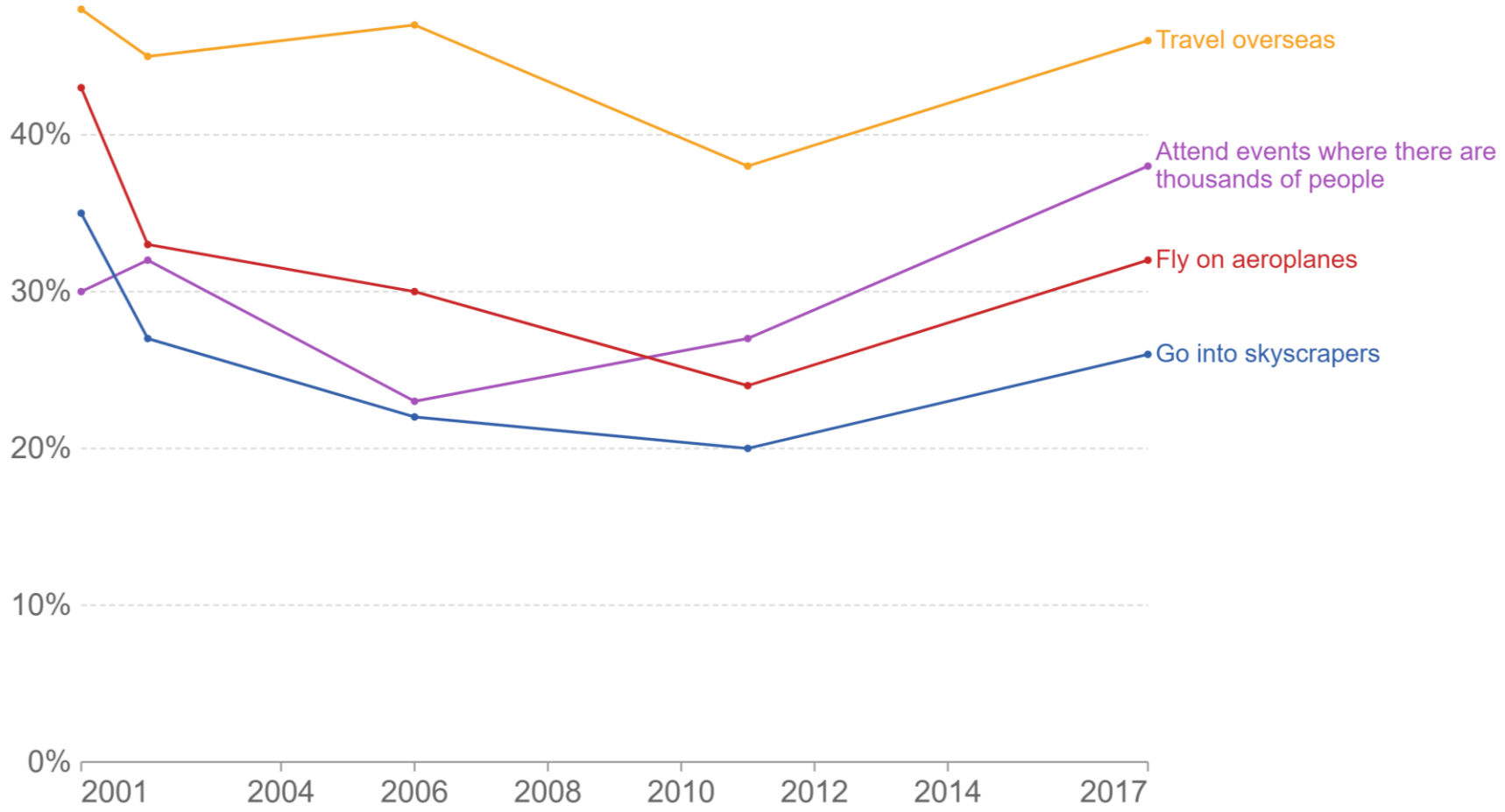
DETECTING TERRORIST NETWORKS

By Akash Govind Kuttikad, Sushama Shankar,
and Thihan Moe Kyaw

UNIVERSITY OF
ILLINOIS
URBANA-CHAMPAIGN

Share of US citizens who say they're less willing to do certain activities due to terrorism



Source: Gallup Survey (2017)

