Measuring Territorial Control in Civil Wars Using Hidden Markov Models: A Data Informatics-Based Approach

Therese Anders
tanders@usc.edu
[corresponding author]

Hong Xu
hongx@usc.edu

Cheng Cheng
chen260@usc.edu

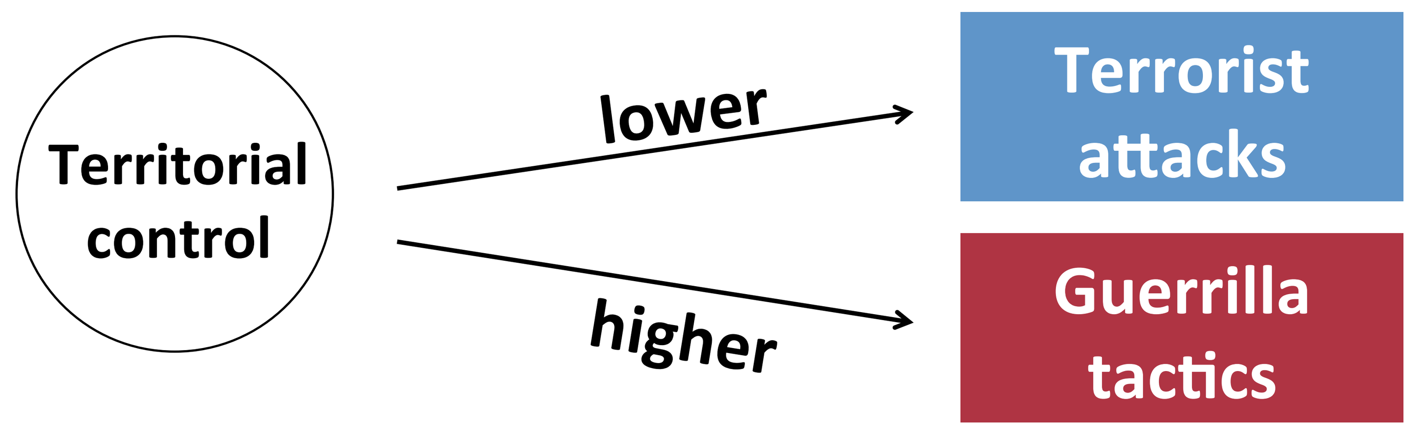
T. K. Satish Kumar
tkskwork@gmail.com

University of Southern California

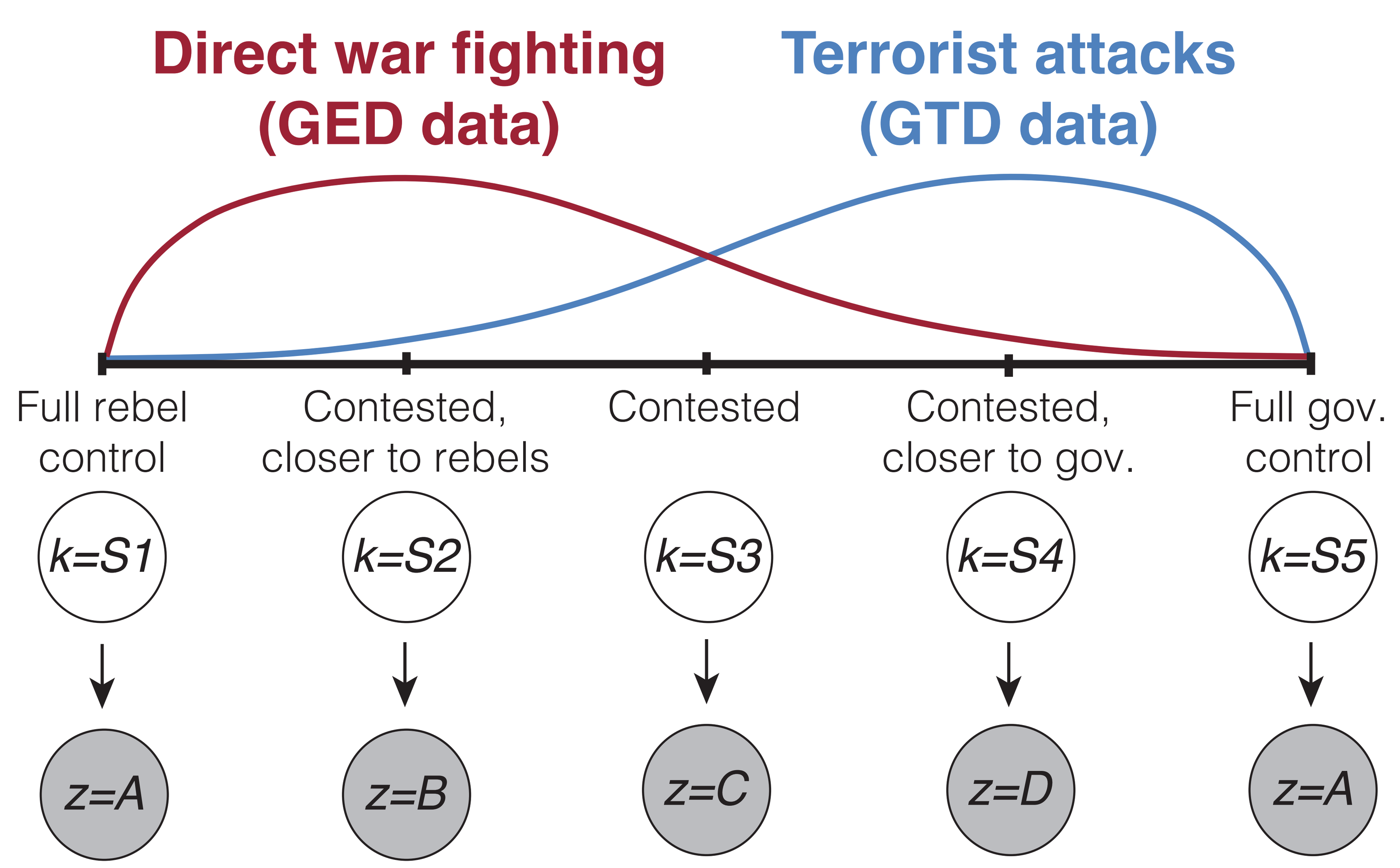
Introduction

We propose a theoretical model of the relationship between territorial control and tactical choice in civil war and outline how Hidden Markov Models (HMM) are suitable to estimate control within a machine learning framework. We discuss both challenges of using HMMs in this application and mitigation strategies for future work.

