Government websites as data: A methodological pipeline with application to the websites of municipalities in the United States

Markus Neumann Fridolin Linder Bruce Desmarais

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Abstract

A local government's website is arguably the most important general source of information about policies and procedures for residents and other community stakeholders. Accordingly, government websites have become prominent sources of data for a variety of research agendas in public administration, public policy, and political science. Existing research has relied on manual methods of website data collection and processing. However, reliance on manual collection and processing limits the scale and scope of website content analysis. We develop a methodological pipeline that researchers can follow in order to gather, process, and analyze website content with established text analysis techniques. First, for the acquisition of website data, we cover approaches to automated scraping methods. Second, pre-processing is a particularly vital step in text analysis, but when websites are concerned, additional measures need to be taken in order to guard against potential sources of bias. We propose a new method for dealing with the types of duplicated and boilerplate contents that are commonly found in government websites. We illustrate our methodological pipeline through the collection and analysis of a new and innovative dataset—the websites of over two hundred municipal governments in the United States. We build upon recent research that analyzes how variation in the partisan control of government relates to content made available on the government's website. Using a structural topic model to analyze municipal website contents, we find that websites of cities with Democratic mayors include more information about policy deliberation and crime control, whereas websites from cities with Republican mayors include more information about the provision of basic utilities and services such as water, electricity, garbage removal and fire safety; and information on municipal ordinances and policies.

1 Introduction

Local governments convey voluminous information about all aspects of their policymaking, policy implementation, and public deliberation, via their official websites. The vital role of official websites in connecting the government and the governed has motivated a wave of research on the contents of government websites (e.g., Grimmelikhuijsen 2010; Wang, Bretschneider and Gant 2005; Osman, Anouze, Irani, Al-Ayoubi, Lee, Balcı, Medeni and Weerakkody 2014). Despite the

potential for automated scraping of website contents, the conventional approach to data collection in projects focused on government websites involves manual content extraction from each website in the dataset. Though highly accurate, the manual approach to data collection is costly, and cannot be scaled to capture even a fraction of the volume of content available on government websites. In this paper we present a methodological pipeline that can be used to automatically scrape government websites in order to build datasets that can be used for text analysis. We provide an illustrative application in which we explore the ways in which the textual contents on city government websites in six American states (IN, LA, NY, WA, CA and TX) correlate with the partisanship of the city mayor.

Though there exists a variety of software tools that are designed to automatically scrape all of the files available at a website (Glez-Peña, Lourenço, López-Fernández, Reboiro-Jato and Fdez-Riverola 2013), raw website downloads have to be processed significantly before the files are adequately prepared for content (e.g., text, image) analysis. We describe and provide solutions to two central challenges in automatically gathering and analyzing website textual contents. First, plain text must be extracted from the files. This involves purging the files of syntax in HTML and other programming languages, and discarding any other character encoding errors that result from reading the files. This challenge would arise in any context in which researchers sought to study the textual contents of websites, and is not unique to comparative analysis of government websites. The second challenge we address in our methodological pipeline is, however, specific to the research objective of comparing websites on the basis of a common lexicon. For any two governments, the textual signatures that most dramatically differentiate the textual contents of their websites consist of what we can call "boilerplate" text—header, footer, or other titling text that is designed to identify the website as being associated with a specific government entity (e.g., "Welcome to the city of Santa Cruz", "The City of Los Angeles welcomes you"). This boilerplate text is replicated across many files that are associated with a government's website, but it provides little

information regarding the form and/or function of the government. The second methodological innovation we offer in our pipeline is designed to minimize the impact of this boilerplate text on the comparative analysis of government website content.

Government websites provide information about how public policies shape the lives of local residents, and how local residents can engage with government to shape public policy. As such, government websites reflect both the results of, and inputs to, the political leadership in the city. In our illustrative application we explore the ways in which the contents of city government websites differ on the basis of the partisanship of the city's elected executive. A substantial body of research has found that the partisanship of the mayor affects city governance along multiple dimensions, including city budget priorities (de Benedictis-Kessner and Warshaw 2016), policies affecting inequality in cities (Einstein and Glick 2016), and framing of criminal justice policy (Marion and Oliver 2013). Furthermore, recent media coverage of changes to government websites that follow transitions in party control suggest that changes in web content are salient government actions, as perceived by the general public (Sharfstein 2017; Kirby 2017; Duarte 2017) . We study whether significant differences between city governments based on mayoral partisanship are reflected in the contents of city websites.

2 The Significance of Government Website Content

According to Mayhew (1974), politicians engage in advertising, credit claiming and position taking in order to get re-elected. Official city websites allow mayors to perform all three of these functions. Their offices frequently take a prominent position on the front page, and many websites also feature a picture of the mayor. We present an example of this in Figure 1. The Erie, Pennsylvania website homepage presents an image of Democratic mayor, Joseph Schember, along with a list of laudable attributes of the city. In local politics, where campaign funds are low, this lends incumbents a crucial advantage in becoming more well-known among their constituencies.

Figure 1: Screenshot from the homepage at http://www.erie.pa.us/, accessed on 06/14/2018. Image depicts Democratic mayor of Erie, PA, Joseph Schember.

Furthermore, municipal politics gives incumbents clear and tangible achievements they can point to, such as completed infrastructure projects, the acquisition of federal or state funding, or the hosting of city-wide events. City websites present an opportunity for local officials to brandish these accomplishments. Finally, they also give mayors a platform from which they can advertise their political beliefs. On municipal websites, this may not manifest in the form of brazen partisanship, but more subtle avenues are available. As noted by Einstein and Glick (2016), there are stark differences in the spending preferences of Democratic and Republican mayors. City websites can then be used to communicate the stance of a mayor on social or economic programs. Another advantage of websites with regard to communication is that unlike direct social interactions, officials have full control over them.

Members of the public visit municipal government websites for a wide variety of purposes Sandoval-Almazan and Gil-Garcia (2012), and with significant regularity. In a survey conducted among a random sample of citizens in the state of Georgia in 2000—nearly two decades ago—

found that 25% of internet users reported visiting a local government website in the previous twelve months (Thomas and Streib 2003). Furthermore, the use of a local government website is associated with an individual's perspective on government. Tolbert and Mossberger (2006) finds that users of local government websites are more likely to trust local governments, and hold other positive attitudes related to local and federal governments. Lastly, in a study of residents of Kansas City, Missouri, Ho and Cho (2017) find that participants' perceived quality of the city website is strongly associated with their perceptions of the overall effectiveness of the City's communication with the public.

The existing research that uses scraped websites provides an indication of the theoretical value of empirical analysis of web contents produced by governments, public officials, and candidates for office. The most pertinent literature to our research is the e-governance literature, which focuses on the online presence of governments from a usability and public service point of view. For the most part, research in this category develops a classification scheme to rate websites in terms of accessibility, ease-of-use and function, and then hand-codes a set of websites according to these criteria (e.g., Urban 2002; Armstrong 2011; Feeney and Brown 2017). As an example, Grimmelikhuijsen and Welch (2012) study local government websites with the goal of uncovering how they aid the goal of transparency. To this end, they analyze a set of Dutch municipalities in which air quality had deteriorated. The authors test whether local governments provide citizens with information about potential complications and solutions associated with this issue. Like most e-government studies however, this publication does not make any use of automated text analysis.

The websites of politicians and their parties have also fallen under scholarly scrutiny. Researchers have found that in order to identify the constituencies, motives and modes of communication of these actors, their websites can be very illuminating sources of information (Druckman, Kifer and Parkin 2009; Druckman, Hennessy, Kifer and Parkin 2010; Cryer 2017; Esterling, Lazer and Neblo 2011; Esterling and Neblo 2011; Norris 2003; Therriault 2010). Druckman, Kifer and

Parkin (2009); Druckman et al. (2010) rely on the *National Journal* to find the websites, then hand-coded them. Cryer (2017) mentions that she relied on Archive-it, a webservice of the Internet Archive. Though the Internet Archive may provide extensive coverage of high profile officials or national governments, we found that its coverage of municipal government websites was sparse and irregular. Esterling, Lazer and Neblo (2011); Esterling and Neblo (2011) rely on hand-coded data by the Congressional Management Foundation, a nonprofit organization which aims to assist Congress. Therriault (2010) use automated text analysis, and also has the most extensive overview of the associated methodology. However, the division of the website into sections (home page, topics, issues, details) is done by hand. The author acquired the websites from the Library of Congress (which only collected them from legislators who actually consented, and Therriault notes that this causes nonrandom missingness).

