

**Special topics: Neuroeconomics and Decision Making**

Spring 2012, Tuesday/Thursday 2-3:15 PM, 7E12

Crosslisted as PSYCH-UA.300.006 (Psych) and NEURL-UA.302.011 (CNS)

Website for readings, announcements, etc: on Blackboard, <http://classes.nyu.edu>

Instructor: Laurence T Maloney, ltm1@nyu.edu

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Office hours: By appointment.

**Note:**

*Substantially the same course was previously offered under the title "Special topics: Decision making." You should not take this course if you have already taken that one.*

**Texts:**

Baron, J. (2008), *Thinking and deciding*, 4<sup>th</sup> Ed. Cambridge University Press. **[required]**

Glimcher, P. W. (2010), *Foundations of Neuroeconomic Analysis*. Oxford University Press. **[optional]**

**Course description:**

Choosing which action to take is as ubiquitous to everyday life as it is crucial to survival. Good decision-making is presumably subject to strong evolutionary selection; poor decision making is associated with many neurological and psychiatric disorders. This course explores how humans and animals make decisions, drawing broadly on many perspectives including particularly the nexus of psychological, neuro-scientific, and economic considerations, but also ethological and computational ones. The course is organized around modules considering decision making in several sorts of tasks; for instance, by foraging animals or by humans in competitive multiplayer interactions. Our approach to each will be framed by a normative analysis of the problem and of theories purporting to describe how rational subjects optimally should approach it. This sets up a number of empirical questions. Behaviorally, do subjects live up to this ideal? Are their (frequent) failures to do so traceable to identifiable psychological or neural constraints? And how are the operations and constructs of the solution implemented, approximated, or represented in neural tissue?

At the core of the course will be a study of "reinforcement learning," that is the problem of learning to make good choices via trial and error and without explicit instruction. We will study how this problem relates to classic conditioning work from behavioral psychology, review algorithmic approaches to it from computer science, and examine neurophysiological evidence that the midbrain dopamine system and its targets are crucially involved in these functions. We will further consider the implications of this for drug addiction, motor disorders such as Parkinson's disease, and psychiatric disorders such as schizophrenia.

**Prerequisites:**

This is an upper-level undergraduate elective, cross-listed in psychology and neural science. It accordingly covers a broad range of topics and it is understood that students with different backgrounds will be differentially prepared (and differentially excited) for different parts of it. An important component of the course will be the formal, mathematical analysis of decision problems, which will depend on a basic competence with simple probabilistic computations.

For psychology students, prerequisites are Statistics (V89.0009 or V89.0010) and Cognitive Neuroscience (may substitute Cognition). For neural science students, the prerequisite is Introduction to Neural Science (V80.0100) and Statistics as a co-requisite or with permission of the instructor. Also recommended is Behavioral and Integrative Neuroscience.

**Course Requirements:**

This is a lecture course, and the primary source of information is the lectures and accompanying slides, which will be posted online. There is a textbook (Baron) but only for part of the course. Readings will be articles (about 1-2 per session) from the primary literature, posted on Blackboard. Often these will be primary data articles expanding on one detail from the week's lecture. The lectures will thus be broader than the readings and students are responsible for the additional material covered only in the lectures. Students are also expected to keep up with the assigned readings. That said, it would be appropriate (and easier) to read them immediately after, rather than immediately before, each class.

Although there is no official course textbook, there are several that cover various aspects of the course, and one ("Neuroeconomics") that covers most of it. I will be assigning relevant chapters from others and posting them electronically. I am *not* recommending that anyone purchase any of these books, and anything that is actually required will be posted online. They are just provided as a reference in case you are lost or want background. They are:

Glimcher et al., *Neuroeconomics*

various chapters cover much of the class; available online

Glimcher, *Foundations of Neuroeconomic Analysis*

A useful complement to the second part of the course

Dayan & Abbott, *Theoretical Neuroscience*

chapter 9 covers much of the second month, will post online when time comes

Camerer, *Behavioral Game Theory*

early chapters cover the last module

There will be roughly 4 short problem sets to practice the technical material. These will be passed out near the beginning of most modules, and due one week later.

