Game Theory

- Game Theory models strategic situations, or **games,** in which an individual's success in making choices depends on the choices of others. It is **normative and prescriptive** as it expresses how people **ought** to make decisions and how they can **improve** their decision making in the presence of others.
  - While initially developed to analyse competitions in which one individual does better at the other's expense (zero-sum games), it has been expanded to treat a wide class of interaction.
  - Some theorists however argue for **evolutionary game theory** which is **descriptive.** This argues that organisms evolved as social creatures in order to maximise gains.

- **Zero-Sum Games** One gains and the other loses
  - In this example, alternatives are assumed to be **equally likely (A, B & C).** Jones could use this and work out expected payoffs: In this case **A** would be the best option (using bayes principles) as it has the highest **expected value.**
    - Jones could also maximise his maximum gain by going for option B, where he stands to win £1000.
    - Or he could minimise his maximum loss, which would be option C. This would arguably be the best option when you take in to account the fact that you are playing against a **rational opponent.**

- **Determinate Games** In these games, the outcome for rational players is the same. If players announce their choice, the outcome is not changed because the amount of plays is determined.

- **Indeterminate Games** In these games, there is no finite amount of games and so there is scope for secrecy, deception and persuasion, The games are still Zero-Sum though.
  - Here the allies should conclude that to minimise maximum losses, they should attack harbours. But the Germans realise they will think this, and will choose to defend them. But allies know this, and choose to attack beaches. But the Germans knowing this, choose to defend the beaches. etc.
  - At what point does this recursive metacognition stop?
    - **von Neumann** suggests that there is an optimal strategy that gives one player an outcome of at least some value and the other an outcome of at most that value - regardless of what the opponent does. The strategy is to **assign probabilities to each option based on the payoff values.** You play according to the weighting assigned to each move. You will **at least break even.**

- **Non-Zero Sum Games** The interacting parties' aggregate gains and losses is either less than or more than zero.
  - **The Prisoner's Dilemma** The prisoner's dilemma states that two suspects arrested by the police and placed in separate rooms, must either choose to testify against the other or stay silent. If one testifies against the other, whilst the other stays silent, the former will go free and the silent prisoner will receive 10 years imprisonment. If both stay silent then they will only face 6 months in jail. However, if both testify against each other, they will both receive a 5-year sentence.
    - **Both should testify** as the consequences of not doing so could at least double chances of imprisonment. **Cooperation** here is costly whereas **defection** is a better solution.
  - **Iterated Prisoner's Dilemma (Axelrod, 1984)** It is unlikely that the situation would ever arise where the prisoner's did not know something about each other than what the interrogators have told them. **Axelrod** ran a tournament in which computer programs competed to maximise the payoff. The winner was the simplest program, TIT-FOR-TAT. TIT-FOR-TAT starts with a co-operative choice & then does whatever the play did on the previous move.
    - **Are Two Tats Better Than One?** Nice strategies did well because they gained when playing other nice programs. Even TIT-FOR-TAT did poorly when paired with a version of itself that tried occasional defections because of continuous mutual defections. A more forgiving **TIT-FOR-TWO-TATS** perhaps would fair better? No. TIT-FOR-TAT still won because the nicer strategies cancelled each other out. TIT-FOR-TAT is robust because it is nice (at first), doesn't hold grudges and clear.
  - **TIT-FOR-TAT in Evolution** If everyone abides by TIT-FOR-TAT then free riders can not exploit the payoffs. Though an 'ALWAYS DEFECT' mutant could potentially be stable against individual invaders, it would not survive for long, as a cluster of TIT-FOR-TAT mutants would overcome these mutants. This explains why TIT-FOR-TAT strategies (or reciprocal altruism) is the most stable explanation for favours between organisms.