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A Case Study of the Delta State Police Divisional Headquarters in Abraka: Applying Games Theory to Crime Investigation

C. R. Swathvika [1], E. Thirupathi[2*]
Department of Mathematics

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Abstract

Games Theory and its practical implementation were the topics of this paper. The misuse of physical force during investigations, the use of numerous (or fake) confessions from suspects, and the wrongful conviction of suspects were among the illegal practices and individuals under scrutiny that Games Theory sought to address. The purpose of this study was to investigate the potential of game theory in the fight against crime. A more strategic approach is required to promote solutions to insecurity, yet the significance of a society free of crime cannot be overstated given the high degree of insecurity. Two criminal suspects are confined in different rooms and are unable to interact with one another; this article use the prisoner's dilemma scenario to illustrate this point. In addition, the research topic was thoroughly examined using a quantitative manner. Sources for the data used in this study came from a systematic sample of authors' prior publications. Because of the terrible conditions in most Nigerian prisons, this study set out to investigate some particularly egregious instances of police misconduct and to learn the truth from those under investigation by applying the principles of game theory. The goal is to expedite the administration of justice and to find effective ways to reduce prison overcrowding.

Keywords: Games theory, crime investigation, Two-person, zero-sum Games.

1 Introduction

In a game, many players work together to make a decision. The outcomes are dictated by the sum of all the acts that arise from the free will of several decision makers. When we study the interactions between decision-makers, we may use the analytical tools provided by Games Theory to make sense of the occurrences we see. Underlying the theory's fundamental assumptions is the idea that decision-makers reason strategically by pursuing their clearly specified external goals while also taking into consideration what they know or anticipate from the actions of other decision-makers.
Games theory models are very generalised depictions of categories of actual events. Due to their abstract nature, they may be used to investigate many phenomena. Oligopolistic and political rivalry, for instance, have been studied using the idea of Nash equilibrium. Bee tongue length distribution and flower tube length distribution have both been explained by theory of mixed strategy equilibrium. A social phenomenon such as threats and promises may be better understood via the lens of repeated game theory. According to game theory, in a multi-agent economy, the result of a price-based trading system is relatively constant.
Formally, Games Theory expresses its concepts using mathematics. Though a mathematical framework facilitates exact concept definition, idea consistency verification, and exploration of implication assumptions, the majority of game theoretical ideas are not intrinsically mathematical. There is a common belief that [2] and [3] are the sources of the modern mathematical method in game theory.
Priority concerns were brought up by Frechet's assertion that many "Zur Theories der

Gesellascha fisspielle" published in the early 20th century by [4] really laid the groundwork for game theory. Frechet and [2] subsequently published these hypotheses with their remarks. Despite this, Borel established the notion of pure and mixed strategy and provided a precise description of a significant class of issues in game theory. No theory of games may be claimed to exist until the minimax theorem has a crucial outcome, as pointed out in [2]. He not only established this to be true in general, but he also developed the theory of games with more than two players, which is rich in concepts.
Based on the attention a theory receives in both mathematical and non-mathematical publications, a scientist with minimal mathematical training might nonetheless understand its purpose, logic, and conclusion (as stated in [5]). Rapid application of the theory in domains like logistics, submarine search, air defence, etc. followed the recent war, which was likely a major cause.

2 Motivation

Although, recent advances have been made by various authors in the area of games theory and in particular to security but it is imperative to properly examine games theory with respect to crime investigation of suspects using Delta State Police Divisional Head-quarters Abraka as a case study due to the high level of insecurity in our Nation as well as the world at large and to suggest current trend to tackling these insecurity challenges.

3 Related Works

A scenario where a player will stick to their chosen strategy, with no reason to change it, after considering the opponent's strategy was proposed by an American mathematician in 1950 (GAMES THEORY-NASH EQULIBRIUM AND ITS APPLICATION 2015b). Following this, games theory takes off. The formulation of non-cooperative game theory by [6] was a watershed moment in the history of social science.
The use of game theory to the assessment of species was shown by a British mathematician [7]. "Game theory and the Evaluation of Fighting" was their book.
According to her book "Elementyary Operations Research with Application" [8], the field known as "Game Theory" examines how rational players' strategic interactions can lead to outcomes that benefit their preferences or utilities, even though no one's intentions were to achieve these outcomes. Many individuals would want to live and work in a safe atmosphere where they can be certain that their lives and the lives of those they care about are protected. Protecting citizens and their possessions should be a government's first priority [9]. From armed robberies and kidnappings in certain regions to Boko Haram strikes in the north-east, Nigeria is now facing significant security issues. In the field of criminal justice, data mining has recently come to the fore [10]. Stocking is the process of keeping goods in a warehouse so they can be sold or used later. Putting things under control is guiding them to follow a predetermined course of action. The relevance of maintaining inventory levels is based on the fact that demand is dynamic.

