Program in Applied Economics
Advanced Academic Programs
Zanvyl Krieger School of Arts and Sciences
The Johns Hopkins University

Real Risk
440.619
Fall 2016 Course Syllabus

Instructor
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Class
Lectures: Tuesdays beginning August 30, 6pm-8:45pm; location WDC Center, 1717 Mass Ave, room 416
Final exam: December 13, 6pm

Note that there is no class on September 6. Instead, there will be a makeup lecture on Saturday Sept 17 at 10am, room TBD.

Office Hours
By appointment, Monday or Thursday evenings.

Objective

The objective of this class is to introduce you to a set of methods and tools that have been developed to analyze risky events (in other words, events whose occurrence is uncertain and that have consequences associated with them) as they occur in the real world. Outside of the imaginations of classical modelers, trials are not repeated under identical conditions (if at all), there is no such thing as random Gaussian error, and there are very few probabilities that one could argue are objective in any sense of the word. In light of this, the notion of risk as the variance of return is of limited use beyond the financial sector. We approach uncertainty from the point of view of an odds maker, and we employ a logic that treats all uncertainties consistently regardless of their apparent subjectivity. This logic has a variety of applications, from engineering reliability, to ecology and medicine, to government policy, to business, project investment, and finance. My professional experience is in the field of national security, and several of the assigned readings focus on national security applications.

What to Expect

This class requires A LOT of challenging reading, much like a doctoral seminar. There is no textbook. Your readings will consist entirely of journal articles that I have selected (all freely and electronically available through the Sheridan Libraries) to teach the core concepts as well as illustrate actual application of those concepts to solve problems, usually three per week, sometimes four. Probabilistic risk analysis is an active and evolving field, and I feel that the best way to learn the concepts and applications is to immerse yourself in the academic discourse. The 'core' readings are essential for passing this class, so be prepared to read some 40 to 80 hard pages per week, and of course ask questions!

Typically, in the first ~90 minutes or so of class I will give a lecture with the goal of fleshing out the concepts introduced in the readings, and I hope that these lectures spark seminar-style discussions. The remainder of class will be spent either working through one or two examples of problems in which we apply the concepts presented, or else in the computer lab. I encourage questions and discussion during lecture. This class is heavy on probability and statistics and will also include a bit of calculus– you are encouraged to review your course notes from the math and statistics classes you have taken. You will also get a taste of some computer programming, although prior experience with computer programming is not required.

Grading Basis

Final exam 35% / project 30% / homework 30% / participation 5%

The final exam will be open-note/open-reading.

The project will require you to work in groups of 4 (I may permit groups of 3 or 5 depending on class size). You should form a team with other students with whom you can meet easily outside of class. The project is intended to provide you with an opportunity to put some of the tools and techniques you learn in this class into practice by analyzing the risk associated with a real-world activity or event using the concepts and tools presented in class. Grading basis for the project will be provided at the time the project is assigned. Each group will be required to submit a presentation (due at 11:59pm the Tuesday prior to your in-class presentation), a written appendix containing your data and probability distributions, and to give a short in-class presentation in which all team members have a speaking role. I will schedule a Skype session with each group a few weeks after the project is assigned in order to give you with some early un-graded feedback.

Most weeks I will assign homework problems to go along with your readings. Their purpose is to get you thinking about new concepts as well as how you might apply the theory to solve real world problems. Problems will be graded on a 4 point scale. A rough interpretation of each point is:

4 - you clearly demonstrated grasp of the concepts and/or how to apply them
3 – you demonstrated partial grasp of the concepts, or else I cannot tell whether you grasp them (for instance because you did not show enough of your work)
2 - you did not demonstrate that you grasp the concept
1 - you skipped the problem or made no effort

Homeworks will be due at 11:59pm on the day of class and should be submitted electronically via email. If you do any problems by hand, please scan your assignment (and write clearly). I will post solutions to the problems about a week after class, which I expect you to review and compare to your homework response in order to identify errors. If you have questions about the homework solutions, you should post a question to the discussion forum on Blackboard, since others may have the same question. Late homeworks will be accepted before the answers are posted but will result in a 10% penalty in the number of possible points. Once the answers are posted, late homeworks will no longer be accepted regardless of reason. If you have a significant extenuating circumstance, contact me before class and I will consider delaying posting the answers.

