Two Computational Models for Analyzing Political Attention in Social Media

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Abstract
Understanding how political attention is divided and over what subjects is crucial for research on areas such as agenda setting, framing, and political rhetoric. However, existing methods for measuring attention, such as manual labeling according to established codebooks, are expensive and restrictive. We describe two computational models that automatically distinguish topics in politicians' social media content. Our models - one supervised classifier and one unsupervised topic model - provide different benefits. The supervised classifier reduces the labor required to classify content according to pre-determined topic lists. However, tweets do more than communicate policy positions. Our unsupervised model uncovers both political topics and other Twitter uses (e.g., constituent service). Together, these models are effective, inexpensive computational tools for political communication and social media research. We demonstrate their utility and discuss the different analyses they afford by applying both models to the tweets posted by members of the 115th U.S. Congress.

Questions about what political topics are receiving attention and how that attention is distributed are central to issues such as agenda setting and framing. Knowing what politicians are talking about and how those topics differ among various populations (e.g., Democrats and Republicans) and over time could enable advances in political communication research and has potential to increase constituents' knowledge.

Our study is motivated by two primary challenges in studying political attention and congressional communication. First, existing methods for studying political attention, such as manual topic labeling, are expensive and restrictive. Labeling content by hand requires tremendous human effort and substantial domain knowledge. Using pre-defined codebooks assumes a particular set of topics and therefore cannot effectively classify content that falls outside those predefined areas. Quinn and colleagues (Quinn et al. 2010) provide a more detailed overview of the challenges associated with labeling according to known topics and by hand; they also provide a topic-modeling approach to classifying speech in the Congressional Record that is similar to ours.

Second, Congress increasingly uses social media as a mechanism for speaking about and engaging with constituencies (Straus et al. 2013), but our tools for studying their social media use have not kept pace. Existing studies of MCs’ social media use rely on the human labeling and domain knowledge mentioned above (Russell 2017; 2018; Evans, Cordova, and Sipole 2014; Frechette and Ancu 2017) or focus on the frequency (LaMarre and Suzuki-Lambrecht 2013) or type of use (Golbeck et al. 2018; Hemphill, Otterbacher, and Shapiro 2013) rather than the content of messages. MCs’ social media speech can be used for understanding polarization (Hemphill, Culotta, and Heston 2016; Hong and Kim 2016) and likely impacts political news coverage (Shapiro and Hemphill 2017; Moon and Hadley 2014), and mechanisms for estimating attention and style would provide richer views of activity and enable new analyses.

To address these methodological challenges, we developed two computational models for estimating political attention—one supervised model that leverages human labels to label texts at scale and a second unsupervised model that uses readily-available data and low computational overhead to automatically label social media posts according to their policy topic and communication style. By providing the model and its codebook, we make it possible for others to label political texts efficiently and automatically, reducing the total effort required to label data for analysis. This enables more efficient and nuanced studies of Congress’s political attention and communication style and facilitates comparative studies of political attention across media (i.e., social media, congressional hearings, news media). We demonstrate the utility of these approaches by applying the models to the complete corpus of tweets posted by the 115th U.S. Congress and briefly discussing the insights gained. We also discuss the costs and benefits of supervised and unsupervised models and provide aspects of each to consider when choosing a tool for analysis. In summary, our contributions are

1. a supervised model for assigning tweets to policy topics
2. an unsupervised model for assigning tweets to policy topics and communication uses
3. trade offs to consider when choosing supervised and/or unsupervised approaches to topic labeling

Why Twitter Existing work in political attention relies largely on political speeches (Laver, Benoit, and Garry 2003;
Oliver and Rahn 2016; Yu, Kaufmann, and Diermeier 2008), the Congressional Record (Quinn et al. 2010), and party manifestos (Gabel and Huber 2000; Slapin and Proksch 2008). At the same time, politicians around the world increasingly use social media to communicate, and researchers are examining the impacts of that use on elections (Bossetta 2018; Karlsen 2011), the press (Murthy 2015; Shapiro and Hemphill 2017), and more. Given its prevalence among politicians and in the public conversation about politics, especially during the Trump presidency in the U.S., politicians’ behavior on Twitter demands our attention. We also expect that Twitter’s ready availability and frequent updating will enable us to study political attention more efficiently and at a larger scale than prior data.

