Dr. Yakov Ben-Haim
Professor
Yitzhak Moda'i Chair in
Technology and Economics

Technion
Israel Institute of Technology
Faculty of Mechanical Engineering
Haifa 32000 Israel

http:/info-gap.com Blog: http:/decisions-and-info-gaps.blogspot.com http:/www.technion.ac.il/yakov
Tel: +972-4-829-3262, +972-50-750-1402 Fax: +972-4-829-5711
yakov@technion.ac.il

Undergraduate/Graduate Course

Decisions: Challenges and Implications

036083

Syllabus. Engineers make decisions, focusing on functionality, efficiency and reliability. This course focuses on philosophical aspects and limitations of decisions under uncertainty. Anomalies of decision. Satisficing and optimizing as bases for decision. No-failure design and disaster recovery. Theory selection for decision support. The need for multiple uncertainty theories. Rationality. Course open to undergraduates with at least 75 credits.
Enrichment studies (limuday ha'asharah): This course is recognized as credit towards the 6-point enrichment-study requirement.
Audience. Students from all departments.
Prerequisite: Course open to graduate students and undergraduates with at least 75 credits.
Credits: 2.0.
Class size: Maximum 30 students.
Weekly sessions. Each 2-hour (120 minute) session is organized as follows:

1. Lecture: 45 minutes.
2. Working groups: 35 minutes.
3. Presentations and discussion: four 10-minute modules. 5 minute presentation; 5 minute discussion.

In the working groups the students divide into small teams (maximum 3 people) to develop an implication or application of the lecture topic to an area of science or engineering practice. Each group addresses the question: what are practical applications or implications of an abstract idea discussed in that week's lecture? Each week 4 teams volunteer to present their proposals which are commented on by the other students and the professor.
Grading. Each student must participate in at least 3 presentations, and must submit 2 short essays. The essays may be written by a working group (maximum 3 people). Essay guidelines on p.5. The course grade is based entirely on the essays.
Attendance: Attendance at no less than 10 lectures is mandatory. Exception: miluim.
Office hours. Sundays 13:00–14:00. Thursdays 10:00–11:00. Other times available by appointment.
Time and place of lectures. Winter semester, 2019–2020, Wednesdays, 14:30–16:30. Lady Davis room to be announced.
Website. http:/www.technion.ac.il/yakov/Decisions/decisions.html

Outline of Lecture Topics

1. *The strange world of human decision making.*[1] Foibles of human decision making.[2] The winner's curse.[3] The optimizer's curse.[4] Risk compensation.[5] Some of these examples illustrate human cognitive frailty.

[0] \lectures\decisions\outline12dcn.tex 23.6.2019
[1] **Lecture notes:** \lectures\talks\lib\foibles03.pdf (163 pp.)
[2] ○ Plous, Scott, 1993, *The Psychology of Judgment and Decision Making,* McGraw-Hill, New York, chap.12.
○ Ben-Haim, Yakov, 1996, *Robust Reliability in the Mechanical Sciences,* Springer-Verlag, Berlin, sect.7.1.
[3] ○ Thaler, Richard H., 1992, *The Winner's Curse: Paradoxes and Anomalies of Economic Life,* Princeton University Press, chap.5.
○ Smith, James E. and Robert L. Winkler, 2006, The optimizer's curse: Skepticism and postdecision surprise in decision analysis, *Management Science,* Vol. 52, No. 3, pp.311–322.
[4] Yakov Ben-Haim, Lecture Notes on the Optimizer's Curse, \lectures\risk\lectures\optimizers-curse03.tex
[5] Adams, John, 1995, *Risk,* Routledge, London, chap.8.

Others illustrate the use of inappropriate decision rules. Yet others assess human behavior by inappropriate norms. Much of the course is devoted to sorting out these categories of error, and exploring their implications.

2. *The paradox of choice.*[6] Why more is less (sometimes) and what this implies about decision making.[7] Concepts of probability?[8] The argument for optimization is that "more" is better than "less" so "most" is "best". We contrast this with the strategy of satisficing: aiming at good enough outcomes. Satisficing is often preferable in conditions of limited time or information.[9]

3. *Uncertainty and the end of science.*[10] Science—the search for patterns in nature—thrives on the Unknown. Science thrives on the possibility of discovery. Could science end?[11] Attempts to answer this question lead us to explore concepts of uncertainty, ignorance and probability. Is ignorance probabilistic? Is quantum indeterminism probabilistic? What are the implications of indeterminism for the Newtonian paradigm?

