. Those more adventurous should go to the nonlinear prediction literature referenced in *The Scandal of Prediction* (Poincaré, Berry).

Those PhD students interested in empirical testing of forecasts should read this paper on herding by prominent econophysicist Bouchaud and use it as a model.

+ Lecture 3, September 26, 2005

MODULE 3. SELECTION BIAS/ REFERENCE CLASS & DATA MINING

- Casanova's problem

- Debunking Myths: *In Search of Excellence, the Millionaire Next Door*.
- Survivorship bias in finance
- Data Mining
- The anthropic principle in physics and philosophy, particularly the "Weak Anthropic Principle"
- The retrospective distortion

Readings: 1) FBR, Introduction to PART II, Chapters 8 & 9. Also read the corresponding notes, 2) NNT, *Casanova's unfailing luck*. See the anthropic bias primer.

PhD readings/presentations:

Iuliana Ismailescu, Survivorship biases in finance (Ross et al, White), etc.

Cosette Chichirau, anthropic biases in philosophy and science (two essays from Nick Bostrom, 2002).

Chris Schwarz. Andrew W. Lo; A. Craig MacKinlay (1990),Data-Snooping Biases in Tests of Financial Asset Pricing Models, *The Review of Financial Studies*, Vol. 3, No. 3., pp. 431-467.

Halbert White 2000, A Reality Check for Data Snooping, *Econometrica*, Vol. 68 (Sep.), No. 5., pp. 1097-1126.

R. Sullivan, A. Timmermann, and H. White: "Data Snooping, Technical Trading Rule Performance, and the Bootstrap," *Journal of Finance*, 54, 1647-1692 (1999).

Further readings. An excellent compact review work is provided in Nick Bostrom,2002, *Anthropic Bias: Observation Selection Effects in Science and Philosophy*. More advanced problems in physics are found in a rather confused but rich classic: Barrow and Tipler (1986) *The Anthropic Cosmological Principle*.

Homework:

Marylin vos Savant received the following question:

Suppose you're on a game show, and you're given the choice of three doors. Behind one door is a car, behind the others, goats. You pick a door, say number 1, and the host, who knows what's behind the doors, opens another door, say number 3, which has a goat. He says to you, "Do you want to pick door number 2?" Is it to your advantage to switch your choice of doors? Craig. F. Whitaker, Columbia, MD

Please explain in a VERY brief comment why you agree or disagree to switch doors.

+ *Lecture 4, October 3, 2005*

MODULE 4. MILD V.S WILD RANDOMNESS (BELL CURVE V/S NONGAUSSIAN PARADIGMS)

- Most people discuss "variance", "sigma", "standard deviation" without understanding them.
- We will go very deep in all aspects of sampling theory
- By the end of the module the student should have an intuitive understanding of what randomness is and how to avoid the major traps
- The notion of value at risk
- The notion of scalability
- Fractals and self-similarity
- Econophysics /Statistical physics of finance

Readings (after the class): NNT, *A derivation of the Bell Curve*. Mandelbrot and Taleb (2005): *How the Risk Gurus Get Everything Wrong* , *John Kay FT*

PhD can take a pre-course intuition from some of these papers – the best is from one of my trainees in my *fat-tails lab*. This is a paper I disagree with.

Best Introductory (but very, very complete) Book on the Topic (PhDs): *Critical Phenomena in Natural Sciences: Chaos, Fractals,*

Selforganization and Disorder: Concepts and Tools by Didier Sornette. The 2004 edition is best.

See Also Mandelbrot, B.B. 1997. *Fractals and Scaling in Finance: Discontinuity, Concentration, Risk*. New York: Springer-Verlag.

There will be no class the week of October 10

POST CLASS Module 4 – required reading: the previous papers.
Class notes (for the derivation of the bell curve, see above); see also the power law calculator.
Those interested in what their "professor" does on days when he is not a professor.