There will also be roughly 3 quizzes, at the end of about every other module. They will largely consist of short answer questions. They are not cumulative.

The numbers of quizzes and problem sets are aspirational. If we run out of time, we may have fewer.

Finally, there will be a short term paper (of about ten pages, though the quality is more important than the length). This will center around proposing an experiment to further test some issue

discussed in class, a discussion of the rationale for the experiment, its relation to readings from the literature, and predictions about the results. It will be due at the final exam time for the course. (There will be no final exam.)

**Grades:**

33% Problem sets

33% Quizzes

33% Final paper

Letter grades are based on a curve.

## Preliminary topics &amp; readings:

Meeting	Date	Topic	Readings	Notes
	1 01/24/12	Introduction / overview		
	2 01/26/12	Math refresher: Probabilities, expectations	Baron5; handout	
<b>Module 1: Lotteries</b>				
	3 01/31/12	Normative theory: Expected utility & risk sensitivity	Baron10; Machina (1987) J Econ Persp 1:121-154	Problem Set 1 out
	4 02/02/12	Behavior: violations & paradoxes	Baron11, Baron12; continue w/ Machina	
	02/07/12	CANCELLED		
	5 02/09/12	Descriptive theory: Prospect theory 1	Baron11; Tversky (1981) Science 211:453-458	
	6 02/14/12	Descriptive theory: Prospect Theory 2	Tom et al. (2007) Science 315:515-518	
	7 02/16/12	Neural representations 1	Platt & Glimcher (1999) Nature 400:233-238	
<b>Module 2: Learning &amp; decision making</b>				
	8 02/21/12	Neural representations 2	Padoa-Schioppa & Assad (2006) Nature 441:223-226	Problem Set 1 due
	9 02/23/12	Risk preference in animals		
	10 2/28/12	Quiz 1 / Catchup / Discuss term paper		
	11 03/01/12	Instrumental conditioning 1	Rescorla	
	12 03/06/12	Instrumental conditioning 2		
	13 03/08/12	Bayesian theory	Handout	
		SPRING BREAK		
<b>Module 3: Learning &amp; decision making II, sequential tasks</b>				
	14 03/20/12	Dopamine neurophysiology	Schultz et al. (1997) Science 275:1593-1599	
	15 03/22/12	Choice+Bayes	Sugrue et al. (2004) Science 304:1782-1787	Problem Set 2 out
	16 03/27/12	Basal ganglia and movement disorders	Delong (1990) TINS 13:281-285	
	17 03/29/12	Neuromodulation and psychiatric disorders	TBA (Cohen schizophrenia work?)	Problem Set 2 due
	18 04/03/12	Discounting: behavioral, ethological, neural	Kacelnik (1997) in Human Psychological Adaptation	
	19 04/05/12	Quiz 2 / Catchup		
<b>Module 4: Decision formation</b>				
	20 04/10/12	Evidence accumulation & the sequential likelihood ratio test	Handout	
	21 04/12/12	Neurophysiology & behavior: evidence accumulation	Gold & Shadlen (2002) Neuron 36: 299-308	Problem Set 3 out
<b>Module 5: Multiplayer games</b>				
	22 04/17/12	Normative theory: Equilibrium, mixed strategies	Handout	
	23 04/19/12	Games with humans: violations of equilibrium, bounded iterative reasoning	Camerer (2003) TICS 7:225-231	
	24 04/24/12	Games: learning and emotion	Sanfey et al. (2003) Science, 300:1755-1758	Problem Set 3 due
	25 04/26/12	Animals, electrophysiology	Barracough et al (2004) Nat. Neurosci 7:404-410	
	26 05/01/12	Wrapup / Quiz 3		
	27 05/03/12	Review		
	?	final exam day		term paper due (no exam)