In order to understand how U.S. Congressional tweets may help us to answer these social and political research questions, we must first understand what U.S. MCs are saying. Given the sheer volume of content that MCs put out on Twitter, manual tweet-by-tweet labeling is neither time efficient nor affordable in the long term. We therefore explore whether an unsupervised topic model could help us understand MC conversations on Twitter in a more cost and time efficient way than manual labeling.

Computational study of MCs use of Twitter will eventually allow us to (1) situate the MCs’ political attention patterns on Twitter within the broader media context, (2) understand whether MCs’ political attention patterns on Twitter reflect attention patterns in a broader media context, and (3) understand the unique value that the use of supervised classification and unsupervised topic modeling techniques can contribute to our overall understanding of MCs’ political attention patterns. However, tools or models for performing these analysis are currently unavailable.

In the sections that follow, we discuss how this process helps us understand important ideas about how MCs communicate their public facing persona, MCs’ agenda setting practices in public facing discourse, and how to ask more specific questions about MCs’ public-facing communications across different media platforms. We propose that Twitter posts offer unique insights that can be studied communicators’ behavior on Twitter demands our attention. We also expect that Twitter’s ready availability and frequent updating will enable us to study political attention more efficiently and at a larger scale than prior data.

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## Data

In this section, we describe the data we used to train our supervised classifier and unsupervised topic model, and to compare our supervised model’s performance against our unsupervised model’s performance.

### Tweets from the 115th Congress

Using the Twitter Search API, we collected all tweets posted by official MC accounts (voting members only) during the 115th Congress which ran January 3, 2017 to January 3, 2019. We identified MCs’ Twitter user names by combining the lists of MC social media accounts from the United States project¹, George Washington Libraries², and the Sunlight Foundation³. Throughout 2017 and 2018, we periodically used the Twitter API to search for the user names in this composite list and retrieved the accounts’ most recent tweets. Our final search occurred on January 3, 2019, shortly after the 115th Congress ended. In all, we collected 1,485,834 original tweets (i.e., we excluded retweets) from 524 accounts. The accounts differ from the total size of Congress because we included tweet data for MCs who resigned (e.g., Ryan Zinke) and those who joined off cycle (e.g., Rep. Conor Lamb); we were also not able to confirm accounts for every state and district. We summarize the accounts present in our dataset in Table 1 and the number of tweets posted by chamber, gender, and party in Table 2.

We used this data to train our unsupervised topic model, and to compare our supervised model’s performance against our unsupervised model’s performance.

### Training Data for Supervised Classifier

We used a selection of Russell’s human-labeled dataset (Russell 2017; 2018), which contains 45,395 tweets labeled with codes from the CAP codebook. We removed retweets from this set to limit our classification to original tweets, resulting in a total set of 39,696 labeled tweets used to train and test our models.

### Table 1: Number of accounts by party, chamber, and gender.

<table>
<thead>
<tr>
<th></th>
<th>Senate</th>
<th>House</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dem</td>
<td>143,522</td>
<td>441,890</td>
<td>585,412</td>
</tr>
<tr>
<td>GOP</td>
<td>171,083</td>
<td>652,240</td>
<td>823,323</td>
</tr>
<tr>
<td>Total</td>
<td>314,605</td>
<td>1,094,130</td>
<td>1,408,735</td>
</tr>
</tbody>
</table>

### Table 2: Number of tweets by party, chamber, and gender.

<table>
<thead>
<tr>
<th></th>
<th>Senate</th>
<th>House</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>190,950</td>
<td>654,347</td>
<td>845,307</td>
</tr>
<tr>
<td>Women</td>
<td>441,890</td>
<td>422,110</td>
<td>864,000</td>
</tr>
<tr>
<td>Total</td>
<td>631,940</td>
<td>1,076,457</td>
<td>1,708,407</td>
</tr>
</tbody>
</table>

¹[https://github.com/unitedstates/congress-legislators](https://github.com/unitedstates/congress-legislators)
³[https://sunlightlabs.github.io/congress/index.html#legislator-spreadsheet](https://sunlightlabs.github.io/congress/index.html#legislator-spreadsheet)
Methodology

Here we describe the processes of building and training the models and applying them to the 115th Congress tweets.

