Topics in Game Theory

Peter Sørensen, Nuffield College

Michaelmas Term 1997

General

The topics of the course are:

- Folk Theorems with and without Perfect Observation (week 1)
- Optimal Private and Social Learning, Herding (week 2)
- Reputation Formation (week 3)
- Equilibrium Foundations: Evolution and Learning (week 4)

The core readings are chapters 5, 8 and 9 in Fudenberg and Tirole (1991), my hand-outs on learning, and most of Weibull (1995).

Text Books

Fudenberg, Drew and David K. Levine, *Theory of Learning in Games*, Cambridge Mass: Forthcoming MIT Press, 1997. Draft available on the internet under http://levine.sscnet.ucla.edu/papers.

—— **and Jean Tirole**, *Game Theory*, Cambridge Mass: MIT Press, 1991.

Hofbauer, Josef and Karl Sigmund, *The Theory of Evolution and Dynamical Systems*, Cambridge: Cambridge University Press, 1988.

Myerson, Roger B., *Game Theory: Analysis of Conflict*, Cambridge, Mass: Harvard University Press, 1991.

Osborne, Martin J. and Ariel Rubinstein, *A Course in Game Theory*, Cambridge Mass: MIT Press, 1994.

Samuelson, Larry, *Evolutionary Games and Equilibrium Selection*, Cambridge, Mass: MIT Press, 1997.

Vega-Redondo, Fernando, *Evolution, Games and Economic Behaviour*, Oxford: Oxford University Press, 1996.

Weibull, Jörgen, *Evolutionary Game Theory*, Cambridge, Mass: MIT Press, 1995.

Folk Theorems

Abreu, Dilip, "On the Theory of Infinitely Repeated Games with Discounting," *Econometrica*, 1988, *56*, 385–396.

———, **Prajit K. Dutta, and Lones Smith**, "The Folk Theorem for Repeated Games: A NEU Condition," *Econometrica*, 1994, *62* (4), 939–948.

———, **David Pearce, and Ennio Stachetti**, "Optimal Cartel Equilibria with Imperfect Monitoring," *Journal of Economic Theory*, 1986, *39*, 251–269.

———, ———, **and** ——— , "Toward a Theory of Discounted Repeated Games with Imperfect Monitoring," *Econometrica*, 1990, *58*, 1041–1063.

Bênoit, J.-P. and Vijay Krishna, "Nash Equilibria of Finitely Repeated Games," *International Journal of Game Theory*, 1987, *16*, 197–204.

Bhaskar, V. and Eric van Damme, "Moral Hazard and Private Monitoring," 1997. St. Andrews and CentER (Tilburg) mimeo.

Cho, In-Koo and Hao Li, "Complexity and Network in Repeated Games II: General Strategies," 1995. University of Chicago mimeo.

Fudenberg, Drew, David K. Levine, and Eric Maskin, "The Folk Theorem with Imperfect Public Information," *Econometrica*, 1994, *62*, 997–1039.

——— **and Eric Maskin**, "The Folk Theorem in Repeated Games with Discounting or with Incomplete Information," *Econometrica*, 1986, *54*, 533–554.

Green, Edward and Robert Porter, "Noncooperative Collusion under Imperfect Price Information," *Econometrica*, 1984, *52*, 87–100.

Kandori, Michihiro, "Cooperation in Finitely Repeated Games with Imperfect Private Information," 1991. University of Pennsylvania mimeo.

——— , "The Use of Information in Repeated Games with Imperfect Monitoring," *Review of Economic Studies*, 1992, *59*, 581–593.

——— **and Hitoshi Matsushima**, "Private Observation, Communication and Collusion," 1994. University of Tokyo mimeo (forthcoming in *Econometrica*).

Piccione, Michele and Ariel Rubinstein, "Finite Automata Play a Repeated Extensive Game," *Journal of Economic Theory*, 1993, *61*, 160–68.

Porter, Robert, "Optimal Cartel Trigger Price Strategies," *Journal of Economic Theory*, 1983, *29*, 313–338.

Rubinstein, Ariel, "Equilibrium in Supergames with the Overtaking Criterion," *Journal of Economic Theory*, 1979, *21*, 1–9.

———, "Finite Automata Play the Repeated Prisoner's Dilemma," *Journal of Economic Theory*, 1986, *39*, 83–96.

——— **and Asher Wolinsky**, "Remarks on Infinitely Repeated Extensive-Form Games," *Games and Economic Behavior*, 1995, *9*, 110–115.