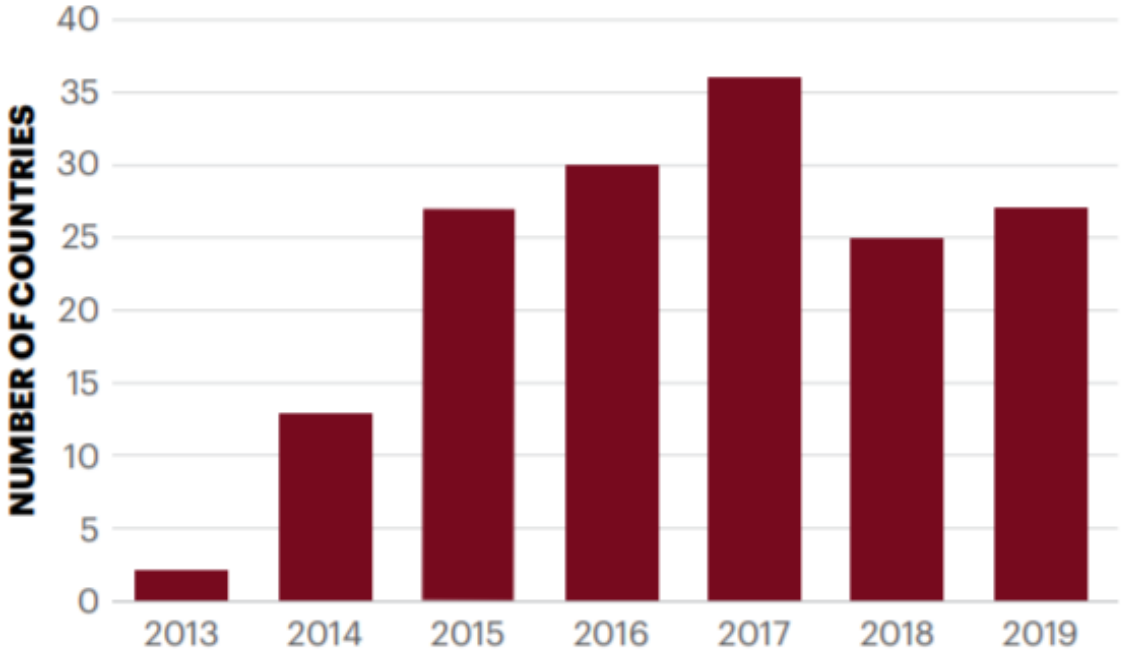
Proliferation and influence of terrorist groups

- No political or ideologically driven organization can survive or thrive without a support network, which includes: (Bandura, A. (2004), Borum, R. (2004))
  - Financial support
  - Weapons,
  - Organizational and operational support

Source: Bandura, A. (2004). The origins and consequences of moral disengagement: A social learning perspective.
Borum, R. (2004). Psychology of terrorism. Tampa: University of South Florida.

Proliferation and influence of terrorist groups

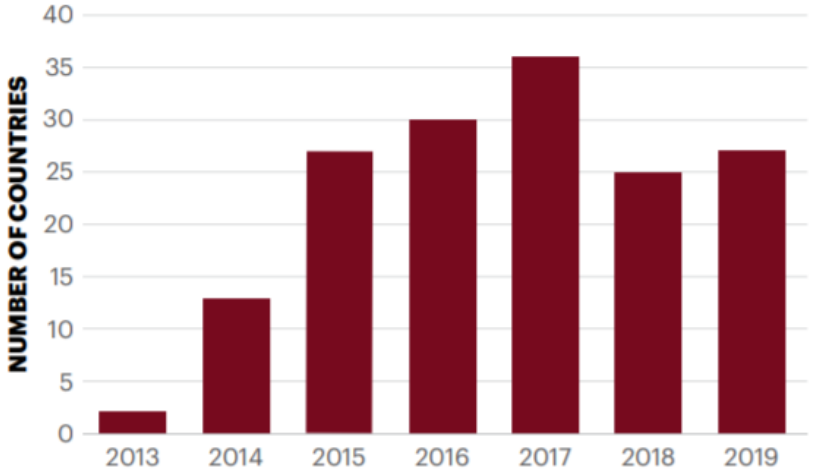
- Islamic State of Iraq and the Levant (ISIL) and its predecessors were responsible for at least 17 per cent of total deaths from terrorism over the past decade. (Source: Global Terrorism Index 2020)



Number of countries recording ISIL-related attacks, 2013-2019
(excludes Iraq and Syria)
Source: START GTD, IEP calculations

What do we observe from the spread of ISIL?

- ISIL first emerged in the early 2000s from local militant outfits.
- ISI, its immediate predecessor was formed in 2010 by surviving members of Al-Qa'ida in Iraq (AQI) and former members of the US-trained Sons of Iraq.
- ISIL-related groups have recorded over 3,000 attacks in 48 countries other than Iraq and Syria, since 2013.
- ISIL's global reach has steadily expanded with provinces and affiliated groups conducting attacks across six regions: Asia-Pacific, Europe, MENA, Russia and Eurasia, South Asia and sub-Saharan Africa.
- In the West, ISIL directed or inspired at least 78 terror attacks between 2014 and 2019, resulting in 471 fatalities.



Number of countries recording ISIL-related attacks, 2013-2019 (excludes Iraq and Syria)
Source: START GTD, IEP calculations

Source: Global Terrorism Index 2020: Measuring the Impact of Terrorism, Sydney, November 2020.

