Information Economics and Game Theory for Management

State Research University, Higher School of Economics

Professor: Jonathan Peterson, jpeterson@hse.ru

Classes: 20 hours of lecture. 16 hours of seminar.

Office hours: TBD

Course Description: Game theory is the science of strategic decision-making in situations where players' actions are interdependent. It provides a method for identifying optimal strategies and predicting the outcomes of strategic interactions. Information Economics examines situations some individuals have different information than others. Using lectures, in-class games, and assignments, we develop the basic tools of game theory and information economics as they relate to business situations, and then apply them to real-world cases. Topics covered may include strategic cooperation and punishment between firms, strategic commitments, predatory and limit pricing, entry deterrence, adverse selection and moral hazard. This course requires only basic mathematics, but a familiarity with microeconomics and strategy is helpful.

Course Objectives:

1. Familiarize students with Game Theory and Information Economics to a level that they can solve simple exercises.
2. Train students to use the above insights in analyzing business situations and opportunities.
3. Using the aforementioned topics as an example, illustrate how scientists identify and approach interesting and important topics for research.

Course blog: I will create a blog (TBD) for the course, to which I will regularly post items regarding the course. I encourage you to send me relevant items you run across so that I can post them to the blog.

Course grade components:

1. Class participation and attendance 20%
2. Midterm exam 20%
3. Individual take-home assignments 10%
4. Group final paper and presentation 20%
5. Final exam 30%

Details of the grade components:

Class participation and attendance: Notice that class participation and attendance for lectures and seminars account for 20% of your grade. Preparation questions will be provided for readings. Doing all the readings with these questions in mind and then thinking through how you might answer them is the best way to learn the material and prepare for class. You are encouraged to prepare in groups. I may cold call and expect all students to be familiar with the day's material. *Not actively contributing to classroom learning will hurt your grade.*

In lectures, I present the topics and go through some games representative of ones in which you will be expected to solve in homework examples and exams. I will also discuss how these concepts in real world settings. In seminar periods, we conduct classroom games, discuss additional motivating examples and attend student presentations. This class is indented to be a unique mix of traditional game theory and case studies. Therefore, attendance and participation is necessary to do well in the class.

Take-home assignments: There will be several take-home assignments due at the beginning of class on dates to be specified. Some may be small group assignments, while others will be individual assignments. By individually, I mean without the help or guidance of others.

Final paper: The final deliverable is a small-group paper on a real-world application of game theory that you will choose with your group. A one-page proposal for this paper is due approximately three weeks prior to the end of class, and the full paper must be emailed to me before midnight of the first day of exam period. Instructions for this assignment are provided later in the syllabus.

Groups: You may form groups with anyone in the class, and group composition may vary by assignment. Groups should have three people (exceptions may be granted upon prior request; expected quality will be proportional to group size). See me if you have trouble forming a group.

Typesetting rules for written work: All assignments must be in English. They must be typeset, double-spaced, 12 point font, Times New Roman font with one-inch margins (so, no more than 23 lines per page). Coversheets do not count towards the page limit. I have found from previous classes that approximately 10 percent of students ignore these rules. Please don't be one of these students. *To be fair to others, violating length rules may lead to a loss of points.*

Readings

The readings in this course will be a combination of textbooks, HBS cases and, newspaper articles.

The following textbooks may be helpful:

1. *Thinking Strategically: The Competitive Edge in Business, Politics and Everyday Life,* Dixit and Nalebuff, 1993. Recommended for general strategic thinking and includes some discussion of business topics. This is a quick and insightful read.
2. *Games of Strategy, 2nd Edition,* Dixit and Skeath, 2004. An accessible, clear introduction to game theory for a general first course. Most applications are not business related.
3. *Game Theory for Applied Economists,* Gibbons, 1992. If you want to learn more game theory and know some calculus and probability, this is a good start. The intended audience is an advanced undergraduate economics student.
4. *Strategies and Games* Dutta, Prajit, MIT Press, 1999.