4. *No-failure design and disaster recovery.*[12] Dangerous and critical technologies are designed not to fail. This creates dis-incentives to provide disaster recovery capability. Designing for no-failure while at the same time designing for disaster recovery entails a moral hazard. What is this moral hazard and how to deal with it?[13]

5. *Picking a theory: How hard can that be?*[14] Engineers, economists, social planners, security strategists, and others base their plans and decisions on theories. They often argue long and hard over which theory to use. Why is it so difficult to pick a theory?[15]

6. *Positivism, axioms, and responsible decision making.*[16] Samuelson claims that the scientific method is the paradigm for all theories.[17] Friedman disagrees.[18] How does this relate to robustness?[19]

7. *Military strategy and economics can teach us about risk-management.*[20] Soldiers fight wars, businesses, housholds and the government run the economy, and risk analysts manage hazards. However, the structure of uncertainty is common in all three disciplines. By considering lessons from military strategy and economics we can learn about managing risks.

8. *Grand Unified Theory of Uncertainty???*[21] Uncertainty thrives in the realm of imagination, incongruity, and contradiction. People have struggled with uncertainty for ages and many theories of uncertainty have appeared. How many uncertainty theories do we need? Lots, and forever. Would we say that of physics? No, at least not forever.

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[6] **Lecture notes:** \lectures\talks\lib\pdox-choice02.pdf (189 pp.)

[7] ○ Schwartz, Barry, 2004, *Paradox of Choice: Why More Is Less,* Harper Perennial, New York, chap.1.

○ Barry Schwartz, Yakov Ben-Haim, and Cliff Dacso, 2011, What Makes a Good Decision? Robust Satisficing as a Normative Standard of Rational Behaviour, *The Journal for the Theory of Social Behaviour,* 41(2): 209–227. Pre-print at: http://info-gap.com/content.php?id=23

○ Yakov Ben-Haim, 2011, (Even) God is a Satisficer, http://decisions-and-info-gaps.blogspot.com/2011/08/even-god-is-satisficer.html

[8] Baron, Jonathan, 2008, *Thinking and Deciding,* Cambridge University Press, 4th ed., chap.5.

[9] ○ Yakov Ben-Haim, 2011, Doing Our Best: Economics and Optimization, http://decisions-and-info-gaps.blogspot.com/2011/08/doing-our-best-economics-and.html

○ Yakov Ben-Haim, 2011, Robustness and Locke's wingless gentleman, http://decisions-and-info-gaps.blogspot.com/2011/09/robustness-and-lockes-wingless.html

○ Yakov Ben-Haim, 2011, Squirrels and Stock Brokers, Or: Dilemmas of Decision Making, \papers\essays\Decis-Dilem-Unc\lgsq01.pdf

○ Yakov Ben-Haim, 2011, Uncertainty, Probability and Robust Preferences, \papers\Uncer-Prob\up03.pdf

[10] **Lecture notes:** \lectures\talks\lib\eos01.pdf (51 pp.)

[11] Yakov Ben-Haim, 2011, The End of Science? http://decisions-and-info-gaps.blogspot.com/2011/10/end-of-science.html

[12] **Lecture notes:** \lectures\talks\lib\no-fail-disas-rec01.tex (111 pp.)

[13] ○ Yakov Ben-Haim, Doing Our Best: Optimization and the Management of Risk, working paper.

○ Yakov Ben-Haim, No-Failure Design and Disaster Recovery: Lessons from Fukushima, http://decisions-and-info-gaps.blogspot.com/2011/08/no-failure-design-and-disaster-recovery.html

[14] **Lecture notes:** \lectures\talks\lib\pick-theory01.pdf (138 pp.)

[15] ○ Yakov Ben-Haim, Picking a Theory is Like Building a Boat at Sea, http://decisions-and-info-gaps.blogspot.com/2011/12/picking-theory-is-like-building-boat-at.html, \papers\essays\Central-Tension\cen-ten06.tex

[16] **Lecture notes:** \lectures\talks\lib\samuelson-friedman01.pdf (172 pp.)

[17] Samuelson, P.A., Problems of methodology — discussion. *American Economic Review,* Papers and Proceedings of the 75th Meeting of the American Economic Association, May 1963, 53: 231–236.

