Decoding the Black Box

Interpretable Methods for Post-Incident Counter-terrorism Investigations

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Agenda

1. Understand the challenges of terrorism and Post-Incident Investigation
2. Explain how machine intelligence has the capability to assist humans
3. Discuss and propose the solutions to make machine decisions human understandable
4. Challenges, Opportunities, and, Future Scope

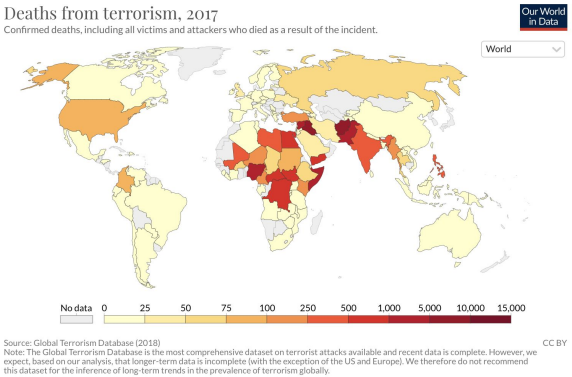
Introduction

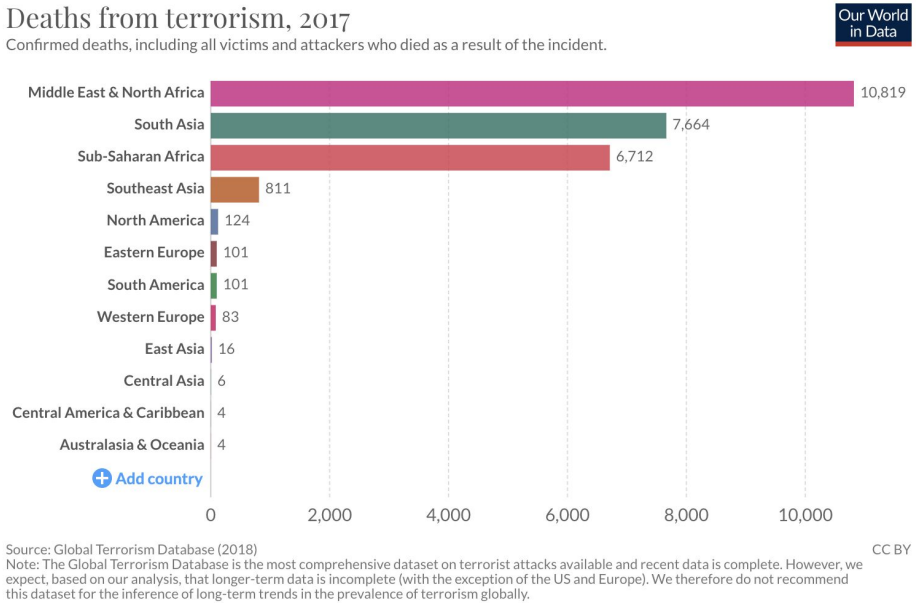
Terrorism is a global challenge

Terrorism and terrorist threat is dynamic and live

Over the past decade, terrorists killed an average of 21,000 people worldwide each year. ↓ jump to section

The global death toll from terrorism over the past decade ranged from 8,000 in 2010 to a high of 44,000 in 2014.





Introduction

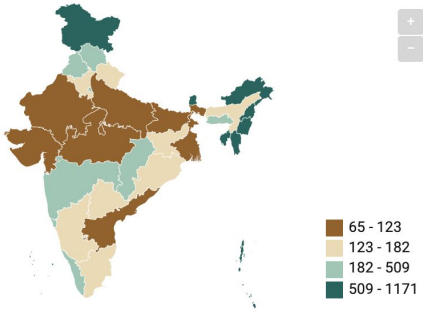
Policing in a developing world

Policing in the Indian context suffers from the dual challenge of manpower and technology shortage

While 47,000 police personnel are involved in VVIP security, the country faces a **shortage of 500,000 policemen**

Police departments in Hindi belt are extremely understaffed

Police officers per 100,000 people



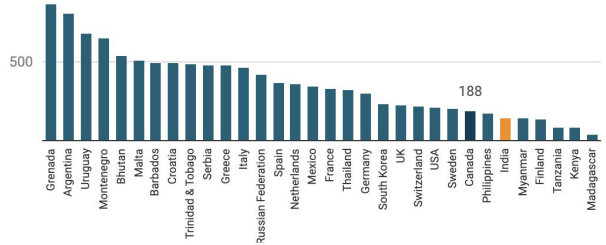
Actual strength of state police in 2017 was calculated as proportion of state's expected population in 2017. The population in 2017 is estimated using state population growth rate between 2001-2011.