OPTIONAL PROBLEM 1– "Someone" offers you the following wager: you are shown two closed envelopes with a check in each. One contains twice the other's. You can open and see the contents of the first, 1)then accept the money or 2) reject and switch to the other one (but you cannot go back to the first). This appears to be a problem because no matter which one you open, the second will be better "in expectation" –and it should be optimal to switch.

This is called a paradox. But there is something wrong somewhere –in the solution of unconditional switching, or the way the problem is presented –or something else. Is it necessarily optimal to switch? Please find what is wrong with it *in words*.

Trick: it is very, very simple if you think out of the box. Otherwise forget about it.

OPTIONAL PROBLEM 2 (less intelligent but more technical) – (for those who work with statistics) Try to explain why a process mixed with standard jumps (jump diffusion, Poisson jumps, etc.) does not produce power laws.

Also I did not do justice to the Fractal Art during the presentation. These images are of ravishing beauty.

image 1
image 2

Lecture 5, October 17

MODULE 5. AN INTRODUCTION TO HEURISTICS AND BIASES, SYSTEM 1/SYSTEM 2

First two answers to the Monty Hall problems, one intuitive and one mathematically "elegant", are in Schmid class notes, p14 onwards.

This class is an introduction to the major ideas behind behavioral and cognitive economics. After this module we would have almost covered in a shallow manner the main ideas (fat tails, skewness, survivorship biases, conditional probability, mental biases) and we will leave disciplines to deal with *problems* and go deeper into them.

Pre-class required reading: FBR, Chapter 3, section "Philostratus in Monte Carlo". (PhDs need to read the mathematical version)

Also required Chapter 11 & 12, with the notes in the back of the book. There is far more information in the notes than in the text itself.

PhD readings (required for PhDs, optional for others): Kahneman's Nobel lecture , Thaler's mental accounting , Camerer, Lowenstein & Prelec Neuroeconomics.

Optional reading for the intellectually hungry: Glimcher's review of his work on neuroscience and economic behavior.

- Bounded rationality
- What is intuition? The formation of statistical judgments
- Dual system reasoning
- Heuristics and biases

1. Availability heuristic
2. Representativeness heuristic
3. Base-rate fallacy

4. Retrospective distortion
5. Affect heuristic
6. Risk as feelings
7. Law of Small numbers
8. Mental accounting
9. Framing
10. Preference reversal
11. Egocentric bias

- Do these biases exist really or are they laboratory induced?
- Signal and noise: the scaling problem

+ Lecture 6, October 24

TERRY BURNHAM –CAVEMAN ECONOMICS.

Lecture contents are at:

www.meangenes.org/caveman

+ Lecture 7, October 31

Required readings: FBR, Chapters 6 & 7, Introduction to PART 3, Chapters 12.

MODULE 6. A DEEPER LOOK INTO BIOLOGY AND COGNITION

- Visual heuristics

- Memory and cognition
- Memory biases: consistency and hindsight distortions
- Patterns & dopamine
- Triver's self-deception
- Fundamental attribution bias
- The narrative fallacy
- Counterfactual thinking and norm theory
- Confirmation bias
- Illusion of control
- Belief systems
- Defaults in choices and vulnerability to framing

Lecture Slides

+ Lecture 8, November 7

Required readings: The Lecture will discuss the MIDTERM answers (they are good), continue Module 6, and move into module 7

Phd (mandatory) readings On the nonobservability of probability distributions , Epistemology of power laws . Recommended readings in epistemology of statistics: TBA

All others: reread Chapter 7.

+Lecture 9, November 14

Continuation of the previous (induction). We are finally getting into the core of the class. We started discussing induction after cognitive science. Note that modules overlap sessions. **STUDENTS ARE REQUIRED TO BE UP TO DATE ON THE CUMULATIVE READING LIST.**

Reading(REQUIRED): A Tutorial on Induction

STUDENT PRESENTATIONS: (Note that an additional student may be called upon to randomly summarize a paper of previous lectures, particularly one of the previous three. These may include the chapters from FBR).

George Martin: Moral Hazard and statistics of traders performance.

Xiaoling Pu: Coval & Shumway: "Expected Options Returns" ; Bodarenko: "Why are Put Options so Expensive?"

