

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

Markus Neumann*

Fridolin Linder[†]

Bruce Desmarais[‡]

May 15, 2019

Abstract

A local government's website is an important source of information about policies and procedures for residents, community stakeholders and scholars. Existing research in public administration, public policy, and political science has relied on manual methods of website content collection and processing, limiting 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. Our approach, which represents a considerable improvement in scalability, involves downloading the entire contents of a website, extracting the text and discarding redundant information. 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, we find that cities with Democratic mayors provide more information on policy deliberation and crime control, whereas Republicans prioritize basic utilities and services such as water, electricity and fire safety.

PA Letter Requirements:

2-4 pages

no longer than 1500-3000 words

1-3 small display items (figures, tables, or equations)

200-300 word abstract

*Department of Political Science, The Pennsylvania State University, University Park, PA 16802, USA. Email: mvn5218@psu.edu. Corresponding author.

[†]Department of Political Science, Social Media and Political Participation Lab, New York University, New York, NY 10012, USA. Email: fridolin.linder@nyu.edu

[‡]Department of Political Science, The Pennsylvania State University, University Park, PA 16802, USA. Email: bdesmarais@psu.edu

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, Balci, Medeni and Weerakkody 2014; Eschenfelder, Beachboard, McClure and Wyman 1997). The conventional approach to data collection in projects focused on government websites involves manual content extraction from each website in the dataset. Though accurate, the manual approach to data collection is costly for large-scale analysis. 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—describing challenges in data collection and processing, as well as the solutions we adopt. We provide an illustrative application in which we explore the ways in which the textual contents on city government websites in six American states correlate with the partisanship of the city mayor.

2 Mayoral Politics and City Government Website Content

A substantial body of research has found that the partisanship of the mayor affects city governance along multiple dimensions of spending and policy attention (Gerber and Hopkins 2011; de Benedictis-Kessner and Warshaw 2016; Einstein and Glick 2016; Marion and Oliver 2013). Official city websites allow mayors to present their views and policy priorities to the public. In local politics, where campaign funds are low, this lends incumbents a crucial advantage in becoming more well-known among their constituencies (Stanyer 2008). Local government websites are frequently visited by the public (Thomas and Streib 2003). City websites can be used to communicate the stance of a mayor on social or economic programs.

The existing research that uses scraped websites provides an indication of the theoretical value of empirical analysis of web contents. Research on ‘e-governance’ evaluates government websites in terms of accessibility, ease-of-use, and function (e.g., Urban 2002; McNutt 2010; Armstrong 2011; Feeney and Brown 2017). As an example, Grimmelikhuijsen and Welch (2012) study local government websites of Dutch municipalities to measure government transparency regarding air quality in the municipalities. The websites of politicians and their parties have also been the object of research (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). For example, Druckman et al. (2010) analyze the issues engaged on websites for candidates in U.S. Congressional elections, and find that candidates strategically engage just a few issues based on the priorities in their districts and the characteristics of their opponents.

3 Data: US Municipal Government Website Text

For data availability reasons, we focus our analysis of municipal websites on six states—Indiana, Louisiana, New York, Washington, California, and Texas. The websites were scraped in March 2018. The selection of states and cities is largely dictated by the presence of partisan mayors and availability of the relevant data. Municipal elections in Indiana and Louisiana are partisan across the board, so our sample is primarily focused on these two states. For Indiana and Louisiana, all cities with a website are included, resulting in a considerably larger sample than for the other four states. New York and Washington do not have nominally partisan elections, but for a subset of cities, partisanship can be determined through contribution data (see appendix for more detail). California and Texas contain a number of large cities whose mayors are sufficiently well-known for their partisanship to be available. Our sample is well-balanced on a number of theoretically important dimensions. One, each of the four Census regions are represented with at least one state. Two, we have a fairly well-balanced sample with respect to the urban/rural cleavage.

Furthermore, the sample is politically balanced—we have three blue states, and three red states. The partisan breakdown of city websites is depicted in Table 1. Details on the sources and methods of raw data collection can be found in the Appendix.

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 government 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 variance in where a city’s executive authority lies. We do not have access to information about the type of governments across the breadth of our dataset. 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. Gerber and Hopkins (2011), whose theory is somewhat comparable to ours, find that the inclusion of this potential confounder does not affect the results.

