

Detecting and Characterizing Events

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Abstract

Significant events are characterized by interactions between entities, such as, countries, organizations, or individuals, that deviate from typical interaction patterns. Analysts, including historians, political scientists, and journalists, commonly read large quantities of text to construct an accurate picture of when and where an event happened, who was involved, and in what ways. In this paper, we present the *Capsule* model for analyzing documents to identify and characterize events of potential significance. Specifically, we develop a model based on topic modeling that distinguishes between topics that describe “business as usual” and topics that deviate from these patterns. To demonstrate this model, we analyze a corpus of over two million U.S. State Department cables from the 1970s. We provide an open-source implementation of an inference algorithm for the model and a pipeline for exploring its results.

1 Introduction

Foreign embassies of the United States government communicate with one another and with the U.S. State Department through diplomatic cables. The National Archive collects these cables in a corpus, which traces the (unclassified) diplomatic history of the United States. The corpus contains, for example, over two million cables sent between 1973 and 1978.

Most of these cables describe diplomatic “business as usual,” such as arrangements for visiting officials, recovery of lost or stolen passports, or obtaining lists of names for meetings and conferences. For example, the embassies sent 8,635 cables during the week of April 21, 1975. Here is one, selected at random:

Hoffman, UNESCO Secretariat, requested info from PermDel concerning an official invitation from the USG RE subject meeting scheduled 10–13 JUNE 1975, Madison, Wisconsin. Would appreciate info RE status of action to be taken in order to inform Secretariat. Hoffman communicating with Dr. John P. Klus RE list of persons to be invited.

But, hidden in the corpus are also cables about important diplomatic events—the cables and events that are most interesting to historians, political scientists, and journalists. For example, during that same week, the U.S. was in the last moments of the Vietnam war and, on April 30, 1975, lost its hold on Saigon. This triggered the end of the war and a mass exodus of refugees. Here is one of the cables about this event:

GOA program to move Vietnamese Refugees to Australia is making little progress and probably will not cover more than 100-200 persons. Press comment on smallness of program has recognized difficulty of getting Vietnamese out of Saigon, but “Canberra Times” Apr 25 sharply critical of government’s performance. [...] Labor government clearly hopes whole matter will somehow disappear.

Our goal in this paper is to develop a tool to help historians, political scientists, and journalists wade through corpora of documents to find potentially significant events and the primary sources around them. We present *Capsule*, a probabilistic model for detecting and characterizing important events, such as the

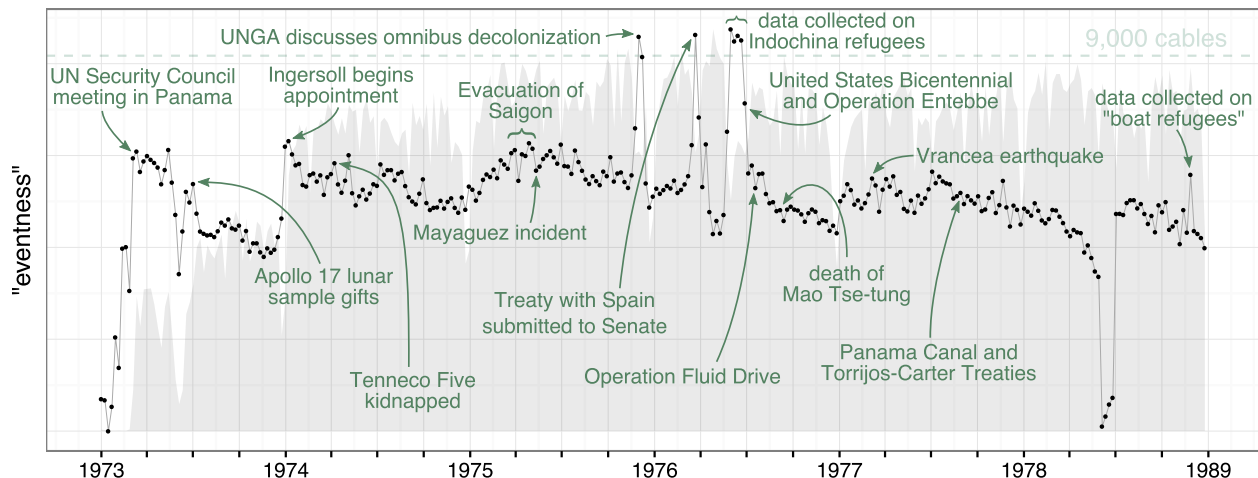


Figure 1: Measure of “eventness,” or time interval impact on cable content (Eq. 3). Grey background indicates the number of cables sent over time. This comes from the model fit we discuss in Section 4. Capsule successfully detects real-world events from National Archive diplomatic cables.

