Complex dynamical evolution and spatio-temporal spread of global terrorism

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Abstract: Human interactions give rise to various complex social and anti-social phenomena. These may be positive as well as negative. The dynamics of these interactions give rise to certain spatio-temporal patterns and complex networks, which can be interesting to a wide range of researchers—from social scientists, physicists and data scientists. Here, we present the study related to terrorist incidents across the globe using open access data and the tools of data science and statistical physics[6]. The results may provide deep insight on their formations and spreading of the anti-social phenomena, and thereby help in framing public policies that may check their spread.

❑ Objectives

- To study the spatio-temporal spread and its analysis through the open access data(GTD) [3].
- To analyze the growth dynamics with complex network [1,2,4] approach, along with the statistical properties of the *anti*-social network.
- To identify backbone structure of this complex network by using disparity filter method.

❑ Methodology

- We constructed a complex network [1,2,4] of global terrorism and studied its growth dynamics, along with the statistical properties of the anti-social network.
- We aso studied the network resilience against targeted attacks and random failures, which could guide the counter-terrorist outfits in designing strategies to fight terrorism.
- We then used a disparity filter method to isolate backbone [5] of the network, and identify the terror hubs and vulnerable motifs of global terrorism.

❑ Disparity Filter

- To find the backbone structure of a weighted network, we have used the algorithm proposed by Serrano *et al.*[5]
- The disparity filter algorithm extracts the network backbone by considering the relevant edges at all the scales present in the system and exploiting the local heterogeneity and local correlations among the weights.
- The disparity filter has a cut-off parameter α_c (0.01), which determines the number of edges that are reduced in the original network.
- The filter, however, preserves the cutoff of the degree distribution, the form of the weight.

❑ Results

- This new method of network approach captures the events and conforms to the fact.
- Edges mentions and the out-degree of an actor have power law tails for the largest values, indicating a strong self-organizing principle behind the events.
- Most of the actors belong to a giant connected component and very small fraction of disconnected clusters are left at periphery.
- In case of El Salvador, Chapultepec Peace Accords were signed in 1992 which is successfully captured by the network and is reflected in backbone.
- In case of Columbia the targeted attack on military comes into picture, when Govt. involved military for eradication of terrorism.
- The evolution of hubs and motifs in a few exemplary cases like Afghanistan, Colombia, India, Israel, Pakistan and the United Kingdom is examined. Here, dynamics of the network backbone may provide deep insight on their formations and spreading, and thereby help in contending terrorism or framing public policies that can check their spread.
- Also, the network resilience against targeted attacks and random failures, is studied, which could guide the counter-terrorist outfits in designing strategies to fight terrorism.

