DARTMOUTH

Institute for Security Technology and Society at Dartmouth

Predicting and Reshaping Boko Haram's Behavior

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Boko Haram exploded into the front pages of world newspapers in April 2014 with the deadly kidnapping of 276 schoolgirls in Chibok, Nigeria. Well-known to military organizations, intelligence agencies, and counter-terrorism researchers well before then, this horrific deed made their deeds known to the common man.

A 3.5 year Dartmouth College-led effort is the first ever predictive model of Boko Haram's behavior – one that not only has made monthly predictions about Boko Haram's attacks 6 months into the future from January 2019 onward, but also developed data-driven, computationally discovered policies that can help reshape their behavior and mitigate future attacks.

Our predictive model of attacks by Boko Haram is the first ever use of machine learning methods to predict and reshape Boko Haram's behavior.

Our work on this model includes four broad techniques: first, we developed a 9 year data set containing 148 variables about both Boko Haram's activities and the prevailing socio-cultural-military-political environment in which they operated. Second, we automatically extracted easy to explain temporal probabilistic (TP) rules to explain various kinds of attacks carried out by Boko Haram. We have been generating actual predictions of attacks by Boko Haram every month since January 2019. Finally, we developed methods that use the predictive models to shape behaviors against Boko Haram.

Our Boko Haram Data

We have collected over 11 years of monthly data about Boko Haram starting from January 2009 when the Boko Haram insurgency began to the current day. The data includes variables for various kinds of attacks carried out by Boko Haram. Examples of attacks include abductions (such as those of the Chibok schoolgirls) to suicide bombings to sexual violence and more. In addition, for each month, we collected data about phenomena occurring within the ecosystem within which Boko Haram operates. These include law enforcement/military variables, e.g. whether there are ongoing arrests or kills of Boko Haram personnel, asset freezes, shutdowns on Boko Haram locations. Other types of variables refer to Boko Haram's operations such as the use of child soldiers and foreign membership in Boko Haram operations. Government related variables include information on ongoing negotiations between Boko Haram and the Nigerian Government. And international variables examine whether Boko Haram was designated an international terror organization and whether foreign military aid to the Nigerian military was suspended or not.

Temporal Probabilistic Behavioral Rules

The Dartmouth team extracted "temporal probabilistic" (TP) rules about Boko Haram's behavior from 8 years of data. A TP-rule has the form: "when condition *C* holds in the environment in which Boko Haram operates, then Boko Haram takes action *A* *m* months into the future". *A* is either the presence or absence of a type of attack and our TP-rules apply 1-6 months into the future.

The extracted TP-rules showed that there is no single variable that is capable of predicting attacks by Boko Haram. However, various combinations of the following variables show a strong connection to attacks of different types by Boko Haram in the over the next 1-6 months: arrests and executions of Boko Haram personnel (usually by the Government of Nigeria), whether Boko Haram members are on trial or not, shutting down of Boko Haram locations by the Government of Nigeria, forcible resettlement of civilian populations, whether the Government of Nigeria has closed borders or not, information about the membership of Boko Haram, and foreign actions such as suspension of military aid from foreign governments to Nigeria and or whether Boko Haram was designated an international terror organization.

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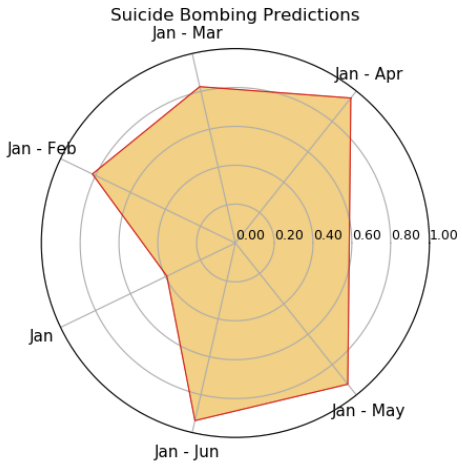
Live Forecasts

Since Jan 2019, the Dartmouth team has been generating a forecast report at the beginning of every month about predicted Boko Haram activities over the next 6 months. The figure below shows a sample graph of about suicide bombings predicted on Dec 31 2020 for the next 6 months. The figure shows, for instance, that there will be at least one suicide bombing with over 80% probability in the Jan-Feb 2021 time frame and this probability climbs to over 90% if the temporal granularity is weakened to the Jan-April 2021 time frame.



The Dartmouth team has monitored these forecasts for over 2 years now and the predicted accuracy (measured via Precision, Recall, F1-Scores and AUCs) have been consistently high when used for out-of-the-lab forecasts. The actual performance measures of the forecasts vary with the type of action forecast and the prediction window (next month, sometime in the next 2 months,..., sometime in the next 6 months).

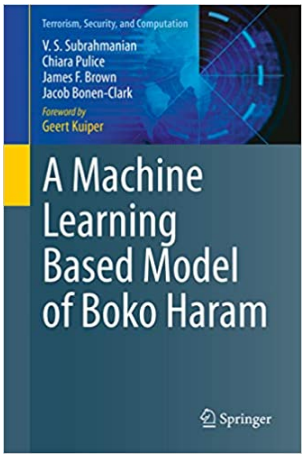
Reshaping Boko Haram's Behavior

The Dartmouth team has also developed methods to reshape the behavior of Boko Haram. Intuitively, a TP-rule contains a condition *C* that when true, predicts an attack with high probability during a given future time window (1-6 months). But because the way TP-rules are formally defined, they also predict that when condition *C* is false, the attack considered in the given time window will not occur.

Hence, one way to mitigate attacks by Boko Haram is to identify combinations of actions – that when implemented either by the Government of Nigeria or by the international community – will cause such "trigger" conditions *C* to be false. However, this is not always feasible – for instance, some conditions that are linked to Boko Haram actions are not either morally or ethically feasible. Our team has implemented an algorithm that combines combinatorial optimization methods (hitting set computations in particular) with logic in order to ensure that the probability of conditions that "trigger" an attack in the future are minimized. We have used this to generate policies that can help reduce attacks by Boko Haram.

References

V.S. Subrahmanian, C. Pulice, J. Brown and J. Bonen-Clarke. *A Machine Learning-based Model of Boko Haram*, Springer, Jan 2021.



https://www.amazon.com/Machine-Learning-Terrorism-Security-Computation-ebook/dp/B08QF8L5CM/ref=sr_1_1?dchild=1&keywords=Boko+Haram+%2BPulice&qid=1612114503&sr=8-1

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Boko Haram Analysis Website

https://dsaildartmouth.github.io/Boko-Haram.pdf

PARTICIPANTS

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