Global Terrorism Database

- Event-level database consisting with more than 200,000 records of attacks from 1970 till 2019

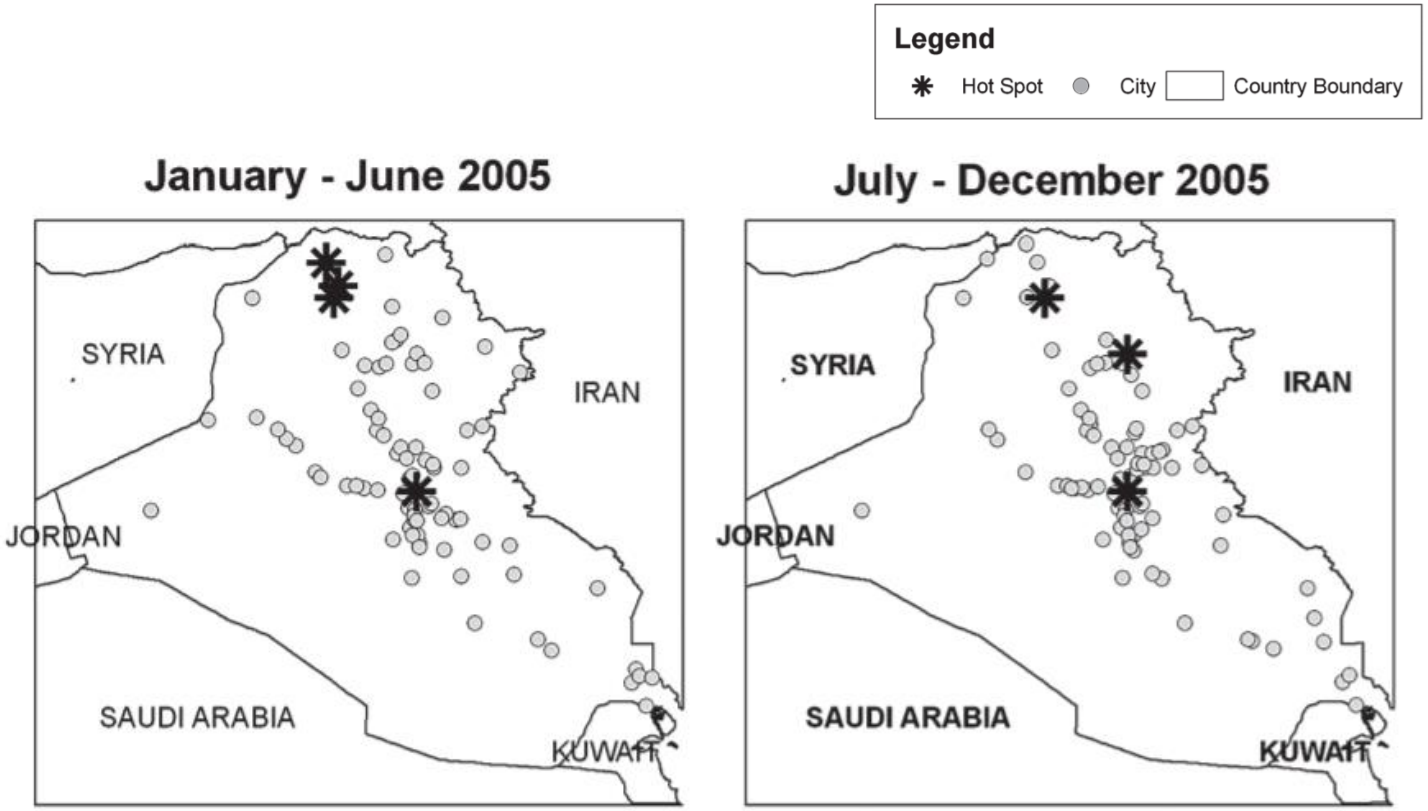
- Developed and maintained by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) at the University of Maryland.

- Includes information on at least 45 variables for each case, with more recent incidents including information on more than 120 variables, which include
  - Incident date
  - Location
  - Target type
  - Perpetrator information
  - Weapon information
  - Casualty

Similarity criteria between terrorist events

Spatial/geographic proximity

- Importance:
  - Can help identify hotspots
  - Target destinations of specific terrorist groups
- Minimal change in target destinations over a span of one year in images 1 and 2 demonstrate increased probability of one event “following” another



Evolution of hotspots of attacks carried out in Iraq during 2005

Source: Global Terrorism Index 2020: Measuring the Impact of Terrorism, Sydney, November 2020.