Important to our methodological objectives, research analyzing and improving the scraping, pre-processing and text analysis pipeline that is applicable to government websites is still in its infancy. Eschenfelder, Beachboard, McClure and Wyman (1997) provide something of an overview of how how federal websites should be assessed from an e-governance point of view, but they largely focus on the substantive criteria that should be fulfilled, rather than the technical aspects of website acquisition and analysis. In what follows we first define the target dataset—the textual contents of websites of United States municipalities, along with associated metadata on the municipalities and their governments. We then define a pipeline for data collection and analysis that includes methods to access government website URLs, scrape their raw contents from the World Wide Web, gather plain text from the website files, and identify boilerplate text within the plain text contents. Lastly, we illustrate the analysis of municipal government website text by exploring the relationship between the city mayors' party affiliations and the topical contents of the websites.

3 Data: US Municipal Government Website Text

In this section we introduce the data we use in our application. For data availability reasons, on which we elaborate below, we focus our analysis of municipal websites on six states—Indiana, Louisiana, New York, Washington, California and Texas. These states provide us with a sample that is well-balanced on a number of theoretically important indicators. One, each of the four geographic regions is represented with at least one state. Two, we have a fairly well-balanced sample with respect to the urban/rural cleavage, as both major cities and less densely populated areas are covered. Furthermore, the sample is politically balanced—we have three blue states (CA, WA, NY) and three red states (TX, IN, LA). Finally, our dataset contains some of the wealthiest states (NY, CA, WA and TX are #2, #8, #9 and #16 respectively, by GDP per capita (Bureau of Economic Analysis 2017)), but also some of the poorer ones (IN and LA).

We acquired the website URLs from two sources: One, we scraped the URLs of city websites from their respective Wikipedia pages, which we found from lists of cities contained within each state. Two, the General Services Administration (GSA) maintains all .gov addresses, and provides a complete list of all such domains to the public. [1] The data from the GSA contains the following variables: (1) domain name, specifically, the all-uppercase version of domain and top-level domain (for example, 'ABERDEENMD.GOV'); (2) the type of government entity to which the domain is registered, such as city, county, federal agency, etc; (3) for federal agencies, the name is specified; (4) the city in which the domain is registered. Naturally, the GSA's list does not contain cities which do not use a .gov website (or, in many cases, a city owns a registered .gov address, but uses a different one). Furthermore, some of the links are non-functional, and some of the county websites on the list are incorrectly marked as city websites (and vice versa). Since the GSA data is less complete and less reliable than the URLs found on Wikipedia, we mainly rely on the former,

[1] The dataset is made available at https://github.com/GSA/data/tree/gh-pages/dotgov-domains. This list is updated once per month—we rely on the version released on January 16, 2017.

and only supplement them with the GSA data if a specific city doesn't have a URL recorded on Wikipedia, or our tests (see below) find it to be non-functional.

To test whether the websites we found actually work, we use a webdriver-controlled browser - a browser that is automatically controlled by a program rather than a human user. We use the Python bindings for the program `Selenium`, which we use to control `Firefox` through the webdriver `Geckodriver`. This is advantageous compared to conventional scraping tools such as `Beautiful Soup` or `Rvest` because most websites are designed to be explored by browsers. Modern browsers perform a lot of actions behind the scenes, such as URL resolution and redirection. Scrapers can perform most, but not all of such operations. The use of a webdriver-controlled browser is necessary in our case because a) some city websites simply don't work, but they don't always output an error code correctly (this can fail, for example, if a webmaster simply stops maintaining a site without removing it entirely) which would throw off an automatic scraper, and more often, b) cities sometimes change their websites' URLs, in which case they redirect from the old to the new URL. A webdriver-controlled browser, unlike the more rigid conventional scraping tools, will simply follow this redirection. This allows us to subsequently record and use the new URL for the actual website scraping. Consequently, an automated browser allows us to robustly answer the following questions: Is the website actually there? Does it work? If not, is it somewhere else or is it broken? We record this information and construct a list of verified URLs.

To download the websites, we rely on the Unix command line tool `wget`. This program is used to download files from the Internet, and with the use of a recursive option, acts like a webcrawler and scraper. This means that `wget` scrapes HTML files, parses them and then follows the links contained therein. Then it follows those links, and repeats the process until it has constructed a complete tree of the website (note that the program is instructed to stay on the same domain). This way, all the files that make up a website are downloaded. For some cities, whose websites make heavy use of JavaScript, this method does not lead to satisfying results. Consequently we restricted

our corpus to cities with at least 3 documents.

The partisanship of the mayor of each city is coded in different ways, depending on the state. For Indiana, where elections are nominally partisan, this information is accessible through the state government's website[2]. For Louisiana, we received data on the outcomes of mayoral elections from the Local Elections in America Project (LEAP) (Marschall and Shah 2013). For the other states, where mayoral elections are not nominally partisan (but the partisanship of the mayor is still well-known), we employed different means: For New York and Washington, we searched the state campaign finance websites, and coded the parties of the candidates based on the party committees from which they received donations. For California and Texas, where our data consists of highly populated cities, partisanship information was acquired from Ballotpedia[3]. Finally, we also scraped mayoral partisanship from the cities' Wikipedia pages. When compared to the other data sources above, (and manual searches in case of conflicts) Wikipedia proved to be very reliable, and added additional cases to our dataset even for Indiana and Louisiana. Generally speaking, we found data scraped from Wikipedia, aided by manual corrections in case of missing or conflicting data, to be more reliable than data from governmental sources. The partisan breakdown of city websites is depicted in Table 1. The dataset is has a relative party balance, with variation in each state.

State	Democratic	Republican
California	9	6
Indiana	46	54
Louisiana	28	17
New York	36	16
Texas	2	7
Washington	11	2

Table 1: Descriptive statistics on the partisanship of the cities in the corpus.

One of the more subtle aspects of local government is the presence of different types of govern-

[2]http://www.in.gov/apps/sos/election/general/general2015?page=office&countyID=1&officeID=32&districtID=-1&candidate=

[3]https://ballotpedia.org/List_of_current_mayors_of_the_top_100_cities_in_the_United_States

ment structures. Between council-manager governments and mayor-council governments (Morgan and Watson 1992)—either in the weak or strong mayor variant (DeSantis and Renner 2002)—there is a certain degree of variance in where a city's executive authority lies. Unfortunately we do not have access to information about the type of governments across the breadth of our dataset and therefore cannot explore heterogeneity in the relationship between mayoral partisanship and municipal website contents based on the executive system variant. Given the prominent place that mayors tend to have on their cities' websites, we feel that any bias arising from this nuance should be minor. Information on other covariates (population and median household income - from the American Community Survey 5) was acquired through the API of the U.S. Census Bureau[4].

4 The Web to Text Pipeline

Once we have gathered the website files, we have the raw data necessary for text analysis, but it is not yet formatted effectively. In this section we describe our pre-processing pipeline, with which we take an archive of website files, and output a corpus of formatted plain text files that are suitable for comparative analysis with text as data methods. In this methodological pipeline we address two methodological challenges. First, though they contain significant amounts of text, websites are not comprised of clean plain text files. Rather, the files available at websites are of multiple types, including HTML, PDF, word processor, plain text, and image files. The first step in the methodological pipeline is aimed simply at extracting clean plain text from this heterogeneous file base. The second step in our methodological pipeline is to process the text to remove boilerplate language—language that is effective at differentiating one website from another, but is uninformative regarding policy or politics differences between governments.

[4]https://www.census.gov/data/developers/data-sets.html

4.1 Site to Text Conversion

For the most part, the file type of a document can be correctly determined through the filename ending—its extension. However, there are exceptions to this, which, if ignored, can lead to large amounts of improperly formatted text, arising from incorrectly converted documents, which leads to a general decrease in the amount of usable data. Two issues in particular need to be addressed: One, HTML files on city websites frequently do not have an ending, but are still perfectly readable if correctly identified as such. Second, some documents contain the incorrect file ending. For example, we found thousands of documents that ended in .html, when they were actually PDFs. To accurately assess their type, we rely on the R package `wand` (Rudis, Zoulas, Rullgard and Ong 2016), which is an R interface to the Unix library `libmagic` (Darwin 2008), which determines the type of a file on the basis of its file signature - or "magic number". This short sequence of bytes at the start (and sometimes end) of files is unique for each file type and therefore allows its correct identification through computer forensics tools such as `libmagic`.