fall of Saigon, in large corpora of historical communication, such as diplomatic cables from the 1970s.

Figure 1 illustrates Capsule’s analysis of two million cables from the National Archives’ corpus. The y-axis represents “eventness,” a loose measure of how strongly a week’s cables deviate from typical diplomatic “business as usual” to discuss some matter that is common to many embassies. (We describe this measure of “eventness” in detail in section 3.)

The figure shows that Capsule detects many of the important moments during this five-year span, including the Air France hijacking and Israeli rescue operation “Operation Entebbe” (June 27–July 4, 1976), and the fall of Saigon (April 30, 1975). It also identifies other moments, such as the U.S. sharing lunar rocks with other countries (March 21, 1973) and the death of Mao Tse-tung (Sept. 9, 1976). Broadly speaking, Capsule gives a picture of the diplomatic history of these five years; it identifies and characterizes moments and source material that might be of interest to a historian.

The intuition behind Capsule is this: Embassies write cables throughout the year, usually describing typical diplomatic business, such as visits from government officials. Sometimes, however, important events occur, such as the fall of Saigon, that pull embassies away from their typical activities and lead them to write cables that discuss these events and their consequences. Capsule therefore operationalizes an “event” as a moment in history when multiple

embassies deviate from their usual topics of discussion and each embassy deviates in the same way.

Capsule embeds this intuition into a Bayesian model that uses latent variables to encode what “business as usual” means for each embassy, to characterize the events of each week, and to identify the cables that discuss those events. Given a corpus of cables, the corresponding posterior distribution of the latent variables provides a filter for the cables that isolates important moments in diplomatic history. Figure 1 depicts the mean of this posterior distribution.

We present the Capsule model in section 3, providing both a formal model specification and guidance on how to use the model to detect and characterize real-world events. In section ??, we validate Capsule using simulated data, and in section 4, we use it to analyze over two million U.S. State Department cables. Although we describe Capsule in the context of diplomatic cables, it is suitable for exploring any corpus with the same underlying structure: text (or other discrete multivariate data) generated over time by known entities. This includes email, consumer behavior, social media posts, and opinion articles.

2 Related Work

We first review previous work on automatic event detection and other related concepts, to contextualize our approach in general and Capsule in particular.

In both univariate and multivariate settings, analysts often want to predict whether or not rare events

will occur (Weiss and Hirsh, 1998; Das et al., 2008). In contrast, Capsule is intended to help analysts explore and understand their data; our goal is human interpretability rather than prediction or forecasting.

Events can be construed as either anomalies—temporary deviations from usual behavior—or “changepoints” that mark persistent shifts in usual behavior (Guralnik and Srivastava, 1999; Adams and MacKay, 2007). We focus on events as anomalies.

Event detection in the context of news articles (Zhao et al., 2012; Zhao et al., 2007; Zhang et al., 2002; Li et al., 2005; Wang et al., 2007; Allan et al., 1998) and social media posts (VanDam, 2012; Lau et al., 2012; Jackoway et al., 2011; Sakaki et al., 2010; Reuter and Cimiano, 2012; Becker et al., 2010; Sayyadi et al., 2009) usually means identifying clusters of documents. For news, the goal is to create new clusters as novel stories appear, without distinguishing between typical content and rare events; for social media, the goal is to identify rare events, but the resultant methods are intended for short documents, and are not appropriate for longer documents that contain information about a variety of subjects.

Many existing methods for detecting events from text focus on individual vocabulary terms, often weighted by tf-idf values (Fung et al., 2005; Kumaran and Allan, 2004; Brants et al., 2003; Das Sarma et al., 2011; Zhao et al., 2007; Zhao et al., 2012). We characterize events by bursts in groups of terms.