Source: Data on Police Organisation 2017, Census 2001, Census 2011 • Get the data

Data from the United Nations Office on Drugs and Crime (UNODC) shows that in 2013, India's ratio of **138 police personnel per 100,000 of population** was the fifth lowest among the 71 countries

India's police force is among the most understaffed in the world

Police officers per 100,000 people



Police estimates from the years of 2015-2017 available for these countries. Population estimates for countries from the United Nations Population Division.

Source: United Nations Office on Drugs and Crime, Data on Police Organisations 2017, UN Population Division

Introduction

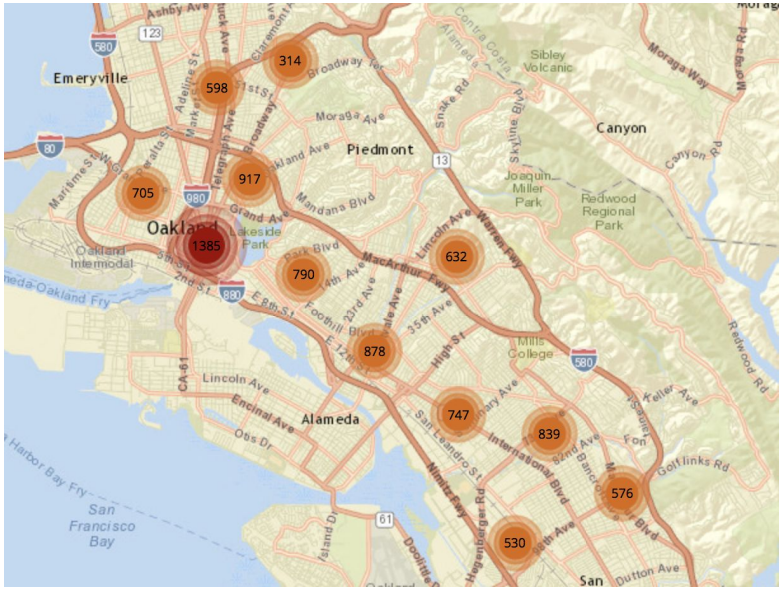
Technology is the solution

Technology has the ability to raise the policing capabilities in the developing world while the economies still struggle to raise manpower. The use of technology across a broad spectrum of policing requirements is already visible-

a) Predictive Policing
b) Intelligent Surveillance
c) Intelligent Case Management
d) Smart Training

Are just some examples, to name a few.

However, most of the modern intelligent systems are artificial intelligence powered and data driven. And data is the new oil.



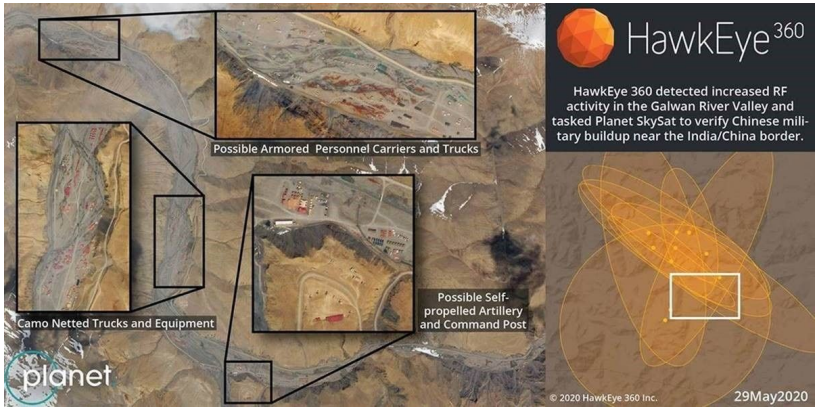
Going Open Source for Data

Hunt for inexpensive data

Open source data is the new normal. New providers and competitive market has also improved accessibility (better access to internet at inexpensive prices) and affordability (cheap to acquire)

While the Open Source Intelligence remained neglected for decades, it has acquired its own space in the contemporary world.