Sekiguchi, Tadashi, "Efficiency in Repeated Prisoner's Dilemma with Private Monitoring," 1996. University of Tokyo mimeo.

Sorin, Sylvain, "On Repeated Games with Complete Information," *Mathematics of Operations Research*, 1986, *11*, 147–160.

Stigler, George J., "A Theory of Oligopoly," *Journal of Political Economy*, 1964, *72*, 44–61.

Learning and Herding

Aghion, Philippe, Patrick Bolton, Christopher Harris, and Bruno Jullien, "Optimal Learning by Experimentation," *Review of Economic Studies*, 1991, *58* (196), 621–654.

———**, Maria Paz Espinoza, and Bruno Jullien**, "Dynamic Duopoly with Learning through Market Experimentation," *Journal of Economic Theory*, 1993, *3*, 517–539.

Avery, Chris and Peter Zemsky, "Multi-Dimensional Uncertainty and Herd Behavior in Financial Markets," 1996. INSEAD working paper 96/79/Fin/Sm.

Banerjee, Abhijit V., "A Simple Model of Herd Behavior," *Quarterly Journal of Economics*, 1992, *107*, 797–817.

Banks, Jeffrey S. and Rangarajan Sundaram, "Denumerable Armed Bandits," *Econometrica*, 1992, *60*, 1071–1096.

Bergemann, Dirk and Juuso Välimäki, "Learning and Strategic Pricing," *Econometrica*, 1996, *64*, 1125–1149.

Berry, D. A. and B. Fristedt, *Bandit Problems*, New York: Chapman and Hall, 1985.

Bikhchandani, Sushil, David Hirshleifer, and Ivo Welch, "A Theory of Fads, Fashion, Custom, and Cultural Change as Information Cascades," *Journal of Political Economy*, 1992, *100*, 992–1026.

Blackwell, David, "Comparison of Experiments," in "Proceedings, Second Berkeley Symposium on Mathematical Statistics and Probability," Berkeley: University of California Press, 1951, pp. 93–102.

——, "Equivalent Comparison of Experiments," *Annals of Mathematics and Statistics*, 1953, *24*, 265–272.

—— **and M. A. Girshick**, *Theory of Games and Statistical Decisions*, New York: John Wiley and Sons, 1954.

Borel, Emile, "La Théorie du Jeu et les Équations Intégrale à Noyau Symétrique," *C. R. Acad. Sci. Paris*, 1921, *173*, 1304–1308. Translated by L. J. Savage in *Econometrica, 21,* 97–100 (1953).

Bulow, Jeremy and Paul Klemperer, "Rational Frenzies and Crashes," *Journal of Political Economy*, 1994, *102*, 1–23.

Cairoli, Renzo and Robert C. Dalang, *Sequential Stochastic Optimization*, New York: John Wiley and Sons, 1996.

Caminal, Ramon and Xavier Vives, "Why do Market Shares Matter?: An Information-Based Theory," 1994. mimeo, Institut d'Anàlisi Econòmica, CSIC, Barcelona.

Caplin, Andrew and John Leahy, "Business as Usual, Market Crashes, and Wisdom after the Fact," *American Economic Review*, 1994, *84*, 548–566.

Chamley, Christophe and Douglas Gale, "Information Revelation and Strategic Delay in a Model of Investment," *Econometrica*, 1994, *62*, 1065–1085.

Chow, Y. S., Herbert Robbins, and David Siegmund, *Great Expectations: The Theory of Optimal Stopping*, Boston: Houghton Mifflin Company, 1971.

DeGroot, Morris H., *Optimal Statistical Decisions*, New York: McGraw-Hill, 1970.

Devenow, Andrea and Iwo Welch, "Rational Herding in Financial Economics," *European Economic Review*, 1996, *40*, 603–615.

Easley, David and Nicholas Kiefer, "Controlling a Stochastic Process with Unknown Parameters," *Econometrica*, 1988, *56*, 1045–1064.

Futia, Carl A., "Invariant Distributions and the Limiting Behavior of Markovian Economic Models," *Econometrica*, 1982, *50*, 377–408.

Gale, Douglas, "What Have We Learned from Social Learning?," *European Economic Review*, 1996, *40*, 617–628.

Grossman, Sanford J., Richard E. Kihlstrom, and Leonard J. Mirman, "A Bayesian Approach to the Production of Information and Learning By Doing," *Review of Economic Studies*, 1977, *44*, 533–547.

