

PHI858 Epistemic Foundations of Game Theory

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Semester: Spring 2014
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Course Description

There are two main goals for this course. The first is to provide a general introduction to game and decision theory with a special focus on the growing body of literature surrounding the so-called “epistemic” foundations of game theory. Epistemic game theory aims at formalizing assumptions about knowledge, belief and rationality, and then studies their behavioral implications in games. The second goal is to carefully examine the assumptions that are built into any game-theoretic model of social interaction. One standard assumption is that there is *common belief of rationality* among all the relevant players. A second, related, assumption is adeptly summarized by Robert Aumann and Jacques Dreze in a recent article (Rational Expectations in Games, *American Economic Review*, 98 (2008), pp. 72-86): “*the fundamental insight of game theory [is] that a rational player must take into account that the players reason about each other in deciding how to play*”. Exactly how the players (should) incorporate the fact that they are interacting with other (actively reasoning) agents into their own decision making process is the subject of much debate. We will finish the course by discussing some broader issues surrounding the role that mathematical models play in the social sciences and the how to interpret a game-theoretic model.

Some previous exposure to game and decision theory will be helpful, but is not required (I will do my best to provide the necessary background in game and decision theory. This will include a tutorial on the basic concepts of game and decision theory during the first lecture and additional lectures on background material as needed during the semester). This is an interdisciplinary topic, and so our readings will be taken from economics, logic, philosophy and cognitive science journals.

The following surveys may be useful references throughout the course:

- E. Pacuit and O. Roy, Epistemic Game Theory, article in preparation for the Stanford Encyclopedia of Philosophy, 2013.
- G. Bonanno, Epistemic foundations of game theory, working paper, 2013.
- A. Brandenburger, The Power of Paradox: Some Recent Developments in Interactive Epistemology, *International Journal of Game Theory*, 35, pgs. 465 - 492, 2007.

- E. Dekel and M. Siniscalchi, *Epistemic Game Theory*, 2013.
- A. Perea, *Epistemic Game Theory: Reasoning and Choice*, Cambridge University Press, 2012.

Readings

The following is a tentative schedule for the course (this may change based on the interests of the students or if we need to spend more time on a particular topic). Some of the readings contain a lot of mathematics (especially the economics paper). I will explain the proofs when it is useful, otherwise we will focus on understanding the philosophical implications of the mathematical results.

Week 1: Mon 1/27 Introductory Remarks: A Crash Course in Decision Theory, Game Theory and Formal Models of Knowledge and Belief

- Background reading on game and decision theory:
 - K. Leyton-Brown and Y. Shoham, *Essentials of Game Theory, Essentials of Game Theory: A Concise, Multidisciplinary Introduction*, Morgan & Claypool, 2008.
- A. Brandenburger, “Origins of Epistemic Game Theory” in *Epistemic Logic: Five Questions*, edited by Vincent F. Hendricks and Olivier Roy, Automatic Press, pgs. 59-69, 2010.
- I. Gilboa, A. Postlewaite and D. Schmeidler, Probability and Uncertainty in Economic Modeling, *Journal of Economic Perspectives*, 22:3, pgs. 173 - 188, 2008

Additional readings

- A. Perea. From Classical to Epistemic Game Theory, *International Game Theory Review*, 2013

Week 2: Mon 2/3 Game Theory *or* Decision Theory?

- J. Kadane and P. Larkey, Subjective Probability and the Theory of Games, *Management Science*, 28: 2, 1982, pgs. 113-120. In addition, take a look at the back-and-forth with Harsanyi:
 - J. Harsanyi, Subjective Probability and the Theory of Games: Comments on Kadane and Larkey’s Paper, pgs. 120-124
 - J. Kadane and P. Larkey, Reply to Professor Harsanyi, pg. 124

– J. Harsanyi, Rejoinder to Professors Kadane and Larkey, pgs. 124 - 125

- E. McClennen, Rational Choice in the Context of Ideal Games, in *Knowledge, Belief and Strategic Interaction*, C. Bicchieri and M. L. Dalla Chiara (eds.), Cambridge University Press, 1992.