Preprocessing

We used the same preprocessing steps for both the supervised and unsupervised models and describe them below.

Stemming We evaluated whether or not to use stemming or lemmatization in training our unsupervised model by reviewing the relative interpretability of topics generated by models trained with each of stemmed texts and unstemmed texts. We found unstemmed texts render significantly more interpretable generated topics, likely reflecting syntactical associations with semantic meanings, which is consistent with prior work(Schofield and Mimno 2016). This pattern is likely especially relevant for tweet data given that unique linguistic patterns and intentional misspellings are used to communicate different semantic meanings. Stemming in these instances may remove the nuance in potential semantic meaning achieved by tweets’ unique linguistic features including misspellings. Therefore, we did not use stemming or lemmatization in data preprocessing for the final models.

Stop lists, tokenization, and n-grams Given the prevalence of both English- and Spanish-language tweets, this project removed both English and Spanish stop words included in Python’s Natural Language Toolkit (NLTK) default stop word lists.

We also used a combination of two tokenization approaches to prepare our data for modeling. First, we used Python’s NLTK tweetTokenizer with parameters set to render all text lower case, strip Twitter user name handles, and replace repeated character sequences of length three or greater with sequences of length three (i.e. “Heeeeeeeey” and “Heeey” both become “Heeey”). Second, we removed punctuation (including emojis), URLs, words smaller than two letters, and words that contain numbers.

In the early stages of model development, we evaluated the comparative interpretability and relevance of topics generated for document sets tokenized into unigrams, bigrams, and a combination of unigrams and bigrams. We found model results for document sets tokenized into unigrams to be most interpretable and relevant, and thus present only these results in this paper.

Specifying Models

Supervised Classifier We developed a supervised machine learning classifier on a collection of human-labeled tweets from the 113th Congress based on the 113th human-labeled data specified in our “Data” section (Russell 2017; 2018). Our training set comprised 90 percent of our total dataset, and our test set comprised 10 percent of the total dataset. We evaluated the performance of each of NLTK’s implementations of Nave Bayes and Logistic Regression classifier against a baseline of NLTK’s Dummy Classifier

Unsupervised Topic Model We evaluated the performance of two unsupervised model implementations for relevance and interpretability: gensim’s Latent Dirichlet Allocation (LDA) model and MALLET’s LDA model wrapper (Rehurek and Sojka 2010).

We began testing with a computationally inexpensive gensim LDA model. We found that the results returned were insufficiently interpretable to effectively answer our research questions. We thus tested an alternative, MALLET’s LDA model wrapper, and found it relatively computationally inexpensive while rendering significantly more interpretable results than gensim’s LDA implementation. We also considered Moody’s lda2vec(Moody 2016), and though preliminary results did return more nuanced topics, we found its setup and computational inefficiency to be too cumbersome and costly for practical use. We present the results of the unsupervised model generated using MALLET’s LDA model wrapper.

The MALLET LDA wrapper requires that we specify a number of topics to find in advance. We evaluated the performance of models generating between 5 and 70 topics in increments of five topics within this range. We found 50 topics to yield the most interpretable and relevant results without excessive redundancy in topics generated.

Evaluating Models

We used common approaches to evaluating the two models, and then compared the results from each with one another. The following subsections describe our evaluation processes in greater detail.

Evaluating the Supervised Model Using a logistic regression classifier achieved an F1 score of 0.791. The F1 score balances the precision and recall of the classifier to provide a measure of performance. We compared our classifier to a dummy classifier using the same training data, and it achieved only $F1 = 0.10$. Given the difference between our classifier’s score and the dummy, we argue the supervised classifier achieved reasonable accuracy. We also compared our classifier’s labels with the human labels and achieved a Cohen’s kappa of 0.769, suggesting moderate agreement (McHugh 2012). We present the results only from our highest-performing classifier (logistic regression) in this paper.

