How To Think About Strategic Games - Introduction And General Principles

Econ 2160 - Chapter 2

Chapter 1 gave some specific examples of strategic games and strategic thinking. In this chapter we will

- discuss the timing of players' actions

    - e.g. highlight the differences between two *pure* game types

- Define some basic terminology

- Describe some simple solution methods

Decisions Versus Games

Broadly speaking for a game to be a strategic game, participants must be **mutually aware** that their actions affect others and vice-versa.

- A **strategic game**, or just game, is then a game consisting of interactions between mutually aware players

- A **decision** is an action situation where each person can choose an action without concern of other players' responses

Decisions Versus Games

Strategic games most prominently arise in head-to-head confrontations

- Labor negotiations between unions and managment

- Sporting matchups

- Disagreements between superpowers, e.g. trade between the U.S. and China

A single, small firm producing under monopolistic competition fails to satisfy the mutual awareness condition; thus, their production choice is a decision with a few caveats.

- **Mutual commitments**

In housing markets, the buyer selects among numerous contractors, and the contractor selects among numerous clients. In doing so they have entered into a *bilateral agreement*. Now both parties must consider the actions of each other and construct incentives for performance.

- **Private information**

Consider the market for loans, banks would like to lend money that will be repaid. Borrowers have private information — creditworthiness, work ethic, field specific acumen — pertinent to banks. The "market" is made up of many of these small games between banker and borrower.

Anytime interactions between two parties *within* a relationship is important, this constitutes a strategic game.

Classifying Games - Sequential or Simultaneous?

- Moves in chess are **sequential**. White moves first, then Black, then White, then Black ...

- Auctions for bids on spectrum rights are **simultaneous**. Each party submits a bid at the same time.

Classifying Games - Sequential Or Simultaneous?

Many games combine sequential and simultaneous move games.

- Coaches simultaneously send plays to be run. After noting alignments, the offense can then shift, audible, or call a timeout

Classifying Games - Sequential Or Simultaneous?

The distinction between sequential and simultaneous move games may be obvious but the strategy set in these games is often nuanced.

- In sequential games, your choices are governed by the consequences of the action.

- In simultaneous move games you must also contemplate the concurrent action of your opponent.
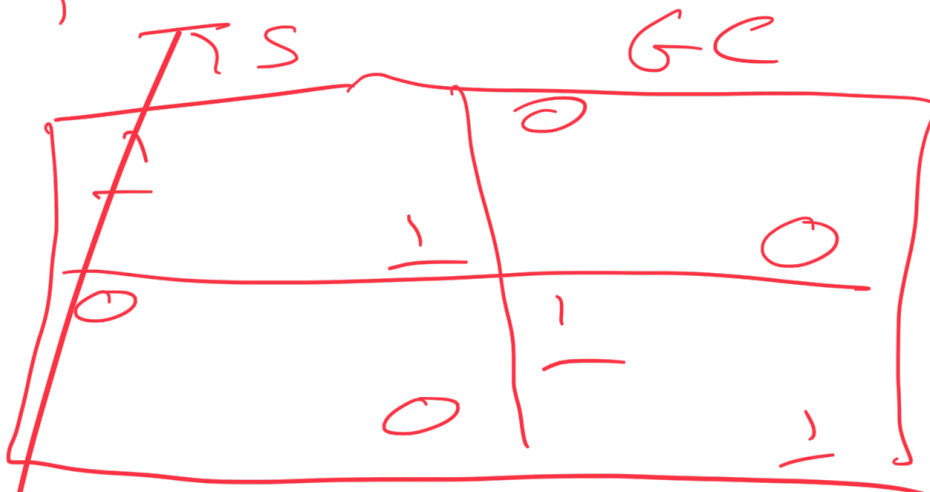
Example - Meeting In Manhattan

2 places
- Timer Square
- Grand Central park

Craig $G \to TS$
         $0 \to TS$

Somebody   TS
else   GC

$\to$ Coordination Failure

Conflict of Interests or Commonality

- Most games we think of as having a winner and a loser. i.e. the game is **zero-sum**. Games are zero, or constant, sum when the possible gains are a fixed amount.

- Many games we consider will not be constant-sum. Consider trade, mergers, or reductions in discrimination. Here all parties can win or at least not lose.