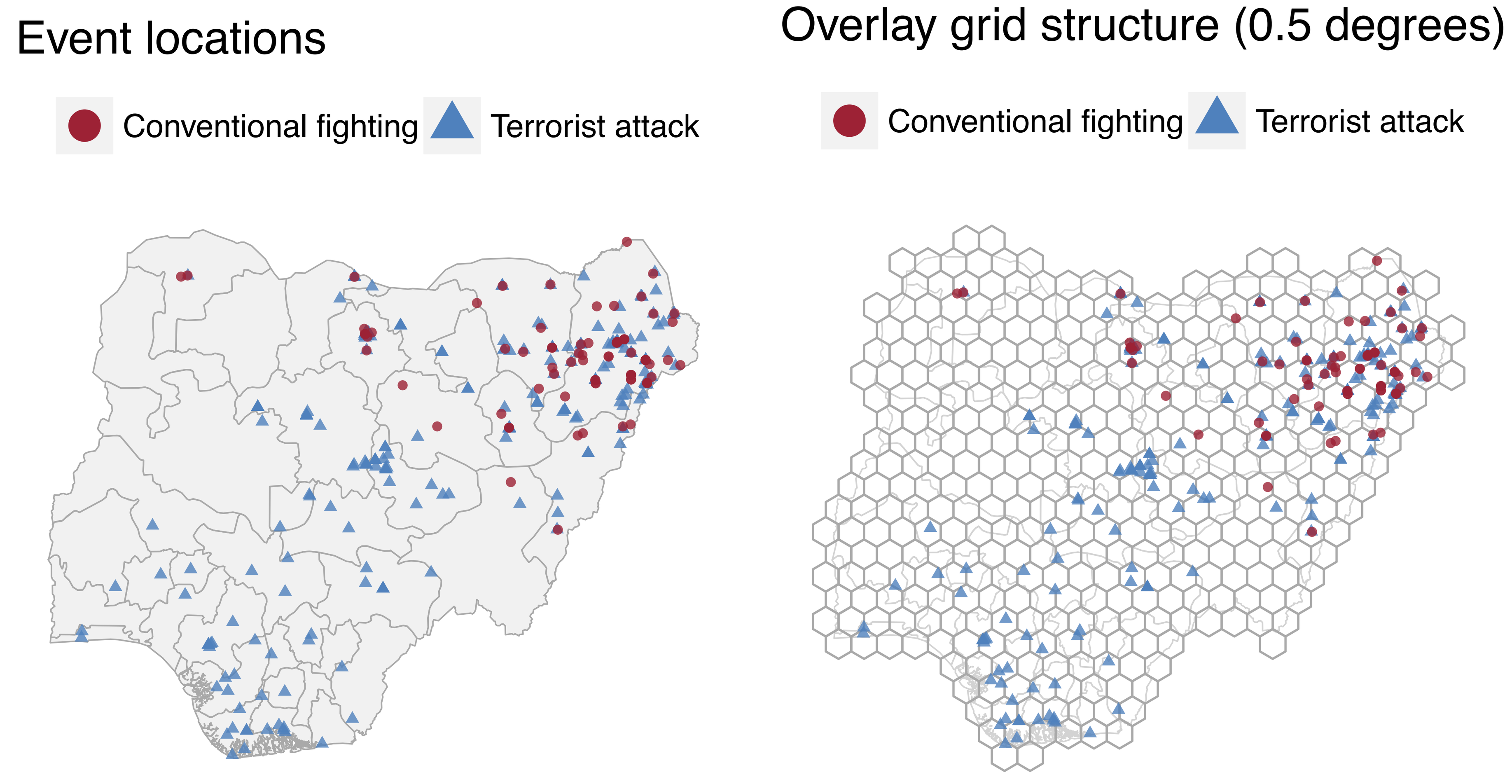
A theory of rebel tactics



Building on the existing literature, we use a function of the number of terrorist attacks (from the Global Terrorism Database, GTD) and conventional war acts (from the UCDP Georeferenced Event Dataset, GED) in each cell as an observable indicator for the underlying level of territorial control.

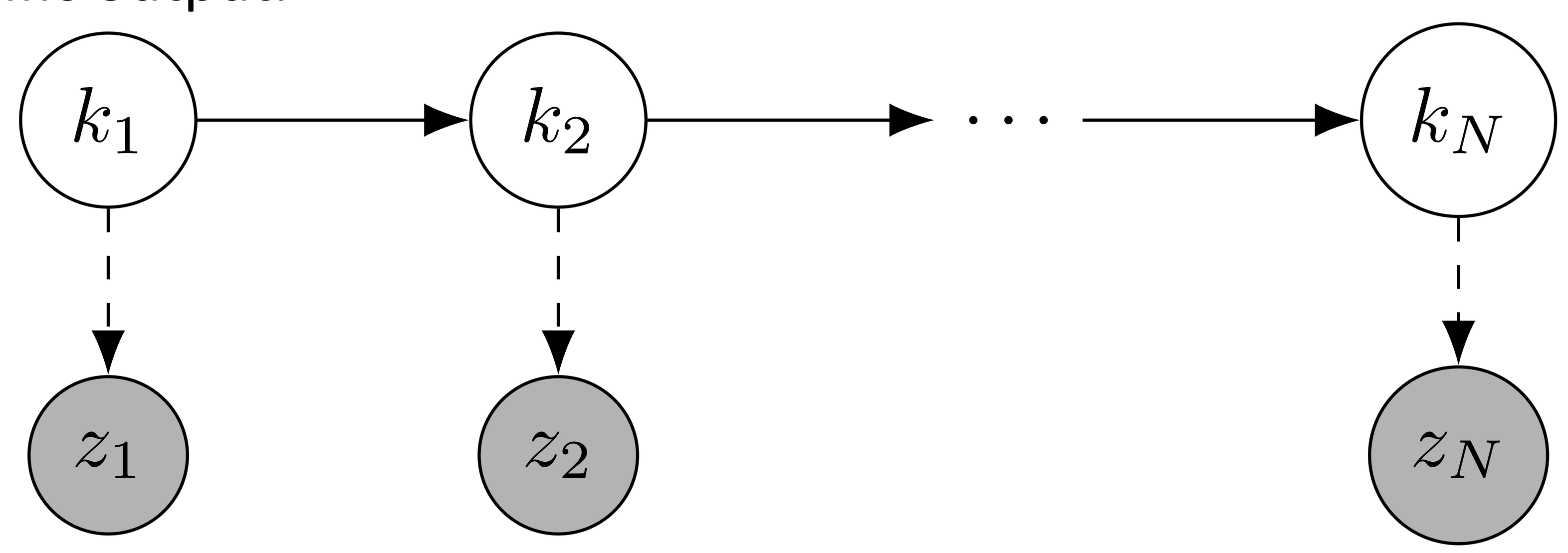


Here, we plot data from Nigeria in 2013:



Estimation

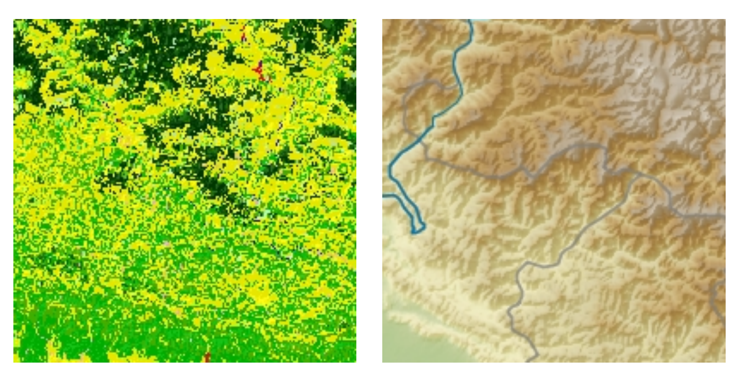
We employ a HMM for each cell. The *true* state k—the level of territorial control—is hidden and its evolution follows a Markov process. Each hidden state at year t produces an observable output z_t. Hidden states are linked by *transition probabilities*. *Emission probabilities* capture the likelihood of hidden states producing a specific output.



Challenges & mitigation

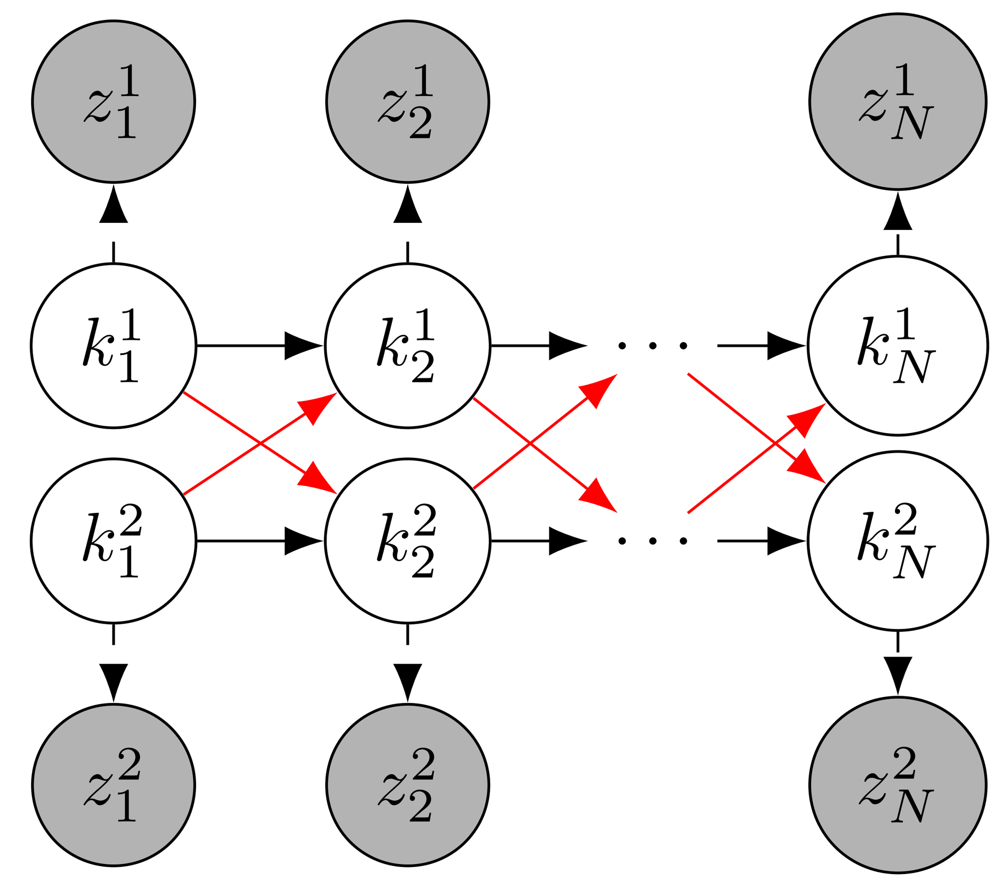
Covariates

We propose to leverage covariates by modeling the transition and emission probabilities to be perturbed by these factors, e.g. land cover or terrain.