According to the United States Department of Defense, "**Open Source Intelligence is produced from publicly available information that is collected, exploited, and disseminated in a timely manner to an appropriate audience for the purpose of addressing a specific intelligence requirement**"



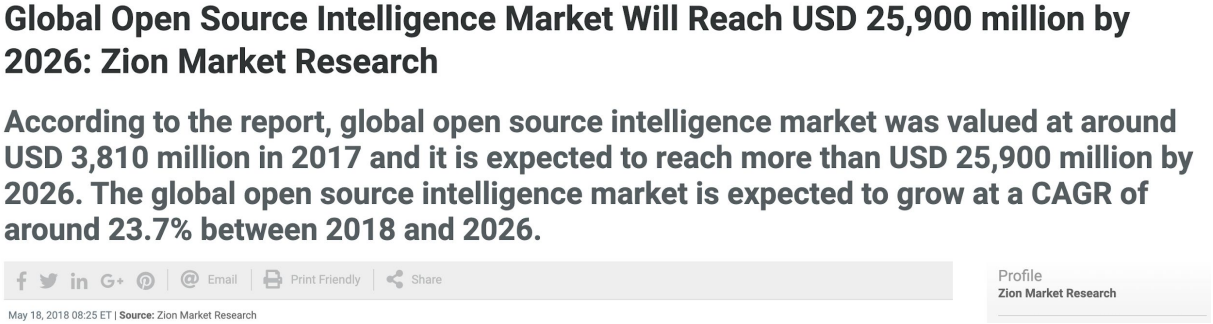
Recently, open source satellite imagery data provided by the Planet Labs © has been extensively used by the media houses, academic, military and strategic experts in analysing the situation on the ground during the 2020 India-China Standoff

The future of Open Source Data

Investing in a safe future with assured returns

In fact, die to the non clandestine nature of acquisition of open source data, open source intelligence Market is growing and so is the need to leverage this intelligence. The major advantages offered are-

- Inexpensive
- Fast
- Easy to process



Global Open Source Intelligence Market Will Reach USD 25,900 million by 2026: Zion Market Research

According to the report, global open source intelligence market was valued at around USD 3,810 million in 2017 and it is expected to reach more than USD 25,900 million by 2026. The global open source intelligence market is expected to grow at a CAGR of around 23.7% between 2018 and 2026.

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May 18, 2018 08:25 ET | **Source:** Zion Market Research

Profile
Zion Market Research

Open Source Intelligence and Counter Terrorism

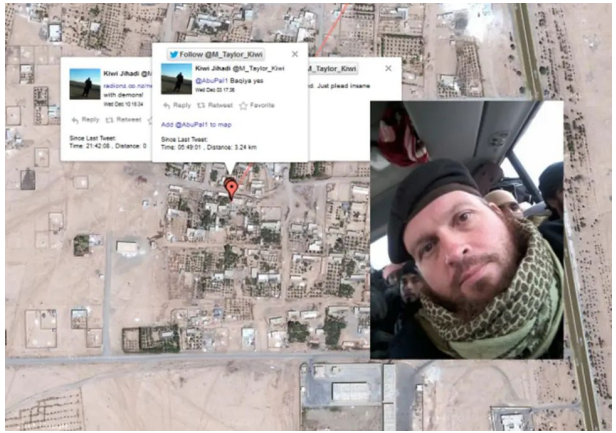
Countering terrorists in modern warfare

Intelligence agencies strive to have round the clock data on everything happening under their jurisdiction. In the context of countering terrorism and terrorist threat, the major priorities, to name a few, are to receive intelligence about-

a) Detecting potential threats
b) Countering radicalisation
c) Investigating incidents

Essentially, any intelligence received for any objective mentioned above can be primarily divided into-
a) **Pre-incident intelligence**: aims at thwarting an incident from its occurrence;
b) **Post-incident intelligence**: aims at advancing the knowledge

In this work, our attention will be how the open source intelligence can be utilised to obtain credible intelligence for post-incident intelligence to support major terrorist investigations



Demonstration image: New Zealand born jihadist accidentally tweeted his location from Syria. United States Air Force Intelligence had extensively hunted for locating potential ISIS targets for airstrikes using such geolocation information.

