Game Theory

Game: Game is defined as an activity among two or more persons as per set of rules at the end of which each person gets some benefit or bears loss. The set of rules and procedure defines the game. A competitive situation is called game. The term game represents a conflict between two or more parties.

Game Theory: Game theory studies interactive decision-making where the outcome for each participant or players depend on the actions of all.
If you are a player in such a game, when choosing your course of action or strategy, you must take into account the choices of others.

Use of Game Theory: Game theory can help companies make strategies choice within or outside of their organizations, especially against compititors.

Different situations are presented through simple games that set up hypothetical scenario meant to simulate real-world conditions and predict a players behaviour.

Game theory can help to predict how people behave when they are in a competitive situation.

Types of Games :

(1) **Two-person and n-person games**: In two-person games, the players may have many possible choices open to them for each play of the game but the number of players remain only two. Hence, it is called a two person game. In case of more than two person, the game is generally called n-person game.

(ii) Zero sum game : A zero-sum game is one in which the sum of the payments to all the competitors is zero, for every possible outcome of the game if the sum of the points won, equals the sum of points lost.

(iii) Two person zero sum: A game with two players, where the gain of one player equals the loss of the other, is known as a two-person zero-sum game. It is also called a rectangular game because their pay-off matrix is in rectangular form.

A	B	
+10	-10	= 0

A	B	C	D	E	
+40	-10	-10	-10	-10	= 0

Strategy: The term 'Strategy' is defined as a complete set of plans of action specifying precisely what the player will do under every possible future contigency that might occur during the play of the game, i.e., strategy of a player is the decision rule he uses for making a choice, from his list of courses of action.

Strategy can be classified as:

(i) Pure strategy (ii) Mixed strategy.

Pure strategy: A strategy is called pure if one knows in advance of the play that its is certain to be adopted, irrespective of the strategy the other players might choose.

Mixed strategy: The optimal strategy mixture for each player may be determined by assigning to each strategy, its probability of being chosen. The strategy so determined is called mixed strategy because

it is a probabilistic combination of the available choice of strategy. Mixed strategy is denoted by the set S,
$S = \{x_1, x_2, \dots x_n\}$, where x is the probability of choosing course

So, $x_1 + x_2 + x_3 + \dots + x_n = 1$

It is evident that a pure strategy is a special case of mixed strategy.

Pay-off : Pay-off is the outcome of playing the game. A pay-off matrix is a table showing the amount recieved by the player name at the left hand side after all possible plays of the game. The payment is made by the player named at the top of the table.

If a player A has m courses of action and player B has n courses, then a pay-off matrix may be constucted using the following steps.

(i) Row designation for each matrix are the courses of action available to A.

(ii) Column designation for each matrix are the courses of action available to B.

(iii) With a two-person zero-sum game, the cell entries in B's pay-off matrix will be the negative of the corresponding entries in A's pay-off matrix and the matrices will be as-

Player B

$$
\text{Player A}\quad
\begin{array}{c c}
 & \begin{array}{cccccc} 1 & 2 & 3 & \cdots & n \end{array} \\
\begin{array}{c} 1 \\ 2 \\ 3 \\ \vdots \\ m \end{array} &
\begin{bmatrix}
a_{11} & a_{12} & a_{13} & \cdots & a_{1n} \\
a_{21} & a_{22} & a_{23} & \cdots & a_{2n} \\
a_{31} & a_{32} & a_{33} & \cdots & a_{3n} \\
\vdots & \vdots & \vdots & & \vdots \\
a_{m1} & a_{m2} & a_{m3} & \cdots & a_{mn}
\end{bmatrix}
\end{array}
$$

Player B

$$
\text{Player A}\quad
\begin{array}{c c}
 & \begin{array}{cccccc} 1 & 2 & 3 & \cdots & n \end{array} \\
\begin{array}{c} 1 \\ 2 \\ 3 \\ \vdots \\ m \end{array} &
\begin{bmatrix}
-a_{11} & -a_{12} & -a_{13} & \cdots & -a_{1n} \\
-a_{21} & -a_{22} & -a_{23} & \cdots & -a_{2n} \\
-a_{31} & -a_{32} & -a_{33} & \cdots & -a_{3n} \\
\vdots & & & & \\
-a_{m1} & -a_{m2} & -a_{m3} & & -a_{mn}
\end{bmatrix}
\end{array}
$$