Although groups of terms can be summarized directly (Peng et al., 2007; Chakrabarti and Punera, 2011; Gao et al., 2012), topic models (Blei, 2012) provide a way to automatically identify groups of related terms and reduce the dimensionality of text data. Researchers have previously used topic models to detect events mentioned in social media posts (Lau et al., 2012; Dou et al., 2012) and to find posts relevant to particular, monitored events (VanDam, 2012). Capsule uses topics to characterize both typical diplomatic content and potentially significant events.

In addition to modeling text over time, researchers have also used spatial information (Neill et al., 2005; Mathioudakis et al., 2010; Liu et al., 2011) and information about authors (Zhao et al., 2007) and news outlets (Wang et al., 2007) to enhance event detection. We rely on author information to characterize diplomatic “business as usual” for each embassy.

Event detection is closely related to detecting and

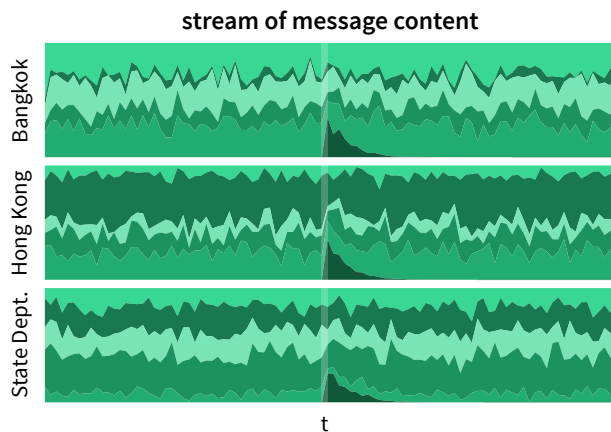


Figure 2: Cartoon intuition of Capsule; the y axis is the stacked proportion of messages about various subjects during a given time interval. The Bangkok embassy, Hong Kong embassy, and State Department all have typical concerns about which they usually send messages. When an event occurs at time t , the stream of message content alters to include the event, then fades back to “business as usual.” Capsule discovers entities’ typical concerns as well as the event occurrence and content.

characterizing relationships between entities (Schein et al., 2015; Linderman and Adams, 2014; Das Sarma et al., 2011). Capsule can trivially use sender–receiver pairs instead of authors, and the model specification can be tailored to reflect network structure.

3 The Capsule Model

In this section we develop the Capsule model for detecting and characterizing events. Capsule relies on text data sent between entities over time, and builds on topics models. We first give the intuition on Capsule, then formally specify the model. We also describe how to explore a corpus using Capsule and how we learn its hidden variables.

Consider an entity like the Bangkok American embassy, shown in Figure 2. We can imagine that there is a stream of messages (or *diplomatic cables*) being sent by this embassy—some might be sent to the US State Department, others to another American embassy like Hong Kong. An entity will usually talk about certain topics; the Bangkok embassy, for instance, is concerned with topics regarding southeast Asia more generally.

Now imagine that at a particular time t , an event occurs, such as the capture of Saigon during the Vietnam war. We do not directly observe that events

occur, but we do observe the message stream. Using this stream, each event will be described as a distribution over the vocabulary, similar to how topics are distributions over these same terms. When an event occurs, the message content changes for multiple entities—significant events impact multiple parties simultaneously. The day following the capture of Saigon, for instance, the majority of the diplomatic cables sent by the Bangkok embassy and several other entities were about Vietnam war refugees. Thus we imagine that an entity’s stream of messages is controlled by what it usually talks about as well as the higher level stream of unobserved events.

Model Specification. We now define Capsule in detail. Our data are *entities* sending *messages* over *time*. The observed variables are $w_{d,v}$, the number of times term v occurs in message d . The message is associated with an entity (or author) a_d and a time (or date) interval i_d .

We model each message with a bank of Poisson distributions, one per term in the vocabulary, $w_{d,v} \sim \text{Poisson}(\lambda_{d,v})$. The rate $\lambda_{d,v}$ blends the different influences on the content of the message, which are defined in terms of different types of *topics*. A topic, as in typical topic modeling (Blei et al., 2003; Canny, 2004; Gopalan et al., 2014), is a distribution over terms.