The following articles may also be used. This list of what might be used for the class, I will likely change some of them before the start of the term in order to stay current.

Foundations

1. "Philips Compact Disk Introduction (B)" HBS case, 4 pages)
2. "American Airlines Value Pricing" HBS case, 24 pages.
3. Harrington (2006) "How do cartels operate?" in Foundations and Trends in Microeconomics, Vol. 2, No. 1. http://www.econ.jhu.edu/People/Harrington/fnt06.pdf
4. The right game: Use game theory to shape strategy, Brandenburger and Nalebuff, *Harvard Business Review*, July-August 1995, pages 57-71

Prisoner's dilemma

1. "Lesser Antilles Lines: The Island of San Huberto," Darden case, 12
2. "DeBeers, Russia wrangle over diamonds," *Wall Street Journal*, November 28, 1996, 1 page

Entry and exit

1. "Chapter 9: Entry and Exit," pages 286-309, excerpted from Besanko, Dranove, Shanley, and Schaefer, *Economics of Strategy*, 2007. These pages discuss facts about entry and exit, and entry-deterring strategies limit pricing and capacity expansion.
2. "Collusive Predation: Matsushita v. Zenith (1986)," in *The Antitrust Revolution: Economics, Competition, and Policy, 3rd edition*. A nice look at a classic predatory pricing case. Involves international predation and demonstrates the difficulty in winning legal cases against predation. A link to the article: http://www.oup.com/us/pdf/kwoka/0195120159_09.pdf
3. "The Ready-to-Eat Breakfast Cereal Industry (A)" HBS case, 17 pages.
4. "Judo in Action" HBS case, sections on Red Bull and AOL vs Freeserve, 3 pages.
5. , "Two years of battle between HD DVD and Blu-ray: a retrospective," Engadget Blog, 2/20/08, 8 pages.
6. Instructions for war of attrition game, which is later in the syllabus.

Asymmetric Information

1. The Market for "Lemons": Quality Uncertainty and the Market Mechanism, George A. Akerlof, *The Quarterly Journal of Economics*, Vol. 84, No. 3 (Aug., 1970), pp. 488-500
2. "Adverse Selection in the Used Car Markets: Evidence from Purchase and Repair Patterns in the Consumer Expenditure Survey." Peterson, Jonathan and Henry Schneider, Unpublished
3. "Paying for PR – but only when it works," *Wall Street Journal*, December 17, 2007, 2 pages

Additional reading examples

1. "New ads will stir up coffee wars," *Wall Street Journal*, May 4, 2009, 1 page.
2. "From Seattle, with lattes: And Russian rivals await," *Wall Street Journal*, August 31, 2007, 2 pages.
3. "Frontier: Not about to pack its bags," *Business Week*, February 20, 2006, 2 pages.
4. "Geox takes on the goliaths of sport," *Business Week*, April 14, 2008, 1 page
5. "Rolls Royce's victory in landing engine job shows industry's ills," *Wall Street Journal*, January 2, 1996, 2 pages.

6. "Technology titans battle over format of DVD successor," *Wall Street Journal*, March 15, 2004, 2 pages.
7. "When hybrid cars collide," *Wall Street Journal*, February 6, 2003, 2 pages

Examples of Possible Classroom Games

Dynamic pricing classroom game
Courtesy of Professor David McAdams, Duke Fuqua (with modifications)

There are 100 customers and two firms. Each customer buys one unit.

Loyalty Stage: Each firm decides whether to create a loyal customer base. At a cost of $250, each firm can guarantee that 30 customers will definitely buy its product regardless of either firms' prices.

Pricing Stage: A coin will be flipped to determine which firm goes first. Both firms start with a tentative price of $50. To keep things simple, firms are only allowed to set price equal to $50, $40, $30, $20, or $10. The pricing stage ends when both firms have had a chance to move and one of them announces "No Change."