Aixin Ma: Introduction to Behavioral Finance. Barberis , Nicholas and Richard H. Thaler (2003), " A Survey of Behavioral Finance. " In *Handbook of the Economics of Finance*. George M. Constantinides, Milton Harris, and Rene' Stultz editors. Elsevier Science, North Holland, Amsterdam. Also the Kahneman-Tversky 1992 follow-up paper on prospect theory.

Additional readings in Behavioral finance: Benartzi, S. and Thaler, R., 1999, "Risk Aversion or Myopia? Choices in Repeated Gambles and Retirement Investments", *Management Science*, Vol. 45:3, 364-381. Shannon entropy, Kolmogorov complexity.

MODULE 7. THE PROBLEM OF INDUCTIVE KNOWLEDGE −A PRACTICAL APPROACH

- Rare events and inference
- Methods in econometrics
- Mental biases in inferential claims
- The round-trip fallacy
- Scorn of the Abstract
- Randomness & knowledge
- Skewness and asymmetric probabilities

HOMEWORK: Please write a brief "note" (<200 words, use word count in your text editor) explaining how you link the topics of the class to the subject of ethics.

+Lecture 10, November 21. The Lecture is on extreme economics and skewness in real life. Fairness implications will be also considered.

Required READINGS

NNT, Postscript to Fooled by Randomness, yevgeniagrassberger, Roots of Unfairness

Sherwin Rosen The economics of superstars.

OPTIONAL READINGS

Very important: Simon, Herbert A., "On a Class of Skew Distribution Functions." Biometrika, 42 (1855): 425-40 (the seminal paper)

Cumulative advantage a review by Thomas Diprete (2005)

Frank, Robert H., "Talent and the Winner-Take-All Society" (a review of Derek Bok's *The Cost of Talent: How Executives and Professionals Are Paid and How It Affects America* (Free Press, 1993). *The American Prospect* 5.17 (March 21, 1994): http://www.prospect.org/print/V5/17/frank-r.html

Art Devany- Hollywood Economics

Student Presentations:

Wesley Pech: presentation of Frank, Robert H. & P.J. Cook, *The Winner-Take-All Society. Why the few at the top get so much more than the rest of us*. New York: Free Press, 1995. Also Rosen's paper above.

Ekundayo Shittu: Simon's paper. The excellent summary is [here](#) .

MODULE 8. NETWORK THEORY AND EXTREME ECONOMICS

- Winner-take-all, superstar effects, Rosen/Fran-Cook nonrandom presentation
- Pareto, Yule, Zipf, Estoup, Champernoyne, Simon, Mandelbrot
- Fat tails/scalability in practice
- Fairness in society
- Merton's Matthew effect
- Mathematical models of preferential attachment/cumulative advantage
- Practical effects
- Percolation v/s diffusion
- Agent based models
- Tipping points; Schelling, Granovetter
- Network theory: models by Watts-Stogatz-Barabasi-Albert

  http://www.fooledbyrandomness.com/amherstclass/Amherst10.pdf

  My lecture notes on Extreme economics

+Lecture 11, November 28. We continue and merge power-law tails with information theory

MODULE 9. ADDITIONAL TOPICS IN RANDOMNESS

- What is information theory?
- What does sampling mean?
- Entropy
- Shannon's Entropy theory

- Mandelbrot's information-theoretic derivation of power laws
- Understanding gambling and what you need to know about it
- Kelly criterion, gambler's ruin, and CPPP
- A Monte Carlo Generator
- A brief history of probabilistic thinking
- Dispersion and Prejudice
- Randomness as information & disorder

MODULE 10. CONVEXITY AND DECISION MAKING UNDER UNCERTAINTY (VERY VERY SHORT)

- Real options simplified
- How to take decisions under incomplete knowledge

HOMEWORK: Please write a "note" (<400 words, use word count in your text editor) summarizing what was said in class about extreme economics and whether or not it matters for you.

More readings on extreme economics. Here is an excellent summary by [Mitzenmacher](#) on internet economics; it shows how the lognormal can arise from multiplicative growth and can be confused for a scalable. [Here](#) is the "long tail" article by Chris Anderson.