4 The Web to Text Pipeline

In this section, we describe our methodological pipeline, with which we take an archive of website files, and output a corpus of formatted plain text documents that are suitable for comparative analysis with text as data methods. Here, we address three 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 is aimed at extracting clean plain text from this heterogeneous file base. The second step in our pipeline is to process the text to remove language that is effective at differentiating one website from another but is uninformative regarding policy or political differences between governments. Finally, these tools need to work consistently across all of the websites in our corpus, in spite of the fact that relevant information is stored and structured in different ways.

4.1 Site to Text Conversion

4.1.1 File Type Detection

The format of a file has a major impact on whether and how textual data can be extracted from a document. 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`. Files with incorrect endings are subsequently renamed.

4.1.2 Extracting Text from HTML

The HTML files that websites are comprised of contain a large amount of useful information, but also completely irrelevant text such as menus, navigational elements and other boilerplate. In theory, HTML tags intended to mark text content exist to prevent this problem. In practice, not every web developer adheres to this standard, and even when they do, there is a large degree of variation in the way it is implemented. Parsing any one website is fairly straightforward, but parsing the 283 different websites in our sample in a consistent and comparable manner makes a rule-based approach impossible.

We leverage methods developed in the information retrieval literature to deal with this problem. These boilerplate detection tools are classifiers which rely on both structural features, such as HTML tags, as well as text statistics such as word and sentence length to estimate whether a given portion of an HTML file is useful. We rely on the method described in Kohlschütter, Fankhauser and Nejdí (2010), which has been published in a reputable conference, is widely cited and can easily be implemented through the R package `boilerpipeR`.

4.1.3 Extracting Text from PDF, XML, DOC, DOCX and TXT

Other files are read in through the `readtext` R package (Benoit and Obeng 2018), which is a wrapper for a set of parsers.^{1,2,3} The breakdown of all files by type is given in Table 2. The most frequent file type besides HTML is 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.

¹`readtext` determines a document's type solely through its ending – so the conversion described above is strictly necessary for the package to work correctly.

²We have also experimented with several Unix-based alternatives, but found that they largely led to the same results as `readtext`.

³`readtext` also contains an HTML parser, but this tool simply extracts all text and is therefore inferior to `boilerpipe`.

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 detecting 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.

4.2 Preprocessing

Preprocessing is an important part of text-as-data research and choices made therein can have significant effects on the outcomes of an analysis (Denny and Spirling 2018). The challenge in conducting preprocessing for a comparative analysis of websites lies in the considerable variance between websites. Some of it is substantively informative and some of it is completely irrelevant. As an example of the latter, names of city officials and citizen petitioners feature frequently in city documents. The same is true for streets, locations and not least of all, the city itself. Since individual names recur at a much higher rate within a city than across the entire corpus, this would cause a topic model to cluster its topics by city. Consequently we require a tool which detects the signal in the noise and does so consistently for a discordant set of sources.

To this end, we turn to an approach that is much more common in natural language processing than political methodology – part-of-speech (POS) tagging and named entity recognition (NER). While not their original purpose, these procedures perform very well in separating the wheat from the chaff. As names convey no substantive information, we NER is used to detect to

remove them.⁴ Furthermore, we select words on the basis of their POS-tags, retaining only nouns (by far the most informative category), verbs, adjectives. Furthermore, we keep proper nouns that also occur as nouns – this removes names, but retains titles such as “Police Chief” which can appear as proper nouns if they are followed by a name. Finally, we also conduct lemmatization to reduce words to their basic form.⁵ POS-tagging, NER and lemmatization are all implemented through `spacyR`. This parsing-based approach is very effective in distilling a comparable corpus from a varied set of sources, as the grammatical rules of the English language remain their common denominator. To deal with any leftover issues, we remove words with less than three characters (these are usually artifacts from improperly encoded documents and faulty or impartial optical character recognition), stopwords and non-English words (using the R package `Hunspell`)⁶.