There are expenses involved with both holding stock and not keeping stock. According to [11], the latter causes manufacturers and distributors to lose clients.
Players whose tactics evolve over time to conform to norms that do not necessarily need rationality or forward-lookingness are studied in evolutionary game theory [12] in "Evolutionary game theory": A rebirth of athletics. Strategies based on these guidelines often evolve across time according to a Markov Chain Model that takes into account factors like the current strategy profile and the game's previous performance.
At its core, a signalling game consists of a two-player competition where one side has an advantage in data accessibility. The one with the better information takes the lead. As an example, [13] used a single supplier and fabrication to create a pattern. The supplier needed to increase production of a critical component for the finished product, but the manufacturer had a more accurate demand

forecast.

When playing screening games, one person doesn't know as much as the other, who may be a supplier proposing a contract. A number of supplier-promised screening games are detailed in [14]. Actually, the supplier presents the manufacturer with a selection of possibilities, and the manufacturer chooses the agreement from among them. The supplier is said to pay for the design structure in economic literature since it provides knowledge about the manufacturing. This one is quite similar to the screening game by [14].

Project management scenarios are most often represented by two-player games, according to [15]. For example, an investor generally has multiple investment alternatives and each pick will probably give birth to a separate project.

4 Material and Method

This paper uses the Prisoner's dilemma method designed by [16], a situation where two suspects apprehended for a crime are held in separate rooms and cannot communicate with each other and the prosecutor inform both suspect 1 and suspect 2 individually that if he confesses and testifies against the other, he can go free, but if he does not co-operate and the other does , he will be sentenced to three years in prison. If both confess, they will get a two-year sentence, and if neither confesses, they will be sentenced to one year in prison. Although co-operation is the best strategy for both suspects, research shows that most rational people prefer to confess and testify against the other person than stay silent and take the chance the other party confesses. With the knowledge of the prisoner's dilemma in mind, the investigator uses such technique to obtain true value from suspect arrested for various crimes committed.

In order to properly examine the research problem effectively, it is necessary that the quantitative method be employed since it is best for measuring ranking, categorizing, identifying patterns and making generalizations which is a standard methodology in mathematical science. Data Collection that aided this thesis were sourced through systematic sampling from previously existing works from authors who have distinguished themselves under review i.e. Game Theory. These data were gathered from publications or archive texts, Google scholar etc.

Before analysis, the gathered data was prepared. The data set was checked by transforming variables since it is decision making process and was analysed using Lab Tech software.

5 Two-Person, Zero-Sum Games

A simple way of showing a game situation is to display the anticipated pay off in matrix form. The quantities gained or lost are looked at from the point of view of one of the player rather than from a neutral point of view. Thus positive entries represent gains of player I and negative entries gains of player II. In this type of game, player I's losses are player II gains and vice versa. A game of this sort with 2 players is known as a two-person Zero-sum game, the sum of gains and losses being zero.

Table 5.1: Matrix of Pay-offs

Player I/Player II	B_1	B_2	...	B_n
A_1	g_{11}	g_{12}	...	g_{1n}
A_2	g_{21}	g_{22}	...	g_{2n}
.	.	.	...	.
A_n	g_{n_1}	g_{n_2}	...	g_{nn}

Table 5.1, which gives the amount g_{ij} won by player I from player II. When player I plays his *ith* pure strategy , A_i and player II plays his *jth* pure strategy, B_j. Thus, the matrix of pay offs (game) to player I is the positive entries while the matrix of the pay-offs (game) of player II is the negative entries of the matrix below.

