

Game Theory as a Tool for Analyzing Terrorism

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Workshop on
"Tactical Decision Making and Situational Awareness
for Defence Against Terrorism"
Alenia Aeronautica, Torino, Italy, 8-9 May 2006

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Introduction

Terrorism:

- is a relevant challenge for our society
- can modify the behavior of large part of the population
- may attract the attention of policy-makers
- can move large monetary amounts (consequences on the economic activities)

Two main actors

government \longleftrightarrow terrorist organization

Major (2002):

“studies of terrorism risk resemble risk analyses of complex engineering systems”

but

“unlike natural disasters, it features human intelligence,
and unlike industrial disasters it features human intent”



Game Theory

interactive situations in which the final outcome
depends on the actions taken by various decision-makers

Game Theory in short

Ingredients of a game:

- *the players*
the agents or decision-makers of the situation
 - *rational* i.e. the choices are driven towards the most preferred outcome
 - *intelligent* i.e. they know all the possible outcomes and which subset of outcomes can be obtained after a strategic choice
- *the set of strategies of each player*
the possible alternatives among which each agent may choose
 - *strategy profile* a set including one strategy for each player
- *the utility function of each player*, i.e. the gain or the loss (in a very wide sense) that each agent gets from each possible outcome

Non cooperative games

each agent makes his selection in his strategy set independently from the others

Cooperative games

agents coordinate their choices for improving their utilities, via *binding agreements* forming *coalitions*

- *Non transferable utility games (NTU-games) or games without side payments*
the players of a coalition get the payoff that the rules of the game assign to them according to the strategy profile
- *Transferable utility games (TU-games) or games with side payments*
the players of a coalition may redistribute among them the total utility they get

Example 1 (Prisoner's dilemma)

<i>I/II</i>	<i>L</i>	<i>R</i>
<i>T</i>	2, 2	9, 1
<i>B</i>	1, 9	4, 4

Non cooperative game

Player chooses *T* ($2 > 1$ and $9 > 4$) and in a similar way player II chooses *L*
the resulting strategy profile is $\{T, L\}$ and the utility is 2 for each of the two players

NTU-game

The players agree on the strategy profile $\{B, R\}$ getting the utility 4 for each of them

TU-game

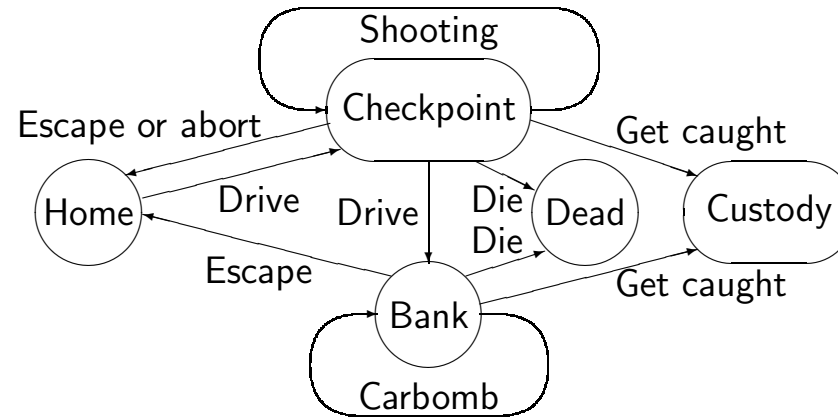
The players may agree on one of the two strategy profiles $\{T, R\}$ or $\{B, L\}$ that give them a global utility of 10 instead of 8, that they may share in several ways, e.g. 5 each

Game theory literature proposes several solutions concepts for all the three classes of games

Three examples

Non Cooperative Game Example (Weaver, Silverman, Shin, Dubois, 2001)

Graph representation of a terroristic attack



The game associated to the checkpoint situation

<i>Terrorist</i>	<i>Drive through</i>	<i>Shoot guard and escape unnoticed</i>	<i>Shoot guard and die</i>	<i>Get caught</i>
<i>Guard</i>	<i>unnoticed</i>	<i>unnoticed</i>	<i>and die</i>	
<i>Unready</i>	-1, 4	-2, 3	-2, 1	2, -1
<i>Ready</i>	-2, 3	-3, 1	0, 1	3, 1

The authors remark that “this example is illustrative, and no real utility values have been specified. It will be a step of the research to conduct the datamining and to interact with experts to elicit the proper structure of the graph and the table elements and utilities”

NTU-Game Example (Owen, 2000)

It is the generalization of the Two-Person Bargaining Problem (Nash, 1950) when the two players act as representatives of a state and a terrorist organization

The organization are *heterogeneous* as there are *hawks* that accept only strong conditions for the counterpart and *doves* that are available also for weak conditions

The members of each organization have similar but not coincident interests, i.e. “have similar utilities for the agreements reached, but different utilities for conflict”

The hawks of a party may take actions in order that the counterpart rethinks the value of the agreement, decreasing the number of members of the counterpart favorable to the agreement

Hawkish members seem more in cooperation than in opposition

A third party that may “subsidize the agreement ... by making some sort of side payment to the members of the organization”

TU-Game Example (Slikker, Norde, Tijds, 2003)

Sharing information against terrorism even if not all the agents have the same target

Consider a small hotel with 8 rooms, 4 on the bottom floor and 4 on the top floor. On each floor, two rooms are on the north side and two rooms on the south side; on the other hand, on each floor two rooms are on the east side and two rooms on the west side

In one of the rooms of the hotel there is a monster

TU-Game Example (cont.)

Player	Information	Target
1	north or south side	be as far away from the monster as possible
2	west or east side	be on a different floor than the monster
3	bottom or top floor	catch the monster

Player 3 needs the cooperation of all the players

Player 2 forms a coalition with player 3 for getting all the information required, but has no incentive to cooperate with player 1

Player 1 has to form a coalition with all the players in order to maximize his distance from the monster

Using his sole information he can avoid the room of the monster

A coalition with one of the other two players may give him an intermediate

A random choice, may give him even the maximal utility (if he is lucky)

Concluding Remarks

Other results are in:

- Bueno de Mesquita (2003): how decisions of one of the two sides influence the behavior of the other one, taking into account also government investment in counter-terror, negotiated settlements, duration of terrorist conflicts, incentives for moderate terrorists to radicalize their followers, and incentives for governments to encourage extremist challenges to moderate terrorist leaders
- Keet (2003): theories of terrorism and its changes over time and applications of game theory for disclosing interactions between actors in a structured format and for studying coalition-formation process and strengths and weaknesses in negotiation processes

Other authors:

McCormick: heterogeneous bargaining with Owen

Dietrich: general model for prevention

Woo: insurance aspects

Arce and Sandler: prevalence of deterrence over preemption

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