[18] Friedman, Milton, 1953, The Methodology of Positive Economics, in *Essays in Positive Economics,* University of Chicago Press.

[19] Ben-Haim, Yakov, 2010, *Info-Gap Economics: An Operational Introduction,* Palgrave-Macmillan, chap. 8: Positivism, F-twist, and robust-satisficing.

[20] **Lecture notes:** \lectures\talks\lib\sra2013-002.pptx (73 pp.)

[21] **Lecture notes:** \lectures\talks\lib\jabberwock01.pdf (107 pp.)

9. *Paradox of universalism: Uncertainty and the innovation dilemma.*[22] Laws of nature hold universally, and other propositions are treated similarly, for instance the UN Universal Declaration of Human Rights. However, universalisms can be paradoxical when applied under uncertainty.

10. *Linguistic uncertainty.*[23] Baseball and linguistic uncertainty.[24] Why is communication so difficult? Can language represent reality? Can statements be true?[25] "What can be said at all can be said clearly, and what we cannot talk about we must pass over in silence." (Wittgenstein[26])

11. *Mathematical metaphors.*[27] What is a metaphor? What is metaphorical about scientific models and theories? Is this a strength or a weakness of scientific models?

12. *Back to the promised land.*[28] In previous lectures we have discussed philosophical aspects of the difficulty of decisions under uncertainty. In this lecture we consider a challenging decision—choose between two options with only 1 measurement—and show that a clever mathematical idea can achieve better than 50% success, even when probabilities are uncertain.

Additional Topics

13. *Why risk analysis is difficult, and some thoughts on how to proceed.*[29] The difficulties arise from limitations of our knowledge. The responses involve ideas of robustness.[30]

14. *Military decisions under severe uncertainty: Application of info-gap theory.*[31] The planning and execution of war requires many decisions surrounded by a fog of uncertainty. We discuss the nature of this uncertainty and an approach to its management based on info-gap theory.

15. *Grand military strategy.*[32]

16. *Decisions and learning.*[33]

17. *Rationality.*[34]
    (a) *Decisions and rationality.* Are suicide bombers irrational? How about profit-maximizing entrepreneurs? What is rationality, and does it dictate one's decisions?[35]
    (b) *Warrant and truth.* Epistemological warrant and criteria of truth.[36] Legal decisions. Old legal dictum: 'reasons are not to be counted, but weighed.'[37]
    (c) *What is a good decision?* Should decisions be evaluated by the outcome, or by the information available at the time of the decision, or by the criteria and reasoning used in making the decision? Can good decision making processes be specified without reference to values?

[22] **Lecture notes:** \lectures\talks\lib\columbia2015-005.tex. See also lectures\talks\lib\reading2015-001.tex.
[23] **Lecture notes:** \lectures\talks\lib\linguis-uncer01.pdf (79 pp.)
[24] Yakov Ben-Haim, Baseball and linguistic uncertainty,
http://decisions-and-info-gaps.blogspot.com/2011/08/baseball-and-linguistic-uncertainty.html
[25] Yakov Ben-Haim, 2006, *Info-Gap Decision Theory: Decisions Under Severe Uncertainty,* 2nd ed., Academic Press, London, section 13.2.
[26] *Tractatus Logico-Philosophicus.*
[27] ○ **Lecture notes:** \lectures\talks\lib\math-metaphor01.pptx.
○ Yakov Ben-Haim, Mathematical metaphors, \papers\essays\Math-metaphor\mphor03.tex, http:/decisions-and-info-gaps.blogspot.co.il/2013/04/mathematical-metaphors.html
[28] **Lecture notes:** \lectures\talks\lib\promised-land01.pdf (40 pp.)
[29] **Lecture notes:** \lectures\talks\lib\risk-anal-dif01.pdf (136 pp.)
[30] Yakov Ben-Haim, 2012, Why risk analysis is difficult, and some thoughts on how to proceed, working paper.
[31] **Lecture notes:** \lectures\talks\lib\military-decision-technion002.pptx, in Hebrew, (134 pp.)
[32] Yakov Ben-Haim, Strategy and uncertainty, \papers\essays\strategy-uncertainty\stratu06.tex
[33] ○ Yakov Ben-Haim, MOOCs and the Unknown, \papers\essays\moocs-unknown\moocun02.tex, http:/decisions-and-info-gaps.blogspot.co.il/2013/02/moocs-and-unknown.html
○ Lecture notes on Info-Gap Learning, section 1: Learning and deciding. \lectures\risk\lectures\lrn02.tex
[34] **Lecture notes (essentially empty):** \lectures\talks\lib\rationality01.pdf
[35] Baron, Jonathan, 2008, *Thinking and Deciding,* Cambridge University Press, 4th ed.
[36] Haack, Susan, 1993, *Evidence and Inquiry: Towards Reconstruction in Epistemology.* Blackwell, Oxford and New York.
[37] Franklin, James, 2001, *The Science of Conjecture: Evidence and Probability before Pascal,* The Johns Hopkins University Press, Baltimore, p.365.

