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A STUDY ON ESSENTIAL OF GAME THEORY IN WIRELESS SENSOR NETWORKS

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INTRODUCTION

Game theory is the formal study of conflict and cooperation. Game theoretic concepts apply whenever the actions of several agents are interdependent. These agents may be individuals, groups, firms, or any combination of these. The concepts of game theory provide a language to formulate structure, analyze, and understand strategic scenarios. The earliest example of a formal game-theoretic analysis is the study of a duopoly by Antoine Cournot in 1838. The mathematician Emile Borel suggested a formal theory of games in 1921, which was furthered by the mathematician John von Neumann in 1928in a "theory of parlor games." Game theory was established as a field in its own right after the 1944 publication of the monumental volume Theory of Games and Economic Behavior by von Neumann and the economist Oskar Morgenstern. This book provided much of the basic terminology and problem setup that is still in use today. In 1950, John Nash demonstrated that finite games have always have an equilibrium point, at which all players choose actions which are best for them given their opponents 'choices. This central concept of non cooperative game theory has been a focal point of analysis since then. In the 1950s and 1960s, game theory was broadened theoretically and applied to problems of war and politics. Since the 1970s, it has driven a revolt. Additionally, it has found applications in sociology and psychology, and customary associations with growth and biology. Game theory received special consideration in 1994 with the awarding of the Nobel Prize in economics to Nash, John Harsanyi, and Reinhard Selten. At the end of the 1990s, a high-profile application of game theory has been the design of auctions. Prominent game theorists have been involved in the design of auctions for allocating rights to the use of bands of the electromagnetic spectrum to the mobile telecommunications industry. Most of these auctions were designed with the goal of allocating these resources more efficiently than traditional governmental practices, and additional liaised billions of dollars in the United States and Europe.

1. GAME THEORY

Game theory, defined in the broadest logic, is a collection of mathematical models formulated to reading situations.

Of conflict and cooperation. It is troubled with finding the best events for entity pronouncement makers in these Situations and recognizing even outcomes. The object of study in game theory is the game, defined to be any situation in which:

- There are at least two players: A player may be an individual, a company, a nation, a wireless node, or even a biological species.
- Each player has a number of possible strategies, courses of action he or she may choose to follow
- The strategies select by each player determine the outcome of the game.
- Associated with each probable upshot of the game is a gathering of statistical payoffs, one to each player. These payoffs signify the value of the upshot to the different players. In 1950 John Nash established that limited games constantly have a Nash equilibrium (also called a strategic stability). Nash equilibrium is a list of strategies, one for each player, which has the chattels that no player can unilaterally change his/her strategy and get a enhanced payoff. This is the central perception of non-cooperative game theory and has been a main point of psychiatry since then. Game theory established exceptional consideration in 1994 with the awarding of the Nobel Prize in economics to John Nash, John Harsanyi and Reinhardt selton.

2. TERMINOLOGIES OF GAME THEORY.

The different terminologies that are associated with the game theory are now defined.

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Players
A group of decision-makers, called players; the likely in a row states of each player at each assessment time; the collection of realistic moves (decisions, actions, plays,...) that each player can choose to make in each of his likely information states; a procedure for determining how the move choices of all the players collectively determine the possible outcomes of the game; preferences of the entity players over these possible out-comes, typically precise by a value or payoff function.

Strategy
It is a way of act taken by a player, for e.g., giving computer furniture's free of cost, giving 30% additional hardware, gibing special prize, etc., while selling computer hard ware. In a game in strategic form, a strategy is one of the given feasible events of a player. In an general game, a strategy is a complete plan of choices, one for each pronouncement position of the player. The strategy can be further confidential into pure strategy and mixed strategy. Let m be the number of strategies of player A and n be the number of strategies of player B, *i* x be the chance of selection of the choice i of player A, i = 1,2,3,….m. Let *j* y be the probability of range of the alternative j of player B, for j = 1, 2, 3…..n. The sum of the probabilities of variety of a range of alternatives of each of the players is equal to 1 as shown below. $\sum_{i=1}^{m} x_i = 1 \; and \; \sum_{j=1}^{n} y_j = 1$.

Pure strategy
A **pure strategy** provides a absolute definition of how a player will play a game. In meticulous, it determines the move a player will make for any location he or she could features. A player's **strategy set** is the set of pure strategies presented to that player.

If player A follows a pure strategy, then only one of the *i* x values will be equal to 1 and the lasting *i* x values will be equal to 0. A sample set of probabilities of selection of the alternatives for player A is shown below: x_1 = 0, x_2 =1, x_3=2. The sum of these probabilities is equal to 1. That is 1 x + 2 x + 3 x =0+1+0 = 1.

Mixed strategy
A **mixed strategy** is a project of a probability to each pure strategy. This allows for a player to by chance decide on a pure strategy. Since probabilities are continuous, there are infinitely many mixed strategies presented to a player.