Additional readings

- B. Skyrms, Principles of Rational Decision, Chapter 1 of *The Dynamics of Rational Deliberation*, Harvard University Press, 1990.
- M. Mariotti, Is Bayesian Rationality Compatible with Strategic Rationality? *The Economics Journal*, 105:432, pgs. 1099 - 1109, 1995.

Week 3: Mon 2/10 Common Knowledge/Belief of Rationality

- D. Monderer and D. Samet. Approximating common knowledge with common beliefs, *Games and Economic Behavior* 1, pgs. 170 - 190, 1989.
- R. Cubitt and R. Sugden. Common Knowledge, Salience And Convention: A Reconstruction Of David Lewis' Game Theory, *Economics and Philosophy*, 19: 2, pgs. 175 - 210, 2003.
- D. O. Stahl and P. W. Wilson. On players models of other players: Theory and experimental evidence, *Games and Economic Behavior*, 10, pgs. 218 - 254, 1995.

Additional readings

- T. Hedden and J. Zhang. What do you think I think you think?: Strategic reasoning in matrix games. *Cognition* 85, 1 - 36, 2002.
- B. Meijering, H. van Rijn, N.A. Taatgen, and R. Verbrugge, I do know what you think I think: Second-order theory of mind in strategic games is not that difficult. In *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*, Cognitive Science Society, Austin, TX, pgs. 2486 - 2491, 2011.
- B. Meijering, H. van Rijn, N.A. Taatgen and R. Verbrugge, What eye movements can tell about theory of mind in a strategic game. *PLoS ONE*, 7:9, 2012.
- Z. Ernst, What Is Common Knowledge? *Episteme*, Volume 8, Issue 03, pgs. 209 - 226, 2011.

Week 4: Mon 2/17 Nash and Correlated Equilibrium

- R. Aumann, Correlated Equilibrium as an Expression of Bayesian Rationality, *Econometrica*, 55, pgs. 1-18, 1987.

- R. Aumann and A. Brandenburger, Epistemic Conditions for Nash Equilibrium, *Econometrica* 63, pgs. 1161-1180, 1995.
- M. Risse, What Is Rational about Nash Equilibria? *Synthese*, Vol. 124, No. 3, pgs. 361-384, 2000.

Additional readings

- R. Aumann Subjectivity and Correlation in Randomized Strategies, *Journal of Mathematical Economics*, 1(1): pgs. 67-96, 1974.
- A. Brandenburger and A. Friedenberg, Intrinsic Correlation in Games, *Journal of Economic Theory*, 141, pgs. 28-67, 2008.
- A. Brandenburger, The Relationship Between Quantum and Classical Correlation in Games, *Games and Economic Behavior*, 69, pgs. 175-183, 2010.

Week 5: Mon 2/24 Deliberation in Game and Decision Theory

- I. Levi, Rationality Prediction and Autonomous Choice, in *The Covenant of Reason*, Cambridge University Press, 1997.
- I. Levi, Prediction, Deliberation and Correlated Equilibrium, in *The Covenant of Reason*, Cambridge University Press, 1997.
- W. Rabinowicz. Does Practical Deliberation Crowd Out Self-Prediction? *Erkenntnis*, 57, pgs. 91 - 122, 2002.
- I. Levi, Deliberation does crowd out prediction, *Hommage à Wlodek: Philosophical Papers Dedicated to Wlodek Rabinowicz*, 2007.

Additional readings

- J. Joyce, Levi on Decision Theory and the Possibility of Predicting One's Own Actions, *Philosophical Studies* 110, pgs. 69 - 102, 2002.
- W. Spohn, Where Luce and Krantz Do Really Generalize Savage's Decision Model, *Erkenntnis*, 11, 113-134, 1977
- B. Skyrms, Chapter 7 "Prospects for a Theory of Rational Deliberation" in *The Dynamics of Rational Deliberation*, 1990

Week 6: Mon 3/3 Class canceled: I will be giving a talk at the Royal Netherlands Academy of Arts and Sciences Colloquium on Dependence Logic. We can try to reschedule this class.