Consequently we rename all documents so that their file ending reflects their actual file type. This is strictly necessary, because we rely on the `readtext` R package (Benoit and Obeng 2018), which determines a document's type solely through its ending—to convert the files to plain text.[5] The breakdown of the files by type is given in Table 2. The most frequent file types are HTML and PDF, from which we are able to extract a substantial amount of usable text. Files of type XML, DOC, TXT, and DOCX, also occur regularly in our corpus and offer a considerable volume of textual data.

The text documents are then read into R line by line, converted to UTF-8 and then stripped of dates, punctuation, numbers and words connected by underscores. At this point, the documents of one city still closely resemble one another in the form of boilerplate content, be it website elements (i.e. "You are here", "Home", "Directory" etc.) in html documents, or commonly used forms

[5] We have also experimented with several Unix-based alternatives, but found that they largely led to the same results as `readtext`.

Filetype	Occurances Before	Occurances After
html	211682	887362
pdf	464842	638802
jpg	0	36958
xml	0	29638
Other	162681	9475
ics	435	8950
png	0	8863
doc	6972	8430
txt	317	6025
	793990	5234
docx	3137	4319
TOTAL	1644056	1644056

Table 2: Number of files per type, before and after detecing them via their magic number. The table shows that a lot of files originally have the wrong type, and that converting them correctly has a large impact on how many of them end up being usable.

or phrases in pdfs, doc and docx files. This is an issue, because this boilerplate content causes the results of analyzing this data with text analysis methods to characterize documents primarily by the cities from which they originate, and not the substantive features of their contents. In other words, the signal would be drowned out by the noise. Our solution to this problem is described in more detail in Section 4.2. Preprocessing further includes setting every character to lowercase, as well as the removal of bullet points which frequently occur in html documents, extraneous whitespace, xml documents mislabeled as html files, and empty documents. Furthermore, some documents contain gibberish, often as a result of faulty or impartial optical character recognition applied to text that was produced through a non-machine-readable medium. To combat this problem, we employ two solutions. One, we use spellchecking, implemented through the `hunspell` R package (Ooms 2017), to remove all non-English words.[6] However, `hunspell` does not cover everything, either because some tokens are not actual words (for example artifacts from defective encoding), or

[6]Some of the cities, for example Los Angeles, do contain a sizable proportion of Spanish content. The analysis of this content is beyond the scope of this paper, but could be explored in future work, for example relying on multilingual word embeddings.

because random sequences of characters just so happen to form words that exist in a dictionary (for example "eh" or "duh"). Since we rely on a bag-of-words model in which syntax does not matter, we can ameliorate these problems by removing all text except for whitespaces and the characters that appear in the English alphabet. Since a lot of the nonsensical text tends to be quite repetitive, we also delete all documents in which the proportion of unique to total number of tokens is less than 0.15. Furthermore, `hunspell` does not spellcheck individual characters or two-character words, so we remove these token types entirely. Since these pre-processing steps reduce documents which are largely unsuitable to only a few tokens (i.e., word occurrences), we also remove all remaining documents containing less than 50 tokens. Finally, to remove words that are extremely rare (which also has the advantage of eliminating any remaining oddities) and thus add nothing substantive to our models while increasing their computational cost, we also discard any token types that occur in only one document. We also conduct lemmatization to reduce words to their basic form. Lemmatization is similar to stemming, but works in a somewhat more sophisticated manner by taking grammar and surrounding words into account to identify the dictionary form of a word. For example, the lemma of the word “lemmatization” would be “lemmatize”, whereas most stemmers would simply chop off the ending, which would yield “lemmatiz”. Thus, lemmatization makes the results more easily comprehensible. To this end, we rely on the R package `spacyr`, which provides an R implementation of the Python library `spaCy`.

4.2 Boilerplate Removal

As noted above, city websites contain a large amount of text that is uninformative for its actual content and therefore a hindrance to correct analysis by automatic text processing methods. This is a common issue with textual data in which informative content is embedded in technically structured documents. See, e.g., Burgess, Giraudy, Katz-Samuels, Walsh, Willis, Haynes and Ghani (2016); Wilkerson, Smith and Stramp (2015) and Linder, Desmarais, Burgess and Giraudy

(Forthcoming) for examples of boilerplate removal in the analysis of legislative text. In the case of websites, lines in documents are generally quite informative, so all of our boilerplate removal efforts are done at the line level.

Boilerplate Classification

In order to determine whether a line should be discarded, we train a classifier on a human-coded sample. We sampled 100 lines from documents in each of the following five cities: Los Angeles, CA, Indianapolis, IN, New York, NY, Shreveport, LA, and Seattle, WA. To ensure that lines which occur more frequently in these cities (sometimes hundreds of thousands of times) had a higher probability of being scrutinized by the classifier, we use sampling weights equivalent to the proportion of total lines in a city's corpus made up by each specific line type. As an example, the most common line throughout all pages of the city of Seattle consists only of the word "total" and occurs 103,068 times. Similarly, the line "page" occurs 58,833 times. Even something completely nonsensical such as "a a" still appears on 376 occasions. To account for the higher likelihood of some lines being part of the training set, we use inverse probability weights in training the classifier—the weight of each line in the sample is 1/[number of occurrences in the corpus].[7]

These 500 lines were then hand-coded as either substantively informative (210 lines) or not (290 lines). We then trained a number of different classifiers with this informativeness measure as the dependent variable. The independent variables we use are: (1) number of times the line was duplicated within the city, (2) the length of the line, in characters, (3) the number of tokens in the line, and (4) the median distance from the document midpoint to the position of the line itself. The purpose of these covariates is as follows:

- **Line length:** The length of the line and the number of tokens are ways to find lines consisting of only a word or two. This is highly predictive of lines which are used as website headers and

[7]Note that the performance of the classifier is robust to the use of these weights and only changes by about one percentage point if they are not used.

navigational elements, which are of of zero substantive interest to us, but are very effective at differentiating cities. These terms also happen to be fairly common, which causes them to be overweighted by the topic model.

- **Number of line duplications:** To directly address the latter problem, we include a measure of the number of times a line is duplicated within a city. Many lines occur hundreds or even thousands of times on a single website, and therefore are terms that are highly predictive of the website, which causes the topic model to find topics that are highly predictive of cities, but not substantively informative.

- **Line position in the document** Since boilerplate terms such as navigational elements, headers, footers, and so on, should occur more frequently at the beginning and the end of websites, we attempt to identify such content as following: We measure the distance between the midpoint of a document and the position of a line, expressed as quantiles (to account for differing document lengths). Since lines can occur in multiple documents, or multiple times in the same document, we take the median of these measures. Thus, for example, a line which often occurs at the beginning of documents might have a score of 0.45, whereas a line that tends to be found more in the center, and thus be indicative of more relevant content, might be scored with a 0.11 instead.

	Value
Percent Correctly Predicted	0.87
Precision	0.87
Recall	0.91
F1-Score	0.89

Table 3: Performance metrics for random forest boilerplate classifier, with inverse probability weights.

We rely on a random forest as the final classifier, which offers slightly better performance than

logistic regression.[8] We assess performance of this classifier through five-fold cross-validation. This means that the classifier is trained on 400 samples and then tested on the held-out set of 100, measuring metrics such as percent correctly predicted, precision, recall, and F1 score. This procedure is carried out five times, so that each sample is part of the test set once. The aggregated (mean) results of this process can be found in Table 3. For the implementation of this method, we rely on the R package `caret`, whose random forest classifier is based on the package `ranger`. We use this classifier to flag and remove all lines that are not classified (based on a threshold of $p = 0.5$) as substantively meaningful. The effect of this process on the corpus is illustrated with the corpus of Anchorage, AK (i.e. a city that isn't part of our sample used in the analysis) as an example in Figures 2 to 5. Before the lines identified by the classifier as boilerplate are removed, lines with very few characters and words are the most common. After the removal, the distribution has changed—lines of medium length now occur more frequently than extremely short ones, which are unlikely to be substantively meaningful (see figures 2 and 3). Furthermore, lines that are duplicated only a few times rather than dozens, hundreds or even thousands are now more common (see figure 4). Finally, the position of the line within the documents is not as important to the random forest, and this also shows in the results. However, this feature still has a positive effect, as lines at either end of the document are a bit less common now (see figure 5). [@markus, this is an excellent demonstration of the effect of the classifier. When you get a chance, would you also add a table listing the top 10 most likely boilerplate lines—to provide face validity that we are accurately flagging boilerplate?] After all the preprocessing is set and done, our corpus consists of 259,099 documents.