A final and crucial step is the removal of duplicate documents, which occur very frequently on websites. In addition to their primary purpose, the previous preprocessing steps also help in stripping otherwise identical documents of information that makes them unique – such as names and dates – thus facilitating their deletion. The removal of duplicate information also solves a problem posed by a recurring feature of municipal websites – city calendars. For most days in most cities, these calendars tend to be empty, but nevertheless contain a template, which would lead to the creation of a document in our corpus. These short and repetitive – but numerous – texts would pose severe problems to a topic model. Our approach preserves the valuable information contained within these calendars when cities do make use of them, but removes them when they offer no substantive data.

After all the preprocessing is set and done, our corpus consists of 259,099 documents.

⁴We retain laws, nationalities or religious or political groups (which are politically salient with respect to immigration and identity) as well as works of art (which frequently feature statutes, plans, etc.)

⁵Lemmatization 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.

⁶As we are using `spacyR` with an English parser, non-English words tend to be erroneously categorized as (proper) nouns.

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. These constraints do not apply to website contents. City governments have great discretion in composing their websites, modifying website content is low cost relative to other policy changes, and, as reviewed above, city websites provide an effective and often-used means of communication with city residents.

In order to analyze content differences between government websites based on mayoral partisanship, we draw upon a recently-developed class model for text, the structural topic model (STM), 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 STM a topic is a multinomial distribution defined on the word types in the corpus dictionary. 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 content, 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 STM 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. Further details on our STM specification can be found in the appendix.

5.0.1 Structural topic model results

The results are shown in Table 3. 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.

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. 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 are 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.

Funding

This work was supported by the National Science Foundation [1320219, 1637089, 1641047].

References

- Armstrong, Cory L. 2011. "Providing a clearer view: An examination of transparency on local government websites." *Government Information Quarterly* 28(1):11–16.
- Benoit, Kenneth and Adam Obeng. 2018. *readtext: Import and Handling for Plain and Formatted Text Files*. R package version 0.71.
URL: <https://CRAN.R-project.org/package=readtext>
- Brown, Anna. 2017. "Republicans more likely than Democrats to have confidence in police.".
URL: <http://www.pewresearch.org/fact-tank/2017/01/13/republicans-more-likely-than-democrats-to-have-confidence-in-police/>
- Cryer, J. E. 2017. "Candidate Identity and Strategic Communication." pp. 1–42.
- Darwin, IF. 2008. "Libmagic."
- de Benedictis-Kessner, Justin and Christopher Warshaw. 2016. "Mayoral partisanship and municipal fiscal policy." *The Journal of Politics* 78(4):1124–1138.
- Denny, Matthew J and Arthur Spirling. 2018. "Text preprocessing for unsupervised learning: why it matters, when it misleads, and what to do about it." *Political Analysis* 26(2):168–189.
- DeSantis, Victor S and Tari Renner. 2002. "City government structures: An attempt at clarification." *State and Local Government Review* 34(2):95–104.
- Druckman, James N., Cari Lynn Hennessy, Martin J. Kifer and Michael Parkin. 2010. "Issue Engagement on Congressional Candidate Web Sites, 2002—2006." *Social Science Computer Review* 28(1):3–23.
URL: <http://journals.sagepub.com/doi/10.1177/0894439309335485>

Druckman, James N., Martin Kifer and Michael Parkin. 2009. "Campaign Communications in U.S. Congressional Elections." *American Political Science Review* 103(03):343–366.

URL: http://www.journals.cambridge.org/abstract_S0003055409990037

Einstein, Katherine Levine and David M Glick. 2016. "Mayors, partisanship, and redistribution: Evidence directly from US mayors." *Urban Affairs Review* p. 1078087416674829.

Einstein, Katherine Levine and Vladimir Kogan. 2015. "Pushing the City Limits: Policy Responsiveness in Municipal Government." *Urban Affairs Review* pp. 1–30.

Eschenfelder, Kristin R, John C Beachboard, Charles R McClure and Steven K Wyman. 1997. "Assessing U.S. federal government websites." *Government Information Quarterly* 14(2):173–189.

URL: [http://www.sciencedirect.com/science/article/pii/S0740624X97900186%5Cnpapers2://publication/doi/10.1016/0740-624X\(97\)90018-6](http://www.sciencedirect.com/science/article/pii/S0740624X97900186%5Cnpapers2://publication/doi/10.1016/0740-624X(97)90018-6)

Esterling, Kevin M, David MJ Lazer and Michael A Neblo. 2011. "Representative communication: Web site interactivity and distributional path dependence in the US Congress." *Political Communication* 28(4):409–439.