Evaluating the Unsupervised Model We used a Grounded Theory approach to interpret and label topics returned by our final unsupervised model (Glaser and Strauss 1967). This approach involved first labeling the baseline model’s topics according to our initial interpretations, allowing us to discovery semantically important topics that arise from the data rather than from a predetermined topic set. Human interpretation and label assignment was performed by two domain experts and confirmed by a third. One expert has prior experience on legislative staff having served in a senior senator’s office, and in public affairs for political organizations. She was able to determine whether the topics identified by the classifier were interpretable.
and were actually capturing political topics as members of Congress understand them. The second expert has spent 12 years working with political communication theory, allowing her to understand topics returned within the context of political behavior. The two labelers discussed disagreements until both agreed on the labels applied to all fifty topics. Following this first labeling process, we performed the second step of the Grounded Theory method, determining patterns across labels and grouping labels together that indicated topical similarity based on their highest-weighted features. For instance, one topic’s top unigram features included health, care, Americans, Trumpcare and another included health, care, access, women. We bundled both of these topics under the umbrella healthcare. Finally, we reviewed our topic labels and features with a senior member of a U.S. policy thinktank to confirm the validity of our labels and interpretability of our topics.

We also compared our set of labels to the Comparative Agendas Project (CAP) Master Codebook (Bevan 2017), a codebook commonly used in social, political, and communications science to understand topics in different types of political discourse worldwide. Where possible, we assigned CAP codes to the related codes that resulted from our inductive labeling. A complete list of our topics, their associated CAP codes, and highly-weighted features is available in Table 3. Not all of our codes had ready analogues in the CAP taxonomy. For instance, our unsupervised model identified media appearance as a separate and frequent topic. The CAP codebook includes only policy areas and not relationship-building or constituent service activities of government officials, and so no CAP label directly applies here. Further, we determined that some nuanced aspects of the topics returned by our unsupervised model are not captured by the policy focus of the CAP codebook. For example, our unsupervised model returned several topics clearly interpretable as related to veteran affairs. The CAP Codebook includes aspects of veteran affairs as a sub-topic under both Housing and Defense, but given that our unsupervised model detected veteran-related issues outside of these sub-topic areas, we determined that a new topic solely devoted to veteran affairs would better describe the thematic content of those topics. A similar situation applied to the unsupervised topic we call legislative process, some but not all aspects of which may have fallen under CAP cod Government Operations. The codes we identified that were not captured by the CAP codebook are marked by “-“ in the Code Number column of Table 3.

### Comparing Models’ Output
The supervised model provides a single topic label for each tweet, and the unsupervised model provides probabilities for each tweet-class pair. In order to compare the labels between classifiers, we assigned tweets the highest-probability topic indicated by the unsupervised model. We measured interannotator agreement between our supervised and unsupervised models using Cohen’s kappa (McHugh 2012). We opted to use Cohen’s kappa as a measure that is widely used and well understood. Since we hope to compare agreement between only two annotators (supervised and unsupervised model), our data is not incomplete, and our topic codes are all of the same unit type, we determined that more robust measures such as Krippendorf’s Alpha were not necessary (Haghighi 2012). Because our supervised model assigns topic labels only to policy-related tweets, a comparison between supervised and unsupervised models is only meaningful for those tweets both models labeled, or policy-related tweets. Therefore, we calculated a Cohen’s kappa score between our supervised and unsupervised model for only policy-related tweets with label assignments corresponding to CAP codes.

The two classifiers achieved a Cohen’s kappa of 0.262. We argue that the classifiers likely measure different things, and the low agreement suggests an opportunity for researchers to select the tool that matches their analytic goals. Low agreement suggests that the two models are well-differentiated; we return to this discussion in detail below under “What the Different Models Capture”.

### Applying Models to 115th Congress’ Tweets
We applied both the supervised and unsupervised models to all of the original tweets posted by the 115th Congress and use those results to illustrate the analytic potential of these new methodological tools. Table 3 summarizes the results by providing the topic description, the corresponding CAP codebook number (if applicable), the proportion of tweets that fell in that topic according to the supervised (SU) and unsupervised (UN1 and UN2) models. For each tweet, the unsupervised model returns the probability that the tweet belongs in each of the 50 topics identified. We provide both the most likely (UN1) and second-most likely topic (UN2) for each tweet.