18. *March of folly: Tuchman's Vietnam.* Large institutions sometimes (or even often) make bad decisions despite the best intentions of the decision makers. We examine Tuchman's account of US decision making in the Vietman war.[38]

19. *Preference reversals.* The Ellsberg paradox and ambiguity.[39] The Allais paradox. Preference reversals and the innovation dilemma.[40] People change their opinions, first preferring one option then another. This is defensible in a wide class of situations.

20. *Decisions by groups.* "Two is better than one"? Group dynamics and the advantages and drawbacks of collective decision making. Decision-making and leadership.

21. *Institutions and decisions.* Individuals make decisions, but they make decisions within the constraints of institutions, rules, mores, and expectations.[41] Can these constraints improve decision making?[42] What does Montesquieu have to say?[43]

22. *Decisions and emergent properties of complex systems.* Microscopic decisions have macroscopic outcomes. The central limit theorem, Einstein-Smoluchowski theory of Brownian motion, and Adam Smith's "invisible hand".[44]

23. *Political theory of decisions.* Why do dictators last longer than democrats, and what does that imply?[45] Or, was Plato right?[46] When should democracies allocate authority to non-democratic agencies?

24. *The strategy of conflict.* Strategic interactions have two or more protagonists with different—perhaps conflicting—objectives. How should decisions be made?[47] What does Clauswitz have to say?[48]

25. *Changing your mind.* The theory of adaptive decisions. The optimal sin problem and the high cost of saintly consistency.[49]

Additional Sources

Many books and articles are cited in the footnotes above. Additional books and articles are:

1. Ben-Haim, Yakov, 2006, *Info-Gap Decision Theory: Decisions Under Severe Uncertainty,* 2nd ed., Academic Press, London.
2. Conlisk, John, 1996, Why bounded rationality? *Journal of Economic Literature,* XXXIV, pp.669–700.
3. Dewey, John, *The Quest for Certainty: A Study of the Relation of Knowledge and Action,* Gifford Lectures 1929, G.P.Putnam's Sons, New York.
4. Hayek, Friedrich A., 1944, *The Road to Serfdom,* University of Chicago Press.
5. Kunich, John Charles, 2010, *Betting the Earth: How We Can Still Win the Biggest Gamble of all Time,* Parkhurst Brothers Publishers Inc.
6. Rubin, Robert and Jacob Weisberg, 2004, *In an Uncertain World: Tough Choices from Wall Street to Washington,* Random House.

[38] Barbara W. Tuchman, 1984, *The March of Folly: From Troy to Vietnam,* Alfred A. Knopf, New York.

[39] Ellsberg, Daniel, 2001, *Risk, Ambiguity and Decision,* Garland Publishing, New York and London.

[40] ○ Yakov Ben-Haim, 2006, *Info-Gap Decision Theory: Decisions Under Severe Uncertainty,* 2nd ed., Academic Press, London, chapter 11.
○ Yakov Ben-Haim, Craig Osteen and L. Joe Moffitt, The Innovation Dilemma: An Info-Gap Approach, working paper.
○ Yakov Ben-Haim, The Innovation Dilemma, http://decisions-and-info-gaps.blogspot.com/2011/08/innovation-dilemma.html

[41] March, James G., 1988, *Decisions and Organizations,* Basil Blackwell Ltd., Oxford and New York.

[42] Øyvind Eitrheim, ed., 2010, *On Making Good Decisions,* Norwegian Academy of Science and Letters.

[43] Montesquieu, Charles De Secondat, 1748, *The Spirit of the Laws,* Cambridge University Press, Trans. and ed. by Anne M. Cohler, Basia C. Miller and Harold S. Stone, 1989.