Gul, Faruk and Russell Lundholm, "Endogenous Timing and the Clustering of Agents' Decisions," *Journal of Political Economy*, 1995, pp. 1039–1066.

Harrington, Joseph, "Experimentation and Learning in a Differentiated-Products Duopoly," *Journal of Economic Theory*, 1995, *66*, 275–288.

Kihlstrom, Richard E., Leonard J. Mirman, and Andrew Postlewaite, "Experimental Consumption and the "Rothschild Effect"," in Boyer and Kihlstrom, eds., *Bayesian Models in Economic Theory*, Amsterdam: North Holland, 1984, pp. 279–302.

Lee, In Ho, "On the Convergence of Informational Cascades," *Journal of Economic Theory*, 1993, *61*, 395–411.

Luce, Robert Duncan and Howard Raiffa, *Games and Decisions*, New York: John Wiley and Sons, 1957.

McLennan, Andrew, "Price Dispersion and Incomplete Learning in the Long Run," *Journal of Economic Dynamics and Control*, 1984, *7*, 331–347.

Mirman, Leonard, Larry Samuelson, and Amparo Urbano, "Monopoly Experimentation," *International Economic Review*, 1993, *34*, 549–563.

——, ——, and Edward Schlee, "Strategic Information Manipulation in Duopolies," *Journal of Economic Theory*, 1994, *62*, 363–384.

Moscarini, Giuseppe, Marco Ottaviani, and Lones Smith, "Social Learning in a Changing World," 1996. Yale mimeo.

Neeman, Zvika and Gerhard O. Orosel, "Herding and the Winner's Curse in Markets with Sequential Bids," 1997. Boston and Vienna mimeo.

Ottaviani, Marco, "Monopoly Pricing with Social Learning," 1995. MIT mimeo.

Pratt, John W., Howard Raiffa, and Robert Schlaifer, *Introduction to Statistical Decision Theory*, Cambridge Mass.: MIT Press, 1995.

Ross, Sheldon M., *Introduction to Stochastic Dynamic Programming*, San Diego: Academic Press, 1983.

Rothschild, Michael, "A Two-Armed Bandit Theory of Market Pricing," *Journal of Economic Theory*, 1974, *9*, 185–202.

—— and Joseph E. Stiglitz, "Increasing Risk: I. A Definition," *Journal of Economic Theory*, 1970, *2*, 225–245.

Smith, Lones and Peter Sørensen, "Pathological Outcomes of Observational Learning," 1996. Nuffield College working paper.

—— and ——, "Informational Herding and Optimal Experimentation," 1997. Nuffield and MIT mimeo.

Stokey, Nancy L. and Robert E. Lucas, *Recursive Methods in Economic Dynamics*, Cambridge, Mass.: Harvard University Press, 1989.

Vives, Xavier, "Social Learning and Rational Expectations," *European Economic Review*, 1996, *40*, 589–601.

von Neumann, John and Oskar Morgenstern, *Theory of Games and Economic Behavior*, 2nd ed., New Jersey: Princeton University Press, 1947.

Wald, Abraham, "Contributions to the Theory of Statistical Estimation and Testing Hypotheses," *Annals of Mathematical Statistics*, 1939, *10*, 299–326.

——, *Statistical Decision Functions*, New York: John Wiley and Sons, 1950.

Welch, Ivo, "Sequential Sales, Learning, and Cascades," *Journal of Finance*, 1992, *47*, 695–732.

Reputations

Aumann, Robert J. and Michael B. Maschler, *Repeated Games with Incomplete Information*, Cambridge, Mass: MIT Press, 1995.

Bénabou, Roland and Guy Laroque, "Using Privileged Information to Manipulate Markets: Insiders, Gurus, and Credibility," *Quarterly Journal of Economics*, 1992, *107*, 921–958.

Fudenberg, Drew and David K. Levine, "Maintaining a Reputation when Strategies are Imperfectly Observed," *Review of Economic Studies*, 1992, *59*, 561–579.

—— **and Eric Maskin**, "The Folk Theorem in Repeated Games with Discounting or with Incomplete Information," *Econometrica*, 1986, *54*, 533–554.

Kreps, David M., Paul Milgrom, John Roberts, and Robert Wilson, "Rational Cooperation in the Finitely Repeated Prisoners' Dilemma," *Journal of Economic Theory*, 1982, *27*, 245–252.