#### Topic Distribution
In Table 3, each of topics 1-23 correspond to the CAP macro-level code numbers. Topic 23, cultural affairs was not detected by either of our models, and as such receives a “-“ value across all columns. Each topic 24-35 corresponds to expert interpretations of unsupervised topic model results; we assigned “0” to tweets whose topics we uninterpretable by either model. Since these latter topics apply only to the unsupervised model’s results, each of these topics receives a “-“ value in column “SU”. Related, each of topics energy (#8), housing (#14), foreign trade (#18), and international affairs (#19) received “-“ values in both columns “UN1” and “UN2”. These “-“ values indicate that our unsupervised model did not detect topics that human interpretation would assign any of these four CAP Codebook topics.

### Discussion
Examining the output from the two models on the same dataset, tweets from the 115th Congress, helps explain the models’ differences, trade-offs, and clarifies the new insights available from the unsupervised model.

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5 The CAP Codebook does not include a codes numbered 11 or 22.
In general, we notice that among the second-most probable topics from the unsupervised model because those two topics are policy-related. In (b) and (c), we report the supervised classifier label and second-most likely unsupervised topic label to illustrate how it’s possible to use each classifier for different analytic purposes. The supervised classifier, (b), shows us differences in political attention by party. The unsupervised classifier’s second-most likely category enables us to compare the style by party. We can see that Republicans give less attention to civil rights, environment, and social welfare and more attention to energy and defense than Democrats. None of these differences are especially surprising given the parties’ priorities, but our models show empirically that the differences are observable even in social media. Among the unsupervised model’s style codes, Republicans exhibit more self promotion than Democrats, but the parties are nearly equal on those style codes. Our model affords similar comparisons among other groups such as gender or chamber that may provide insight into how political attention changes or how communication styles differ among groups.

Additional similarities and differences in the proportions of SU and UN2 in Figure 1 may help us to understand the utility of each model. We can see that our unsupervised model’s maximum probability topic predictions did not include topic labels transportation, defense, technology, public lands for any policy-related tweets. However, we can also see that each of these topics are included among the unsupervised model’s second most probable topic predictions. This suggests that in some policy topics’ cases, each of our supervised and unsupervised models may be able to predict approximately similar ideas if both most probable and second most probable topics are taken into account.

First, we examined the proportion of supervised labels matching the first and second most probable unsupervised labels for policy-related tweets. Table 3 shows that both models were able to detect a topic in nearly all tweets (i.e., the proportion of uninterpretable appears relatively infrequently). This topic appears more frequently in the second set of labels from the unsupervised classifier (UN2). The uninterpretable topic’s features were comprised largely of prepositions, conjunctions, and other words with little semantic meaning. This suggests that the most significant semantic meaning of a tweet labeled by the unsupervised model can likely be understood by using its maximum probability topic.

In Figure 1 (a), we include the supervised model and most-likely topic from the unsupervised model because those two topics are policy-related. In (b) and (c), we report the supervised classifier label and second-most likely unsupervised topic label to illustrate how it’s possible to use each classifier for different analytic purposes. The supervised classifier, (b), shows us differences in political attention by party. The unsupervised classifier’s second-most likely category enables us to compare the style by party. We can see that Republicans give less attention to civil rights, environment, and social welfare and more attention to energy and defense than Democrats. None of these differences are especially surprising given the parties’ priorities, but our models show empirically that the differences are observable even in social media. Among the unsupervised model’s style codes, Republicans exhibit more self promotion than Democrats, but the parties are nearly equal on those style codes. Our model affords similar comparisons among other groups such as gender or chamber that may provide insight into how political attention changes or how communication styles differ among groups.

Table 3: Topic Distribution Across the 115th Congress. Contains proportional distributions across all topics for both supervised (SU) and unsupervised (UN1 and UN2) classifiers. UN1 indicates the highest probability category assigned, and UN2 indicates the second highest.