- If prices stay at $50 for both firms, the firms split the non-loyal customers in the market (splitting 100 customers if neither firm choose loyalty; splitting 70 customers if one firm choose loyalty; splitting 40 customers if both firms choose loyalty)
- If one firm ends up with a lower price, the lower-price firm gets all customers who are not loyal to the higher-price firm (either 100 or 70) while the higher-price firm sells to its loyal customers only (0 or 30)
- If both firms end up with the same price, less than $50, then whoever was first to set that price gets all customers who aren't loyal to the other firm (100 or 70) while the other firm sells to its loyal customers only (0 or 30)
- You can only stay at the current price or lower your price; you cannot raise prices once you have lowered them

Payoffs of the game: Each firm's goal is to maximize its profits. For simplicity, cost of production is assumed to be equal to zero. Thus, Profit = (Revenue) - (Cost of Loyalty).

Example of play: (This example is not intended to illustrate good or bad play.) In the Loyalty Stage, firm A creates loyalty while firm B does not. In the Pricing Stage, Firm B wins the coin flip. Firm B chooses to keep its price at $50. Firm A then lowers its price to $30. Firm B then lowers its price to $20. Firm A chooses to keep its price at $30, and hence the game ends. Firm A's profit is 30*$30 - $250 = $650. Firm B's profit is 70*$20 - $0 = $1400.

War of attrition classroom game

From Professor Eric Rasmusen, Kelley School of Business (with modifications)

You and your team members represent a firm that must decide whether to stay in the industry or exit each year. If you stays in, you incur a fixed cost of 300 and a marginal cost of 2 per unit sold, and choose an integer price at which to sell (i.e., 0,1,2, ... ,10). Each firm is backed by a large corporation that can supply capital indefinitely, and hence you can lose an unlimited amount of money.

Demand is inelastic at 60 units up to a threshold price of $10/unit, above which demand is zero. Each firm writes down its price or the word "EXIT" on the decision sheet and brings it to me. I then write each firm's strategy on the blackboard (price or EXIT), and the firm with the lowest price supplies all 60 customers. (In case of ties, the firms with the low price split the demand evenly.) You are free to discuss your strategy with other teams in real time, which may or not be of value.

The game then repeats with a new year, but any firm that exited is out permanently. The game continues until only one firm remains active, and this firms receives a prize of $2000, the capitalized value of being a monopolist. (This implies that the game can continue forever; I will cut off the game at some point if this appears to be happening.)

One person then receives a real money payout. The probability of receiving this payout increases in your team's earnings.

Written Assignments

Predatory pricing classroom game
From Capra, Goeree, Gomez, and Holt (2000) "Predation, Asymmetric Information, and Strategic Behavior in the Classroom: An Experimental Approach to the Teaching of Industrial Organization," *International Journal of Industrial Organization*, 18.

Earnings
In this experiment there are three independent markets, markets I, II, and III, in which the same good is exchanged. Each of you is a seller in one of the three markets for a series of periods. The sellers with identification numbers 1 and 2 will be in markets I and II respectively, in all periods. The rest of you will choose to join a market in sequence, at the beginning of each period. We will use seller identification numbers to indicate which sellers are in which markets. This information will be written on the blackboard. Each of you has a number of units to sell. If you sell a unit, you will incur a cost for that unit, as explained below. Once you have seen the number of sellers in each market, you will be asked to set an offer price and choose a corresponding quantity to be made available at that price. All units that you sell will be sold at the same price. The only restriction you face is that the quantity offered must be positive and an integer (i.e., you cannot sell zero units or half a unit).