I will not take attendance, but I do expect participation in class through discussions and/or on the Blackboard forum throughout the semester. Don't worry getting a comment in every class – I'm not keeping count! If you participate in class discussion by asking questions and responding to other students, and if you post an occasional reaction to the readings online or respond to other students posts, you'll get the 5%.

Technology

We will utilize Blackboard whenever possible. Your assigned readings and homeworks will be posted to Blackboard, as will class announcements, homework solutions, and my lecture notes. (Homeworks, however, should be submitted via email.) Finally, I encourage you to use Blackboard to discuss class-related topics and to ask questions. (Please use good "netiquette.") I will monitor the forums, and you should do the same.

You will be expected to utilize the following software to solve certain homework problems:

- Norsys Netica, available at www.norsys.com, the free version suffices for class purposes
- Mathworks MATLAB, academic license $99 through www.mathworks.com, possibly available free to JHU students (contact software@jhu.edu for details)

Additionally, you should use MS Excel to solve decision trees, and you are encouraged to obtain a plug-in to automate computation and generate graphics. Two such plug-ins are:

- Treeplan (plugin for MS Excel), cost $59, available at www.treeplan.com
- Simple Decision Tree, free, available at sites.google.com/site/simpledecisiontree/

You may find that you are able to use Python or R in lieu of Netica and MATLAB, given the necessary libraries/toolkits/packages. I do not insist on your using Netica and MATLAB for your assignments, but I will teach using those software platforms in the computer lab, since they are industry-standard in the fields of operations research, decision analysis, and risk analysis. If you use Python, R, or other software platforms not listed above to solve an assignment, the burden is on you, doubly so, to clearly demonstrate your grasp of a concept. Do not assume that I will follow your code.

Policy on collaboration

You are welcome to work in groups on your homework, but you must write up your answers individually and list your collaborators. Please do not abuse this policy -- a "divide-and-conquer" strategy to homework collaboration is not acceptable, nor is it acceptable for the project. If I decide to give any take-home exam problems in connection with the final exam, it is expected that you will not collaborate to solve these questions, as described in the Johns Hopkins University AAP Code of Conduct (http://advanced.jhu.edu/wp-content/uploads/2013/03/AAP1101_CodeofConduct1.pdf).

Schedule

The following schedule is tentative and subject to change. Please note that I expect you to come to the first class on September 14 having completed the assigned readings. Your project will be due on November 2.

Readings are marked with three different letters to assist you in deciding how to approach them. They are listed by number inside square brackets [ ] in the table below. Those numbers refer to the numbering scheme in this syllabus beginning on the next page. Please be aware that the numbering scheme in Blackboard may be different (the E-Reserves staff assigns numbers to each E-Reserve item on Blackboard, and unfortunately I cannot control what number they assign).

C: *Core* You are responsible for knowing the material in these readings. Exam questions will draw on them, and subsequent weeks' readings may build on this material. These readings are essential.

E: *Examples* These readings demonstrate the implementation of some of material presented in the core readings. They are assigned to assist you in understanding how one might use that material in practice. You will not be tested on them directly, but you may find them helpful to understand how the concepts are applied to problems, such as those on the exam. Many of these readings include problem formulations and solutions.

O: *Optional* These readings go into greater depth on some facet of the core material. We will discuss this material in the classroom, but it will not be tested on the exams.