Esterling, Kevin M. and Michael A. Neblo. 2011. "Explaining the Diffusion of Representation Practices among Congressional Websites." *Working Paper* pp. 1–42.

Feeney, Mary K. and Adrian Brown. 2017. "Are small cities online? Content, ranking, and variation of U.S. municipal websites." *Government Information Quarterly* 34(1):62–74.

URL: <http://dx.doi.org/10.1016/j.giq.2016.10.005>

Gerber, Elisabeth R and Daniel J Hopkins. 2011. "When mayors matter: estimating the impact of mayoral partisanship on city policy." *American Journal of Political Science* 55(2):326–339.

- Grimmelikhuijsen, Stephan G. 2010. "Transparency of Public Decision-Making: Towards Trust in Local Government?" *Policy & Internet* 2(1):5–35.
- Grimmelikhuijsen, Stephan G and Eric W Welch. 2012. "Developing and testing a theoretical framework for computer-mediated transparency of local governments." *Public administration review* 72(4):562–571.
- Guillamón, Ma Dolores, Francisco Bastida and Bernardino Benito. 2013. "The electoral budget cycle on municipal police expenditure." *European Journal of Law and Economics* 36(3):447–469.
- Kohlschütter, Christian, Peter Fankhauser and Wolfgang Nejdl. 2010. Boilerplate Detection using Shallow Text Features. In *Web Search and Data Mining*.
- Marion, Nancy E and Willard M Oliver. 2013. "When the Mayor Speaks... Mayoral Crime Control Rhetoric in the Top US Cities: Symbolic or Tangible?" *Criminal justice policy review* 24(4):473–491.
- Marschall, Melissa and Paru Shah. 2013. "Local Elections in America Project." *Center for Local Elections in American Politics. Kinder Institute for Urban Research, Rice University.(Database)* .
URL: <http://www.leap-elections.org/>
- McNutt, Kathleen. 2010. "Virtual policy networks: Where all roads lead to Rome." *Canadian Journal of Political Science/Revue canadienne de science politique* 43(4):915–935.
- Monroe, Burt L., Michael P. Colaresi and Kevin M. Quinn. 2008. "Fightin' words: Lexical feature selection and evaluation for identifying the content of political conflict." *Political Analysis* 16(4 SPEC. ISS.):372–403.

Morgan, David R and Sheilah S Watson. 1992. "Policy leadership in council-manager cities: Comparing mayor and manager." *Public Administration Review* pp. 438–446.

Norris, P. 2003. "Preaching to the Converted?: Pluralism, Participation and Party Websites." *Party Politics* 9(1):21–45.

Osman, Ibrahim H, Abdel Latef Anouze, Zahir Irani, Baydaa Al-Ayoubi, Habin Lee, Asım Balcı, Tunç D Medeni and Vishanth Weerakkody. 2014. "COBRA framework to evaluate e-government services: A citizen-centric perspective." *Government Information Quarterly* 31(2):243–256.

Roberts, Margaret E., Brandon M. Stewart and Dustin Tingley. 2018. *stm: R Package for Structural Topic Models*. R package version 1.3.3.

URL: <http://www.structuraltopicmodel.com>

Roberts, Margaret E., Brandon M. Stewart, Dustin Tingley, Christopher Lucas, Jetson Leder-Luis, Shana Kushner Gadarian, Bethany Albertson and David G. Rand. 2014. "Structural topic models for open-ended survey responses." *American Journal of Political Science* 58(4):1064–1082.

Rudis, Bob, Christos Zoulas, Mans Rullgard and Jonathan Ong. 2016. *wand: Retrieve 'Magic' Attributes from Files and Directories*. R package version 0.2.0.

URL: <https://CRAN.R-project.org/package=wand>

Stanyer, James. 2008. "Elected representatives, online self-presentation and the personal vote: Party, personality and webstyles in the United States and United Kingdom." *Information, Community & Society* 11(3):414–432.

