Two Player Non-cooperative Games for First Person Shooters

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The Theory of Games has been important throughout the past century and has had implications in such fields as biology, economics, mathematics, and war. This article presents several games that could be used in a war-time situation, using First Person Shooter games as simulation and model.

# introduction

The theory of games is rich, vast, and a relatively new science. In this article we address First Person Shooter games, an analogue to real war games, and their optimal solutions, failures, and points of equilibria.

# GAME THEORY IN BRIEF

Game theory is the study of mathematical models of rational players, their interactions and outcomes.

It has broad branches, from psychology, economics, political science, as well as mathematics, computer science and logic. Modelling first person shooters with game theory has significant reward for the military. In this paper we use the normal form which is a matrix consisting of the players and their strategies. In this particular instance the combination of each strategy and player occupies a cell, where the first number is reward and second number is punishment.

To find the winner of the game, we sum across the player columns – their rewards vs. punishments. First for each cell of the matrix, the punishment is subtracted from the payoff. Then that score for each cell is summed across the columns. Practical example will make things clearer.

# ATTACK ATTACK Strategy

In this strategy, as soon as a player encounters another player, they both immediately attack each other. We assume that the players are of equal power, denoted as |p1| and |p2| for player p1 and p2.

|  |  |  |
| --- | --- | --- |
|  | Attack | Attack |
| Player One | 1,1 | 1,1 |
| Player Two | 1,1 | 1,1 |

Score 1 for a reward for attacking and punish 1 for possible damages. As you can see, the two players kill each other and cancel out. And obviously…

|  |  |  |
| --- | --- | --- |
|  | Attack | Stronger Attack |
| Player One | 1,1 | 2,1 |
| Player Two | 1,1 | 2,1 |

The stronger among the two wins the fight.

# ATTACK FLEE STRATEGY

|  |  |  |
| --- | --- | --- |
|  | Attack | Flee |
| Player One | 2,1 | 2,2 |
| Player Two | 2,1 | 2,2 |

Attack is scored a 2 versus fleeing which scored a 2 as well. This is the neverending chase situation. Considering they both run at the same speed….The attacker is least likely to take damage. The fleeing party is likely to take damage or get caught in a corner.

In this case, the attacker wins.

**Attacker versus Strong Flee**

|  |  |  |
| --- | --- | --- |
|  | Weak  Attacker | Strong  Flee |
| Player One | 1,1 | 2,2 |
| Player Two | 1,1 | 2,2 |

This case is a total equilibrium. Both player one and player two lose.

# SPAWNING LOCATIONS

When a character spawns, he is created or brought into the game. In the following game, two players spawn close together, or two players spawn far-away.

|  |  |  |
| --- | --- | --- |
|  | Spawn Far | Spawn Close |
| Player One | 1,1 | 1,2 |
| Player Two | 1,1 | 1,2 |

Spawning far is advantageous for strategy but gives the opposing player time to strategize as well. Spawning close allows one to get the jump on a player but also allow the opposing player to get the jump on him, but only in fewer cases. Spawning far is slightly more advantage to the negative, spawning close.

# CHASE PLAYER GET WEAPON

|  |  |  |
| --- | --- | --- |
|  | Chase Player | Get Weapon |
| Player One | 2,1 | 2,1 |
| Player Two | 2,1 | 2,1 |

It is just as good right now to get the weapon as it is to chase the player. But what happens if we look ahead to the next situation?

|  |  |  |
| --- | --- | --- |
|  | Chase Player | Get Weapon |
| Player One | 2,1 | 2,0 |
| Player Two | 2,1 | 2,0 |

We score 2 for a successful attack. We score a 1 for a possible collateral damage. We score 2 for getting a powerful weapon. Here, getting the weapon before chasing the player has an advantage.

But what is the sum matrix of the two previous, the first and the lookahead. How well does our soldier do overall?

|  |  |  |
| --- | --- | --- |
|  | Chase Player | Get Weapon |
| Player One | 4,2 | 4,1 |
| Player Two | 4,2 | 4,1 |

Here, in the end, we find that chasing the player was the best overall strategy to begin with.

# DAMAGING SITUATIONS

In the following game the player is damaged and has the choice of either running from his opponent or stand and fight.

|  |  |  |
| --- | --- | --- |
|  | Damaged  Keep Attacking | Damaged  Flee |
| Player One | 2,1 | 2,0 |
| Player Two | 2,1 | 2,0 |

Here we score 2 for damage since any damage done will have to be significant and 1 for collateral damage that may be taken while in attack. We score a 2 for fleeing successfully as well. Here it seems fleeing when damaged is the optimum strategy.

# WEAK VS STRONG

The next game is where the weak player attacks and the strong player defends.

|  |  |  |
| --- | --- | --- |
|  | Weak Player Attacks | Stronger Player Defends |
| Player One | 1,1 | 2,0 |
| Player Two | 1,1 | 2,0 |

Here w score a 1 for the weak player attacks, 1 for collateral damage. The stronger player is stronger, and scores a 2 for his defense and 0 for collateral damage. Here the defending player wins clearly.

# STRONG VS WEAK

The next game is for when the strong player attacks versus the weak player defends.

|  |  |  |
| --- | --- | --- |
|  | Strong Player Attacks | Weak Player Defends |
| Player One | 3,1 | 1,3 |
| Player Two | 3,1 | 1,3 |

The strong player attacking scores a 3. The weak player defending scores a 2. The strong player receives some small collateral damage, 1, and the weak player receives a large amount of collateral damage, 3. The strong player obviously wins. The best defense is a good offense.

# SNIPERS

This game utilizes look-ahead matrices.

|  |  |  |
| --- | --- | --- |
|  | Sniper | Close-Attack |
| Player One | 3,0 | 1,1 |
| Player Two | 3,0 | 1,1 |

The sniper strategy is successful and is scored a 3 because of its accuracy and a 0 because of his inaccessibility. Close attack isn’t necessary a kill shot so the close-attack gets a 1. Close attack also has collateral damage of 1. Here the sniper clearly wins.

The look ahead matrix on these snipers and attackers are…

|  |  |  |
| --- | --- | --- |
|  | Sniper Dies  Attacker Wins | Attacker Dies Sniper Wins |
| Sniper | 0,3 | 3,0 |
| Attacker | 3,0 | 0,3 |

Now the summation of these sniper matrices are...

|  |  |  |
| --- | --- | --- |
|  | Sniper | Attack |
| Sniper | 3,3 | 4,1 |
| Attacker | 6,3 | 1,4 |

We say that the snipers when attacking have an equilibrium to the attacker acting as a sniper. Curious result.

# CONCLUSION

As we can see, games can be used to model various different situations both in combat and simulation. There are many more that can utilize the look-ahead matrices and summation matrices introduced here.