### Comparing Model Labels

Remember that the resulting Cohen’s kappa between supervised and unsupervised model results was only 0.262. Common practice suggests that a Cohen’s kappa of .21-.40 indicates fair interannotator agreement, with 0 indicating interannotator agreement that approximates random choice (McHugh 2012). In this sense 0.262 does not represent particularly high interannotator agreement between the supervised and unsupervised models. In order to understand why this was, we examined individual cases of disagreement and agreement. We discuss example cases below, how these disagreements contribute to the Cohen’s kappa score returned, and what they reveal about the utility of each of the modeling approaches.
That none of the CAP Codebook topics
Rare Topics
these policy issues. which, the reason for, and with whom MCs are discussing
the topic of second-highest probability captures the way in
est probability more effectively captures a policy focus, and
cur more frequently. This suggests that the topic of high-
est probability more effectively captures a policy focus, and
the topic of second-highest probability captures the way in
which, the reason for, and with whom MCs are discussing
these policy issues.

Rare Topics
That none of the CAP Codebook topics energy, housing, for-


ternational affairs are detected by the unsuper-
vised model indicates that these topics are occurring rarely
enough that the unsupervised model does not have enough
data to detect these topics as distinct. In reviewing Figure 1,
it is possible to see that a very low proportion of tweets were
labeled housing (#14) or foreign trade (#18) by the super-
vised classifier, for example. That these topics are not fre-
quently occurring according to the supervised model either
suggests that that MCs do not spend a lot of time tweeting
about each of topics housing or foreign trade. These omis-
sions are likely an artifact of the U.S. federal government’s
structure. Though housing, for example, is in part an issue
addressed by the U.S. Department of Housing and Urban
Development and thus an appropriations issue for the U.S.
Congress, many housing issues are addressed at state and lo-
cal levels. It is possible that given this distribution of signif-
ificant responsibility to the state and local levels, MCs spend
less time talking about housing at the federal level.

Where the Models Diverge
It is also possible that those terms associated with these top-
ics for the supervised model are being associated with or
grouped together with terms corresponding to different top-
ics. For example, given that international affairs, defense,
and immigration topic areas have some overlapping topical
relevance, it is possible that certain tweets were labeled by
the unsupervised classifier as defense or immigration rather
than international affairs as by the supervised classifier. By
examining the features associated with each topic in each
classifier (see Tables 6 and 7), we can see some of these dif-
fences. For instance, the defense topic (#16) has features
“iran”, “nuclear”, and “strategy” in the unsupervised model
and “veteransday”, “drones”, and “stolenvalor” in the super-
vised model. In the unsupervised model, topics about vet-


ersans emerged that were distinct from defense and housing,
where veterans occur in the CAP codebook. So we see that
similar terms are associated with different topics in the two
types of models, and that explains some of their differences.
However, each set of associations is reasonable and inter-
pretable, and that suggests that the models capture different
latent properties with their feature-class associations.

Table 4 describes several sample tweets that were labeled
international affairs by the supervised model, and indicates
how the unsupervised model labeled the same tweet. For ex-
ample, the unsupervised model labeled the first tweet fea-
tured as agriculture because of the presence of the hash-
tag #FarmBill and mention of sorghum. At the same time,
the tweet also reflects international affairs topical focus by
mentioning the international trade market and naming other
countries in that market. In this case, each of the super-
vised and unsupervised models captured different thematic
focuses of the tweet both perhaps of comparable relevance.

The second example where the models diverge was la-
bled by the unsupervised model as emergency response
(highest probability) or district affairs (second highest prob-
ability). It is possible that the supervised model associated
words like “proud”, “send”, and “help” with the interna-
tional affairs topic, but the thematic focus of the tweet does
indeed appear to be more related to emergency response
and district affairs via discussion of “#FirstResponders”,
hurricane Harvey, and mention of local communities New
York City and Texas. In this case, the unsupervised model
captures more relevant themes than the supervised model.
These disagreements illustrate that the fixed parameters of
the CAP Codebook may not capture all types of conversa-
tion by MCs on Twitter. Since the unsupervised model rep-
resents a bottom-up Grounded Theory approach, it is able
to capture a new topic not featured in the CAP Codebook
but that provides additional nuance to the analysis of these
tweets.

