Prisoner's Dilemma

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1. Introduction :

Prisoner's Dilemma is probably the most widely used game in *game theory*. It is widely used in the fields of Market Economics, Business management, Psychology , Life Sciences, Political Theory, etc to name a few. It was originally framed by Merrill Flood and Melvin Dresher while working at Rand Corporation in 1950. Albert W. Tucker formalized the game with prison sentence rewards and named it "prisoner's dilemma".

2. The Game :

Albert Tucker explained the Game in the following way.

Two suspects (A and B) are arrested for armed robbery. If convicted each would receive a prison term of 10 years. As there was no eyewitness of the robbery their crime cannot be proved unless one of them confesses. If the crime cannot be proved each would receive a prison term of 1 year for possession of stolen goods. Each suspect was kept in separate rooms with no possibility of communication between them. The District attorney visits each of them and gives the following four options-

a) If A confesses and B doesn't, B will serve 10 years in prison and A will be free for turning approver.
b) If B confesses and A doesn't, A will serve 10 years in prison and B will be free for turning approver.
c) If A and B both confess both will face 5 years in prison for robbery.
d) If A and B both do not confess, they will serve 1 year in prison for possession of stolen goods.

The negative Pay off matrix n terms of detention years is given below.

		SUSPECT B	
		CONFESS	DON'T CONFESS
SUSPECT A	CONFESS	5, 5	0, 10
	DON'T CONFESS	10, 0	1, 1

In the above situation Prisoner A , with no chance of communicating with B will be in a dilemma whether to confess or not to confess. If he doesn't confess and B also doesn't

confess both will face a term of 1 year each. But If A doesn't confess and B betrays him and confesses he will get 10 year prison term and B will go free. On the other hand If he confesses and B also confesses both will face a term of 5 years each. But If A confesses and B doesn't confess, B will get 10 year prison term and he will go free. In both the cases the dominant Strategy of A is to confess, because in either case he will face lesser prison term.

Likewise B will also think like this and choose the dominant strategy of Confess. Both the players will adopt their dominant strategy and face 5 years of jail term each. But if they had selected their alternative strategies of not confessing they would have got a jail term of only 1 year each. Each suspect was afraid that if he does not confess and his friend confesses he will have to go for 10 years jail term. Only if they were sure that their partner would not betray them they would not confess and get 1 year term. But as there is no scope for communication they couldn't come to an agreement and both became losers.

3. Prisoner's Dilemma in Economics:

The Game of Prisoner's Dilemma can be seen very frequently in Economics. It is seen that Oligopolists usually play game which is similar to the Prisoner's Dilemma. This model is used to analyse price and non price competitions in an Oligopoly market.

Let us explain the Prisoner's Dilemma in a Oligopoly market where two producers are involved in non-price competition.

Let us assume two producers of crude oil A and B are operating with similar cost conditions. After prolonged negotiations they have agreed to keep production low at 300 thousand Barrels per day so that the price could be kept high and they will be able to earn maximum profit. After the initial agreement each of them are free to take their own decision whether they will keep producing according to the agreement or betray the competitor in order to earn higher profit. Each of the producers has the following options before them which is expressed by the pay off Matrix.

a) If A betrays the agreement and B doesn't, A will earn a profit of $20 Million and B will earn a profit of $15 Million.
b) If B betrays the agreement and A doesn't, B will earn a profit of $20 Million and A will earn a profit of $15 Million.
c) If A and B both betray each other and opt for High production both will earn a Profit of $16 Million.
d) If A and B both honour the Agreement and keep production low both will earn a profit of $18 Million.

		PRODUCER B	
		HIGH PRODUCTION 400,000 Barrels	LOW PRODUCTION 300,000 Barrels
PRODUCER A	HIGH PRODUCTION 400,000 Barrels	16, 16	20, 15
	LOW PRODUCTION 300,000 Barrels	15, 20	18, 18

In the above situation producer A will think like this. “I can keep on producing 300000 Barrels according to the agreement or I can increase production to 400000 Barrels. If B follows the agreement I can earn $20 Million by increasing Production or can earn $18 Million by keeping production Low. If B violates the agreement and increases production then I can earn $16 Million by increasing production or can earn $15 Million by producing less.”

Irrespective of the steps taken by B, A will gain more by increasing production. Thus the dominant strategy for A will be to increase production which he will follow. Likewise B will also think like this and he will also adopt his dominant strategy of increasing production. As a result both will earn a profit of $16 Million each. But if they had cooperated and kept the production low both could have earned a profit of $18 Million each. Thus instead of cooperating by adopting the dominant strategy both the Oligopolists lose out the chance to earn increased profit. This is ideal situation of Prisoner’s Dilemma.

4. Practical Examples:
   There are many instances of Prisoner’s Dilemma in real world. Following are some of the examples-
   a) In 1980’s some of OPEC countries, particularly Iran and Iraq breaking OPEC agreement and producing more Crude Oil thus reducing its price.
   b) During the cold war period both the US and USSR involved in Arms race and thus wasting huge amount of resources.
   c) Every country knows that reduction of Carbon emission is very important for the survival of this planet. But No country is willing to cut their Carbon emission.
   d) Airline companies fare war of 1992, (American, Continental, Delta, United and US Airways) is another frequently referred-to example.

Prisoner’s Dilemma describes many of life’s situation. It shows that cooperation is difficult to maintain even if cooperation makes us better off.