❑ References

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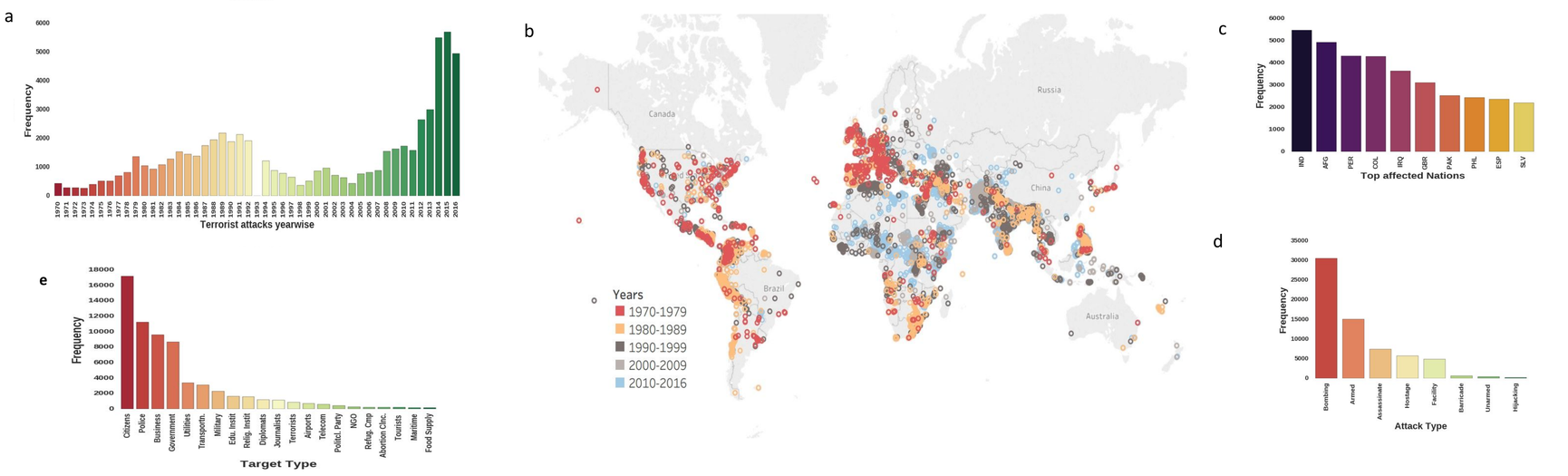
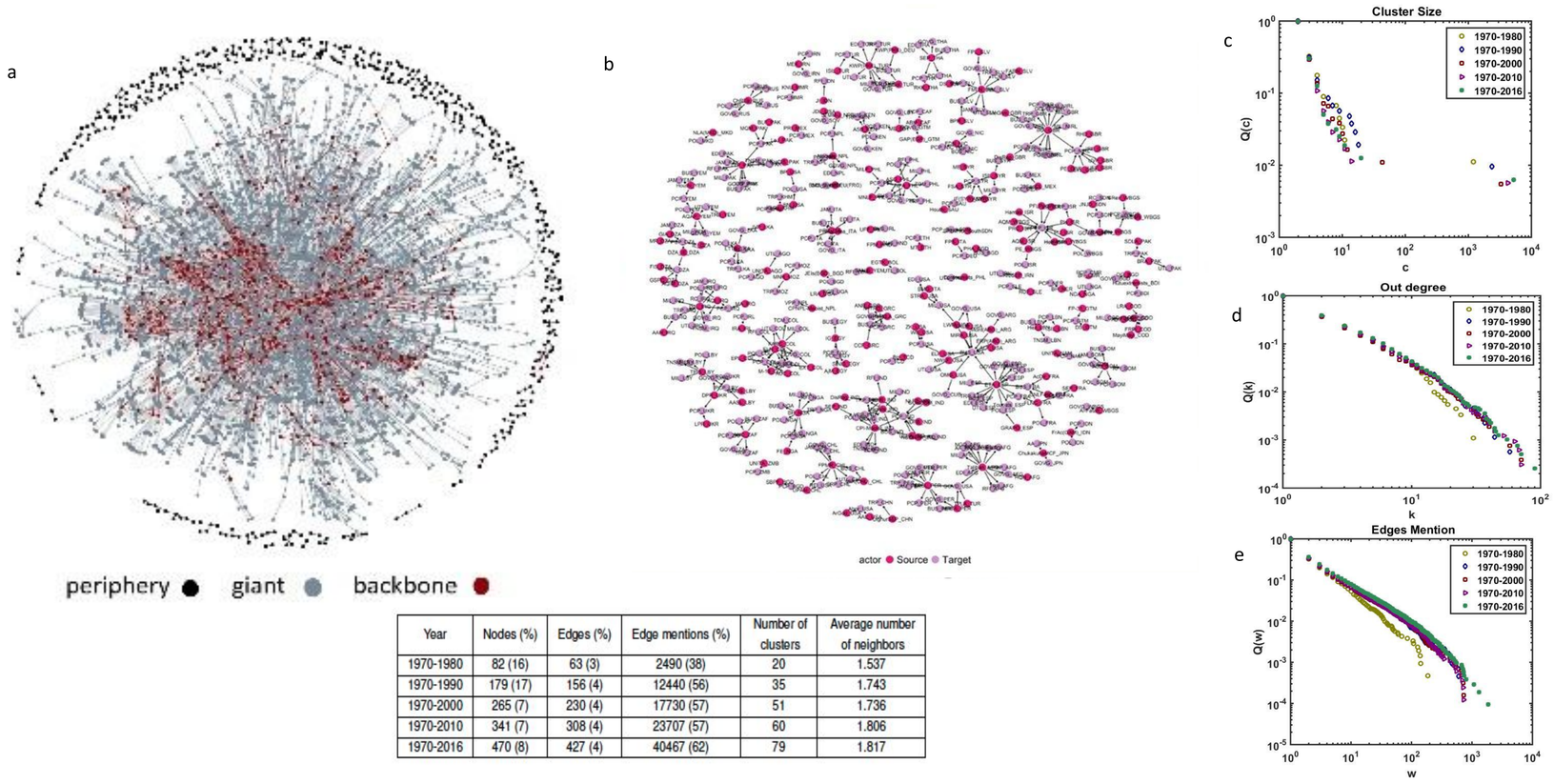
Spatio-temporal spread of terrorism



a)Year wise terror count b)Spatio-temporal spread across the globe c)Top affected Nations d)Modus operandi of assault e)Common targets