Week 7: Mon 3/10 Ratifiability in Game Theory

- J. Joyce and A. Gibbard. “Causal Decision Theory” In Salvador Barbera, Peter Hammond, and Christian Seidl, eds., *Handbook of Utility Theory*, Kluwer Academic Publishers, pgs. 627 - 666, 1998. (Focus on the section on Ratifiability in Game Theory)
- W. Harper, Mixed Strategies and Ratifiability in Causal Decision Theory, *Erkenntnis*, 24:1, pgs. 25 - 36, 1986.

Additional readings

- H. S. Shin, Two Notions of Ratifiability and Equilibrium in Games, in M. Bacharach and S. Hurley (eds.), *Foundations of Decision Theory*, Blackwell, 1989.
- B. Skyrms, Ratifiability and the Logic of Decision, *Midwest Studies In Philosophy*, Volume 15, Issue 1, pgs. 44 - 56, 1990.
- E. Eells and W. Harper. Ratifiability, game theory, and the principle of independence of irrelevant alternatives, *Australasian Journal of Philosophy*, 69:1, pgs. 1-19, 1991.

Week 8: Mon 3/17 No Class: Spring Break

Week 9: Mon 3/24 Skyrms’ Model of Deliberation in Games

- B. Skyrms, Chapter 2 “Dynamic Deliberation: Equilibria” and Chapter 3 “Dynamic Deliberation: Stability” in *The Dynamics of Rational Deliberation*, Harvard University Press, 1990.
- J. McKenzie Alexander, Local Interactions and the Dynamics of Rational Deliberation, *Philosophical Studies*, vol. 147, pgs. 102 - 121, 2010.

Additional readings

- R. Jeffrey Review of the dynamics of rational deliberation by Brian Skyrms. *Philosophy and Phenomenological Research* 52(3), pgs. 734 - 737, 1992.
- J. McKenzie Alexander, Social Deliberation: Nash, Bayes, and the Partial Vindication of Gabriele Tarde, *Episteme*, 6(2): pgs. 164 - 184, 2009.

Other models of deliberation in games

- R. Cubitt and R. Sugden, Common Reasoning in Games, working paper, 2012.
- E. Pacuit, Models of Deliberation in Game Theory, manuscript, 2013.

- R. Cubitt and R. Sugden, The reasoning-based expected utility procedure, *Games and Economic Behavior*, 71(2), pgs. 328 - 338, 2011.

Week 10: Mon 3/31 Common Belief of Rationality, Rationalizability and Iterated Removal of Strictly/Weakly Dominated Strategies

- D. Samet, Weakly dominated strategies: A mystery cracked, Last revision: October, 2013.
- K. Apt, The Many Faces of Rationalizability. *The B.E. Journal of Theoretical Economics*, 7(1), (Topics), Article 18, 2007.
- K.R. Apt and J.A. Zvesper, The Role of Monotonicity in the Epistemic Analysis of Strategic Games, *Games* 1(4), pgs. 381 - 394, 2010.

Additional readings

- L. Samuelson, Dominated strategies and common knowledge. *Game and Economic Behavior* 4, pgs. 284-313, 1992.
- A. Brandenburger, J. Keisler, A. Friedenberg, Admissibility in Games, *Econometrica*, Vol. 76, pgs. 307-352, 2008.

Week 11: Mon 4/7 Backwards Induction and Common Knowledge of Rationality

- J. Halpern, Substantive rationality and backward induction, *Games and Economic Behavior* 37, pgs. 425-435.
- D. Samet, Common belief of rationality in games of perfect information, *Games and Economic Behavior*, 79, 2013.
- K. Binmore, Interpreting Knowledge in the Backward Induction Problem, *Episteme*, 8:3, pgs. 248 - 261, 2011.
- A. Baltag, S. Smets and J. Zvesper. Keep 'hoping' for rationality: a solution to the backward induction paradox, *Synthese*. Volume 169, Number 2, pgs. 301-333, 2009.

Additional readings

- R. Aumann, On the Centipede Game, *Games and Economic Behavior* 23, pgs. 97-105, 1998.
- R. Aumann, Backward Induction and Common Knowledge of Rationality, *Games and Economic Behavior* 8, pgs. 6-19, 1995.