You must write the price and quantity you selected on your seller decision sheet, in the appropriate column for the current period. After all sellers have chosen prices and quantities, the decision sheets will be collected and the prices for all markets will be written on the blackboard. Sellers' identification numbers are used to label their prices. Then, we will simulate the buyers in the following manner: in each market there are 12 fictitious buyers. Each of the 12 buyers is willing to purchase at most one unit of the good and will purchase it only if the price offered is less than or equal to the "value" the buyer has for the unit. The buyers are ordered by their values so that the buyer with the highest value purchases first. Then, the buyer with the second highest value purchases, and so on. The buyers purchase their units from the seller that offers the lowest price. If two or more sellers in a market choose the same low price and there are not enough consumers willing to buy all the units offered at that price, we will randomly select one of the sellers to be the first to sell. Your earnings are determined in the following manner:
earnings = price offered x quantity sold - a cost of units sold

Note: the buyers could buy less units than the number of units offered when the price is too high or when there are not enough buyers in the market. If this happens, you will only incur the cost of the units that you actually sell, not the costs of the units that you offered.

Example: suppose you have four "units" to sell and that your production costs are:
Cost of producing first unit: $3.30
Cost of producing second unit: $3.10
Cost of producing third unit: $2.90
Cost of producing fourth unit: $2.70

If you select a price of $5.75 and you sell 4 "units," then your earnings are: $5.75 * 4 - $3.30 - $3.10 - $2.90 - $2.70 = $11.00.

If you select a price of $2.85 and offer to sell 4 units but only sell 3 units, then your earnings are: $2.85 * 3 - $3.30 - $3.10 - $2.90 = -$0.75, i.e. a loss of 75 cents.

The trading period ends when the last buyer has had the chance to buy or as soon as all of the units offered have been sold. When the period has ended we will write on your seller decision sheet the units you sold, and we will return the decision sheets to you so that you can calculate your earnings for the period.

Record of Results

Please examine the specific information sheet that is attached to the instructions. Your identification number is written on the top-right part of the page. This sheet contains specific information about your production costs and your market; this information is private, please do not reveal this information to anyone. Others may or may not have the same production costs as you have.

Next, please have a look at the decision sheet. Going from left to right, you will see columns for the "Period", "Market", "Your Price", "Your Quantity", "Quantity Sold" and "Your Earnings." At the start of period 1 you select and record the market you would like to enter in period 1 (recall that sellers 1 and 2 have been selected to be in markets I and II for all periods). We do this by choosing one seller at random, with the throw of a 10-sided die, and let that seller choose a market first. Then we let the seller with the next higher ID number choose, etc. We will write your market decisions on the blackboard. After all sellers have selected their markets, each of you must select a price and maximum quantity decision and write these decisions in the appropriate columns of your decision sheet. After you have made and recorded your decisions, we will collect the decision sheets and write the prices for all sellers on the blackboard. Next we will use the simulated demand to determine the quantity actually sold by each seller in each market. When all purchases are finished, we will write the quantity you sold on your decision sheet and return it to you so that you can calculate your earnings for the period, as described above. This process will be repeated a number of periods. At the end of the experiment we will randomly select one of you by throwing a die to pay you in cash a percentage of your total earnings.

Please read the specific information sheet that will be provided to you in class. Please be careful not to reveal any information that appears on your specific information sheet.

Simultaneous and sequential-move games <u>individual</u> written assignment

Name:_____

The assignment will be graded with a check-plus for excellent work, check for good work, and 0 for inadequate work. Remove this page from the syllabus and submit, along with another piece of paper for the sequential game results for part 2 (see next page).

<u>For each of the simultaneous-move games below</u>:
1. Circle the Nash equilibrium/equilibria.
2. Then denote which games have no equilibria, one equilibrium, and multiple equilibria.
3. Denote which games represent a prisoners' dilemma.