- In some games there are only losers, i.e. not even zero-sum. A nuclear war triggering a nuclear winter is bad for everyone even parties not privy. The concept of a Pyrrhic victory is similar.

Pyrrhus of Epirus defeating the Romans

Is The Game Played Once Or Repeatedly?

Interactions that occur once are likely to have different behavioral responses than those that will happen with some frequency.

- one-shot games imply a lack of information about our opponents

- we may use strategies that are more aggressive and ruthless

- secrecy or surprise may be the main elements of our strategy

Is The Game Played Once Or Repeatedly?

In repeated games, cultivating a reputation becomes important as well as the ability to obtain information.

- unlike one-shot games, there is more scope for mutually beneficial outcomes

- we may be willing to sacrifice short-run profit for long-run profit

How Do I Treat The Waitstaff?

Let's consider our interactions with waitstaff as either a one-shot or repeated game:

- One-shot Game
  - Little room for the waitstaff's actions to have any long-term impact on you
- Repeated Game
  - Over time you may develop a reputation as a bad tipper/rude customer
  - This in turn may affect the quality of service you receive

Willie Mae's, New Orleans, LA

Games Of Imperfect Information

"(Insert your state's name here) has bipolar weather"

Games where the player know the current situation and all the moves that preceded it are called **games of perfect information**. All other games are ones of **imperfect information**. Games of imperfect information arise from

- **External uncertainty** - uncertainty of external circumstances (e.g. inability to predict the weather)

- **Strategic uncertainty** - uncertainty about moves one's opponent has played in the past or is making concurrently

Games Of Incomplete Information

Games where one player has more information than another player are called **incomplete games** or **games of asymmetric information**.

Are The Rules Fixed Or Manipulable?

The rules of card games and sports are fixed and must be followed. The rules of business and politics are protean and often made by the players.

Where games are manipulable, the real game is in the "pregame" where the rules are made.

Merrick Garland, we hardly knew ye.

Are Agreements To Cooperate Enforceable

It may be beneficial for participants to come together and reach some joint agreement to maximize their total benefit.

However, enforcing the agreement might be impossible.

- Games where joint-action agreements are enforceable are called **cooperative games**

- Games where joint-action agreements are unenforceable are called **non-cooperative games**

Some Terminology & Background Assumptions

Strategies

Strategies are the choices available to players. Further, a strategy constitutes a *complete* plan of action

Some Examples:

- In Rock, Paper, Scissors, a strategy is one move, {R, P, S}

- In Tic-Tac-Toe, a strategy is more complicated at least when fully described {1st: Lower Left Corner, 2nd: Middle if player does not select middle, upper right otherwise, 3: Upper Right Corner … 5th: }

Your strategy *must* describe *every* action you would take in *every* state of the world; otherwise, it is not a complete action plan.

Could you write down your plan of action, hand it to someone else, and your representative play the game just as you've described?

Payoffs

Player 2

Player 1

	y	z
b	1,3	0,2
c	2,1	1,2
d	0,1	2,4

A normal form game where the payoffs

are listed inside the boxes.

Most games are mixed-motive; that is, they combine common interest and conflict among the players. Therefore, we need a way to measure the gray area between simple victory and defeat.

A **payoff** is a numerical value given to a player's outcome to compare all logically conceivable outcomes of a game.

A higher payoff is associated with a better outcome. Sometimes, this is natural like a monetary value. Other times its ordinal, 3 > 2 > 1, but the distance between each payoff doesn't have a meaningful interpretation.

More On Payoffs

- The payoffs for one player capture everything in the outcomes of the game that they care about.

    - Consider to monetary outcomes, A & B, where payoff A is $0 and payoff B is $100

    - The probability of outcome A is 75% and of outcome B is 25%

    - The expected payoff is then $(.75) \times 0 + (.25) \times 100 = 25$

- Expected Monetary Value ≠ Expected Utility

    - Players may have different risk preferences; thus, an expected payoff of $25 might be different from getting $25 with certainty.

