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Topology and Dynamics of Terrorism

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Ref

4. Tench S., Fighting Terrorism with Mathematics. *SIAM News*, Vol. 49. No.6, July-August, 2016.

Topology and Dynamics of Terrorism

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I. Introduction

Terrorism is a social as well as an historical problem that has posed a great threat to mankind. It is one of the greatest challenge of nations in the 21st century that has killed multitudes, rendered many able bodied persons invalid and displaced many households. Countries such as United States of America, Afghanistan, Pakistan, France, United Kingdom, Iraq, Somalia, Kenya, Nigeria etc. have been the worst hit on a daily basis when it comes to the scourge of Terrorism according to press daily reports. World organizations such as United Nations, the African Union and other government agencies are on a passionate search for a panacea to this perennial problem.

Terrorism is a very complex phenomenon that poses threat to international security. It affects every aspect of life. The economy of affected nations is under severe threat as no ready to invest in turbulent communities. Trade is put on hold because of violence. Agriculture and food security is also affected as no farmer will want to be exposed to attack in such areas. Health facilities cannot be sustained as this faceless group are hell-bent on total destruction of life and properties.

Not so many mathematicians have studied this perilous problem that has plagued vast populace of humanity. Among the few authors that have studied terrorism as a problem are Gutfrained [1, 2], Caulkins et.al [3], Woo [5], and Zhuang and Bier [7]. Also, Wright [6] in his paper, looks at terrorism as a thing of ideology than brute force. Stephen Trench [4] in his paper writes on how to fighting terrorism with Mathematics. The result discussed in this paper does not use the approach of previous discussants but adopts the topological strategy.

In what follows, it is necessary to outline what shall be presented in each section. In section two, we shall introduce the definitions of some fundamental concepts in topology required for this study. Section three contains the application of these concepts to the study of the problem. Section four shall reflect some recommendations on safety measures as well as counter-terrorism strategies.

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II. Fundamental Concepts

In this section, we introduce some important concepts in topology.

2.1 Definition: A set X is called a topological space if it is closed with respect to a family of its subsets $\tau \subseteq 2^X$ so that (i) $\emptyset, X \in \tau$ (ii)$\cup_{\alpha \in \mathcal{A}} U_\alpha \in \tau$ and (iii)$\cap_{i=1}^{n} U_i \in \tau$ where $\mathcal{A}$ is an indexing set.

In the above definition τ is called the topology of X and every open set $U \in \tau$ is called an open set.

2.2 Definition: A set $\mathcal{N}(x)$ is called the neighbourhood of $x \in X$ if there exists an open set $U \in \tau$ such that $x \in U \subseteq \mathcal{N}(x) \subset X$.

2.3 Definition: A point $x \in X$ is called a limit point, cluster point or accumulation point of S if $\mathcal{N}(x) \setminus \{x\} \cap S \neq \emptyset$.

2.4 Definition: A point $x \in X$ is called an isolation point of S if $\mathcal{N}(x) \setminus \{x\} \cap S = \emptyset$.

2.5 Definition: Let X and $\tilde{X}$ be topological spaces and $p : \tilde{X} \to X$ be continuous map. An open set $U \in \tau_X$ is said to be evenly covered by the map p if and only if

$$p^{-1}(U) = \coprod \{V : V \in \tau_{\tilde{X}}\}$$

each of which is mapped homeomorphically onto U by p. Then the map p is a covering map.

2.1 Theorem: (Lifting Lemma). Let $p^{-1} : \tilde{X} \to X$ be a covering map and $f : (B, b_0) \to (X, x_0)$ a map from a base space (B, b_0) with a base point b_0 into the base space (X, x_0) with base point x_0. If $\tilde{x}_0$ is in the fibre of x_0 then there exists a unique map $\tilde{f} : (B, b_0) \to (\tilde{X}, x_0)$ such that $p \circ \tilde{f} = f$.

2.1 Remark: The map $\tilde{f}$ in Lemma 2.1 above is called the lift. When the base space (B, b_0) equals $(I, 0)$ a unit interval I based at 0 or any other path then $\tilde{f}$ is called a path lifting map. This principle is what is required when instead of engaging ground battle, air strikes could be adopted. The war airplanes serve as the lift.

III. Main Result

In this section, the application of the above concepts in the discussion of the problem of terrorism and the strategies for counter-terrorism operations is presented. In what follows, the topological space X shall be likened to regions susceptible to terror attack.

3.1 Theorem (Bomb ignition): An ignited bomb's point of impact affects its ignition point $x \in X$ and its neighbourhood $\mathcal{N}(x, \epsilon)$ bounded by the radius of impact ϵ.

3.1 Remark: The radius of impact ϵ of the bomb as a weapon of mass destruction at times ranges from $1m$ to $50m$ depending on its components.