[8] We also tried SVM, boosted trees and AdaBoost, with similar results and chose the random forests because this method has a probabilistic basis and is more intuitive.

Figure 2: Effects of the boilerplate classifier on the corpus of the city of Anchorage, AK.

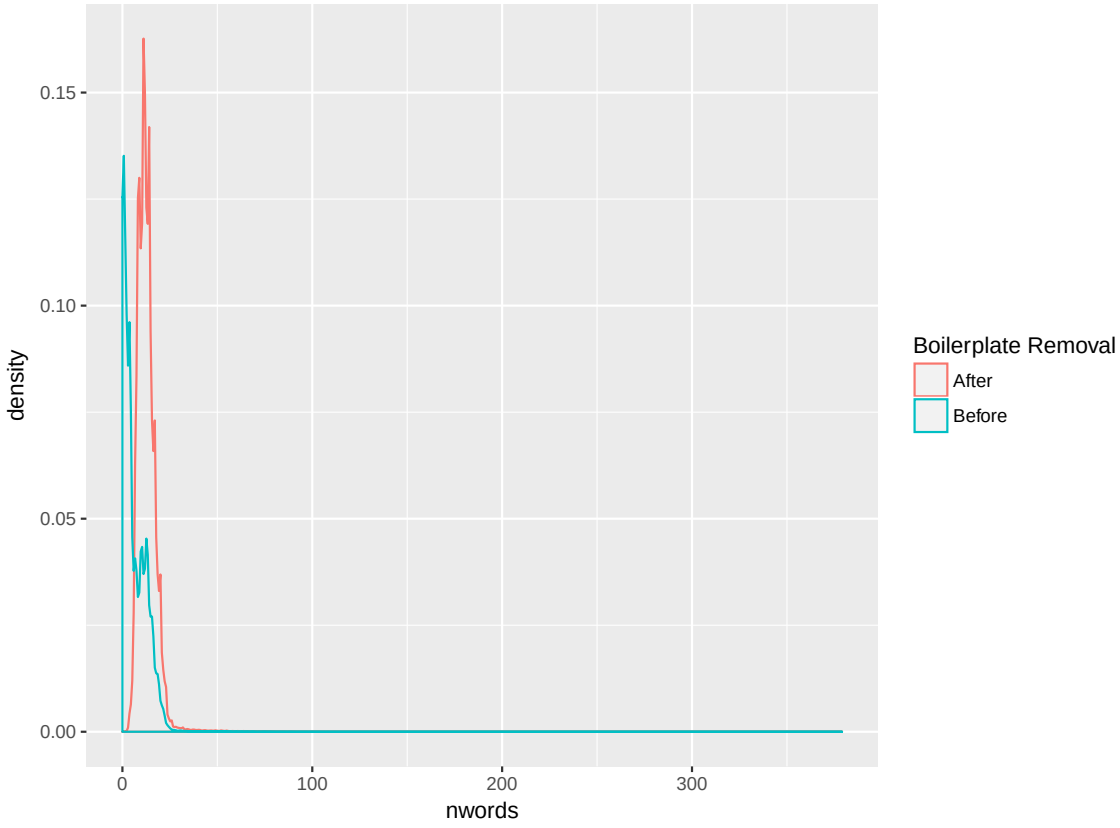


Figure 3: Effects of the boilerplate classifier on the corpus of the city of Anchorage, AK.

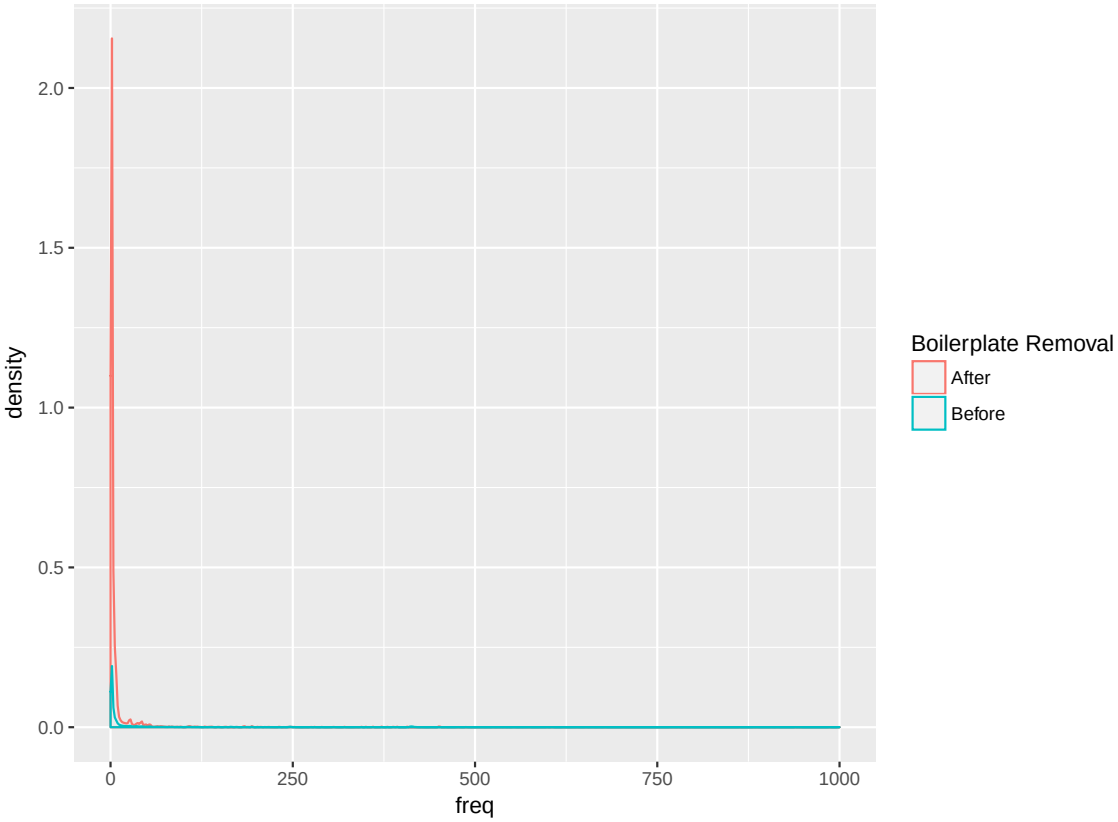


Figure 4: Effects of the boilerplate classifier on the corpus of the city of Anchorage, AK.