<table>
<thead>
<tr>
<th>tweet Text</th>
<th>UN1</th>
<th>UN2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum market is very dependent on export. China is main market w/ 75% of it, then Mexico. #FarmBill</td>
<td>agriculture</td>
<td>uninterpretable</td>
</tr>
<tr>
<td>NYC is proud to send 120 #FirstResponders to help Texans in the wake of #Harvey <a href="https://t.co/vdumEKFnQA">https://t.co/vdumEKFnQA</a></td>
<td>emergency response</td>
<td>district affairs</td>
</tr>
<tr>
<td>@realDonaldTrump @RepMcEachin @RepJoeKennedy Any time someone is brave enough to serve, we must respect that choice, not stomp on their rights and liberties. #TransRightsAreHumanRights</td>
<td>civil rights</td>
<td>veterans</td>
</tr>
</tbody>
</table>

Table 4: Sample tweets labeled International Affairs by Supervised Classifier. UN1 refers to the maximum probability class according to the unsupervised classifier, and UN2 indicates the second-highest probability class.
New Insights from the Unsupervised Model

The final example in Table 4 raises another important difference between our supervised and unsupervised models. Where our supervised model is limited by the policy-focused labels defined by the CAP Codebook, our unsupervised model is not. We see that approximately 21.32% and 35.76% of all maximum probability and second maximum probability topics detected fall in topic codes that are not captured in the CAP Codebook. These topics reveal that MCs spend a significant portion of their tweets posting about issues other than policy and identify the topics and behaviors beyond policy that they exhibit.

The additional topics the unsupervised classifier identified largely reference activities related to personal relationship building. The ability to distinguish these activities enables analyses of behavior beyond policy debates such as home style. For instance, to differentiate Fenno’s (Fenno 1978) “person-to-person” style from “servicing the district”. Relationship building topics include sports, holidays, awards, sympathy, constituent relations, and power relations. Service-related topics include district affairs, emergency response, and legislative process. Prior research has conducted similar style analysis on smaller sets of tweets around general elections (Evans, Cordova, and Sipole 2014), and our models enable this analysis at scale and throughout the legislative and election calendars.

That somewhere between 20 and 40 percent of all tweets are labeled with these topic codes tells us that the CAP Codebook alone is unable to capture how and why MCs use Twitter. The supervised model does a good job of capturing the policy topics present in the CAP codebook and facilitating the comparative analysis that codebook is designed to support. The unsupervised model enables us to see that MCs invest significant attention in personal relationship building and constituent service on Twitter and to analyze those topics and behaviors that are not clearly policy-oriented.

Recommended Uses of Each Model

Given the performance and capabilities of each model, we recommend the supervised model for conducting comparative studies across political systems, and we recommend the unsupervised model for understanding the nuances of the U.S. Congress (e.g., their topics, their non-policy content and behavior). Though useful for comparative studies, our unsupervised model helps us understand that Congress’ communications on Twitter do not easily map to the Comparative Agendas Codebook and that there are different ways to classify MCs Twitter behavior that help us understand more about Congress’ attention.

To further understand the usefulness of each model, we assessed each of their Cohen’s Kappa agreement with labels assigned by a human annotator to 13,943 policy-related tweets made available by Russell (as used in (Russell 2018; 2017)). As expected, since our supervised model was trained on a subset of this data, we found that our supervised model and human-labeled tweets receive a high Cohen’s kappa of 0.96, close to nearly complete agreement. The low Cohen’s kappa between manual labels and the unsupervised classifier suggest that the taxonomies are mostly independent—these coding approaches measure and capture different aspects of the tweets.

Our unsupervised model’s findings suggest potential extensions to the CAP Codebook to reflect tweet-specific U.S. legislative discourse (see codes 24-35 in Table 3. It is worth noting that the proposed additional topics largely do not reflect policy topics, but rather different forms of communicating with constituents. These codes describe topics that embody certain communication styles more than topical ideas such as Public Lands or Health. The emergence of these topics suggests that unsupervised topic modeling supports different kinds of analysis than manual and codebook-oriented labeling. Unsupervised topic modeling can also detect communication styles and intents. Further investigation about this potential could yield interesting insights concerning the utility of unsupervised topic modeling to understanding the political communications space.