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3.2 Theorem (Risk of Casualties): Let the location of any potential risk victim be $y \in X$ then anyone at point $y \in \mathcal{N}(x, \epsilon)$ is at the risk of casualty.

3.2 Remark: By risk of casualty we mean that anyone at the point of impact is likely to suffer injuries and at worst will risk death.

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3.3 Theorem: An isolation point which describes the location of a suicide bomber with no other person within the neighbourhood will have the minimum casuality impact of the bomb.

3.4 Theorem: A cluster point which describes a densely populated neighbourhood will record maximum casualty impact of the bomb.

3.5 Theorem: Let $y_i(i = 1, \ldots, m\,)$ denote the location of individuals in $\mathcal{N}(x, \epsilon)$ then minimum casualty will be recorded if $\mathcal{N}(x, \epsilon) \setminus \bigcap_{i=1}^{m} \{y_i\} = \{x\}$ where x is the location of the suicide bomber.

3.3 Remark: In other cases $\mathcal{N}(x, \epsilon) \setminus \bigcap_{i=1}^{m} \{y_i\} = \emptyset$ when x is the location of a timed bomb in the absence of a suicide bomber from $\mathcal{N}(x, \epsilon)$. Here, x is an isolated point.

Next, it is necessary to consider network topology because it is a well known fact that terrorist groups work in very intrinsic networks that make it difficult for security forces to crackdown on them. Terrorism is the worst kind of warfare because of its unpredictable nature. A network topology is the arrangement of a network, including its nodes and connecting lines. There are two ways of defining network geometry: the physical topology and the logical (or signal) topology (See Fig 1). In advanced technologies, drones technology is used in mapping out the networks of suspected terrorists using some of their known bio-data obtained in the course of interrogation. Though in actual modus operandi most crude terrorists operate using courier correspondence that are not electronic in nature. The reason for this is because such domains are trackable.

Sometimes the network topology allows one to loop points to a certain base point which helps the military to develop a strategy of counter-terrorism operations. (See fig 2).

3.6 Theorem: In counter terrorism operations, air raid can be carried out using a translated rotational triangular network loops from at least three surrounding air base where operations are taken in hourly permuted sequence group A_3 pattern with terms:

$$\imath, (12), (23), (13), (321), (213), (132), (312), (231)$$

Here, $\imath = (123)$ is the identity path.

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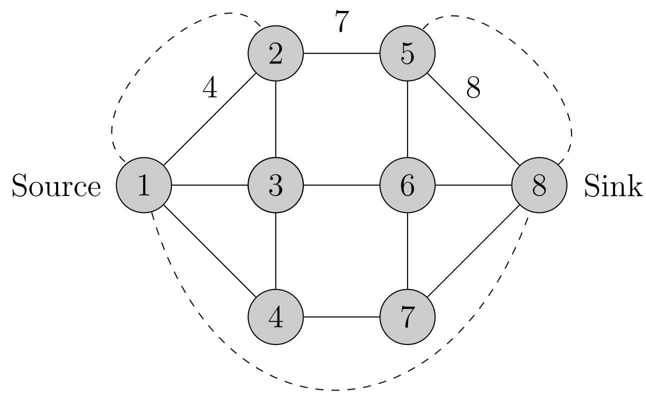
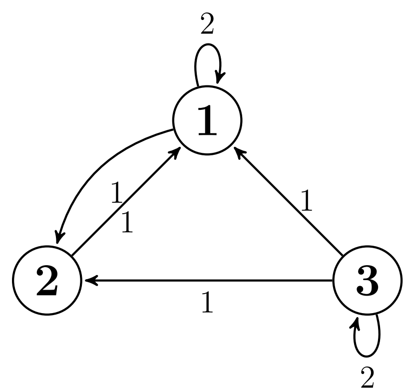


Figure 1: A Figure Showing An Example of Networks of Points in A Topological Space



$\Longrightarrow$

Figure 2: Figure Showing A simple loop of network of points called nodes

IV. Conclusion

This paper has discussed the safety and counter terrorism strategy for cubbing the menace and excesses of terrorist apart from the ideology and propaganda strategy. Other models for combating terrorist groups which can mesmerize them can be adopted using more advanced group permutations $A_n, n > 3$.

V. Recommendations

The following recommendations can be deduced from this paper:

(a) Precautions should be taken by the Governments not to make inciting statements that could trigger violence.

(b) Government and Non-governmental agencies should use the mass media platforms to educate their citizenry to avoid cluster gatherings in highly susceptive areas.

(c) Places of high density such as markets, churches, mosques, etc. should be properly guarded by security agents well equipped with surveillance cameras, drowns, and bomb detectors.

(d) In counter terrorism feats, arial bombardments should be used more in dealing with concentrated hideouts of terrorists. The translated triangular symmetry model can be adopted to make their formation unpredictable by the insurgents.

(e) Intelligence gathering should also use satellite and drones technologies.

Notes

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