—— **and Robert Wilson**, "Reputation and Imperfect Information," *Journal of Economic Theory*, 1982, *27*, 253–79.

Mailath, George and Larry Samuelson, "Your Reputation Is Who You're Not, Not Who You Are," 1997. UPenn and Wisconsin mimeo.

Milgrom, Paul and John Roberts, "Predation, Reputation, and Entry Deterrence," *Journal of Economic Theory*, 1982, *27*, 280–312.

Morris, Stephen, "An Instrumental Theory of Political Correctness," 1997. UPenn and Northwestern mimeo.

Persson, Torsten and Guido Tabellini, *Macroeconomic Policy, Credibility and Politics*, Chur, Switzerland: Harwood Academic Publishers, 1990.

Schelling, Thomas C., *The Strategy of Conflict*, Cambridge, Mass.: Harvard University Press, 1960.

Schmidt, Klaus M., "Reputations and Equilibrium Chracterization in Repeated Games of Conflicting Interests," *Econometrica*, 1993, *61*, 325–357.

Selten, Reinhard, "The Chain-Store Paradox," *Theory and Decision*, 1978, *9*, 127–159.

Tadelis, Steven, "What's in a Name? Reputation as a Tradeable Asset," 1996. Harvard mimeo.

Watson, Joel, "Reputation and Outcome Selection in Supergames," 1994. Nuffield College.

Zwiebel, Jeffrey, "Corporate Conservatism and Relative Compensation," *Journal of Political Economy*, 1995, *103*, 1–25.

Evolutionary Foundations

Björnerstedt, Jonas and Jörgen Weibull, "Nash Equilibrium and Evolution by Imitation," 1994. Stockholm University, Unpublished.

Börgers, Tilman and Rajiv Sarin, "Learning Through Reinforcement and the Replicator Dynamics," 1994. UCL mimeo, forthcoming *Journal of Economic Theory,* 1997.

Brown, George W., "Iterative Solutions of Games by Fictitious Play," in Tjalling C. Koopmans, ed., *Activity Analysis of Production and Allocation*, New York: Wiley, 1951.

Foster, Dean and Peyton Young, "Learning with Hazy Beliefs," 1996. Johns Hopkins mimeo.

Fudenberg, Drew and David M. Kreps, "Learning Mixed Equilibria," *Games and Economic Behavior*, 1993, *5*, 320–367.

____ **and** ____ , "Learning in Extensive-Form Games, II. Experimentation and Nash Equilibrium," 1994. Economic Theory DP 20, Harvard Institute of Economic Research.

____ **and** ____ , "Learning in Extensive-Form Games, I. Self-Confirming Equilibria," *Games and Economic Behavior*, 1995, *8*, 20–55.

____ **and David K. Levine**, "Self-Confirming Equilibrium," *Econometrica*, 1993, *61*, 523–546.

——— **and** ———, "Steady State Learning and Nash Equilibrium," *Econometrica*, 1993, *61*, 547–574.

Jordan, James S., "Bayesian Learning in Normal Form Games," *Games and Economic Behavior*, 1991, *3*, 60–81.

———, "The Exponential Convergence of Bayesian Learning in Normal Form Games," *Games and Economic Behavior*, 1992, *4*, 202–217.

———, "Three Problems in Learning Mixed-Strategy Nash Equilibria," *Games and Economic Behavior*, 1993, *5*, 368–86.

———, "Bayesian Learning in Repeated Games," *Games and Economic Behavior*, 1995, *9*, 8–20.

Kalai, Ehud and Ehud Lehrer, "Rational Learning Leads To Nash Equilibrium," *Econometrica*, 1993, *61* (5), 1019–45.

Nash, John, "Non-Cooperative Games." PhD dissertation, Princeton University 1950.

Robinson, Julia, "An Iterative Method of Solving a Game," *Ann. Math.*, 1951, *54*, 296–301. Reprinted in Kuhn: *Classics in Game Theory,* Princeton 1997.

Roth, Alvin E. and Ido Erev, "Learning in Extensive-Form Games," *Games and Economic Behavior*, 1995, *8*, 164–212.

——— **and Jianbo Zhang**, "Evolutionary Stability in Asymmetric Games," *Journal of Economic Theory*, 1992, *57*, 363–91.

Smith, John Maynard, "The Theory of Games and the Evolution of Animal Conflicts," *Journal of Theoretical Biology*, 1974, *47* (1), 209–221.

———, *Evolution and the Theory of Games*, Cambridge: Cambridge University Press, 1982.