Similarity criteria between terrorist events

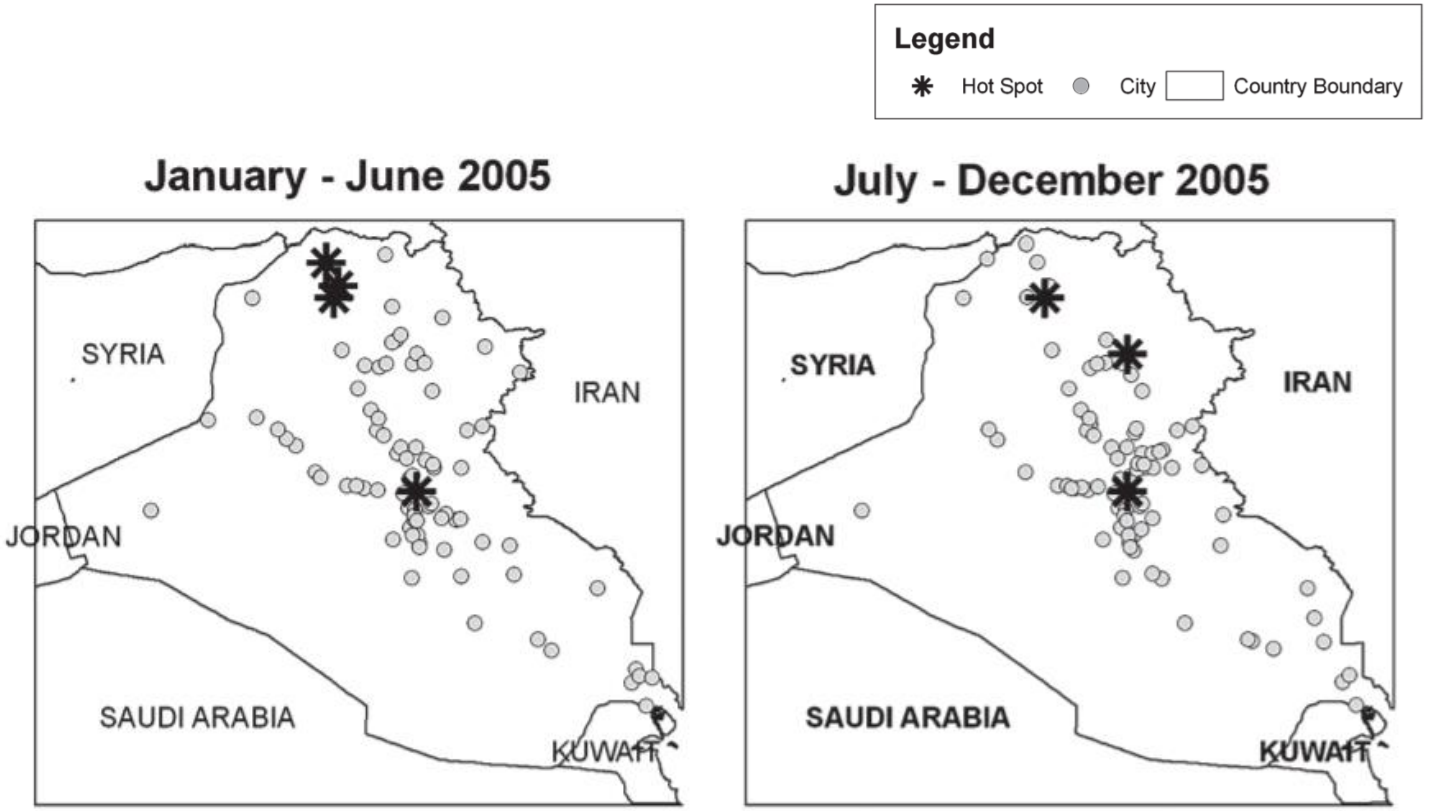
Spatial/geographic proximity

- Theoretical comprehension: Relationship between distance and similarity of events:
  - Distance is inversely proportional to similarity
- Practical Application:
  - Calculating distance between two event locations:
    The haversine function computes the distance between two locations based on the latitude and longitude values
  - Distance similarity function:
    $weight = e^{\{-1*|d_i - d_j|\}}\ for\ |d_i - d_j| \leq \delta$
    where,
    d_i, d_j – location of two events
    δ – upper limit for difference in distance

Similarity criteria between terrorist events

Temporal proximity

- Importance:
  - Target destinations of specific terrorist groups in a narrow time gap
  - Identification of copycat events
  - Deduce patterns of non-random attacks within a time frame
- Minimal time window between two terrorist attacks in Iraq, increasing probability of one event “following” another (Jenkins et al., RAND Corporation, 2016)



Evolution of hotspots of attacks carried out in Iraq during 2005

Source: Global Terrorism Index 2020: Measuring the Impact of Terrorism, Sydney, November 2020.
Jenkins, Brian Michael, Henry H. Willis, and Bing Han, Do Significant Terrorist Attacks Increase the Risk of Further Attacks? Initial Observations from a Statistical Analysis of Terrorist Attacks in the United States and Europe from 1970 to 2013. Santa Monica, CA: RAND Corporation, 2016. https://www.rand.org/pubs/perspectives/PE173.html.

Similarity criteria between terrorist events

Temporal proximity

- Theoretical comprehension: Relationship between time and similarity of events:
  - Time is inversely proportional to similarity
- Practical Application:
  - Calculating time difference between two events:
    The time function computes the time difference between two events
  - Time similarity function:
    $weight = e^{\{-1*|t_i - t_j|\}} \; for \; t_i - t_j \leq \tau$
    where,
    t_i, t_j – time gap between two events
    τ – upper limit for difference in time

Similarity criteria between terrorist events

- Target type: The most frequently attacked type of target in the United States between 1970 and 2013 was business targets. Nearly one-third of all attacks on business targets were on banks/commerce, and an additional 23% were on retail entities

94% of attacks against **abortion-related targets** were on clinics, while 6% targeted providers or personnel.