+Lecture 12, December 12.

MODULE 11. UNCERTAINTY AND ETHICS

MODULE 12. CHANCE AND THE ECONOMICS OF HAPPINESS

- Utility theory
- Prospect theory
- Hedonic treadmill
- Happiness and pecking order
- Social dimension of the problem

Readings: Richard Layard, *Happiness--Has Social Science a Clue?* London School of Economics Lionel Robbins Lectures.
Lecture 1. What is happiness? Are we getting happier?
Lecture 2. Lecture 2. Income and happiness: rethinking economic policy
Lecture 3. Lecture 3. How can we make a happier society?

Hedonic Treadmill (ASA presentation). Robert Frank (review) –

MODULE 13. THE PROBLEM OF OFF-MODEL RISKS (AKA THE PLATONIC FALLACY)

- The Casino problem
- Tipping points
- Schelling's problems
- Sociophysics and econophysics
- Epistemology of scalable distributions

- Backward and forward induction

Readings: NNT, *TBSKnight, Frank H. (1921) The Meaning of Risk and Uncertainty, Part III,   Chapter VII from Risk, Uncertainty, and Profit. Boston: Houghton and Mifflin. Online edition: <http://www.econlib.org/library/Knight/knRUP.html>.*

APPENDIX 1

Additional Readings on Extreme Economics (this is a long list of classical texts/papers but acquaintance with the bulk of the ideas is essential):

Barabási, A.-L. and R. Albert. 1999. Emergence of scaling in random networks, *Science* 286, 509–512.

Barabási, Albert-László and Eric Bonabeau. 2003. Scale-free networks. *Scientific American* 288 (5): 50-59

Estoup, J. B., 1916. *Gammes Stenographique.* Institut Stenographique de France, Paris.

Faloutsos, M., P. Faloutsos, and C. Faloutsos. 1999. On Power-Law Relationships of the Internet Topology, *Computer Communications Review* 29: 251-62.

Lotka, Alfred J., 1926. The Frequency Distribution of Scientific Productivity. *Journal of the Washington Academy of Sciences* 16(12): 317-323.

Merton, R. K., 1968. The Matthew effect in science. *Science* 159: 56-63.

Mitzenmacher, Michael. 2003. A brief history of generative models for power law and lognormal distributions. *Internet Mathematics* 1 (2): 226-251.Pareto, V., 1896. *Cours d'economie politique.* Geneva, Switzerland: Droz.

Price, D. J. de Solla, 1965. Networks of scientific papers. *Science*, 149, 510-515.

Price, D.J. de Solla. 1976. A general theory of bibliometrics and other cumulative advantage processes. *Journal of the American Society of Information Science*, 27: 292-306.

Simon, Herbert A., 1955. On a class of skew distribution functions. *Biometrika* 42:425-440 (reprinted in Ijiri, Y. and Simon, H. A., 1977. *Skew Distributions and the Sizes of Business Firms*. New York: Elsevier/North Holland).

Vogelstein, Bert, David Lane and Arnold J. Levine, 2000. Surfing the p53 network. *Nature* 408: 307-310.

Watts, D. J., 2003. *Six Degrees: The Science of a Connected Age*. New York: WW Norton & Company

Willinger, W., D. Alderson, J.C. Doyle, and L. Li. 2004. A pragmatic approach to dealing with high variability measurements. *Proc. ACM SIGCOMM Internet Measurement Conference 2004*, Taormina, Sicily, Italy. October 25-27.

Yule, G. 1925. A mathematical theory of evolution, based on the conclusions of Dr. J. C. Willis, F. R. S. *Philosophical Transactions of the Royal Society of London, Series B*. 213:21-87

Zipf, George Kingsley, 1932. *Selective Studies and the Principle of Relative Frequency in Language*. Cambridge, MA: Harvard Univ. Press.

Zipf, George Kingsley. 1949. *Human behavior and the principle of least effort*. Cambridge, MA: Addison-Wesley.