Column Player

Row Player	L	R
T	3, 3	1, 1
B	0, 0	2, 2

Column Player

Row Player	L	R
T	4, 3	1, 1
B	0, 0	3, 4

Column Player

Row Player	L	R
T	-1, -1	-5, 0
B	0, -5	-2, -2

Column Player

Row Player	L	R
T	3, 3	6, 1
B	0, 0	2, 2

Column Player

Row Player	L	R
T	3, 3	2, 1
B	4, 0	1, 2

Column Player

Row Player	L	R
T	10, 30	35, 25
B	15, 10	40, 5

Column Player

Row Player	L	C	R
T	9, 2	4, 5	7, 4
M	5, 6	3, 1	2, 8
B	8, 9	1, 7	6, 3

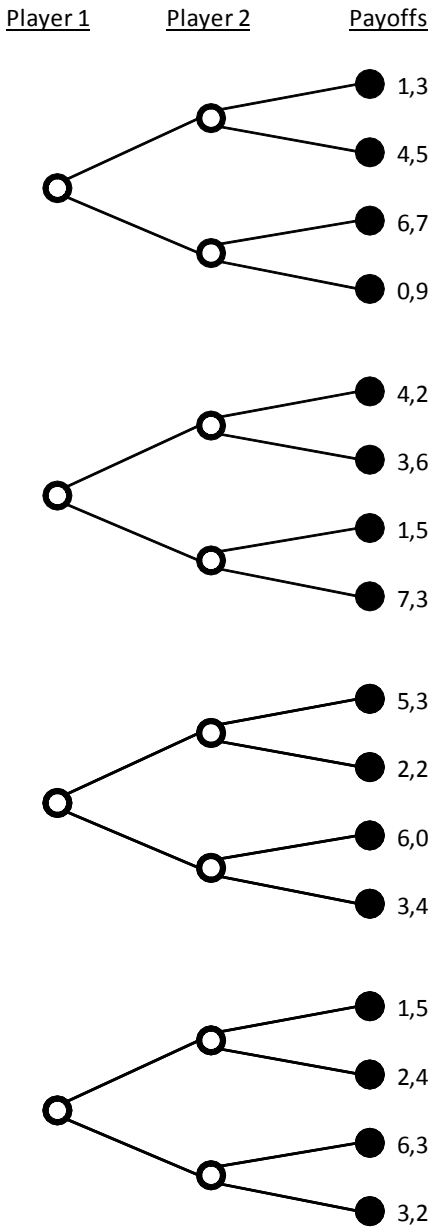
Column Player

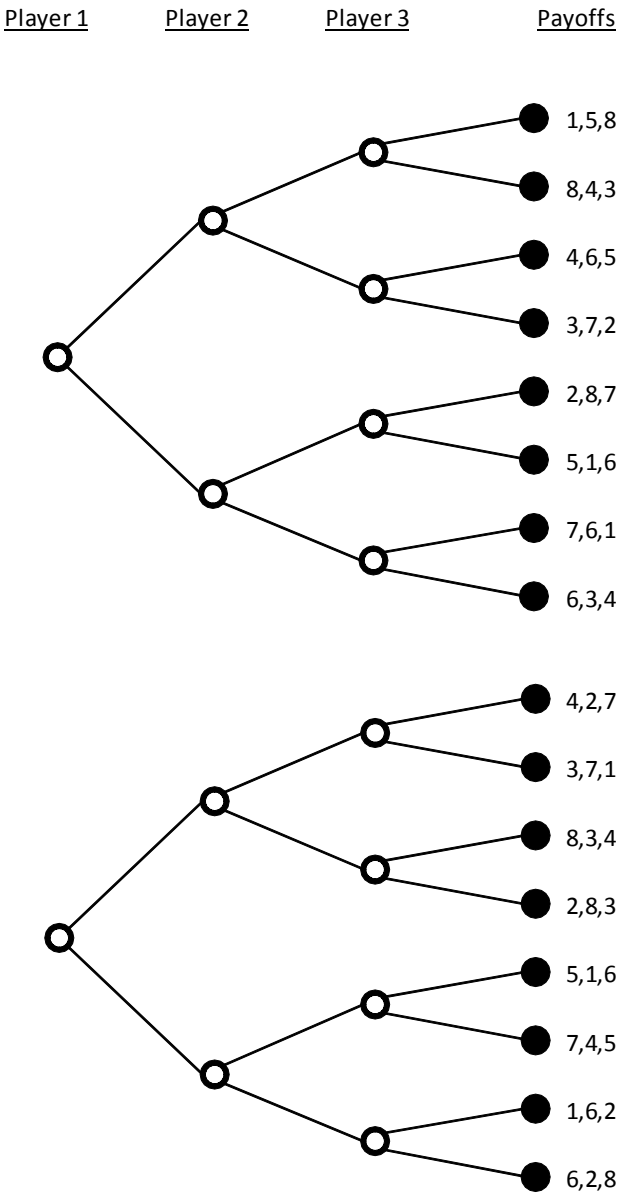
Row Player	L	C	R
T	8, 7	4, 3	2, 8
M	3, 2	1, 5	5, 4
B	7, 6	6, 9	9, 1