Using Open Source Intelligence for Suspicion

Learning to suspect for post-incident investigation

Most of the post incident investigation revolves around pointing suspicion.

Some of the major grounds based on which suspect is recognised are dependent on Modus Operandi-

- Geolocation
- Timestamp
- Weapons profile
- Attack profile
- Target Profile

Suspicion is raised based on historical information and trends about individual terrorist outfits.

For e.g. Jaish-e-Mohammad (JeM) is famous for carrying out suicide attacks

Suspected JeM terrorist arrested from Haryana

The police received an information on Friday evening from J&K military intelligence and Punjab Police that a suspected militant of JeM was passing through Ambala in an apple-laden truck going towards Delhi

CHANDIGARH Updated: Sep 29, 2019 00:17 IST

PTI
Hindustan Times, Chandigarh

THE NEWSWIRE NATIONAL | INTERNATIONAL | BUSINESS | SPORT |

26 FEBRUARY 2012 Last Updated at 5:11 PM | NATIONAL

'IM Suspected to Be Behind May Delhi HC Blast'

NEW DELHI

Mail Print AAA INCREASE TEXT SIZE

Banned Indian Mujahideen terror outfit is suspected to be behind the low intensity blast outside the Delhi High Court in May last year.

The NIA, which took over the probe in December last year after the Special Cell of Delhi Police failed to make any headway, has got some leads to suggest that the blast on May 25 last year was a handiwork of the banned terror outfit, official sources said.

Lashkar/JeM terrorists suspected to be behind attack

Tehrik-e-Kasak pamphlets found on the body of the slain terrorists at Swaminarain temple may have been a red herring thrown in by the jehadi outfits.

TNN | Last Updated: Sep 26, 2002, 01.12 AM IST

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0 Comments

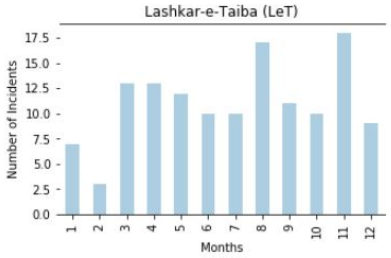
A+

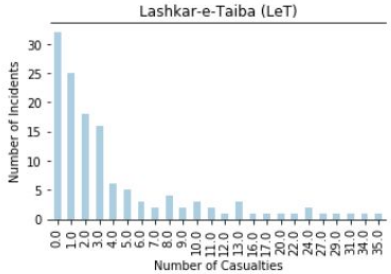
This realization arises from the fact that the two dreaded outfits, which have carried out sensational acts of terror, have re-badged themselves and, quite uncharacteristically, refrained from owning up actions which are unmistakably theirs. The assessment, Union government officials told The Economic Times, was reached after analysing the modus operandi and weapons used by the terrorists to carry out the temple attack. In their opinion, these clearly bore the trademark of the LeT and JeM, both well versed in carrying out fidayeen attacks on civilian targets.

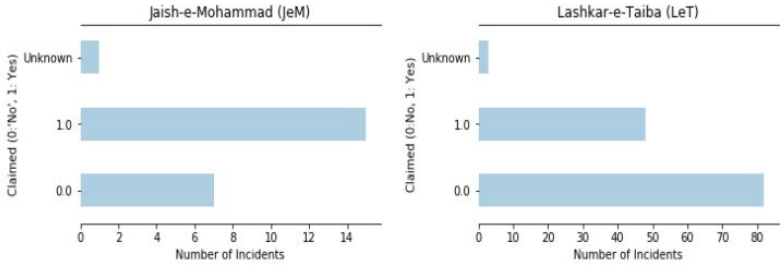
Every terrorist outfit leaves signatures

Knowing our operating environment and actors

Different terrorist outfits have different operating patterns. It is these operating patterns that experts learn over the time to determine if a particular group has been involved in an incident or not.