    - To sidestep this issue payoffs are generally not measured using dollar amounts but a rescaling of them to indicate one's appetite for risk

Rationality

Game theory assumes that all players are **rational actors**, that is, they are perfect calculators and flawless followers of their best strategies. Rationality in this sense has two essential ingredients:

- Complete knowledge of one's own interests

- Flawless calculation of what actions will best serve those interests

This does not mean

- Players are selfish
- Players are short-term thinkers
- Each player has the same value system

More On Rationality

How good is the assumption of rationality?

- On a literal level, probably not the best

    - Games are often long and complex. Thinking through every possible contingency and weighing the relative consequences of each is likely impossible

- In games we play often, probably closer to reality

    - We benefit from experiencing different possible outcomes and different strategy profiles

- The benefit of making rational and complete calculations is that your opponent cannot exploit mistakes you may make using piecewise tactics
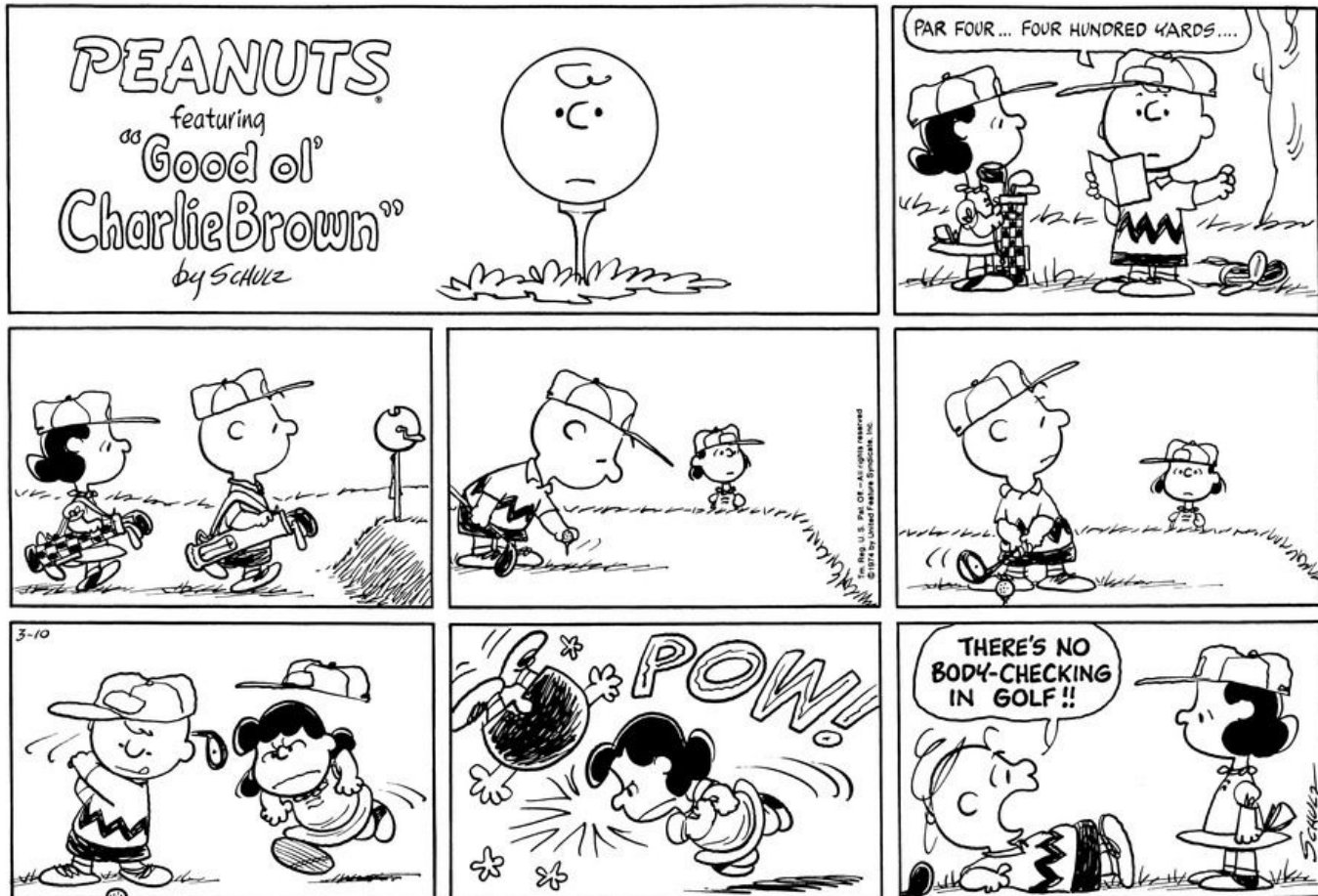
12 players   244 actions