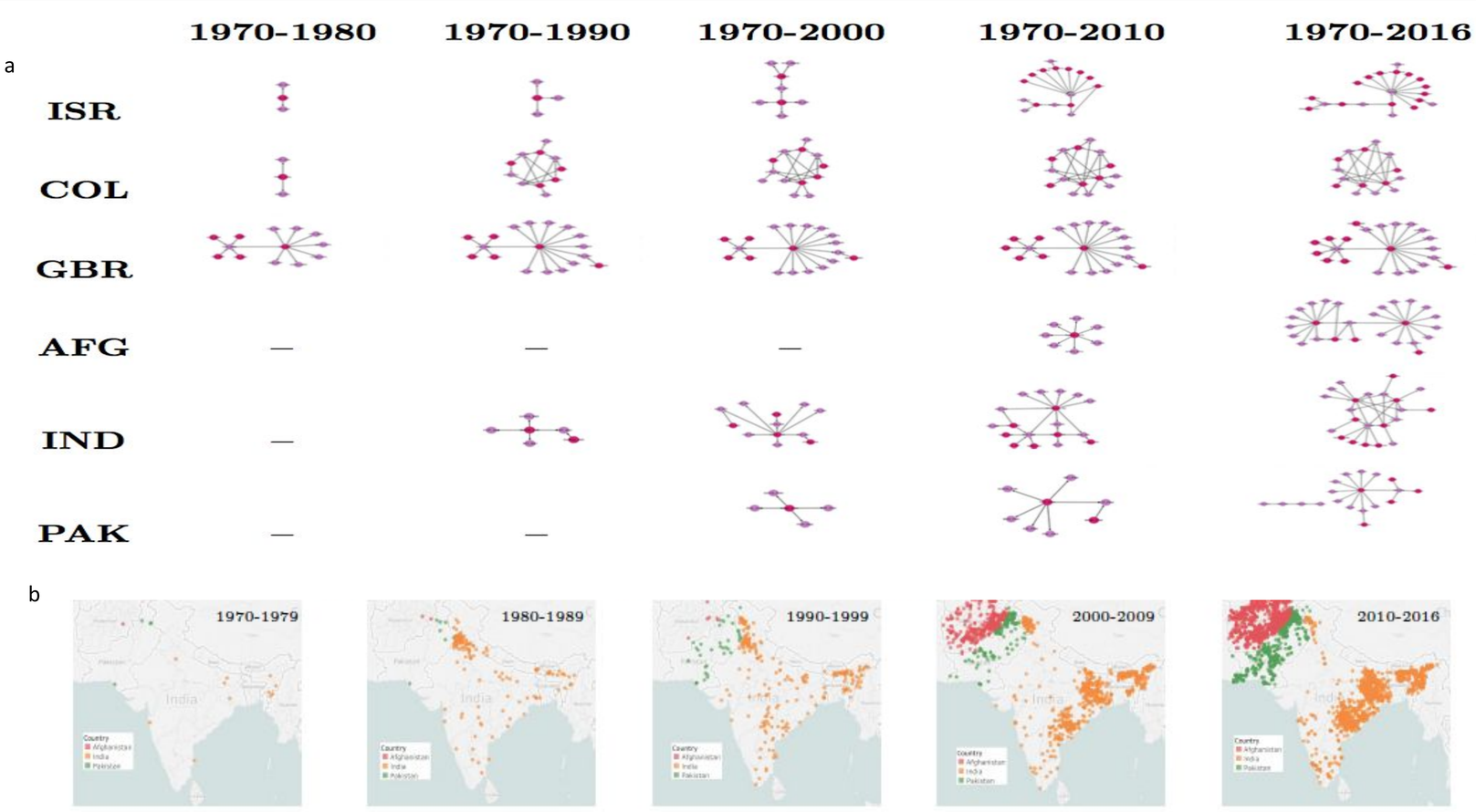
Network and its backbone



Year	Nodes (%)	Edges (%)	Edge mentions (%)	Number of clusters	Average number of neighbors
1970-1980	82 (16)	63 (3)	2490 (38)	20	1.537
1970-1990	179 (17)	156 (4)	12440 (56)	35	1.743
1970-2000	265 (7)	230 (4)	17730 (57)	51	1.736
1970-2010	341 (7)	308 (4)	23707 (57)	60	1.806
1970-2016	470 (8)	427 (4)	40467 (62)	79	1.817

a)Network with giant component b)Giant component c)Cluster size d)Out degree e)edge mention

Country wise terror hubs and vulnerable targets



Left to right a)decade wise backbone evolution b)decade wise spread in Indian sub-continent