** ASSIGNMENT CONTINUES ON NEXT PAGE **

For each of the sequential-move games below:

1. Circle the Nash equilibrium/equilibria. In which of the two-player games does Player 1 have an advantage as first-mover? A disadvantage?
2. On a separate piece of paper, change each of the two-player games into a simultaneous-move game. For each, does the equilibrium change?





Repeated prisoners' dilemma individual written assignment

Name:_____

The assignment will be graded with a check-plus for excellent work, check for good work, and 0 for inadequate work. Remove this page from the syllabus and submit, along with a screenshot of your online results (see below).

Instructions:
Visit http://www.gametheory.net/Mike/applets/PDilemma/Pdilemma.html. On this site you will play a repeated prisoner's dilemma game against 5 opponents 25 times each. Each opponent brings a different strategy to the game. It is your role to learn how best to play against each strategy. You may play the game as many times as you wish in order to determine optimal strategies. Be sure to describe which strategies work against which players and which do not in the spaces provided below.

When you are finished, you will be given a scorecard of your performance. Take a screenshot of your results, and submit this with your assignment (command-shift-3 generates a screenshot on a mac; the "Print Screen" button (sometimes labeled "Prt Scn") generates a screenshot on a PC).

1) What strategy did you find to be most effective against Opponent #1?

2) Against Opponent #2?

3) Against Opponent #3?

4) Against Opponent #4?

** ASSIGNMENT CONTINUES ON NEXT PAGE **

5) Against Opponent #5?

6) Did your strategy change as you approached the end of the 25 iterations? If so, how?

7) Would you have done anything differently if the number of iterations were unknown?

Auction small-group written assignment
Adapted from "Simultaneous Ascending Auctions." Peter Cramton, in Peter Cramton, Yoav Shoham, and Richard Steinberg (eds.), *Combinatorial Auctions*, Chapter 4, MIT Press, 2006.

The assignment will be graded with a check-plus for strong answers, a check for a good try, and 0 for inadequate effort.

Groups: See instructions regarding group formation on page 2 of the syllabus. Do not consult with other groups.

Instructions:
Answer the questions below. If you cannot figure out the answers, write down whatever thoughts you come up with. In particular, question (2) is challenging, and most groups won't get it.

Suppose there are two individuals bidding for two adjacent development lots. One bidder wishes to build a car dealership, which requires a showroom and a parking lot (each of which fills one development lot). She values the two lots together at $100,000, but a single lot is worth nothing to her. The second bidder wishes to build a coffee shop. Either lot is worth $75,000 to him, but he receives no value from having a second lot (i.e., the lots are perfect substitutes, and there is no resale of lots in a secondary market).