We examined real life application of games theory to the interrogation and crime detection in combating insecurity in our society using the Delta state Police Divisional Head-quarters, Abraka, as a case study. We examined how the investigator uses the skills of interviewing, questioning, and interrogation of suspects as information gathering techniques police used to aid investigation. They are aimed at the goal discovering the truth, not just getting confession to a crime. This is a contrast to earlier times of policing, when techniques called the "third degree" techniques were identified in the united States by the Wickersham commision in 1931, as being unlawful police practices that caused false confessions and miscarriages of justice, where suspects were sometimes wrongfully convicted and imprisoned.

However, two tables were examined. Table I gives an illustration of the investigation carried out at the Delta State Police Divisional Head-quaters, Abraka. In this case, the techniques of games theory was not applied. Next, the algebra of the game in Table 1 were obtained and the outcome determined. A similar approach is employed in Table II(where Games Theory was applied) and therefore make comparison from the outcome geenrated and then make our conclusion.

6 The Algebra of the Game

Table 1: **Analysis of suspects arrested for various crime according to the Annual Report released by the Delta State Police Divisional Head-quarters, Abraka in 2019**

Months	No of Arrest on Suspect ($A_1 - A_3$)	Crime			
		Theft	Kidnapping	Electoral Violemce	Others
Jan- April	9	3	2	3	1
May- Aug	11	2	3	4	2
Sept- Dec	13	6	4	-	3

Table 2: **Outcome of investigation after interviewing and interrogation of suspects.**

Player I	Player II		
	B_1(Yes)	B_2(No)	B_3(Under Investigation)
A_1	1	3	5
A_2	4	2	5
A_3	4	3	6

Saddle point → Maximin = Minimax

$x_1 + 4x_2 + 4x_3 \geq g$

$3x_1 + 2x_2 + 3x_3 \geq g$

Table 3: **Pay-off matrix**

Player I	Player II			
	B_1(Yes)	B_2(No)	Row Minima	Maxima
A_1	1	3	1	
A_2	4	2	2	
A_3	4	3	3	3
Column Maxima	4	3		
Minimax		3		

Recall that $x_1 + x_2 + x_3 = 1$.(expectation of two person non-zero sum games)
Similarly, taking inequalities accross row, we have;

$$\begin{aligned} y_1 + 3y_2 &\leq g \\ 4y_1 + 2y_2 &\leq g \\ 4y_1 + 3y_2 &\leq g \end{aligned}$$

Recall that $y_1 + y_2 = 1$(expectation of two person non-zero sum games)

$$\begin{aligned} y_2 &= 1 - y_1 \\ y_1 + 3y_2 &\leq g \\ y_1 + 3 - 3y_2 &\leq g \\ 3 - 2y_1 &\leq g \end{aligned}$$

$$\begin{aligned} 4y_1 + 2(1 - y_1) &\leq g \\ 4y_1 + 2 - 2y_1 &\leq g \\ 2 + 4y_1 - 2y_1 &\leq g \\ 2 + 2y_1 &\leq g \end{aligned}$$

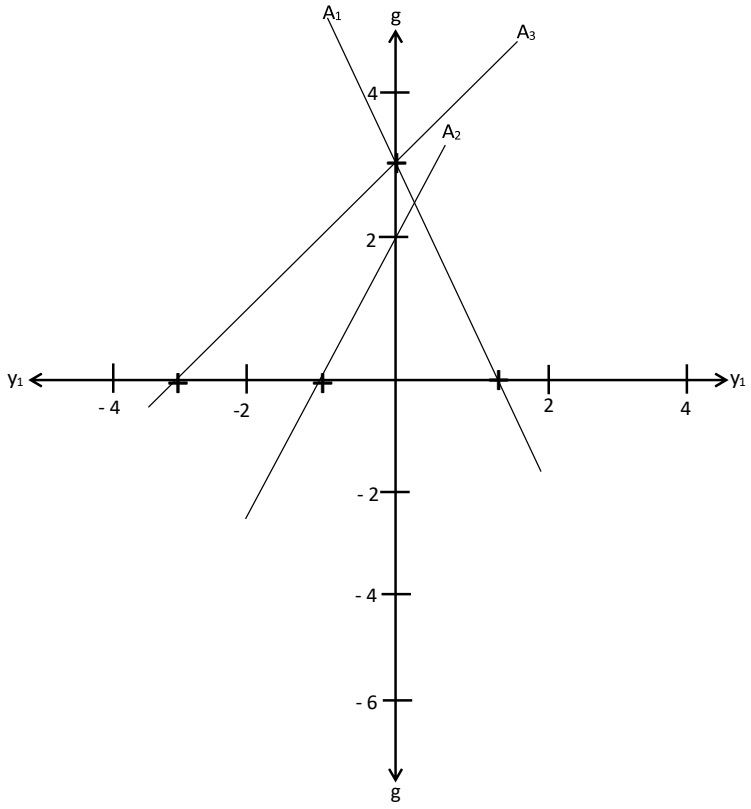
$$\begin{aligned} 4y_1 + 3y_2 &\leq g \\ 4y_1 + 3(1 - y_1) &\leq g \\ 4y_1 + 3 - 3y_1 &\leq g \\ 3 + 4y_1 - 3y_1 &\leq g \\ 3 + y_1 &\leq g \end{aligned}$$