Specifically, the message blends general topics about diplomacy (e.g., diplomats, communication) β_k , an entity topic that is specific to the author of the message (e.g., terms about France) η_{a_d} ,¹ and an event topic that is specific to the events of relevant recent weeks (e.g., terms about an international crisis) γ_t . Notice how messages share these topics in different configurations: all messages share the general topics; messages from the same entity share the entity topics; and messages from the same interval share the event topics.

Examples of these three types of topics are in Table 1—the general topic relates to planning travel, the entity topic captures words related to the U.S.S.R., and the event topic captures words related to the evacuation of Saigon toward the end of the Vietnam War.

Each message blends its corresponding topics with different strengths, which are drawn per message.

¹These entity-specific topics are similar to background topics (Paul and Dredze, 2012).

| topic type | top terms |
|------------|-----------------------------------|
| general | visit, hotel, schedule, arrival |
| entity | soviet, moscow, ussr, agreement |
| event | saigon, evacuation, vietnam, help |

Table 1: Top vocabulary terms for examples of each of the three topic varieties; these three types of topics blend to form the distribution of each message. They come from the model fit we discuss in Section 4.

Each message represents a different mix of the events of recent weeks, entity-specific items, and general diplomacy.

Putting this together, the Poisson rate for term v in document d is

$$\lambda_{d,v} = \theta_d^\top \beta_v + \zeta_d \eta_{a_d,v} + \sum_{t=1}^T f(i_d, t) \epsilon_{d,t} \gamma_{t,v}, \quad (1)$$

where θ_d corresponds to strength of general diplomacy, ζ_d corresponds to strength of entity-specific concerns, and ϵ_d corresponds to strength of events; f is some function of decay. This function is important because events should not remain at their full strength indefinitely, but should decay over time. In our experiments, we find that exponential decay, as in Equation (5), performs well.

We place gamma priors on the topic strengths and Dirichlet priors on the topics. The distributions of general and entity topic strengths are defined hierarchically by entity, capturing the different topics that each entity tends to discuss. The prior on the entity strength is also defined hierarchically; different weeks are more or less “eventful.” The graphical model is shown in Figure 3 and the generative process is in Figure 4.

Given a collection of messages, posterior inference uncovers the different types of topics and how each message exhibits them. We will see below, how inferences about the event strengths enable us to filter the corpus to find important messages.

There are connections between Capsule and recent work on Poisson processes. In particular, we can interpret Capsule as a collection of related discrete time Poisson processes with random intensity measures. Further, marginalizing out the event strength prior reveals that word use from one entity can “excite” word

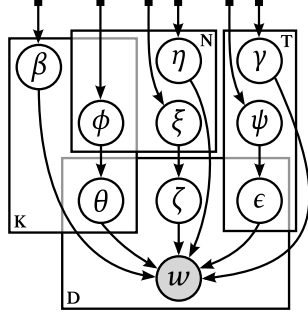


Figure 3: The graphical model for Capsule. Observed words w depend on general topics β , entity-specific topics η , and event topics γ , as well as document representations θ , ξ , and ϵ . Variables ϕ and ζ represent entity concerns (with general topics and entity-specific topics, respectively) and ψ represents the event strength of a given time interval. Hyper-parameters are indicated by black squares, but not labeled for visual simplicity.

use in another, which suggests a close relationship to Hawkes processes (Hawkes, 1971).

Detecting and characterizing events. Once we estimate the posterior distribution of the Capsule parameters, described in the following section, we can use the expectations of the latent parameters to explore the original data. To detect events, we consider the proportion of the document about event j , and take a weighted average of these proportions:

$$m_j = \frac{1}{\sum_d f(i_d, j)} \sum_d \frac{\varepsilon_{d,j}}{\zeta_d + \sum_t \varepsilon_{d,t} + \sum_k \mathbb{E}[\theta_{d,k}]},$$

where $\varepsilon_{d,t} = f(i_d, t) \mathbb{E}[\epsilon_{d,t}]$. This measure of “eventness” provides an estimate of the proportion of words that are related to a real-world event in that interval. Figure 1 shows events detected with this metric.