For example,

Operating patterns in case of Lashkar-e-Taiba could be compared to those of Jaish-e-Mohammad. Jaish is a group more actively known for claiming the incidents as compared to Lashkar. It speaks volumes about its ideology.

Similarly, Lashkar has attempted most of the attacks with zero casualties as an outcome.

It allows to conclude that Lashkar is more interested in political achievements than mere publicity.

Curating a dataset to collect signatures

Leveraging data for generating intelligent intelligence

We have collected a set of **18 features (coming from the Global Terrorism Database, 2017)** and building models to learn about the patterns from the terrorist outfit operations.

The following image provides a snapshot of the dataset that we curated which corresponds to the incidents performed by Lashkar-e-Taiba

gname	iday	imonth	extended	attacktype1_txt	success	suicide	city	districts	weaptype1_txt	weapsubtype1_txt
Lashkar-e-Taiba (LeT)	1	4	0	Bombing/Explosion	1	0	Udhampur district	Udhampur	Firearms	Automatic Weapon
Lashkar-e-Taiba (LeT)	13	7	1	Hostage Taking (Kidnapping)	1	0	Madar	Bandipore	Explosives/Bombs/Dynamite	Grenade
Lashkar-e-Taiba (LeT)	15	8	0	Bombing/Explosion	1	0	Chenani	Udhampur	Explosives/Bombs/Dynamite	Land Mine
Lashkar-e-Taiba (LeT)	3	11	0	Armed Assault	1	0	Srinagar	Baramula	Firearms	Automatic Weapon
Lashkar-e-Taiba (LeT)	15	12	0	Bombing/Explosion	1	0	Dungiwatcha	Baramula	Explosives/Bombs/Dynamite	Grenade

The main reason behind using data driven intelligent intelligence is to **avoid differing perceptions and human bias**. The list of right is the list of features used to learn about terrorist outfits.

gname: group responsible,
iday: day,
imonth: month,
iyear: year,
extended: extended,
success: success,
suicide: suicide,
city: city,
districts: districts,
weaptype1_txt: weapon type,
weapsubtype1_txt: weapon subtype,
targtype1_txt: target type,
targsubtype1_txt: target subtype,
attacktype1_txt: attack type,
nkill: kill count,
claimed: claimed,
claimmode_txt: claim mode,
property: property,
propextent_txt: damage extent,
INT_ANY: international

Measuring signatures of terrorist outfits

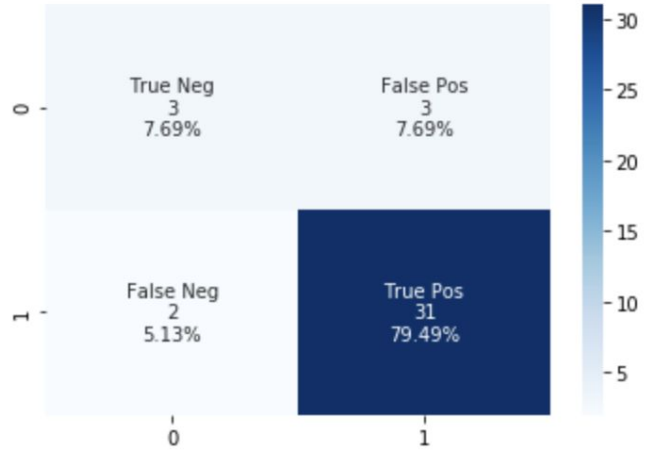
Using machine learning to learn about terrorist modus operandi

Based on a simple model built built using **Random Forest Algorithm** using a set of **18 features (coming from the Global Terrorism Database, 2017)** and the name of the extremist outfit as the label to train the model, our model achieved an accuracy of 85.45% on the validation set

- There were two terrorist outfits used for modelling purposes- Lashkar-e-Taiba and Jaish-e-Mohammad. These are also the classes used for building the classifier. Class 0 corresponds to Jaish-e-Mohammad and Class 1 represents Lashkar-e-Taiba
- Models were not tuned and we used the base model which achieved aforementioned accuracy

In the next steps, we will discuss how this method aligns with the decision making of human investigators about the suspected involvement of a terrorist outfit in an incident.

	precision	recall	f1-score	support
0	0.50	0.60	0.55	5
1	0.94	0.91	0.93	34
accuracy			0.87	39
macro avg	0.72	0.76	0.74	39
weighted avg	0.88	0.87	0.88	39