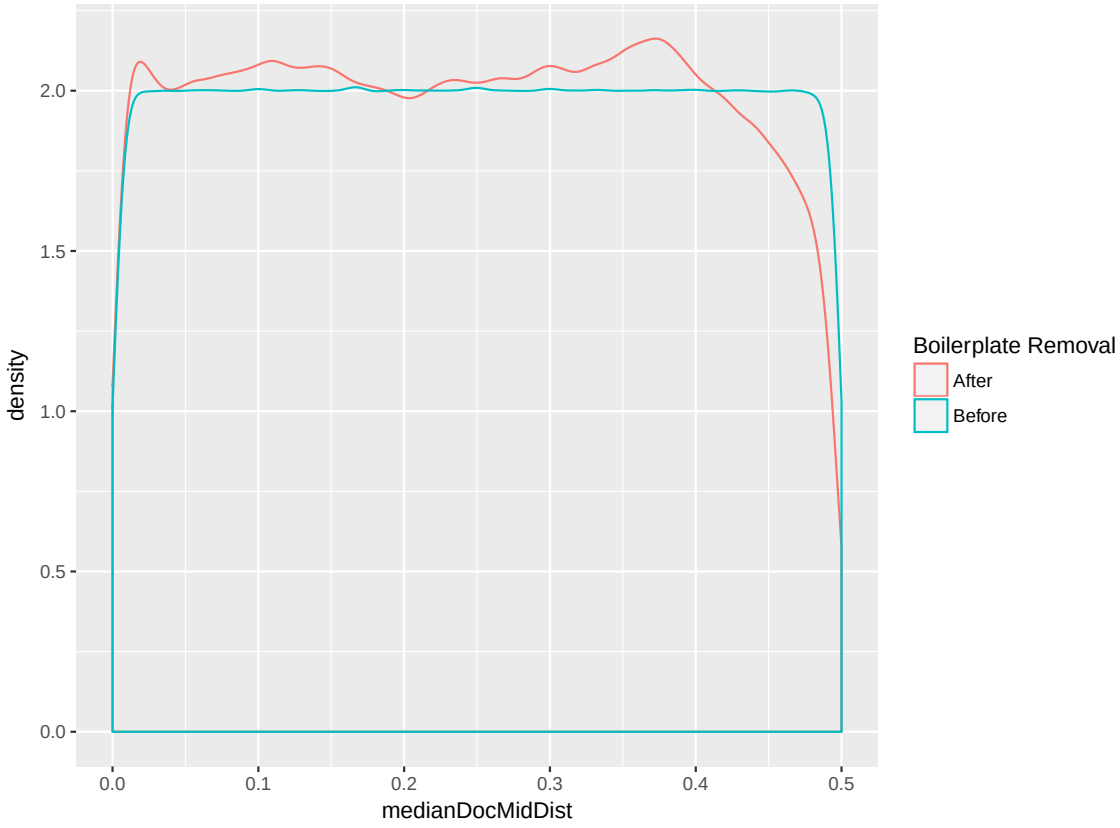
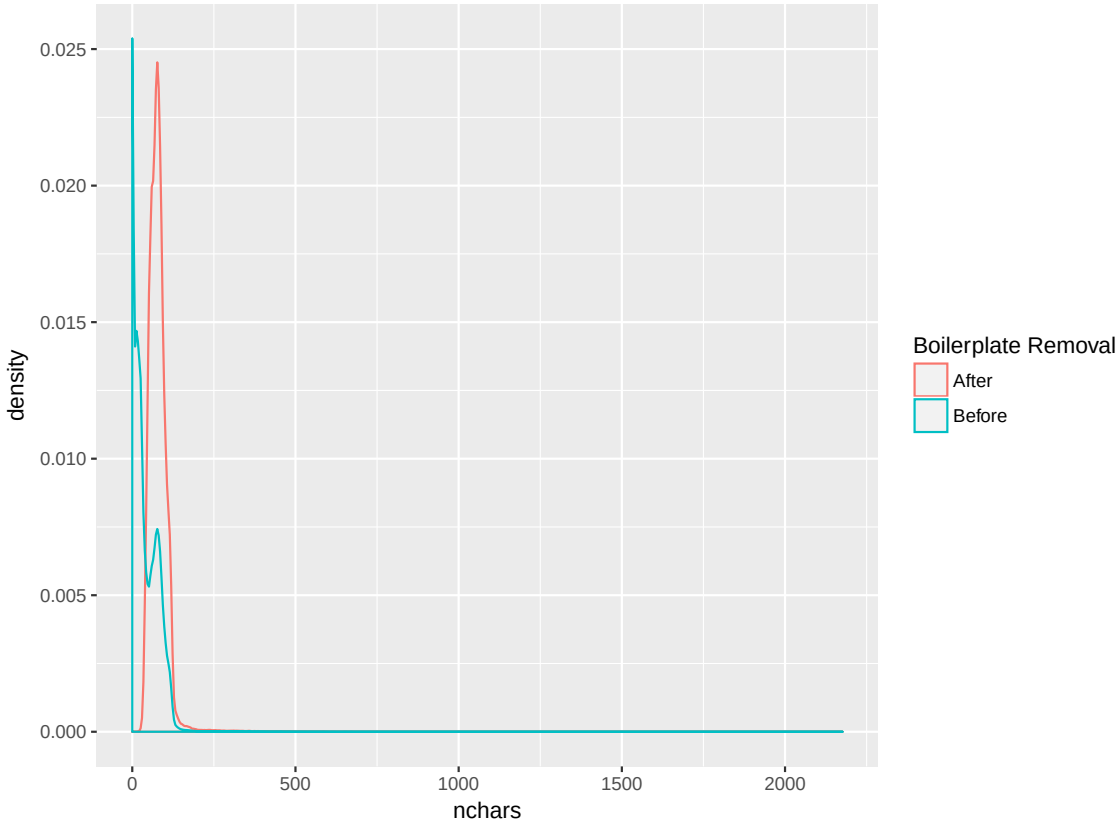


Figure 5: Effects of the boilerplate classifier on the corpus of the city of Anchorage, AK.



5 Partisan Language on Municipal Websites

We illustrate the analysis of municipal website content by studying differences in website content based on the party of the mayor. As we reviewed above, the partisanship of the mayor has been found in past research to affect several features of city governance. However, Gerber and Hopkins (2011) note that, due to the constraints of state and national policies, municipalities lack discretion in many domains of governance. They find that cities with Democratic mayors spend a smaller share of their budgets on public safety, but that mayoral partisanship does not appear to be significantly related to spending in most other areas, where cities have less discretion. As opposed to budget allocation or even the presence/absence of policies, cities have a great deal of discretion regarding what is emphasized on their websites, and how policies are framed. Since (1) city governments have great discretion in composing their websites, (2) modifying website content is low cos relative to other policy changes, and (3), as reviewed above, city websites provide an effective and often-used means of communication with city residents.

5.0.1 Analytical approach: Structural topic modeling

In order to analyze content differences of government websites based on mayoral partisanship, we draw upon a recently-developed class of text-as-data methods, the structural topic model, developed by (Roberts, Stewart, Tingley, Lucas, Leder-Luis, Gadarian, Albertson and Rand 2014). Building on the conception of "topics" in Latent Dirichlet Allocation, in the structural topic model a topic is a multinomial distribution defined on the word types in the dictionary. Each word occurrence in a document is attributed with a single topic label. The word topic assignments are also drawn from a multinomial distribution. The log-odds of the topic probabilities in each document-specific multinomial distribution over topics are drawn from a multivariate normal distribution in which the topic-specific means are determined by a linear regression function that associates document-attributed covariates with topics. For example, in the context of municipal website con-

tent, the structural topic model can be used to estimate a regression coefficient that defines the linear relationship between the log-odds of the municipality's population and the log-odds of each topic. For our primary empirical investigation, the structural topic model provides with a tool with which to estimate the relationship between the party of the city's mayor and the prevalence of each topic we estimate. A topic interpreted through post-hoc analysis of the collective meaning of the most likely words to be drawn from the multinomial distribution defined by the respective topic.[9]

The structural topic model is implemented in the R package `STM` (Roberts, Stewart and Tingley 2018). We use 60 topics—the number recommended by the authors [@markus, please add a cite to the specific document in which this number is suggested?] for medium- to large-sized corpora. Since our corpus is at the larger end of that spectrum, the appendix also contains the results of a model with 120 topics, which corroborates the findings of the one presented here. We use four covariates: First, *party*, to estimate the difference in topic prevalence based on whether mayors are Republican or Democratic. Second, *city population*, which the literature frequently emphasizes as a determinant of the issues a city faces (see, for example, Guillamón, Bastida and Benito (2013)). Third, we control for wealth by relying on *median income* as a covariate, which we use as a proxy for the tax base in a city. Fourth and finally, we include state dummy variables, which should account for language that is associated with state-specific issues, and general background variables that vary across states.

