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Problem

*What is strategic interaction?*
Two SMU students, Al and Bob, very confident about their midterm exam performance in ECO 5341, decided to attend a party the weekend before the final exam. The party was so good that they overslept the whole Sunday. Instead of taking the final unprepared on Monday, they pleaded the professor to give them a make-up exam. Their excuse was a flat tire without a spare and any help. The professor, surprisingly, agreed.

- On Tuesday morning, the professor placed them in separated rooms and handed them the test. The test had just one question:
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- “Which tire?” ......
Incentive Issues

- The principle that incentives matter will be a running theme in this class.
  - Do incentives matter?
  - Is this surprising?
  - Is this important?

- Example 1. Mexico City’s Driving Restrictions.

- Example 2. Should we increase the minimum wage?
  - A Minimum Wage Increase, NYTimes (March, 2011): “Despite evidence to the contrary, businesses and Republicans may keep pushing against the minimum wage — using the jobs crisis now to clinch their argument. They should be disregarded, because their argument is wrong and the United States is too rich to tolerate such an underclass.”
Underlying story: two students (Alice and Bob) are taking a course together. There are three effort levels for each student: work hard (utility $= -5$), work sometimes (utility $= -2$), shirk (utility $= 0$). Consider the following two grade schemes.

- **Grade Scheme A**: A student’s final grade only depends on her own effort level — if a student works hard, she will get an A for sure (utility $= 10$); if she works sometimes, she will get a passing grade (utility $= 5$); while if the student shirks, she will fail the course for sure (utility $= 0$).

### Individual Decision Problem

<table>
<thead>
<tr>
<th>Effort Level</th>
<th>Utility</th>
<th>Disutility</th>
<th>Net Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Hard</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Work Sometimes</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Shirk</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Another Example

Grade Scheme B: Each student’s final grade depends on her own effort level, as well as on her ranking of the two: whoever gets a higher score receives an A; while if both get the same score, both will fail the course. Alice’s payoffs are:

<table>
<thead>
<tr>
<th>Effort Level</th>
<th>Utility</th>
<th>Cost</th>
<th>Net Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Hard</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Work Sometimes</td>
<td>10</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Shirk</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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<td>0</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>Shirk</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
We can represent this game in a "Bi-Matrix Form":

<table>
<thead>
<tr>
<th></th>
<th>Bob</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Work hard</td>
<td>Work Sometimes</td>
<td>Shirk</td>
</tr>
<tr>
<td>Alice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Hard</td>
<td>-5, -5</td>
<td>5, -2</td>
<td>5, 0</td>
</tr>
<tr>
<td>Work Sometimes</td>
<td>-2, 5</td>
<td>-2, -2</td>
<td>8, 0</td>
</tr>
<tr>
<td>Shirk</td>
<td>0, 5</td>
<td>0, 8</td>
<td>0</td>
</tr>
</tbody>
</table>

**Key difference:**
- **Individual Decision Problems:** your final payoff depends ONLY on your own choices;
- **Strategic Interactions:** your final payoff depends not only on your own choices, but also on the choices of your opponents.
We can represent this game in a "Bi-Matrix Form":

\[
\begin{array}{c|ccc}
  & \text{Work hard} & \text{Work Sometimes} & \text{Shirk} \\
\hline
\text{Work Hard} & -5, -5 & 5, -2 & 5, 0 \\
\text{Alice} & -2, 5 & -2, -2 & 8, 0 \\
\text{Work Sometimes} & 0, 5 & 0, 8 & 0 \\
\text{Shirk} & & & \\
\end{array}
\]

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<th>Work Hard</th>
<th>Work Sometimes</th>
<th>Shirk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alice</strong></td>
<td>Work Hard</td>
<td>-5, -5</td>
<td>5, 0</td>
</tr>
<tr>
<td></td>
<td>Work Sometimes</td>
<td>5, -2</td>
<td>8, 0</td>
</tr>
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<td>Shirk</td>
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Two suspects (Al and Bob), held in separate cells, are charged with a major crime. However, the police does not have sufficient evidence to convict them. The two suspects are offered the following deal:

- If one confesses and the other denies the crime, then the one who confesses is free, while the other goes to prison for 5 years;
- If both confess the crime, then both suspects will serve 4 years;
- If both deny taking part in the crime, then they both go to prison for 2 years.
Construct a game table (bi-matrix):

- Each row of the table corresponds to one of the row player’s strategies;
- Each column of the table corresponds to one of the column player’s strategies;
- The cells of the table specify the payoffs for the row and column player, respectively.
- Game table:

<table>
<thead>
<tr>
<th></th>
<th>Stays Silent</th>
<th>Confesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stays Silent</td>
<td>-2, -2</td>
<td>-5, 0</td>
</tr>
<tr>
<td>Confesses</td>
<td>0, -5</td>
<td>-4, -4</td>
</tr>
<tr>
<td>Bob</td>
<td></td>
<td></td>
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</tbody>
</table>
Applications of Game Theory

Why study game theory?
Applications of Game Theory

Why study game theory?

- Game theory has become a building block for and has been successfully applied to various disciplines, such as economics, business, biology, political science, computer science, etc.
Competition between Intel and AMD

Intel and AMD compete fiercely to develop innovations in CPUs for PCs. As a result of this, CPU speeds have increased dramatically, but there are few differences between the products of the two companies. Even though both companies expended huge amounts of money to gain a competitive advantage, their relative competitive position ends up unchanged. Both companies are worse off than if they had each slackened the pace of innovation.
Price Protection and Price Guarantee (Circuit City)

- If a consumer, after buying a product from Circuit City, finds a lower price for the same product within 30 days of the purchase, Circuit City would refund 110% of the difference in prices. So, consumers wishing to buy now are “protected” against regrets from lower prices offered by other stores. Why would Circuit City do that? What are the incentives behind this?
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- At the same time, Circuit City can also offer lower prices to capture those with lower willingness to pay (or those who are more informed).
- Price matching practices also change the price competition game among firms...
Two General Approaches for Studying Games of Strategies

There are two general approaches for studying game theory:

- The case-based approach:
  - Pro: Relevance, connection of theory to application
  - Con: Generality

- The theory approach:
  - Pro: General principle is clear
  - Con: Applying it may not be

The approach of this course will be somewhere in between theory and cases.
Course Outline

1. Static Games of Complete Information
   - Strategic-Form (Normal-Form) Games
   - Games, Dominance, Nash Equilibria, Rationalizability
   - Mixed Strategies (Mixed Strategy Nash Equilibria, Interpretations)
   - Applications (Cournot Model, Bertrand Model, Tragedy of the Commons, Auctions)

2. Dynamic Games of Complete Information
   - Extensive-Form Games (Game Tree, Subgame-Perfect Nash Equilibria)
   - Repeated Games (Finite and Infinite repetition, Folk theorems)
   - Applications (Stackelberg Model, Sequential Bargaining, Collusion of Firms, Bank Runs)

3. Static and Dynamic Games of Incomplete Information
   - Static Bayesian Games, Baysian Nash Equilibrium
   - Dynamic Games with Incomplete Information, Perfect Bayesian Equilibrium
   - Applications (Auctions, Signaling)