Of course, one can observe a pure strategy as a be reduced to case of a mixed strategy, in which that picky pure strategy is preferred with probability 1 and each other strategy with probability 0.

Payoff
A payoff is a number, also called effectiveness that reflects the attraction of an outcome to a player, for anything reason. When the outcome is random, payoffs are habitually weighted with their probabilities. The likely payoff incorporates the player's thoughts towards threat.

Perfect information
A game has perfect information when at any point in time only one player makes a progress, and knows all the events that have been made awaiting then.

Dominating strategy
A strategy dominates a special strategy of a player if it ceaselessly gives a enhanced payoff to that player, in any case of what the additional players are doing. It inadequately dominates the other strategy if it is always in any case as excellent.

Rationality
A player is said to be rational if he seeks to play in a manner which maximizes his own payoff. It is often assumed that the rationality of all players is common knowledge.

Strategic form
A game in strategic form, also called normal form, is a compressed illustration of a game in which players at the same time desire their strategies. The consequential payoffs are offered in a table with a cell for each strategy grouping.

Zero-sum game
A game is said to be zero-sum if for any upshot, the sum of the payoffs to all players is zero. In a two-player zero-sum game, one player's gain is the other player's loss, so their interests are absolutely divergent.

Two-Person Zero-Sum Games

- A two-person game is characterized by the strategies of every player and the payoff matrix. The payoff matrix shows the gain (positive or negative) for player 1 that would result from every grouping of strategies for the two players. Note that the matrix for player 2 is the unenthusiastic of the matrix for player 1 in a zero-sum game.
- The entries in the payoff matrix can be in any units providing they are in contact to the effectiveness (or value) to the player.
- There are two key assumptions about the proceedings of the players. The first is that both players are based on reason. The second is that both players are greedy meaning that they choose their strategies in their own curiosity (to promote their own wealth).

Maximum Principle

The **maximin value** of a player is the highest value that the player can be confident to get exclusive of perceptive the events of the other players; equally it is the lowly value the other players can force the player to accept when they know the player's achievement

Minimax Principle

The minimax value of a player is the minimum value that the other players can power the player to consider without significant the player's trial; similarly, it is the most important value the player can be sure to vicious circle when they be familiar with the trial of the other players

Saddle Point

The Saddle point in a pay off matrix is one which is the least value in its row and the prime value in its article. The saddle point is also known as stability point in the theory of games. An factor of a matrix that is at the same time least of the row in which it occurs and the maximum of the editorial in which it occurs is a saddle point of the matrix game. In a game having a saddle point most select strategy for a player X is always to play the row containing saddle point and for a player Y to participate the article that contains saddle point.

Value of Game

In game theory, the concept value of game is considered as very important. The value of game is the maximum guaranteed gain to the maximizing player if both the players use their best strategy. It refers to the average payoff per play of the game over a period of time. Consider the following the games.

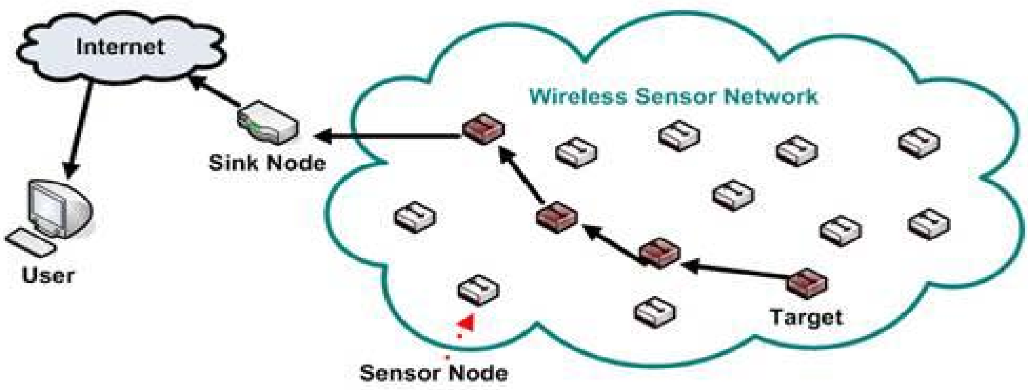
$$\text{Player X} \quad \overset{\text{Player Y}}{\begin{bmatrix} 3 & 4 \\ -6 & -2 \end{bmatrix}} \qquad \text{Player X} \quad \overset{\text{Player Y}}{\begin{bmatrix} -7 & 2 \\ -3 & -1 \end{bmatrix}}$$

(with positive value) (with negative value)

In the first game player X wins 3 points and the value of the value is three with positive sign and in the second game the player Y wins 3 points and the value of the game is -ve which indicates that Y is the Winner. The value is denoted by 'v.