Explaining the signatures

Making machines explainable and accountable

Machine learning models often perform complex computations to fit the decision boundary. These computations are sometimes in extremely high dimensions which cannot be graphically represented for the sake of human inspection. In this sequence, the set of methods used to explain the decisions of such models are called ‘Interpretability Methods’. These are primarily divided into-

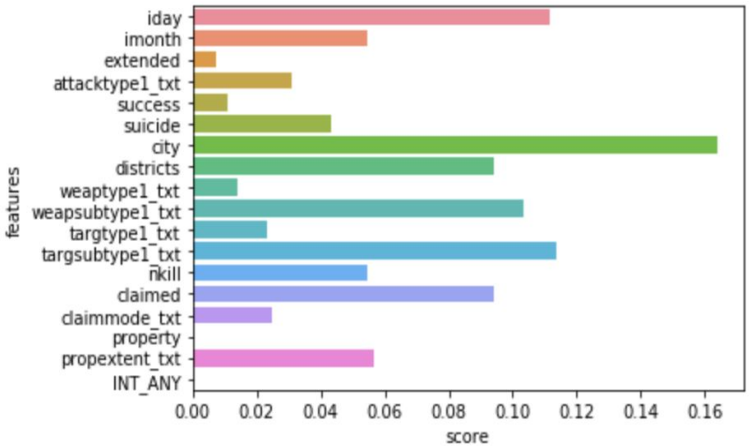
a) **Global Interpretability Methods**: the objective is to obtain a ranking of features in decreasing order of their significance to describe their relative importance considered by the model while learning from the data.

b) **Local Interpretability Methods**: the objective is to obtain instance level explanations for the decision i.e. how and why a particular is classified into a specific class.

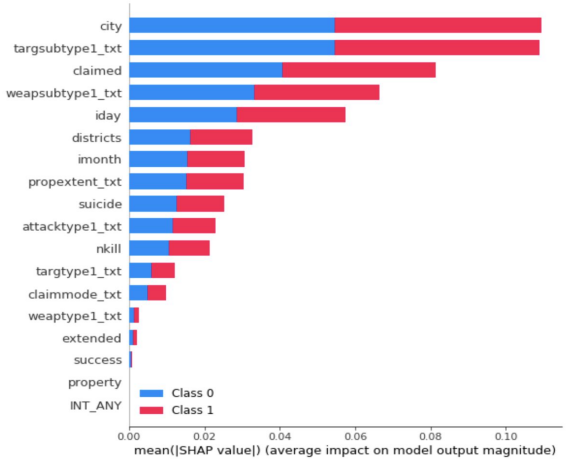
Global Explanations

Making machines explainable and accountable

Based on the feature significance of the random forest model, we can conclude that the model on an average considered the **'city' as the most important feature** followed by 'target subtype', 'day of the incident', 'weapon subtype' as the top most features.



The validity of the model's chosen features can be verified by ranking features considered using Shapley values. We can clearly observe that 'city', 'target subtype' and 'weapon subtype' are in the top most features.



Global Explanations

Making machines explainable and accountable

The significance of a geolocational feature like ‘city’ from the perspective of human investigators is easy to comprehend. Often attacks by terrorist outfits cluster around some specific locations where there logistics and overground support is strong.

Guns ‘n’ poses: The new crop of militants in Kashmir

They are young, educated and wealthy. And they love wielding their guns for the camera. Bashaarat Masood on the new crop of militants in the Valley. Photographs by Shuaib Masoodi

Written by **Bashaarat Masood** | Updated: July 26, 2015 7:37:58 am

The north-to-south shift also tells the story of homegrown militancy. Earlier, north was the base because the two major infiltrating frontiers for Pakistani militants, Kupwara and Handwara, are in the north. The local militants need not go that far, and have set up base in south Kashmir, especially in Pulwama, Shopian and Kulgam districts. Tral, a town in Pulwama and a stronghold of Hizbul Mujahideen, has emerged as a major base of the new militants.