78% of attacks against **educational targets** were on schools, universities, or other buildings, while 22% targeted teachers or other educational personnel.

73% of attacks against **government targets** were on government buildings, facilities, or offices, while 27% targeted personnel, public officials, or politicians.

Source: Miller E., START Novemeber 2014, Terrorist Attacks in the U.S. Between 1970 and 2013: Data from the Global Terrorism Database (GTD)

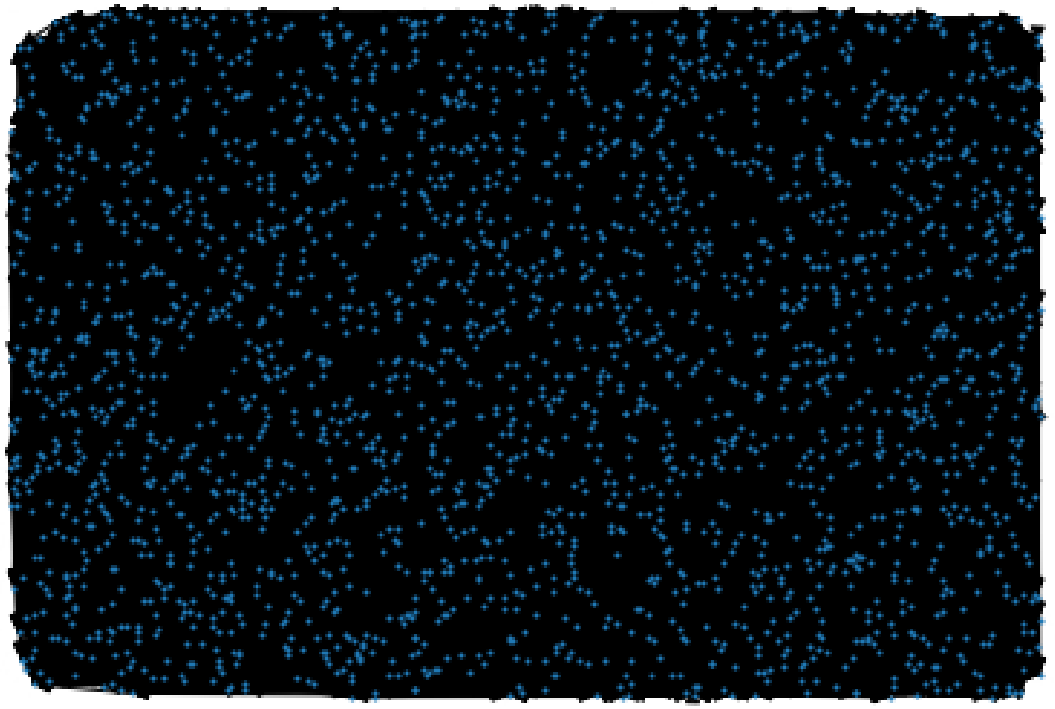
Similarity criteria between terrorist events

Target Group Equality

- Theoretical comprehension: Relationship between target group and similarity of events:
  - If the target group is the same, there exists a similarity between two terrorist attacks
  - Motivated by the fact that groups with similar ideologies attack the same target groups
- Practical Application:
  - Checking for similarity through target groups:
    A simple equality check between target groups of two events under consideration permits further weight addition to the edges based on spatial and temporal relevance.

Formation of events graph

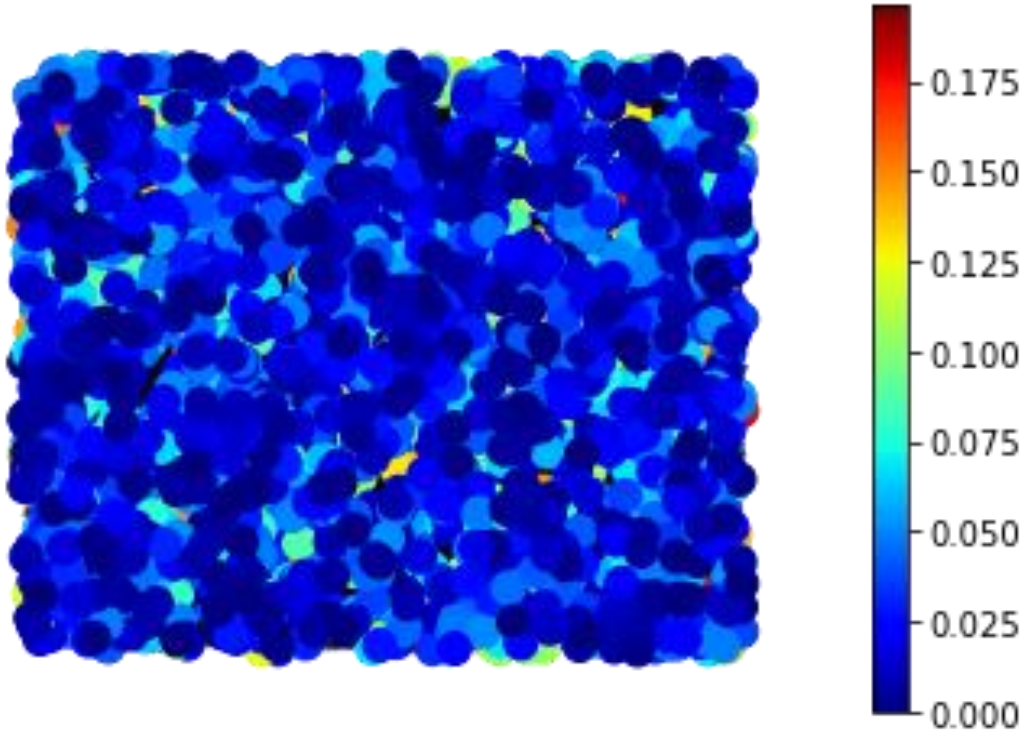
- Based on the aforementioned similarity criteria, a graph connecting various terrorist events in the United States was formed.
- Graph directed from influencer to the influenced event.
- Total number of nodes = Number of events = 2437
- Total number of edges = 186789
- Top 8 influential events have been identified by calculating closeness centrality value of each node.