244!
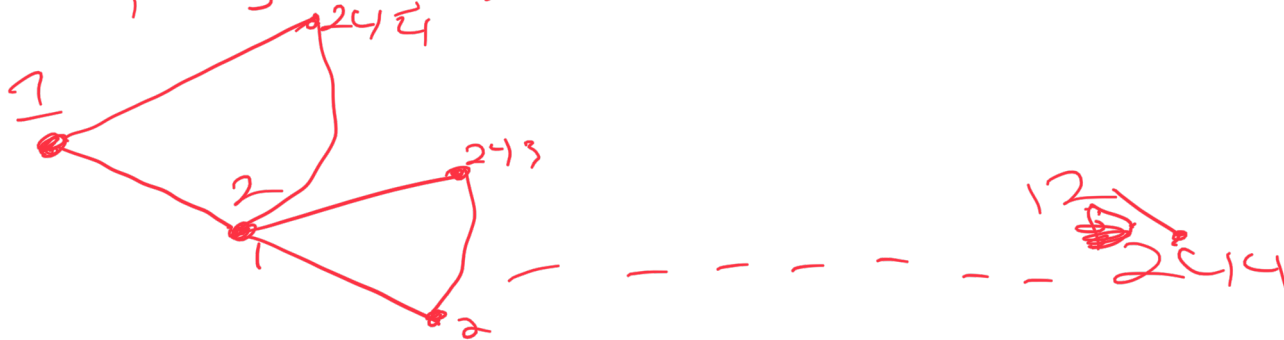
$$244 \times 253 \times \ldots \ldots 1$$

244!

Common Knowledge Of Rules

Common Knowledge Of Rules

We suppose, *at some level*, each player is aware of the rules of the game. *At some level* is important. As the Mitch McConnell example indicated, there is a *prima facie* game, and there is another game at a deeper level. In the political context it's what goes on the agenda and how is it set?

Abstracting away from deeper issues, we assume all players know the following:

- the list of players

- the strategies available to each player

- the payoffs for each player for all possible combination of strategies

- the assumption that each player is a rational maximizer

In perplexing game theory parlance, common knowledge is often said as "Player A knows that Player B knows that Player A knows ..." and so on *ad infinitum*

Equilibrium

A game is in **equilibrium** if both (all) players are best responding to the strategies of the other player (players).

This doesn't mean

- Things don't change

- We arrive at the best possible outcome (Prisoner's Dilemma)

We're mostly going to stick to solving simple instances of strategic behavior, but game theory can be extended to complex interaction with many participants. Often, we'll need a computer to solve these complex and/or dynamic systems.

Dynamic & Evolutionary Games

.In a slight contrast to the theory of rational players, we can alternatively take an **evolutionary** approach to gameplay. i.e. certain behaviors are "hardwired" into a player's strategy.

- In this game, each player brings its "programmed" behaviors to the game

- The game is played and payoffs obtained

- The players who obtain the best payoffs multiply faster

- The strategies that fare poorly disappear

Colorfulness is a evolutionary trait that increases the likelihood of mating. It of course comes with downsides.

Uses Of Game Theory

1. Explanation

   - Why did something happen?
   - Politics and campaigning are rife with what appear to be head-scratching decisions but game theory generally has plausible solutions

2. Prediction

   - Adding onto explanation, we can use game theory to predict outcomes between interactions of rational players

3. Advice/Prescription

   - The final building block is to then aid in crafting a best response in the service of one participant

Game theory is far from a panacea and is imperfect in performing the three functions

Summary

- Strategic games defer from individual decision-making

- Games fall into numerous categories: sequential/simultaneous, dynamic/static, perfect/imperfect...

- Learning the terminology of games will be helpful when we begin analyzing more complex games

- Game theory may be used for explanation, prediction, or prescription

- In the next chapter, we will discuss sequential games and the construction of game trees