It’s play time!
Recall, Hawk/Dove Game

- Hawk/Dove – highest total payoff gets $50

<table>
<thead>
<tr>
<th>Hawk (H)</th>
<th>Dove (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawk (H)</td>
<td>(-2, -2)</td>
</tr>
<tr>
<td>Dove (D)</td>
<td>(0, 6)</td>
</tr>
</tbody>
</table>

- Version 1: single round, no communication
  - Again, but with a different partner
- Version 2: single round, communication allowed
  - Again, but with a different partner
- Version 3: ??? rounds, no communication
- Version 4: ??? rounds, communication allowed
What happened?
Discuss.
Axelrod’s Prisoner’s Dilemma Simulation

- Recall Prisoner’s Dilemma in normal form
  
<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>(-1, -1)</td>
<td>(-4, 0)</td>
</tr>
<tr>
<td>D</td>
<td>(0, -4)</td>
<td>(-3, -3)</td>
</tr>
</tbody>
</table>

- In 1980, political scientist Robert Axelrod runs a tournament playing Prisoner’s Dilemma
  
  - Entries invited
    - Entry: well-defined rules of play (computer programs)
  
  - Game is played with 200 rounds
  
  - Each entry plays every other entry five times
  
  - Entries sorted by score after all games
Axelrod’s Prisoner’s Dilemma Simulation

- Entries include:
  - Always defect
  - Always cooperate
  - Random (50/50 chance)
  - Tit-for-tat
    - In 1st round: cooperate
    - In round $n$ ($n > 1$), take action of other player from round $(n - 1)$
    - Submitted by Anatol Rapoport, psychology professor (Toronto)
  - Various other (more complicated) strategies
  - Tit-for-tat was winner of simulation
    - Consider it’s behavior when faced with various strategies
  - Modern versions of simulation still run
Policy Implications of Game Theory

• “Mutually Assured Destruction” Doctrine
  - Policy for the avoidance of nuclear war during cold war
  - Notice similarity in structure to Prisoner’s Dilemma
    
    |       | Don’t Fire | Fire         |
    |-------|------------|--------------|
    | Don’t Fire | (0, 0)     | (-1010, 10)  |
    | Fire       | (10, -1010)| (-1000, -1000)|

  - Notice similarity in structure to Prisoner’s Dilemma
    
    |       | C          | D            |
    |-------|------------|--------------|
    | C     | (-1, -1)   | (-4, 0)      |
    | D     | (0, -4)    | (-3, -3)     |

  - But, we both know the other player’s action will be when we choose our action
Extensive Form Games

- Represented as tree of players choices
  - Captures order in choice making
    - Normal-form representation doesn’t show this information
  - We consider perfect information case
    - All information in game state known (e.g., chess, checkers)
      - 2008: Schaeffer’s Chinook program used to solve checkers
        - But 2 losses by Tinsley were among only 7 games he lost in 45 years!
  - Many games involve imperfect information
    - Some information in game state is not shared (e.g., poker)
    - Complication: need probability distribution over possible states of unknown information