Future Work

Political Attention The most exciting next steps for work in this area involve using the models to study political attention and social media use in political communication. Our models dramatically reduce the costs of obtaining labeled data for comparative analysis and provide a mechanism for identifying additional behavior beyond policy discussions. For example, by using our supervised model, we are able to study the complete 115th Congress and their relative attention to policies over time. We can compare attention between subgroups (e.g., parties, chambers, regions of the U.S.) and over time (e.g., around primaries, during recess). When combined with similar advances at labeling and accessing news content (Saito and Uchida 2018; Gupta et al. 2018), our models also facilitate analysis of the political agenda, enabling researchers to test the paths through which topics reach the mainstream or legislation.

International Comparison Our supervised model directly allows for comparative analyses by using a standard codebook designed for such studies. Whether our models work on tweets in languages other than English (and marginally Spanish) is an open question. We are currently training models on German parliamentary tweets from 2017 in order to evaluate the potential utility of our approach for understanding politicians’ public-facing rhetoric across different languages and country contexts.

Evaluating Non-Policy Related Topics The dataset we used to train the supervised model includes additional human-labeled binary tags indicating personal relationship

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Model 2</th>
<th>Cohen’s Kappa Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsupervised</td>
<td>Supervised</td>
<td>0.012</td>
</tr>
<tr>
<td>Unsupervised</td>
<td>Hand-Labeled</td>
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</tr>
<tr>
<td>Supervised</td>
<td>Hand-Labeled</td>
<td>0.960</td>
</tr>
</tbody>
</table>

Table 5: Comparing Model Output to Manual Labels
or service-related content in the 113th Congress’ tweets. Interestingly, many of these manual tags reflected similar personal relationship or service-related tags that our unsupervised model independently detected. Future work could compare these results—manual labels and unsupervised labels—for this relational content and potentially inform another useful computational tool.

Model Improvements. Our next steps involve evaluating whether alternative topic modeling techniques can achieve even more nuanced topic results. One such approach may include implementing Moody’s lda2vec approach (Moody 2016). Moody’s approach builds upon word2vec’s ability to determine word to word relationships in order to augment LDA’s ability to determine word to document relationships by building document-level abstractions. Nikita compared the lda2vec’s returned topical output with a genism LDA model’s returned output (Nikita, 2016). His replication attempt provided a helpful example of comparative model im-
Niu’s work with topic2vec modeling explores ways to address the issue of uninterpretable output from LDA models (Niu et al., 2015); he notes that because LDA assigns high probabilities to words occurring frequently, those words with lower frequencies of occurrences are less represented in the derivation of topics, even if they have more distinguishable semantic meaning than the more frequently occurring words. In a similar approach to Moody, Niu tries to combine elements of word2vec and LDA modeling techniques to address the issue of under-specific topics resulting from pure LDA methods. His topic2vec approach yields more specific terms (i.e., where LDA yields patients and medical in each of two topics when run on a particular dataset, topic2vec yields aricept, memantine, and enbrel in one topic and anesthesiologists, anesthesia and comatose in a second topic with the same dataset). We did not pursue topic2vec in our tests due to replicability issues encountered with the methodologies proposed, but they offer an interesting avenue to explore in attempts to improve the model.

**Conclusion**

We provide computational models to facilitate research on political attention in social media. The supervised model classifies tweets according to the CAP codebook, enabling comparative analyses across political systems and reducing the labor required to label data according to this common codebook. The unsupervised model labels tweets according to their policy topic, social function, and behavior. It enables nuanced analyses of U.S. Congress, especially the intersection of their policy discussions and relationship building.

Together, these two models provide methodological tools for understanding the impact of political speech on Twitter and comparing political attention among groups and over time.
References


Moody, C. E. 2016. Mixing dirichlet topic models and word embeddings to make lda2vec.