Given an identified event, we can characterize it in terms of its top terms under γ , but we can also use weighted event relevancy parameters $\varepsilon_{d,t}$ to sort documents; Section 4 explores relevant documents for events found in the National Archive diplomatic cables data. In addition to detecting and characterizing events, Capsule can be used to explore entity concerns and the general themes in a given collection.

To make Capsule more accessible, we developed an open source tool for visualizing its results.² Our tool creates a navigator of the documents and latent

²Source code: <https://github.com/ajbc/capsule-viz>; demo: <http://www.princeton.edu/~achaney/capsule/>.

- for each time step $t = 1:T$,
 - draw interval description over vocabulary (event topic) $\gamma_t \sim \text{Dirichlet}_V(\alpha)$
 - draw interval strength $\psi_t \sim \text{Gamma}(s_\psi, r_\psi)$
- for each entity $n = 1:N$,
 - draw entity-specific topics over vocabulary $\eta_n \sim \text{Dirichlet}_V(\alpha)$
 - draw entity-specific topic strength $\xi_n \sim \text{Gamma}(s_\xi, r_\xi)$
- for each topic $k = 1:K$,
 - draw general topic distribution over vocabulary $\beta_k \sim \text{Dirichlet}_V(\alpha)$
 - for each entity $n = 1:N$,
 - draw general entity concern $\phi_{n,k} \sim \text{Gamma}(s_\phi, r_\phi)$
- for each document $d = 1:D$ sent at time i_d by author a_d ,
 - draw local entity concern $\zeta_d \sim \text{Gamma}(s_\xi, \xi_{a_d})$
 - for each topic $k = 1:K$,
 - draw local entity concern $\theta_{d,k} \sim \text{Gamma}(s_\theta, \phi_{a_d,k})$
 - for each time $t = 1:T$,
 - draw local interval relevancy $\epsilon_{d,t} \sim \text{Gamma}(s_\epsilon, \psi_t)$
 - for each vocabulary term $v = 1:V$,
 - set $\lambda_{d,v} = \theta_d^\top \beta_v + \zeta_d \eta_{a_d} + \sum_{t=1}^T f(i_d, t) \epsilon_{d,t} \gamma_{t,v}$
 - draw word counts $w_{d,v} \sim \text{Poisson}(\lambda_{d,v})$

Figure 4: The generative process for Capsule.

parameters, allowing users to explore events, entities, topics, and the original documents. Figure 5 shows several screenshots of this browsing interface.

Learning the hidden variables. In order to use the Capsule model to explore the observed documents, we must compute the posterior distribution. Conditional on the observed word counts w , our goal is to compute the posterior values of the hidden parameters—general topics β , entity topics η , event topics γ , entity concerns ϕ (for general topics) and ξ (for their own topic), overall event strengths ψ , and document-specific strengths for general topics θ ,

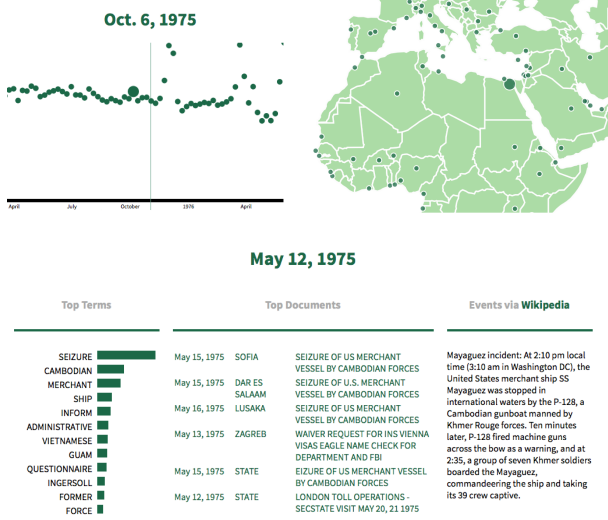


Figure 5: Screenshots of Capsule visualization of US State Department cables. Top-left: events over time (similar to Figure 1). Right-top: entities shown on a map. Bottom: time interval summary, including top terms, relevant documents, and text scraped from Wikipedia.

entity topics ζ , and event topics ϵ .