OPINION, OP ED

AAKAR PATEL

Aakar Patel is a senior journalist and columnist

India must calibrate response to Jaish

Published Feb 17, 2019, 2:26 am IST **Updated** Feb 17, 2019, 2:26 am IST

The Jaish is a Pakistani entity and its recruits are mostly rural Punjabis. It is much smaller than Lashkar-e-Tayyaba and has a different ideology. The suicide bombing is not preferred by LeT because in its particular belief of Islam, which is called Salafi, suicide is a grave sin.

Similarly, the other features like preferred target or weapons also determine to a large extent the signatures of extremist outfits. For example, Jaish-e-Mohammad is notorious for its suicide bombings while most of the attacks by Lashkar-e-taiba were mostly armed attacks in nature.

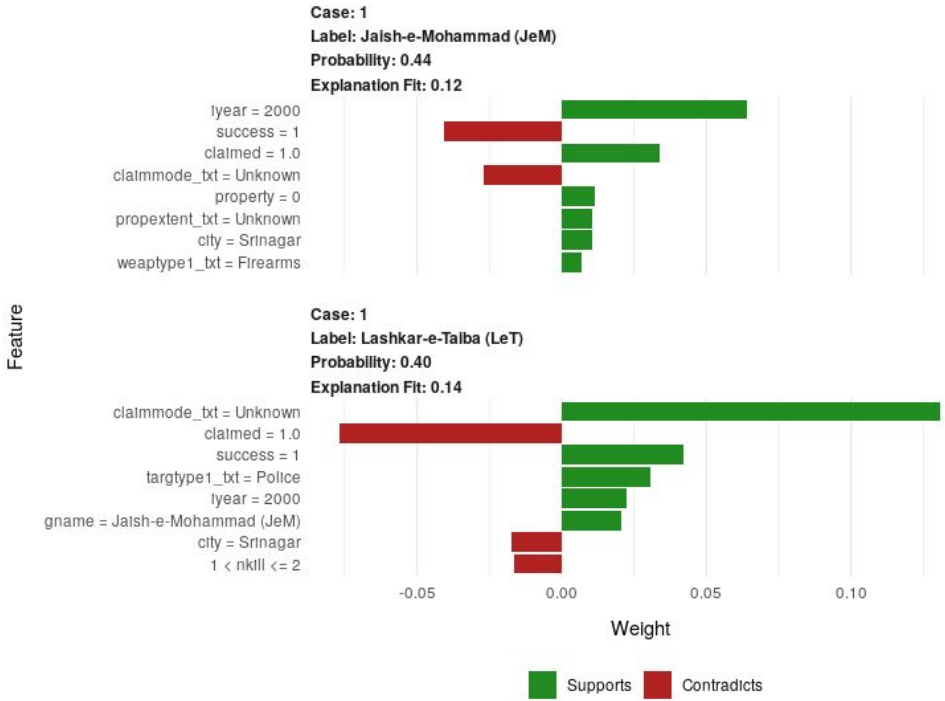
Local Explanations

Explaining the case of Jaish-e-Mohammad

The idea of interpreting a machine learning model locally is based on the requirements to understand **why a particular data point is classified into a particular class** if the problem is about classification. We used the Local interpretable **model**-agnostic explanations (**LIME**) framework for explaining he decisions of the model at the instance level.

For example, the image at the right describes the predicted perpetrator as Jaish-e-Mohammad with a probability 0.44 which is true as per ground truth. The major features contributed to the decision are-

a) **Year**: The year of the incident is 2000. Often terrorist groups have a tendency to go dormant for a few years became active in later ones.
b) **Claimed**: Jaish-e-Mohammad is more vocal while claiming its attacks as compared to others