(1) Suppose the lots are sold through a Vickrey Auction in which each bidder simultaneously submits individual bids for lot A, lot B, and both lots together (just as in the Spectrum Auction example from class). What are the equilibrium bids made by each bidder for lot A, lot B, and both lots together? *Your answer should contain six bid amounts.*

(2) Suppose the lots are sold through a Simultaneous Ascending Auction. What is the equilibrium outcome of this auction? That is, if we assume the bidders are rational, this is common knowledge, and bidders valuations are common knowledge, to whom will the lots be allocated and for how much? How much would the car dealership owner have to pay to obtain both lots?

It may be helpful to assume for this question that the individuals know each others' valuation; and if both players drop out of the bidding at the same price, they flip a coin to see who drops out first (and hence doesn't win the item).

(3) Which auction format would you recommend to the seller of the lots?

Lesser Antilles Lines small-group written assignment
Courtesy of Professor David McAdams, Duke Fuqua (with modifications)

The assignment will be graded with a check-plus for strong answers, a check for a good try, and 0 for inadequate effort.

Groups: See instructions regarding group formation on page 2 of the syllabus. Do not consult with other groups.

Instructions:
In your coursepack you will find the case "Lesser Antilles Lines - The Island of San Huberto." This case is useful for reviewing basic concepts of game theory and considering the implications of alternative decisions. Read the case carefully, then answer the following questions. [Note: The contribution matrix in Exhibit 4 of the case is denominated in thousands of dollars.]

1. With reference to the game situation depicted in the matrix at the end of the game,
    a. What is a Nash Equilibrium (provide a definition)? Are there any Nash equilibrium in this game?
    b. What is the "best" outcome for the firms? [Hint: To answer this question, think about what LAL and KL would agree on if they could write a binding contract. Consider both the cases that the contract can dictate prices and that the contract can dictate prices as well as a transfer from one firm to the other.]
    c. If LAL could somehow (irreversibly) commit to a price, would it do so? And if so, to what price would it commit? If LAL could somehow commit that it would always charge the same as KL, would it do so?
    d. What strategy would you recommend that LAL do? Why?

2. What happens if - due to an increase of world trade following a sudden deregulation wave - the market size suddenly doubles? Would that change the Nash equilibrium described above? [HINT: You do not need to recalculate the payoff matrix.]

Small-group written final project

Please read these instructions carefully.

Due dates:
1. A one-page proposal is due on the date specified in the syllabus above.
2. The final paper must be emailed to me by the date specified in the syllabus above. Grades will be marked down for each day the paper is late (e.g., an A- paper turned in between 12:00a and 11:59p on the day after the due date will receive a B+).

Paper length:
7-13 pages. Follow the typesetting guidelines on page 2 of the syllabus.

Groups: See instructions regarding group formation on page 2 of the syllabus.

Instructions:
Conduct a game-theoretic analysis of a real-world situation of your choice. I expect many of you may choose a business situation, but feel free to write about topic related to politics, sports, social interaction, etc.

You may write the paper however you wish. However, I suggest the following structure,
1. A short executive summary
2. A description of the situation being analyzed
3. A game model of the situation (i.e., players, possible strategies, payoff matrix, equilibrium)
4. A discussion of the strategies actually employed by the players
5. Brief comments on issues outside the scope of the model

I am available to discuss your paper topic, so feel free to use me as a resource. Also, try to choose a topic that is sufficiently complex that the game theory tools we learned can be applied in an interesting way, yet easy enough to analyze in a final paper for a half-semester course. Choosing a suitable topic is challenging so I recommend carefully considering several options before deciding.

A sample of final paper topics from previous years:
1. Steroid use in the Major League baseball
2. Game theory and the DRAM Cartel, 1999-2002
3. A game theoretic analysis of the Philippine mobile telecom industry
4. A game theoretic analysis of the timing of movie release dates
5. The Fuqua business school cheating scandal
6. Bidding for classes at the Johnson School
7. Game theory applied to the Johnson School's investment banking recruiting process
8. Strategic behavior within the wine industry in Bordeaux
9. A game theoretic analysis of eBay's reputation system
10. Competition between U.S. states over state tax levels