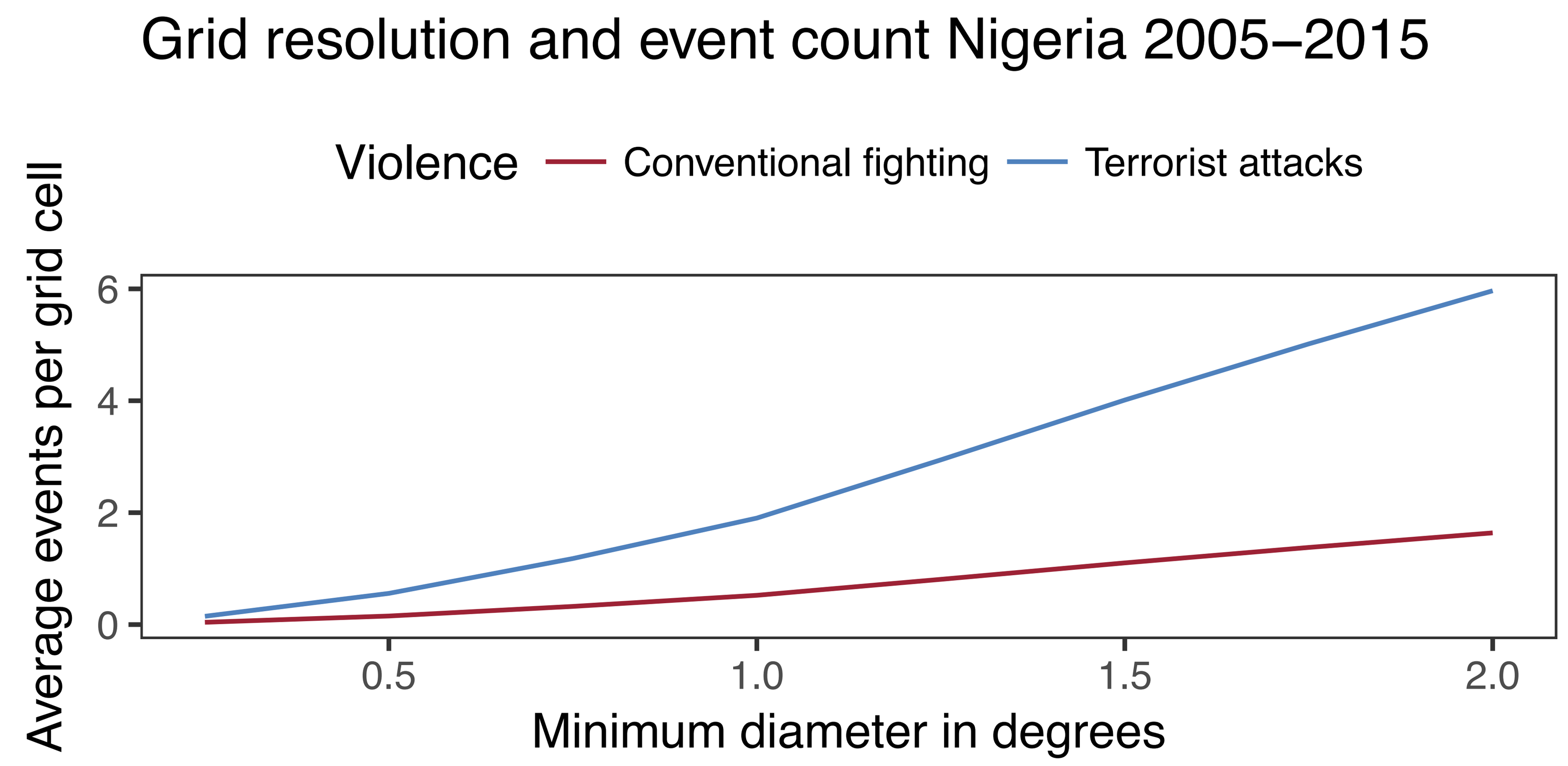
Spatial dependencies

To take the spatial correlation between cells into account, we propose to employ a Hidden Markov Random Field (HMRF) and solve utilizing Markov Chain Monte Carlo.



Grid resolution

In addition to the movable area unit problem, there is a trade-off between grid size and the number of events captured in each cell. We consider estimating the optimal size using simulated data.



Rare events

To account for conflict events being rare events, we assume them to be drawn from a Poisson, rather than a normal distribution.