Local Explanations

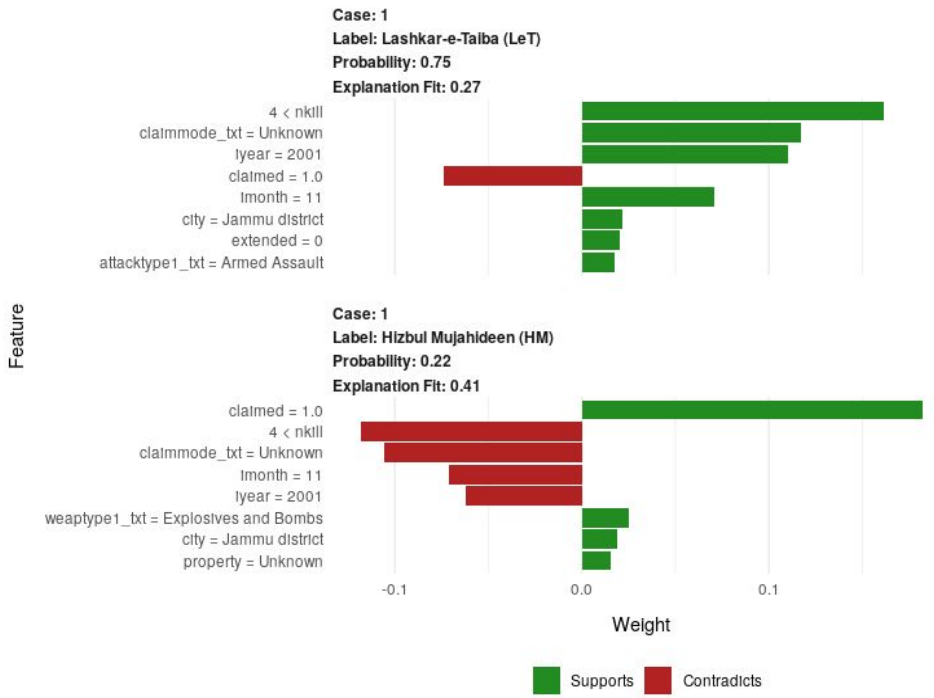
Explaining the case of Lashkar-e-Taiba

Similarly, we have tried to explain a specific instance where our model predicted Lashkar-e-Taiba as the perpetrator. In this case, we can observe that the most important features that contributed to the decision are-

a) **Kill count**: Most of the attacks orchestrated by this outfit are armed assaults using firearms and not bombing or explosive campaigns like that of Jaish-e-Mohammad. Therefore, the casualty count is fairly low.

b) **Year**: The year is 2001 and we have enough reasons to conclude that Jaish remained less active during the years after 2000 after it successfully hijacked the Indian flight IC-814 on 24th December 1999.

Although while the incident frequency dropped, the Jaish-e-Mohammad was successful in making an impact with more deadly incidents as it attacked the Indian Parliament on 13th December, 2001



Local Explanations

Explaining the case of Lashkar-e-Taiba

Jaish-e-Mohammed: Terror outfit once crushed in Kashmir, now in revival effort

Jaish is the newest terror group operating out of Pakistan; it was launched in 2000 with men from the Harkat-ul-Ansar which had already carried out major terror strikes in Kashmir.

By: **Express News Service** | New Delhi | Updated: February 27, 2019 8:32:20 am

Then Pakistan President Pervez Musharraf, under international pressure, launched a crackdown. Pakistan banned Jaish in 2002, but Azhar renamed Jaish as Khudam-ul Islam and then as Al Rehmat Trust as a cover for terror activities.

The killing of the entire Jaish top brass in Lolab in 2004, after Indian intelligence sleuths lured them into a trap, routed the outfit in Kashmir. The group didn't emerge for the next 10 years.

Its revival began with a strike on a military camp in Kupwara in 2014, and the launch of 'Shaheed Afzal Guru fidayeen' squads. Major attacks include those in Pathankot and Uri in 2016.

"Pakistan-based militants hijacked Indian Airlines flight IC-814 to Kandahar and secured the release from Indian jails of three top militants including Maulana Masood Azhar, a designated court in Patiala today sentenced three persons to life in jail, holding them guilty of murder and conspiracy with the hijackers.

Challenges, Opportunities and Future Scope

Making machines explainable and accountable

Every data driven system comes at a cost. In this case, there are multiple costs to pay in terms of-

1. Privacy and Security
2. Fairness and Bias Correction
3. Interpretability and Transparency
4. Governance, Accountability and Legal Frameworks
5. Human Resources and Finance

There are enormous opportunities in terms of-

1. Complete automation of intelligence cycle to release additional manpower for gathering human intelligence
2. Human-in-the-loop based smart decision systems with significant accountability

And many more!

Questions?

Together we can make it safer!