Continued on next page

Week	Date	Topic	Readings
1	08/30/16	Nature of Probability	[13]C (read first) [1]C (focus on logic, not eqs) [18]O
3	09/13/16	Measuring Risk	[19]C [20]C [28]C (sections 1, 2, 4, 6, others O) [39]E
2 (makeup)	09/17/16 (Saturday)	Monte Carlo simulation (meet in Comp Lab, room TDB)	[17]C (sections 1, 2, 3.1, 3.2, 7 only) [9]E (focus on the logic, not the code)
4	09/20/16	Decision Analysis PROJECT ASSIGNED	[15]C (pp. 211-217 stop at "Informational Phase", remainder O) [38]E (focus on sections 2.5, 2.6, 2.7, other sections useful for context) [8]E/O [29]O
5	09/27/16	Encoding probability distributions	[10]C, [34]C, [21]O
6	10/04/16	Influence Diagrams and Bayesian Networks 1 (meet in Comp Lab, room TBD)	[16]C [22]C ("Introduction" and "Basic" sections) [27]E (sections 4, 5 6) [35]E
7	10/11/16	Influence Diagrams and Bayesian Networks 2	[31]C [4]E [26]O
8	10/18/16	Tools of Risk Analysis	[23]C [6]E [14]E [25]O
9	10/25/16	Portfolios of Projects	[12]C [40]C and E [36]O
10	11/02/16	Dynamic Random Processes PROJECT SUBMISSIONS DUE	[2]C [30]C (sections 1-5 only, remainder E/O) [37]E
11	11/09/16	PROJECT PRESENTATIONS (you are invited to attend all presentations but are only required to attend your presentation)	
11	11/16/16	Dynamic Programming and Real Options	[3]C (pgs 1-7 and 9-11, i.e. Introduction through Mathematical Formulation #2, and Examples 1 & 2, remainder O), [7]C [11]E [32]O
12	11/23/16	NO CLASS (Thanksgiving vacation)	
13	11/30/16	Early Warning	[24]C [5]C and E [33]O
14		REVIEW	
	12/13/16	FINAL EXAM	

We have a very aggressive schedule and are covering material that could fill several graduate level courses.

Other Notes

Students with documented disabilities and who require reasonable accommodations should contact the AAP accommodations coordinator list at
http://advanced.jhu.edu/current-students/current-students-resources/disability-accommodations/

If you encounter any technical difficulty with Blackboard, please contact the 24hr help desk at 855-593-0086 and email me.

Readings

[1] Apostolakis, George, 'The Concept of Probability in Safety Assessments of Technological Systems', *Science*, 250 (1990), 1359–64 <http://dx.doi.org/10.1126/science.2255906>

[2] Beck, J. Robert, and Stephen G. Pauker, 'The Markov Process in Medical Prognosis', *Medical Decision Making*, 3 (1983), 419–58 <http://dx.doi.org/10.1177/0272989X8300300403>

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[12] Fox, Edward G., Norman R. Baker, and John L. Bryant, 'Economic Models for R and D Project Selection in the Presence of Project Interactions', *Management Science*, 30 (1984), 890-902 < http://dx.doi.org/10.1287/mnsc.30.7.890>

[13] Good, I. J., 'Kinds of Probability', *Science (New York, N.Y.)*, 129 (1959), 443–47 <http://dx.doi.org/10.1126/science.129.3347.443>

[14] Hong, Eun-Soo, In-Mo Lee, Hee-Soon Shin, Seok-Woo Nam, and Jung-Sik Kong, 'Quantitative Risk Evaluation Based

on Event Tree Analysis Technique: Application to the Design of Shield TBM', *Tunnelling and Underground Space Technology*, 24 (2009), 269–77 <http://dx.doi.org/10.1016/j.tust.2008.09.004>

[15] Howard, Ronald A., 'The Foundations of Decision Analysis', *IEEE Transactions on Systems Science and Cybernetics*, 4 (1968), 211 –219 <http://dx.doi.org/10.1109/TSSC.1968.300115>

[16] Howard, Ronald A., and James E. Matheson, 'Influence Diagrams', *Decision Analysis*, 2 (2005), 127–43 <http://dx.doi.org/10.1287/deca.1050.0020>

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[30] Rabiner, L.R., 'A Tutorial on Hidden Markov Models and Selected Applications in Speech Recognition', *Proceedings of the IEEE*, 77 (1989), 257–86 <http://dx.doi.org/10.1109/5.18626>

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[32] Smith, James E., and Robert F. Nau, 'Valuing Risky Projects: Option Pricing Theory and Decision Analysis', *Management Science*, 41 (1995), 795–816 <http://dx.doi.org/10.1287/mnsc.41.5.795>

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