5.0.2 Structural topic model results

The results are shown in table **??**. The rows of the table are sorted so that the most Republican topics (marked by a deeper red color) appear at the top, and the most Democratic ones (blue) at the bottom. The degree of partisanship shown in the table is determined by the size and direction

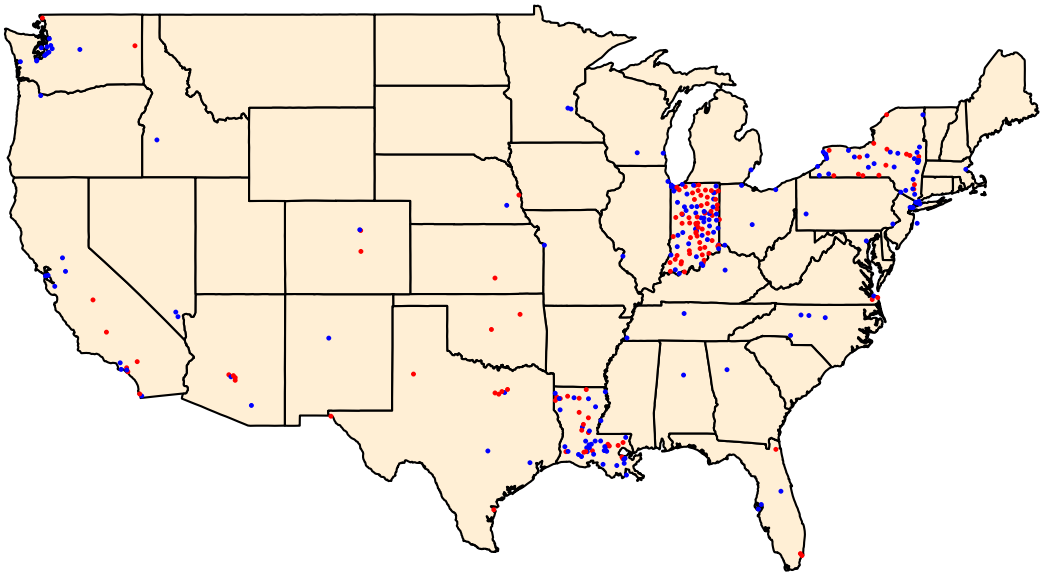
[9]The "Fightin' Words" methodology developed by Monroe, Colaresi and Quinn (2008) could also be used to analyze word-frequency differences between cities based on mayors' partisanship, but we elected to use the structural topic model since, unlike "Fightin' Words" , the structural topic model enables us to adjust for several other features through multiple regression.

of the coefficient of the party variable for each topic. The topics that are entirely white have 90% credible intervals on the effect of mayoral party that include zero. [@markus, do the results from the stm package allow us to say anything about whether the overall fit of the model improved from adding party? if so, can we mention that?].

Many of the topics associated with Democrats fit with what we understand to be national party priorities. Topic 21, on affordable housing, clearly resonates with the Democratic party's appeal to low-income voters. Similarly, employee rights are represented in Topic 47. Democrats also exhibit a strong preference for words related to public finances, such as Topic 32 ('budget', 'revenue', 'expenditure') as well as Topic 19 ('debt', 'bond', 'financial'). We suspect that the association of Democratic mayors with finance-related terms is indicative of a greater willingness to emphasize the city's efforts to raise and spend money. This finding is consistent with (Einstein and Kogan 2015), who show that Democratic mayors tend to favor greater spending. A second, consistent Democratic focus appears to be law enforcement: The most Democratic topic, 55 ('robbery', 'homicide', 'sergeant') (a comparable topic is also the most Democratic topic in the model with 120 topics in tables 5 and 6 of the Appendix) depicts Democrats' complicated relationship with law enforcement. On the one hand, Democratic partisans have a more negative perception of the police, rating it considerably more negatively on the appropriate use of force and the equal treatment of minorities (Brown 2017). On the other hand, the literature has also shown that cities with a higher Democratic vote share spend more on the police, even after controlling for crime (Einstein and Kogan 2015). Finally, Democrats also focus more on the deliberative process of policymaking, as topics 31 ('agenda', 'committee'), 34 ('comment', 'draft', 'feedback'), 48 ('absent', 'aye', 'nay'), and 37 ('audit', 'procedure', 'oversight') attest to. This openness regarding the policy process on behalf of cities with Democratic mayors fits with the findings of Grimmelikhuijsen and Welch (2012), which are that left-wing local governments exhibit greater transparency via website content.

City websites with Republican mayors, meanwhile, exhibit a pronounced focus on the essential functions of government. Basic utilities such as energy (Topic 7), fire protection (Topic 17), drinking water (53), and garbage removal (Topic 49) are included among those topics that are more prevalent in cities with Democratic mayors. Similarly, protecting citizens from natural disasters is a focus in topics 1 ('storm', 'runoff', 'drainage') and 42 ('breastfeed', 'infection', 'mosquito' – and so, essentially, about the Zika virus), which may reflect the greater prevalence of Republican mayors in the southeast, a region which is more often affected by hurricanes and tropical diseases.

Figure 6: Cities in the corpus, by partisanship of mayor. **REVISE to remove everything not in our six states.**



6 Conclusion

We have developed a methodological pipeline for automatically gathering and preparing government websites for comparative content analysis. This methodology holds the potential to vastly scale up the data collection efforts underpinning the growing body of research that is focused on government website analysis. The methods involved in the pipeline include checking the integrity of the site addresses, extracting english language from website contents, identifying document types, and removing boilerplate language. Through an application to the analysis of municipal websites in six different states, we show how our pipeline is capable of gathering corpora that shed light on the forms and functions of local government. We find that government website contents is associated with the partisanship of the mayor in ways that would be expected based on the parties' national priorities and past research on the effects of mayoral partisanship on city governments.

We offer several contributions that will be valuable in future research endeavors. First, the data collected in the current study can be used for comparative analysis of US city website contents. Second, the pipeline we present can be used as a set of procedures to follow in gathering large scale datasets of textual contents from other samples of governments. Third, our findings regarding the effects of mayoral partisanship on city website contents advance the literature on the role of partisan leadership in local government, and reinforce the finding of Gerber and Hopkins (2011) that the effects of mayoral partisanship can be best observed through the analysis of domains of government (e.g., website contents) that are not heavily constrained by state or national governments.

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Appendix

Figure 7: Five largest topic effects for the population covariate. The fact that the population and epidemiology topics are positively correlated with city size is indicative of the model's validity.