Closeness centrality of events graph

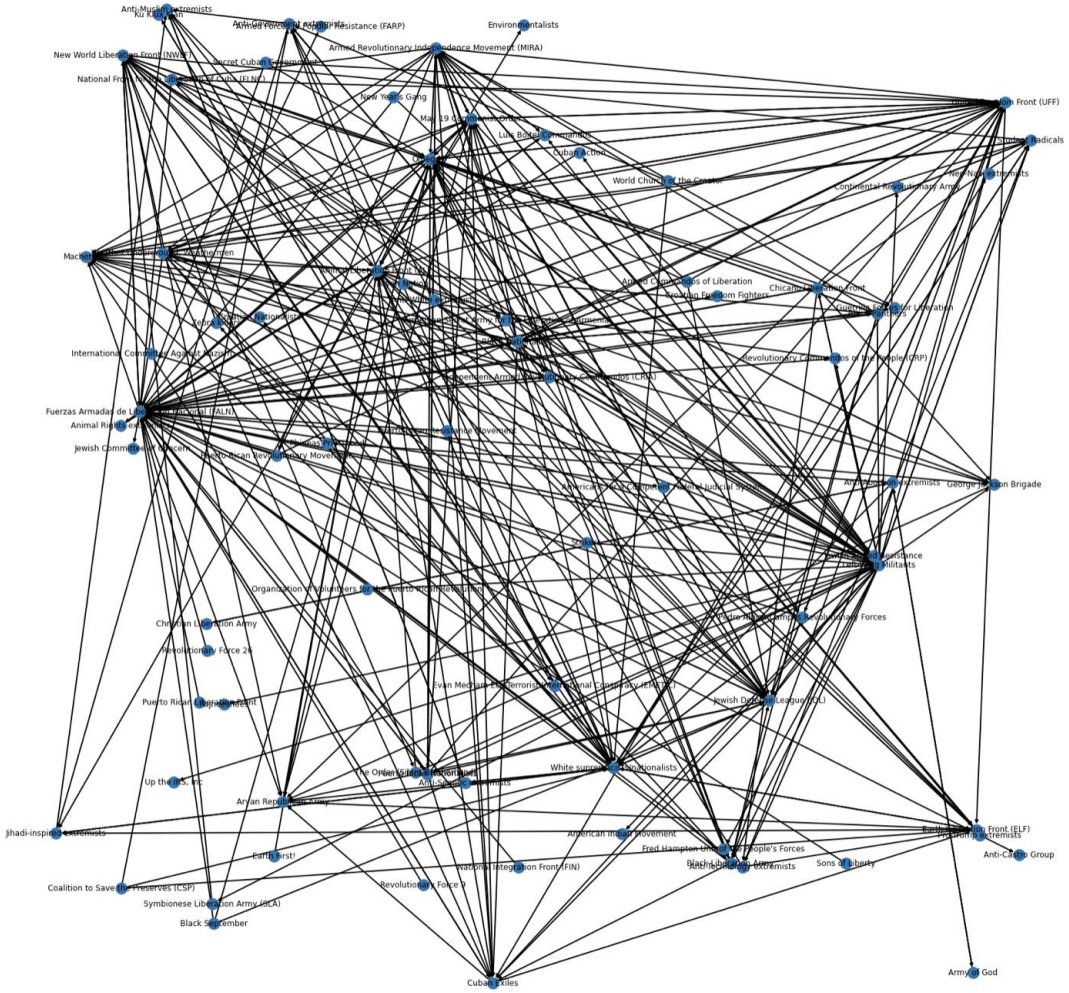
- Range varies from 0.19589 to 0.
- Centralization of the graph formed = 0.3088
- Top 8 influential events and corresponding groups:

Event ID	Closeness value	Group name
251	0.19589	Revolutionary Force 26
252	0.19589	Revolutionary Force 26
37	0.19429	Strikers
243	0.19423	Black Nationalists
570	0.18812	Black Nationalists
593	0.18773	Black Nationalists
228	0.18699	Left-Wing Militants
229	0.18699	Left-Wing Militants



Network with terrorist groups as nodes

- Edge included between two groups if one has followed more than 100 events ‘similar’ to another.
- Number of events followed between groups (initial edge weight) varies between 1 and 2779
- Number of nodes = 79
- Number of edges = 306

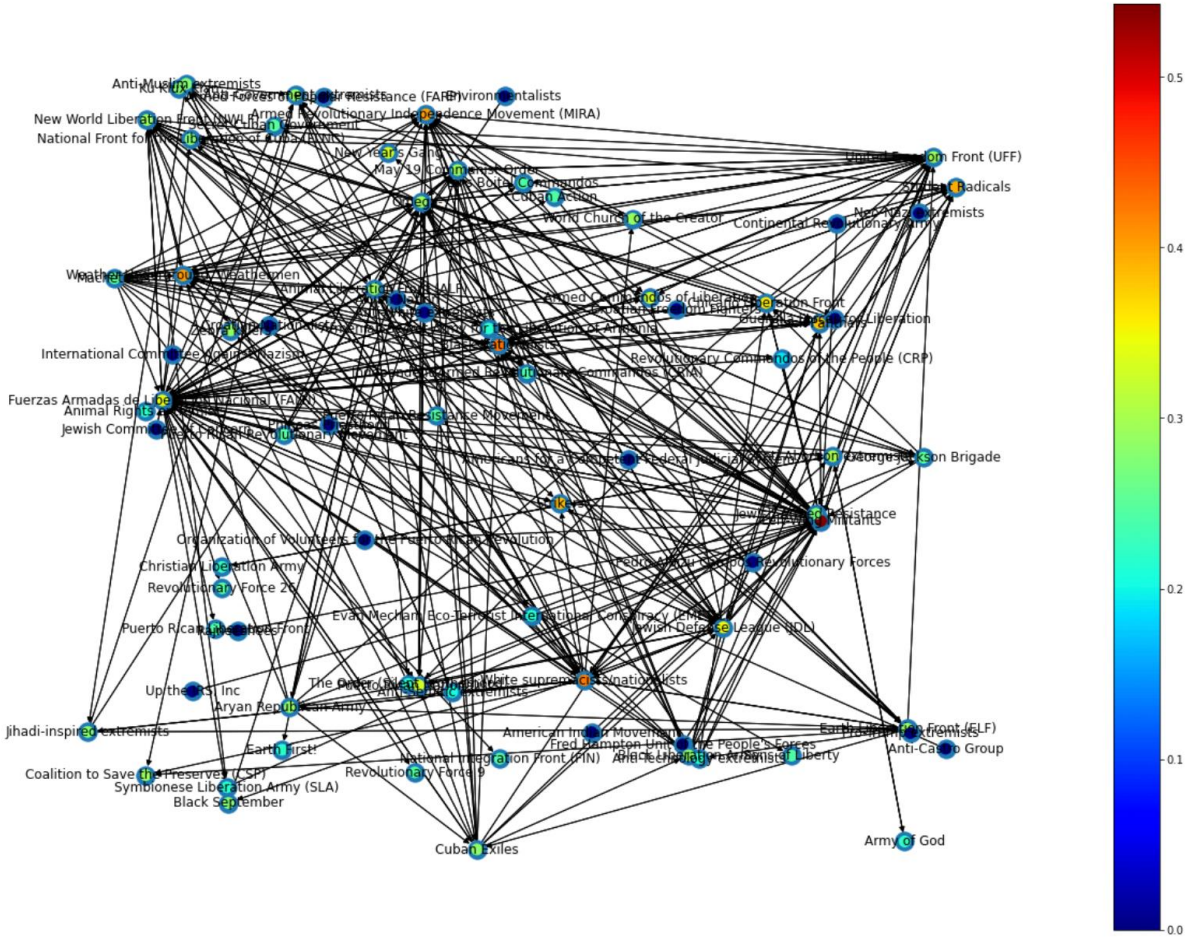


Closeness centrality for the groups

- Range of values of closeness: 0.54299 to 0

- Top 5 influential groups in order of closeness centrality:

Group name	Closeness centrality
Left-Wing Militants	0.54299
White Supremacists/Nationalists	0.42735
Jewish Defence League	0.42343
Black Nationalists	0.40486
Weather Underground, Weathermen	0.40134



Maximum relaxed-star found in the graph

Formulation:

- Data:
  - H (V, E) – Graph with terrorist groups as vertices and number of events they influence as edge weight
  - λ – Constant limiting the number of connections between leaves

- Variables:
  - x_i = {0,1}, 1 if the node is the center of the star, 0 otherwise
  - y_i = {0,1}, 1 if the node is a leaf, 0 otherwise
  - k_{ij} = {0,1}, 1 if connection (i, j) is allowed between leaves, 0 otherwise
  - w_{ij} = {0,1}, linearisation term used in Fortet's linearisation