- R. Stalnaker, Belief Revision in Games: Forward and Backward Induction, *Mathematical Social Sciences*, 36, pgs. 31 - 56, 1998.
- J. Kadane and T. Seidenfeld, Equilibrium, Common Knowledge, and Optimal Sequential Decisions, in *Knowledge, Belief and Strategic Interaction*, pgs. 27 - 45, 1992.
- K. Binmore, J. McCarthy, G. Ponti, L. Samuelson, and A. Shaked, A Backward Induction Experiment, *Journal of Economic Theory* 104, pgs. 48 - 88, 2002.

Week 12: Mon 4/14 Forward Induction Reasoning

- J. van Benthem, Logic in a Social Setting, *Episteme*, 8:3, pgs. 227-247, 2011.
- A. Perea, Backward Induction versus Forward Induction Reasoning, *Games*, 1, pgs. 168-188, 2010.

Additional readings

- P. Battigalli and A. Friedenberg, Forward Induction Reasoning, Revisited, *Theoretical Economics* Volume 7, Issue 1, pgs. 57 - 98, 2012.

Week 13: Mon 4/21 Counterfactual Reasoning in Game Theory

- R. Stalnaker. Knowledge, belief and counterfactual reasoning in games. *Economics and Philosophy*, 12:133163, 1996.
- G. Bonanno, Counterfactuals and the Prisoners Dilemma, manuscript, 2013
- C. Bicchieri, Strategic Behavior and Counterfactuals, *Synthese* 76, pgs. 135 - 69, 1988.

Additional readings

- B. Skyrms, Subjunctive Conditionals and Revealed Preference, *Philosophy of Science* 65, pgs. 545-574, 1998.
- E. Zambrano. Counterfactual reasoning and common knowledge of rationality in normal form games. *Topics in Theoretical Economics*, 4:Article 8, 2004.
- O. Board. The equivalence of Bayes and causal rationality in games. *Theory and Decision*, 61:119, 2006.

Week 14: Mon 4/28 Language and Game Theory

- A. Bjorndahl, J. Halpern and R. Pass, Language-based games, Proceedings of the Fourteenth Conference on Theoretical Aspects of Rationality and Knowledge, 2013, pgs. 39 - 48, 2013.
- A selection of readings from A. Rubinstein's *Economics and Language*

Additional readings

- Bacharach, M. (1993). Variable universe games. In K. Binmore, A. Kirman, and P. Tami (Eds.), *Frontiers of Game Theory*, pp. 255 - 275. The MIT Press.

Week 15: Mon 5/5 What is Game Theory Trying to Accomplish?

- J. Kadane and P. Larkey, The Confusion of Is and Ought in Game Theoretic Contexts, *Management Science*, 29:12, pgs. 1365 - 1379, 1983.
- R. Aumann, What Is Game Theory Trying to Accomplish?, in *Frontiers of Economics*, edited by K. Arrow and S. Honkapohja, Basil Blackwell, Oxford, 1985, pp. 28-76.

Additional readings

- W. Spohn, How to Make Sense of Game Theory, in: W. Stegmüller, W. Balzer, W. Spohn (eds.), *Philosophy of Economics*, Springer, Berlin, pgs. 239 - 270, 1982.
- C. Bicchieri, Rationality and Predictability in *Rationality and Coordination*, Cambridge University Press, 1993

Week 16: Mon 5/12 Interpreting Game Theoretic Models

- A. Colman, Cooperation, psychological game theory, and limitations of rationality in social interaction. *Behavioral and Brain Sciences*, 26, pgs. 139-153, 2003.
- A. Rubinstein, Comments on the Interpretation of Game Theory, *Econometrica*, 59, 909-924, 1991.

Additional readings

- I. Gilboa, A. Poslewaite, L. Samuelson and D. Schmeidler, Economic Models as Analogies, *Economic Journal*, 2013.
- F. Dietrich and C. List, Mentalism versus behaviourism in economics: a philosophy of science perspective, 2012.
- K. Arrow, Mathematical models in the social sciences. In D. Lerner and H. Lasswell (Eds.), *The Policy Sciences*. Stanford University Press, 1951.