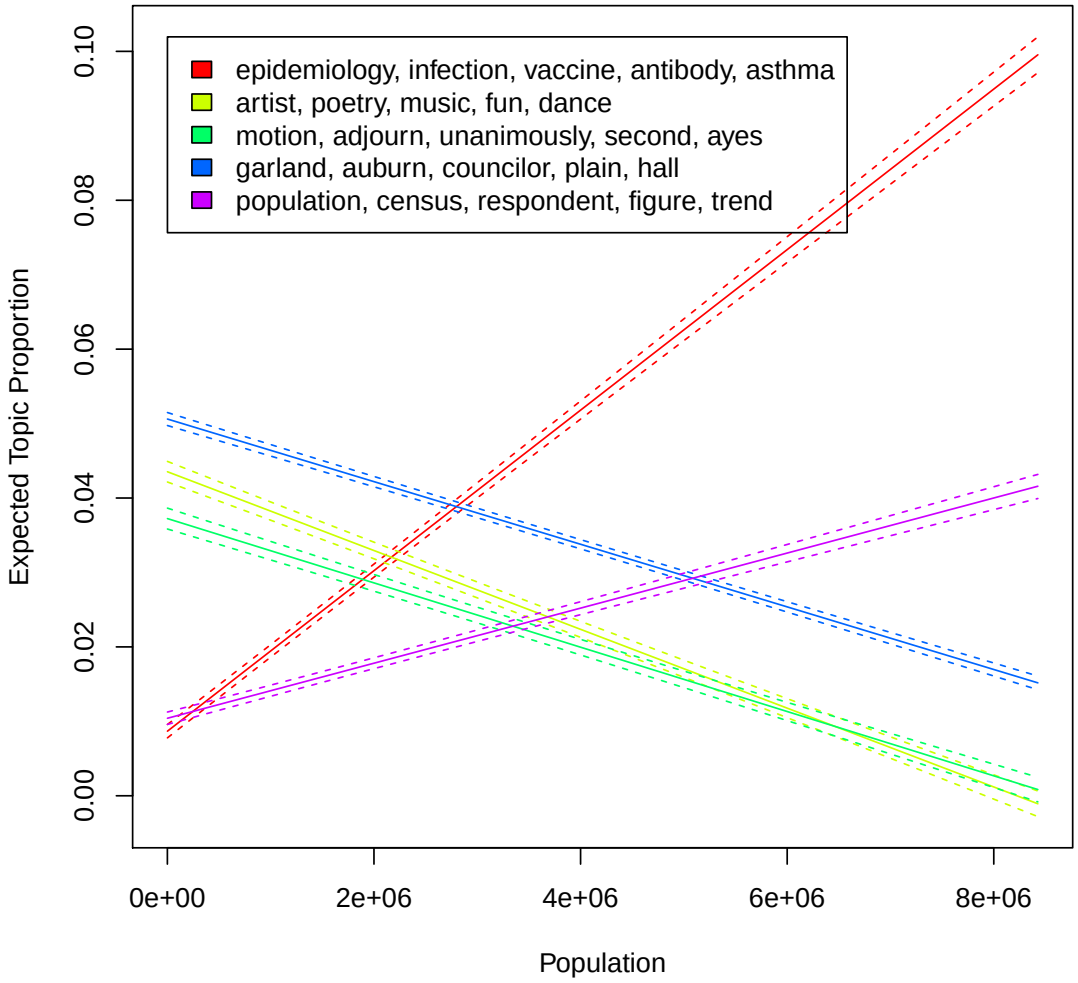
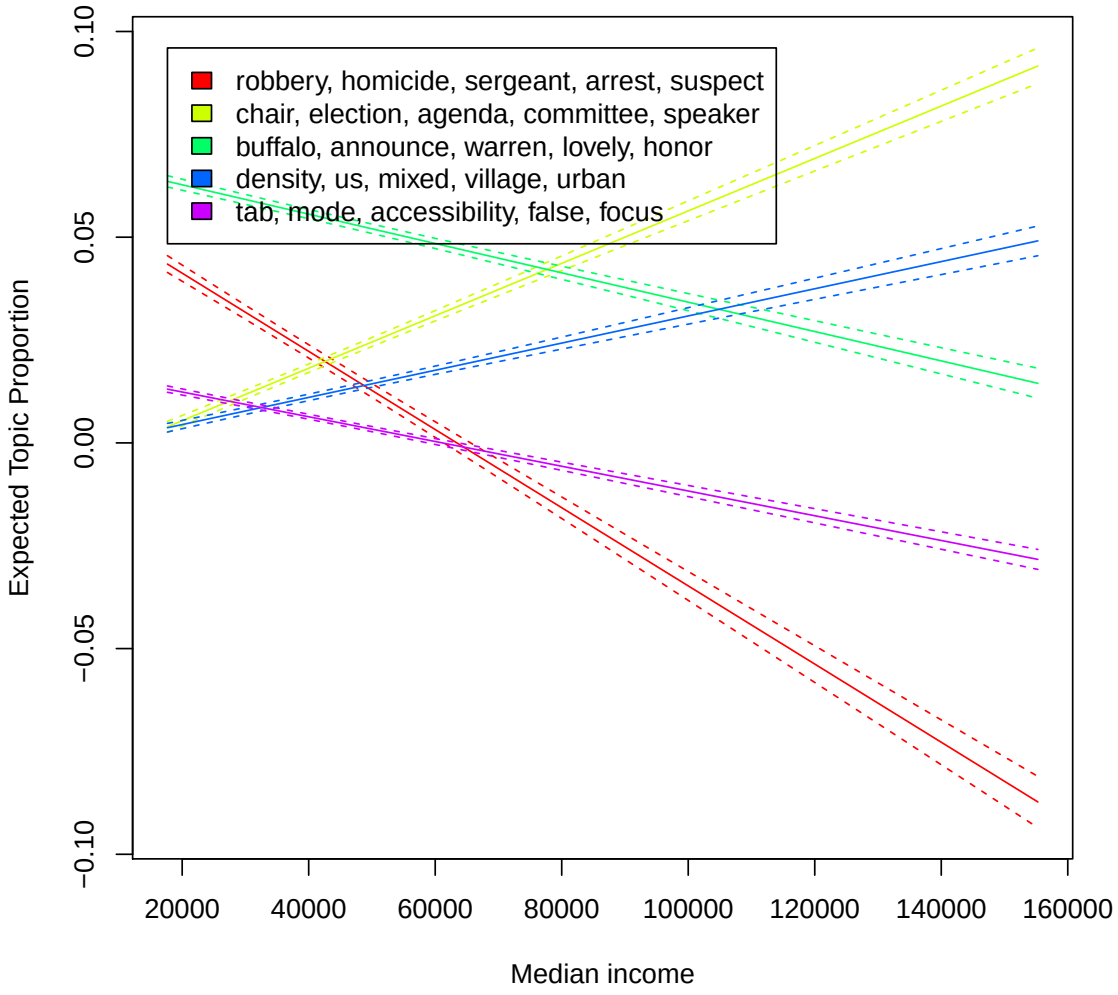


Figure 8: Five largest topic effects for the median income covariate. The fact that the crime topic is most prevalent in poorer cities, good governance is the most positively correlated with income is indicative of the model's validity.



#	Top Word 1	Top Word 2	Top Word 3	Top Word 4	Top Word 5	Top Word 6	Tokens assigned
43	fun	player	dream	celebration	favorite	blog	3460
5	please	email	contact	copy	mail	click	201
42	breastfeed	vaccine	infection	symptom	asthma	mosquito	2497
17	alarm	disaster	fire	rescue	preparedness	evacuation	989
53	drinking	wastewater	water	pipeline	pump	disinfection	461
50	buffalo	news	honor	warren	announce	lovely	1106
52	reappoints	digest	cat	leg	legislator	sander	997
33	really	think	something	thing	somebody	anybody	1873
44	shall	herein	forth	deem	thereof	pursuant	405
8	invoice	card	amt	filer	debit	officeholder	527
26	fee	charge	billing	per	meter	monthly	233
2	yon	borough	comm	gen	sou	spec	709
49	bin	recycling	garbage	recyclables	recyclable	bag	1791
7	energy	garland	renewable	solar	electricity	climate	742
23	bid	proposer	bidder	contractor	subcontractor	contract	447
57	duct	conduit	bolt	splice	valve	fitting	1373
13	server	wireless	software	telecommunication	subscriber	desktop	1092
54	motion	adjourn	second	unanimously	ayes	carry	474
1	storm	runoff	infiltration	discharge	drainage	drain	516
38	youth	student	parent	teacher	immigrant	literacy	714
35	artist	rouge	baton	art	artwork	exhibition	1632
59	sampling	sample	analytical	concentration	hydrocarbon	toxicity	1241
3	portfolio	yield	jun	maturity	investment	rating	544
45	premise	licensee	violation	license	permit	inspection	509
9	para	persona	ante	horas	junta	largo	1469
60	exhaust	fugitive	aircraft	airport	aviation	diesel	731
30	fort	thence	blvd	worth	ave	west	681
58	councilor	auburn	plain	ward	beech	glen	480
51	whereas	councilman	alderman	ordain	hereby	resolution	420
16	recreation	park	golf	playground	picnic	zoo	682
36	retiree	retirement	actuarial	deductible	dental	pension	470
27	exam	incumbent	supervise	supervision	examination	knowledge	687
56	historic	landmark	revival	archaeological	century	historian	2587
12	parking	hotel	garage	space	retail	square	321
41	tax	exemption	abatement	real	estate	property	310
4	facade	awning	porch	roof	balcony	exterior	1108
28	census	population	respondent	figure	percent	margin	541
18	prune	tree	deer	forestry	shrub	bulrush	2522
15	complainant	defendant	allegation	complaint	allege	discrimination	1384
20	noise	mitigation	impact	adverse	significant	vibration	325
14	yes	agency	federal	recipient	compliance	entity	205
46	variance	setback	plat	zoning	yard	fence	289
29	learn	neighborhood	graffito	event	resident	online	196
25	cannabis	marijuana	senate	dispensary	ballot	cultivation	1188
22	priority	strategic	ongoing	goal	implementation	implement	141
6	project	improvement	phase	replacement	upgrade	capital	174
11	shoreline	beach	marina	coastal	waterfront	salmon	1069
24	attract	economy	workforce	innovation	sector	economic	748
47	employee	overtime	sick	wage	grievance	bargaining	511
39	tab	accessibility	mode	var	alt	false	259
10	density	village	urban	us	mixed	corridor	358
37	audit	auditor	internal	procedure	accountability	oversight	420
21	housing	affordable	homeless	homelessness	affordability	landlord	318
34	comment	draft	feedback	stakeholder	suggest	discussion	289
19	debt	bond	governmental	obligation	financial	accounting	251
40	bicycle	bike	lane	crosswalk	pedestrian	bicyclist	574
32	budget	revenue	expenditure	appropriation	fund	million	242
48	absent	aye	khan	nay	berry	voting	528
31	chair	agenda	commission	speaker	chairperson	committee	314
55	robbery	homicide	arrest	sergeant	suspect	burglary	1395

Table 4: Top words from a structural topic model with 60 topics and FREX scoring. Colors depict partisanship based on coefficient size. White cells are non-significant topics. Based on data preprocessed with the classifier.