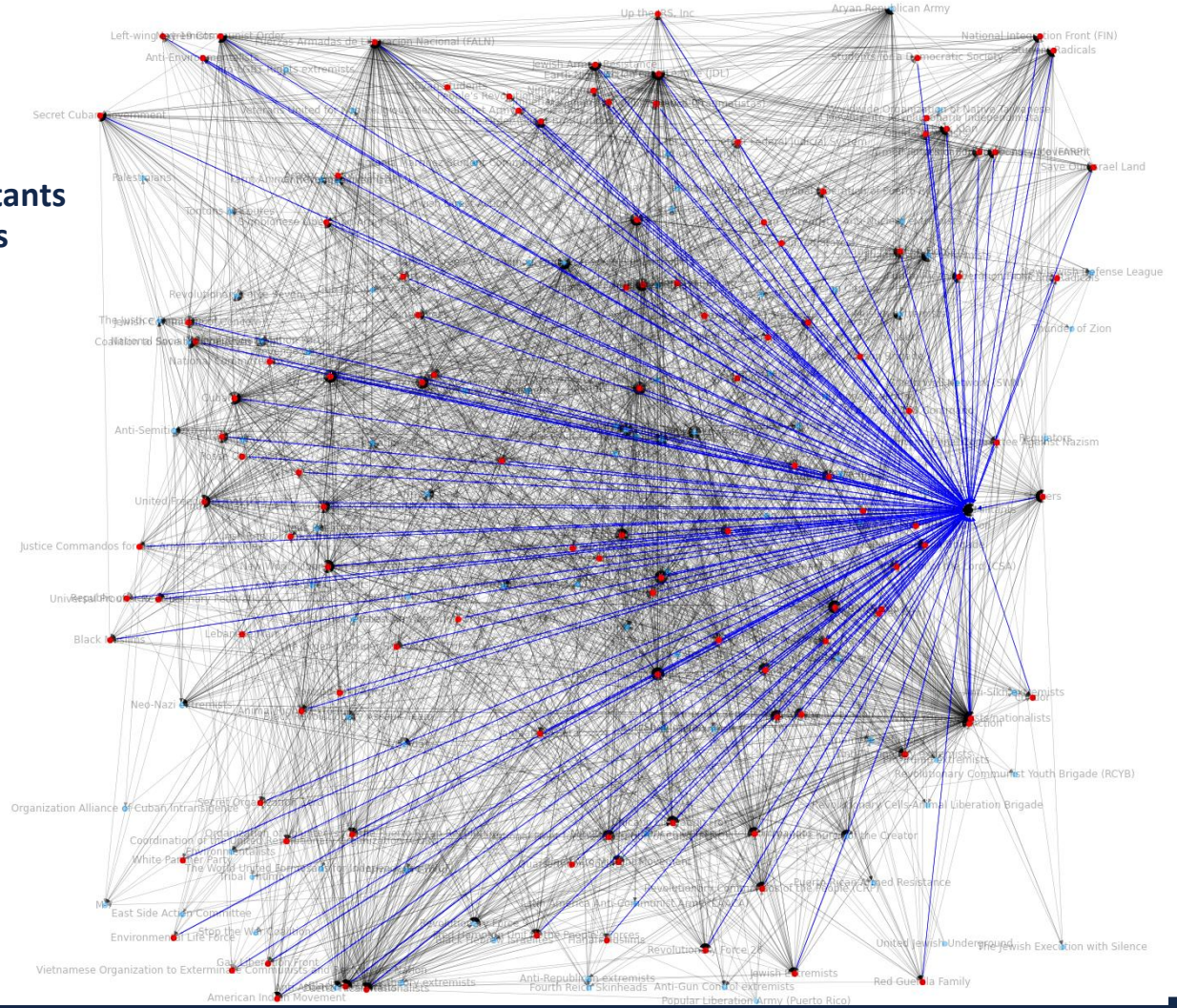
Maximum relaxed-star found in the graph

Formulation: Objective: Maximize $\sum_{i \in V} x_i$

- Constraints:
  - $\sum_{i,j \in V} k_{ij} \leq \lambda$
  - $w_{ij} \leq yi$ for all i, jϵ V
  - $w_{ij} \leq yj$ for all i, jϵ V
  - $w_{ij} \geq yi + yj - 1$ for all i, jϵ V
  - $k_{ij} \leq wij$ for all i, jϵ V
  - $y_i \leq \sum_{i,j \in E} x_j$ for all $i\epsilon$ V
  - $\sum_{i \in V} x_i = 1$

Legend

- **Central Node – Left-Wing Militants**
- **Leaf Nodes – Influenced Nodes**
- **Star Edges**
- **Other Edges**



Maximum relaxed-star found in the graph Final Outcome

- Maximum relaxed star obtained with **Left-Wing Militants** as the center (Interestingly, this has the maximum closeness centrality as well!)
- Allowed relaxation of the star = 20
- Blue node - center of the star
- Red nodes – leaves of the star
- Blue edges – star edges between center and leaves
- Green edges – Relaxed edges allowed between leaves