[44] Smith, Adam, *An Inquiry into the Nature and Causes of the Wealth of Nations,* 1776, Prometheus Books, 1991.

[45] Root, Hilton L., 2006, *Capital and Collusion: The Political Logic of Global Economic Development,* Princeton University Press.

[46] Stone, Isidor F(einstein)., *The Trial of Socrates,* Little, Brown and Co., 1988.

[47] Schelling, Thomas C., 1960, *Strategy of Conflict,* Harvard University Press.

[48] Paret, Peter, 1976, *Clausewitz and the State: The Man, His Theories, and His Times,* re-issued 2007, Princeton University Press.

[49] James G. March, 1988, Bounded rationality, ambiguity, and the engineering of choice, in David E. Bell, Howard Raiffa, and Amos Tversky, eds., 1988, *Decision Making: Descriptive, Normative, and Prescriptive Interactions,* Cambridge University Press.

Essay Guidelines

1. Each student will write two essays. The essays may be written by a working group (maximum 3 people).
2. Each essay develops a **broad implication or application of a central idea from a specific lecture, to an area of science or engineering practice.** That is, the essay addresses the question: what is a wide-ranging practical implication or application of a central idea discussed in that lecture? The essay must identify the central idea and the lecture from which it came. The essay must **present and defend a *strong assertion* regarding the implication or application.** You must assert something that could be true or false. The claim should not be a specific engineering example (e.g., use this material, or apply that algorithm, or reject that design). The claim can be motivated by a specific example, but must then assert a broad implication or application of which the specific example is one case. The assertion must be 'strong' in the sense that it excludes at least as much as it includes. The lectures contain many examples of such claims and their analysis and defense.
3. **Expected depth and complexity:** The essay should present and explain a broad application or implication of a central idea from a lecture. The structure of the essay should be roughly as follows:
   (a) First paragraph: Concisely introduce the application or implication and the central idea from which they came. Identify the lecture in which the idea is developed.
   (b) Body of the essay: Explain and support the application or implication. Present clear, logical, coherent arguments connecting the central idea to your application or implication.
   (c) Final paragraph: Concisely summarize.
4. **Example or argument?** An example illustrates or explains an idea, but is rarely actually an argument in support of a generic claim. Reasoning involves the identification of generic causes, or mechanisms, or relationships, or underlying factors.
5. Each essay must be written in either Hebrew or English, and must be **no more than 800 words long for Hebrew, 900 words for English** (excluding references). Submission in electronic form as an MS Word document is required. Please include the names, ID numbers, and email addresses of all authors (maximum 3 authors) at the top of your essay (not included in the word count). Include all full names in the accompanying email, and send that email to me with copies to all authors.
6. **Plagiarism** is forbidden. Write in your own words or use quotation marks. Cite your sources. Plagiarism is "the deliberate or reckless representation of another's words, thoughts, or ideas as one's own without attribution in connection with submission of academic work, whether graded or otherwise."[50] Plagiarism is defined in paragraphs 4.10 a and d in Technion Student's Disciplinary Regulations. See also paragraph 10.15.[51] Plagiarism will result in complaint to the Technion Disciplinary Court.
7. **Writing style.** The essay must be clearly and precisely written.
8. **Grading.** Each of the two essays makes up 1/2 of the final grade for each author. Each essay grade will be one of four: 100 (excellent: sound and innovative), 85 (good: sound), 70 (pass: adequate), 40 (fail). The grading criteria are:
   (a) Is there a clear strong claim about a broad implication or application of a central idea from a lecture?
   (b) Is there coherent reasoned support for the claim?
   (c) Is the exposition clear and precise?

   The possible grades are:
   (a) 100: Strong affirmative to each of the above questions.
   (b) 85: At least moderate affirmative answers to each of the above questions.
   (c) 70: Less than for 85 but no strongly negative answers to any of the above questions.
   (d) 40: None of the above.
9. **Dates of submission:** The first essay will be submitted no later than the day of the 10th lecture, and the second essay no later than the day of the last lecture of the course.
10. **Advice and suggestions** can be obtained by consulting with the instructor in person or by email.

[50] http://writingcenter.unc.edu/handouts/plagiarism, accessed 18.1.2015.
[51] Site: http://ugportal.technion.ac.il/regulations/ File: http://ugportal.technion.ac.il/files/2014/05/570-575.pdf