As for many Bayesian models, the exact posterior for Capsule is not tractable to compute; approximating it is our central statistical and computational problem. We develop an approximate inference algorithm for Capsule based on variational methods (Jordan et al., 1999),³ which is detailed in ??.⁴ This algorithm produces a fitted variational distribution which can then be used as a proxy for the true posterior, allowing us to explore a collection of documents with Capsule.

4 Evaluation

In this section we explore the performance of Capsule on simulated data and a collection of over 2 million U.S. State Department diplomatic cables from the 1970s.

4.1 Results on Simulated Data

Prior to exploring Capsule results on data of historical interest, we provide a quantitative assessment of the model on simulated data.

³Source code is available at <https://github.com/ajbc/capsule>.

⁴Appendices are located in the supplemental materials document.

We generated ten data sets, each with 100 time steps, 10 general topics, and 100 entities. Each simulation contained about 20,000 documents and followed the generative process assumed by Capsule, as shown in Figure 4.

To evaluate event detection, we created a ranked list of all time intervals and computed the overlap between a method and the simulated ground at every threshold; this generates an curve under which we can compute the area and normalized based on ideal performance—we refer to this metric as event detection AUC:

$$\frac{\sum_{i=1}^T |\text{Truth}_i \cap \text{Model}_i|}{\sum_{i=1}^T i}, \quad (2)$$

where Model_i is a set of the top i most eventful intervals according to the model, and Truth_i is the known set of the top i most eventful intervals. As the data is simulated, we can order all intervals by their known “eventness”—this metric captures how well the model recovers the true ordering.

The most successful of the baseline methods for event detection were based on absolute error in word count relative to the mean. This can be computed for all words:

$$\sum_{v=1}^V \left[\sum_{d=1}^D \text{abs} \left(w_{d,v} - \frac{1}{|D|} \sum_{d=1}^D w_{d,v} \right) \right], \quad (3)$$

and can also be weighted by tf-idf,

$$\sum_{v=1}^V \text{tf-idf}(v) \left[\sum_{d=1}^D \text{abs} \left(w_{d,v} - \frac{1}{|D|} \sum_{d=1}^D w_{d,v} \right) \right]. \quad (4)$$

We also considered metrics that computed deviations on the entity and document level, but the simplest overall metrics performed best.

Figure 6 shows that Capsule⁵ outperforms these approaches for event detection. We also consider an “event only” model—this is a model that only uses the interval-related subset of Capsule’s parameters; comparing to this shows that it is important to model “business as usual” for improved event detection. LDA based approaches like average deviation

⁵The model was set with the same number of topics $K = 10$ and exponential decay f used to simulate the data. More details on the decay function surround its formal definition in Equation (5).

from mean in topic space ((Dou et al., 2012)) do not perform well for event detection as deviations in topic space are too coarse to provide a meaningful signal.

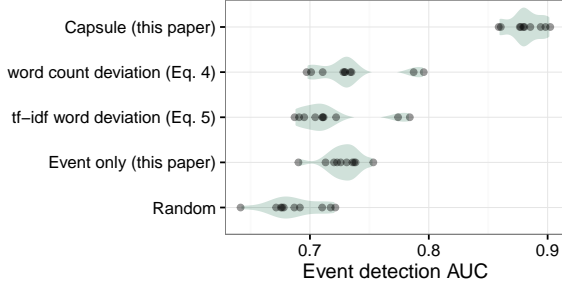


Figure 6: Event detection performance on ten simulated datasets; each dot is the performance on a single dataset, and the shaded green describes the distribution of the performances. Capsule detects events better than comparison methods.

Once events have been identified, our next task is to identify relevant documents; to evaluate this, we calculate precision of recovering the top N documents. Both Capsule and its event-only partial model outperform all comparison methods in terms of document recovery. For Capsule, average precision at 10 documents was 0.44; the event-only model had average precision of 0.09. LDA performed slightly worse than the event-only model, and the other comparison methods (similar to Equations 3 and 4) recovered zero relevant documents—equivalent to random.