A_1 : If $y_1 = 0$, $g = 3$. If $g = 0$, $y_1 = \frac{-3}{-2} = \frac{3}{2}$.

A_2 : If $y_1 = 0$, $g = 2$. If $g = 0$, $y_1 = \frac{-2}{2} = -1$.

A_3 : If $y_1 = 0$, $g = 3$. If $g = 0$, $y_1 = -3$

$$\begin{aligned} x_1 + 4x_2 + 4x_3 &\geq g \\ 3x_1 + 2x_2 + 3x_3 &\geq g \end{aligned}$$



Graph 1: Arrested Suspects using Games Theory

Recall that $x_1 + x_2 + x_3 = 1$ (Expectation of two person non-zero sum games).
Taking $g = 3$ and $x_2 = 0$, we have;

$$
\begin{aligned}
x_1 + 4x_3 &= 3 \ldots\ldots\ldots\ldots\ldots (1) \times 3 \\
3x_1 + 3x_3 &= 3 \ldots\ldots\ldots\ldots\ldots (2) \times 1 \\
3x_1 + 12x_3 &= 9 \ldots\ldots\ldots\ldots\ldots (3) \\
3x_1 + 3x_3 &= 3 \ldots\ldots\ldots\ldots\ldots (4) \\
(3) - (4) : 9x_3 &= 6
\end{aligned}
$$

So, $x_3 = \frac{6}{9} = \frac{2}{3}$. Now, substitute $x_3 = \frac{2}{3}$ into (4) to get

$$3x_1 + 3x_3 = 3 \Rightarrow$$
$$3x_1 + 3(\tfrac{2}{3}) = 3 \Rightarrow$$
$$3x_1 + 2 = 3 \Rightarrow$$
$$3x_1 = 3 - 2 \Rightarrow$$
$$3x_1 = 1 \Rightarrow$$
$$x_1 = \tfrac{1}{3}.$$

7 Discussion of Results

The reward matrix has a saddle point at 3 (i.e. Maximin=Minimax), as can be shown in Table 3. The objective of Player A's questioning of the detained suspects is to ascertain the truth value while minimising his worst possible loss. He has two options, A1 and A3, to do this. If he goes with A1, his worst nightmare will come true when B selects method B1, which means fewer suspects will provide legitimate confessions while in custody. The biggest setback for A will be a loss of 3, which happens when B uses technique B2, which suggests an increase in legitimate confessions from suspects indirectly. Picking strategy A3 will restrict player A's maximum loss to 3, the saddle point (i.e., Maximin = Minimax)—the optimal choice for minimising losses during questioning. Using a combination of tactics, with an emphasis on A1 (interview and questioning), one-tenth of the duration and A3 (questioning), second

We get the optimal strategy combination three out of ten times, in which

After a thorough investigation, the investigator is able to get the truth out of the suspects. Given that the investigator accomplished the given job by operating the methods at random, it is reasonable to assume that it will utilise these tactics in the future to achieve the same outcome.

8 Conclusion

As previously mentioned, Table 3 shows that the number of suspects who positively confess to the different crimes is consistently rising. Because of the efficient use of interview, questioning, and interrogation procedures, we were able to gather valuable information from the suspects and implement decisive punishments in every instance. Finally, considering the prior conclusions from both cases and the circumstantial evidence, we conclude that using game theory is a strong avenue for prison decongestion in Nigerian prisons, an effective way to obtain truth value from suspects, and a fast way to administer justice.

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