3. WIRELESS SENSOR NETWORK

Wireless sensor network is the most standard armed forces in employment in marketable and manufacturing applications, because of its mechanical development in a mainframe, communiqué, and low-power usage of rooted computing devices. The WSN is built with nodes that are used to scrutinize the atmosphere like temperature, humidity, ressure, position, vibration, sound etc. These nodes can be used in various real-time applications to perform various tasks like smart detecting, a discovery of neighbor node, data processing and storage, data collection, target tracking, monitor and controlling, synchronization, node localization, and effective routing between the base station and nodes. Presently, WSNs are beginning to be organized in an enhanced step. It is not awkward to expect that in 10 to 15 years that the world will be protected with WSNs with entree to them via the Internet. This can be measured as the Internet becoming a substantial n/w.



By means of the high degree of deployment flexibility, applications of WSN are vast and can be broadly classified into the monitoring and tracking categories. Monitoring applications include environmental monitoring such as forest fire detection, biocomplexity mapping of the environment, flood detection, precision agriculture; health monitoring contains tele-monitoring of human physiological data, monitoring doctors and patients conditions and drug administration in hospitals; inventory location monitoring; factory, machine, chemical and structural monitoring. Military monitoring examples can be found in monitoring friendly forces, equipment and ammunition, battlefield and terrain surveillance, reconnaissance of opposing forces, targeting, battle damage assessment, nuclear, biological and chemical attack detection. Tracking applications include objects, animals, humans, vehicles, and military enemy tracking. These applications are made possible due to the fact that WSN has a short system setup time and sensors can be disposed with acceptable operation cost.

4. MOTIVATION

Among the fast growth in electronics and wireless technology, WSN will definitely find progressively appliance when the necessitate for location sensing arises. Alternatively, the developments of WSN theory and systems have customary a group of concentration in both the trade zone and make inquiries area. Amid scores of another approaches, GT has been greater than continually functional in the plan of WSNs, thus, the range of this paper is classified to the use of GT for WSNs. From 2003 to 2011, about 330 research papers with topics on or closely related to GT for WSN were published. Figure 1 shows the yearly distribution of these published papers. The number of records for 2011 is not complete because some publications have not been integrated in the indexing databases. A moderately less significant scrap of the offerings in this region has been summarized .Machado and Tekinay reviewed 29 publications which for the most part focusing on the use of game-theoretic approaches to originate problems linked to security and energy efficiency. Shen *et al.* summarized 30 publications of the presented game theoretical approaches that are premeditated to support WSN security.

Among the selection of residential methods using GT, the main differences and significant facial appearance can be briefly summarized below. Cooperative game theory provides systematic tackle to study the behavior of balanced players when they cooperate and consider the effectiveness of all the players. In non-cooperative game theory, the nodes purchase, trade, and purchaser goods in answer to the prices that are exhibited in a effective promote. A node attempts to take advantage of its profit for taking a progression of measures. Whether or not a node receives a turnover is decided by the success of the action. Note that non-cooperative game theory is mainly paying attention on each user's personality effectiveness pretty than the efficacy of the sum total network. On the contrary, cooperative game theory can accomplish common pareto-finest concert and maximize the entire network's payoff while maintaining fairness. In addition to cooperative and non-cooperative game theories, repeated game theory is anxious with a class of energetic games, in which a game is played for several times and the players can examine the outcome of the preceding game before attendance the next repetition .

5. GAME THEORY IN WIRELESS SENSOR NETWORKS COMPONENTS OF A GAME

A game is a set of three elementary components: a set of players, a set of strategies, and a set of payoffs. Players or nodes are the pronouncement takers in the game. The strategies are the unusual choices existing to nodes. To conclude, a effectiveness purpose (payoffs) decides the all potential outcomes apiece player. Table 1. Shows typical components of a wireless sensor networking game.

Game Theory and Wireless Network

- Game theory has emerged in divers current moving parts interrelated to announcement networks, cognitive telephone system networks, wireless sensor networks, source distribution and power run.
- Components of a wireless networking

apparatus of a game	Elements of a Wireless network
group of actors	Available nodes in WSNs
A set of strategies	Modulation ,Coding, Power level & etc
A set of payoffs	Performance indicators (throughput, delay, signal noise ratio, ...)

Game theory is a common theory which relevant all most all the field. The central momentous of game theory is to organize the substitute strategy to struggle with one another and in the same sense it is an indispensable utensil for managerial process according to fluctuations in relevant contents. Game theory is inspirational because the terms and ideology are comparatively trouble-free than other theories in this division. Game theory is the revision of how players should logically play games, and it is a powerful tool in many areas, such as war, politics, economics, sociology, psychology, biology, and communications, networking and so on where the conflict and cooperation exist. In this

article we propose a game model to interpret the working mechanism and also point out the some orders that deserve study. Our results show that game theory is an appropriate tool to research and analyze the performance of wireless sensor networks. Of course, most networks are enormously complex, it is usually impossible to delineate all conceivable strategies and to say what outcomes they lead to, and it is not easy to assign payoffs to any given outcome. However, by edifice and analyzing a effortless game that models some imperative features of the complex network, we can gain insight into the original situation, which is just what we expect in many cases.

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