As described in ??, we assessed the sensitivity of our model to different settings of event duration τ three different decay functions f : exponential, linear, and step functions. We found that fitting Capsule with an exponential decay function, or

$$f(i_d, t) = \begin{cases} 0, & \text{if } t \leq i_d < t + \tau \\ \exp\left\{\frac{-(i_d - t)}{\tau/5}\right\}, & \text{otherwise,} \end{cases} \quad (5)$$

provided the best performance and the most interpretable results.

4.2 Results on U.S. State Department Diplomatic Cables

As Capsule is intended to be used to explore large collections of documents, we must demonstrate its use in that context. This section describes and explores the application of Capsule to a real-world collection of diplomatic messages.

Data. The National Archive collects communications between the U.S. State Department and its embassies. We obtained a collection of these diplomatic messages from the History Lab at Columbia,⁶ which received them from the Central Foreign Policy Files at the National Archives. The communications in this data set were sent between 1973 and 1978.

In addition to the text of the cables themselves, each document is supplemented with information about who sent the cable (e.g., the State Department, the U.S. Embassy in Saigon, or an individual by name), who received the cable (often multiple entities), and the date the cable was sent. We used a vocabulary of size 6,293 and omitted cables with fewer than three terms, resulting in a collection of 2,021,852 messages sent between 22,961 entities. We selected a weekly duration for the time intervals, as few cables were sent on the weekends.

Model Settings. We fit Capsule with $K = 100$ general topics and using the exponential decay f , shown in Equation (5), with event duration $\tau = 4$. With these settings on the cables data, fitting the model takes about one hour per iteration.⁷

Quantitative Results. The History Lab at Columbia provided a list of 39 real-world events in the time period covered by the cables data; they validated that these events were present in at least one of six reputable collections of events, such as the Office of the Historian list of milestones.⁸

We ran Capsule and baseline comparison methods to recover these events, and used the nDCG metric to evaluate the methods. The nDCG metric is discounted cumulative gain,

$$\text{DCG} = \sum_{j=1}^T \frac{\mathbf{1}[\text{interval at rank } j \text{ in known events}]}{\log j}, \quad (6)$$

divided by the ideal DCG value, or

$$\text{nDCG} = \frac{\text{DCG}}{\text{ideal DCG}}. \quad (7)$$

As shown in Table 2, Capsule outperforms the baselines.

⁶<http://history-lab.org>

⁷Our algorithm is batch—we consider each data point for every iteration. Modifying the algorithm to stochastically sample the data would reduce the time required to achieve an equivalent model fit.

⁸<https://history.state.gov/milestones/1969-1976>

| Method | nDCG |
|---|-------|
| Capsule | 0.693 |
| Average tf-idf weighted word count deviation | 0.652 |
| Average unweighted word count deviation | 0.642 |
| Single term maximum tf-idf weighted deviation | 0.561 |
| Random (10k ave) | 0.557 |
| Single term maximum unweighted deviation | 0.555 |

Table 2: Evaluation of Capsule and comparison baselines on a collection of 39 real-world events. Capsule performs best.

| Model | LL at 10 iterations | LL at convergence |
|---------------------|---------------------|-------------------|
| Full Capsule | -1.62e7 | -1.52e7 |
| Entity Topics Only | -1.64e7 | – |
| General Topics Only | -1.71e7 | -1.53e7 |
| Event Only | -1.79e7 | – |

Table 3: Log likelihood (LL) computed on validation data at 10 iterations and at convergence—the event only and entity only models are small enough that they converge with very few iterations. The full Capsule model achieves the lowest log likelihood in both cases.

Additionally, we can compute held-out validation data likelihood on the model and each of its component parts; Table 3 shows that the full Capsule model captures the data better than any of its component parts individually.

Model Exploration. The evaluations to this point are useful in validating that Capsule captures its intended constructs, but the objective of the model is not prediction; rather, it is to be used as a scaffold to explore large collections of documents. We now turn to exploring the cables data using Capsule.

We begin our exploration by detecting events using Capsule. With Section 3 as our metric of “eventness,” we consider this metric over time, which is shown in Figure 1. Here, high values—often peaks—correspond to real-worlds events, several of which are labeled.