#	Top Word 1	Top Word 2	Top Word 3	Top Word 4	Top Word 5	Top Word 6	Tokens assigned
93	kindness	winner	hero	famous	tribute	wager	3042
36	copy	record	request	mail	submit	fax	111
98	community	resident	mission	quality	excellent	life	78
52	county	leg	legislator	legislature	town	municipality	132
18	often	always	sometimes	never	easy	even	505
20	click	blog	email	copyright	dream	sorry	336
38	camp	yoga	library	camper	fun	librarian	1009
43	antibody	infection	hepatitis	tuberculosis	infect	viral	1551
66	drinking	water	reservoir	contaminant	irrigation	tap	228
68	spray	mosquito	pesticide	pest	repellent	soap	898
33	fire	alarm	firefighter	rescue	apparatus	emergency	271
56	holiday	weekend	parade	event	auburn	host	283
44	microchip	cat	euthanasia	spay	rabies	neuter	1229
70	election	ethic	ballot	political	candidate	lobbyist	382
60	shall	unless	except	mean	deem	forth	103
59	motion	unanimously	adjourn	prince	carry	ken	220
81	effluent	sludge	wastewater	mercury	lbs	gal	537
89	ask	explain	say	reply	suggest	ruff	427
5	home	family	homeowner	single	residence	cottage	94
105	proposer	breach	franchisee	indemnify	agree	hereunder	273
119	alderman	councilor	councilwoman	alderwoman	common	roll	260
14	borough	exam	trademark	veteran	immigrant	new	359
116	asthma	overdose	diabetes	obesity	hospitalization	prevalence	609
37	dental	medicare	deductible	coinsurance	prescription	copay	444
67	plat	thence	easement	pud	petitioner	annexation	271
35	parent	youth	child	mentor	literacy	foster	326
75	website	plain	please	online	customize	contact	98
21	bid	bidder	contractor	subcontractor	contract	procurement	238
95	duct	valve	splice	piping	conduit	conductor	850
83	storm	runoff	drainage	sewer	sanitary	infiltration	224
64	discrimination	gender	disability	race	religion	racial	437
32	think	really	thing	something	maybe	just	899
49	recycling	recycle	garbage	trash	waste	bin	405
3	maturity	portfolio	rating	jun	yield	investment	276
8	invoice	payment	card	cash	account	amt	222
12	password	header	archive	browser	folder	text	552
90	student	school	elementary	college	academic	graduate	303
48	application	applicant	must	certificate	license	proof	150
92	food	calorie	meat	vend	utensil	salad	1291
86	whereas	hereby	resolve	bond	anticipation	redemption	194
26	petroleum	spill	contamination	asbestos	contaminate	radioactive	444
4	para	persona	ante	horas	junta	sin	644
7	energy	renewable	solar	electricity	climate	efficiency	416
22	wireless	server	software	telecommunication	cable	technology	376
76	year	fiscal	five	annual	last	three	50
34	fee	charge	per	cost	plus	hourly	109
109	city	fort	manager	worth	hall	municipal	10
103	com	perm	tor	cigarette	loo	comm	1386
79	tow	plow	vehicle	trailer	motor	truck	594
54	dwell	building	remodel	unit	occupancy	alteration	132
23	name	address	description	number	list	zip	92
69	vista	ranch	suite	trinity	coliseum	mesa	657
61	cannabis	marijuana	cultivation	dispensary	collective	liquor	470
114	beach	orange	platinum	resort	ocean	angel	517
1	landlord	tenant	lease	lessee	golf	rent	288
118	flood	earthquake	floodplain	hurricane	tornado	disaster	513
99	roof	porch	awning	masonry	brick	vinyl	729
111	buffalo	player	league	ballpark	baseball	football	542
112	excavation	trench	excavate	gravel	silt	concrete	696
53	downtown	mall	hotel	midtown	uptown	shopping	531

Table 5: Top words from a structural topic model with 120 topics (first 60 topics displayed here) and FREX scoring. Colors depict partisanship based on coefficient size. White cells are non-significant topics.

#	Top Word 1	Top Word 2	Top Word 3	Top Word 4	Top Word 5	Top Word 6	Tokens assigned
53	downtown	mall	hotel	midtown	uptown	shopping	531
117	police	patrol	chief	lieutenant	captain	swear	283
2	page	yon	rev	sou	spec	gen	165
100	senate	house	butler	hook	rep	haven	590
55	chapter	code	section	subsection	article	amend	124
19	fugitive	noise	exhaust	receptor	coal	ozone	437
31	aviation	taxicab	airport	runway	airline	hangar	498
85	homeless	homelessness	supportive	client	transitional	encampment	232
42	tax	exemption	taxable	deduction	taxpayer	appraisal	160
80	artist	artwork	art	exhibition	gallery	artistic	1060
65	density	land	us	urban	village	growth	102
101	marsh	riparian	habitat	wetland	grassland	freshwater	1110
120	bend	rogers	walnut	grape	parenthood	shalom	315
108	owner	inspector	property	inspection	unsafe	nuisance	156
110	incumbent	ability	supervise	knowledge	supervision	essential	378
102	parking	space	height	garage	foot	lot	83
30	figure	census	population	respondent	comparison	table	240
71	economic	workforce	economy	industry	sector	job	312
91	prune	forestry	tree	planting	shrub	root	1092
28	conviction	guilty	offense	convict	misdemeanor	felony	762
115	mitigation	impact	adverse	significant	mitigate	measure	135
27	workshop	learn	tour	upcoming	get	view	119
16	park	recreation	playground	picnic	trail	zoo	253
15	landmark	historic	revival	preservation	archaeological	historical	936
10	ave	rainier	beacon	aurora	greenwood	capitol	353
51	waterfront	boat	shoreline	maritime	dock	port	788
82	avenue	east	west	north	street	south	78
73	actuarial	pension	retirement	retiree	unfunded	contribution	181
6	variance	setback	fence	exception	yard	nonconforming	122
46	allegation	complainant	misconduct	complaint	bias	allege	631
25	bankruptcy	plaintiff	examiner	creditor	trial	appeal	843
78	violent	gang	violence	inmate	crime	offender	710
97	employee	sick	wage	grievance	bargaining	overtime	243
77	board	appoint	chairperson	secretary	member	vice	137
24	grant	funding	program	fund	federal	match	49
104	project	improvement	upgrade	replacement	phase	appropriated	84
94	audit	auditing	deficiency	auditor	internal	weakness	195
13	yes	agency	successor	redevelopment	oversight	disposition	128
9	realm	design	proponent	courtyard	facade	concept	468
96	propose	draft	comment	alternative	plan	planning	68
106	sidewalk	crosswalk	signal	traffic	intersection	curb	269
41	bicycle	bike	transit	bus	route	mobility	279
63	memorandum	council	resolution	negotiation	manager	ward	132
39	commission	committee	commissioner	advisory	chair	discussion	126
84	implement	monitor	performance	inventory	process	track	146
107	budget	appropriation	fund	expenditure	adopt	levy	99
62	affordable	housing	affordability	household	income	renter	224
17	million	revenue	forecast	offset	deficit	projection	187
74	neighborhood	vision	attractive	node	amenity	corridor	351
45	zoning	district	zone	acre	dist	rezoning	71
113	debt	governmental	asset	net	statement	obligation	133
72	rouge	parish	baton	hogan	councilman	bowman	528
88	position	staffing	citywide	analyst	strategic	allocation	111
40	accessibility	mode	false	null	else	tab	105
11	strategy	goal	stakeholder	strategic	engagement	outreach	168
58	news	warren	announce	lovely	release	today	501
50	aye	absent	khan	nay	berry	voting	318
87	digest	proposal	reappoints	sander	gray	metropolitan	232
29	agenda	speaker	item	divided	speak	refrain	146
47	consolidated	reinvestment	contingency	contract	authorize	engineering	131
57	suspect	fatal	shoot	pronounce	stopper	gunshot	500

Table 6: Top words from a structural topic model with 120 topics (second 60 topics displayed here) and FREX scoring. Colors depict partisanship based on coefficient size. White cells are non-significant topics.

Line	Substantive	Boilerplate
have questions	0.00	1.00
stay connected	0.00	1.00
accident or injury	0.00	1.00
fire damaged buildings	0.00	1.00
gas connections	0.00	1.00
harboring of vagrants	0.00	1.00
roof system problem	0.00	1.00
violation plat note	0.00	1.00
violation setback	0.00	1.00
violation site plan	0.00	1.00

Table 7: Lines (or the first 50 characters of a line) in the corpus of Anchorage, AK, with the 10 highest probabilities of being classified as boilerplate.