One of the tallest peak occurs the week of December 1, 1975, during which the United Nations General Assembly (UNGA) discussed omnibus decolonization. As discussed in Section 3, we sort documents by their weighted event relevancy parameters $f(i_d, t) \in_{d,t}$ to find cables that reflect an event. Table 4 shows the top cables for this discussion. Capsule accurately identifies this real-world event and recovers relevant cables.

Another notable event was the seizure of the S.S. Mayaguez, an American merchant vessel, in May of 1975—at the end of the Vietnam War. The

top documents for this week are shown in Table 5. We can inspect individual documents to confirm their relevancy and learn more about the events. For instance, the content of the most relevant document, according to Capsule, is as follows.

In absence of MFA Chief of Eighth Department Avramov, I informed American desk officer Yankov of circumstances surrounding seizure and recovery of merchant ship Mayaguez and its crew. Yankov promised to inform the Foreign Minister of US statement today (May 15). Batjer

A third week of interest occurs in early July of 1976. On July 4th, the US celebrated its Bicentennial, but on the same day, Israeli forces completed a hostage rescue mission—an Air France flight from Tel Aviv had been hijacked and taken to Entebbe, Uganda. This event, like many events, is mostly discussed the week following the real-world event; relevant cables are shown in ??, ??. The cable from Stockholm describing the “Ugandan role in Air France hijacking” begins with the following content, which reveals further information about the event.

1. We provided MFA Director of Political Affairs Leifland with Evidence of Ugandan as-

| $f * \epsilon$ | Date | Entity | Subject |
|----------------|------------|----------|--|
| 4.60 | 1975-12-05 | Canberra | 30th UNGA: Item 23, Guam, Obmibus Decolonization and ... |
| 4.26 | 1975-12-05 | Mexico | 30th UNGA-Item 23: Guam, Omnibus Decolonization and ... |
| 4.21 | 1975-12-06 | State | 30th UNGA-Item 23: Guam, Omnibus Decolonization and ... |
| 4.11 | 1975-12-03 | Dakar | 30th UNGA: Resolutions on American Samoa, Guam and ... |
| 4.08 | 1975-12-04 | Monrovia | 30th UNGA: Item 23: Resolutions on decolonization and A... |

Table 4: Top documents for the time interval of week December 1, 1975, when the UN discussed decolonization resolutions; Capsule recovers relevant documents related to this real-world event. Typos intentionally copied from original data.

| $f * \epsilon$ | Date | Entity | Subject |
|----------------|------------|---------------|---|
| 5.06 | 1975-05-15 | Sofia | Seizure of US merchant vessel by Cambodian forces |
| 5.05 | 1975-05-15 | Dar es Salaam | Seizure of U.S. merchant vessel by Cambodian forces |
| 4.92 | 1975-05-16 | Lusaka | Seizure of US merchant vessel by Cambodian forces |
| 4.61 | 1975-05-13 | Zagreb | Waiver request for INS Vienna visas Eagle name check... |
| 4.59 | 1975-05-15 | State | eizure of US merchant Vessel by Cambodian forces |

Table 5: Top documents for the week during which the S.S. Mayaguez was captured. Capsule identifies documents relevant to the real-world event. Typos intentionally copied from original data.

sistance to hijackers contained in Ref A. After reading material, Leifland described it a “quite good”, and said it would be helpful for meeting MFA has scheduled for early this morning to determine position GOS will take at July 8 UNSC consideration of Israeli Rescue Operation. ...

Capsule assumes that only one event occurs in each time interval—this example is a clear violation of this assumption, but it also demonstrates that the model successfully captures both events, even when they overlap.

In addition to events, Capsule can be used to explore the general themes of a corpus and entities’ typical concerns. Examples of general topics of conversation are shown in ??, ?? and entity-exclusive topics are shown in ??, ??; these show us how entity topics absorb location-specific words, preventing these terms from overwhelming the general topics.

These exploratory results show that our model is successfully capturing when multiple entities are discussing the same subjects and that our model can be used to explore the underlying data by providing a structured scaffold from which to view the data.

5 Conclusion

We have presented Capsule, a Bayesian model that identifies when events occur, characterizes these events, and discovers the typical concerns of author entities. We have shown that Capsule outperforms comparison methods and explored its results on a real-world datasets. We anticipate that Capsule can be used by historians, political scientists, and others who wish to investigate events in large text corpora.

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