Therriault, Andrew. 2010. "Taking Campaign Strategy Online: Using Candidate Websites to Advance the Study of Issue Emphases." pp. 1–23.

URL: <http://poseidon01.ssrn.com/delivery.php?ID=5881250961130801011070071091041011210350310770540170>

- Thomas, John Clayton and Gregory Streib. 2003. "The new face of government: citizen-initiated contacts in the era of E-Government." *Journal of public administration research and theory* 13(1):83–102.
- Urban, Florian. 2002. "Small town, big website? Cities and their representation on the internet." *Cities* 19(1):49–59.
- Wang, Lili, Stuart Bretschneider and Jon Gant. 2005. Evaluating web-based e-government services with a citizen-centric approach. In *System Sciences, 2005. HICSS'05. Proceedings of the 38th Annual Hawaii International Conference on*. Ieee pp. 129b–129b.

Appendix

Raw data collection methods and sources

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.⁷ 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 latter 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.

Not all of the URLs contained in these archives are functional. To test the URLs’ functionality, we use a web driver-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 web driver `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. The use of a web driver-controlled browser is necessary

⁷The 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.

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 web driver-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 web crawler and scraper. This means that `wget` downloads 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, i.e. it does not follow external links). This way, all the files that make up a website are downloaded. For some cities, whose websites make heavy use of JavaScript to serve content dynamically, such content is not reachable with our methodology and would require additional steps to obtain. For this paper, we ignore such sites and restricted our corpus to cities with at least three successfully downloaded pages.⁸

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 website⁹. For Louisiana, we received data on the outcomes of mayoral elections

⁸There is a possibility that this leads to a small bias in selecting against cities with the resources to build more elaborate websites. However, given that our sample is generally more on the wealthy side, this, if anything, should lead to a more balanced sample.

⁹<http://www.in.gov/apps/sos/election/general/general2015?page=office&countyID=1&officeID=32&districtID=-1&candidate=>

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 Ballotpedia¹⁰. 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.¹¹

Information on other covariates (population and median household income - from the American Community Survey 5-Year Data (2015)) was acquired through the API of the U.S. Census Bureau¹².

Details on STM specification

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 authors¹³ for medium- to large-sized corpora.¹⁴ 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

¹⁰https://ballotpedia.org/List_of_current_mayors_of_the_top_100_cities_in_the_United_States

¹¹In Indiana, the data includes only cities - incorporated municipalities with at least 2,000 inhabitants - as opposed to towns.

¹²<https://www.census.gov/data/developers/data-sets.html>

¹³For this recommendation, see the documentation for the function `stm()` in version 1.3.0 of the R package *stm* (Roberts, Stewart and Tingley 2018).

¹⁴Since our corpus is at the larger end of that spectrum, we also estimated a model with 120 topics, but found no notable differences.

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.¹⁵

¹⁵The “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.

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

Table 3: 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.

#	Top Word 1	Top Word 2	Top Word 3	Top Word 4	Top Word 5	Top Word 6		Tokens assigned
43	artist	fun	celebrate	player	prize	music	5103	<div></div>
59	chair	subcommittee	agenda	briefing	committee	meeting	709	<div></div>
17	motion	second	adjourn	carry	unanimous	legislator	801	<div></div>
16	mesa	canyon	vista	beach	balboa	mission	825	<div></div>
2	infection	rabies	vaccine	influenza	syphilis	virus	3560	<div></div>
24	think	something	want	everybody	try	thing	2687	<div></div>
40	customer	renewable	recycled	efficiency	energy	conservation	765	<div></div>
41	effluent	inf	eff	infiltration	sludge	discharge	1349	<div></div>
27	subcontractor	proposer	subcontract	bidder	rev.	consultant	939	<div></div>
26	subsection	article	shall	licensee	chapter	sec	864	<div></div>
13	style	craftsman	bungalow	architecture	brick	distinctive	2085	<div></div>
57	fax	application	click	copy	mail	applicant	519	<div></div>
5	earthquake	evacuation	preparedness	disaster	flood	emergency	1478	<div></div>
29	garland	assoc	canceled	alteration	association	dwelling	509	<div></div>
33	setback	height	variance	accessory	conditional	zoning	682	<div></div>
31	picnic	playground	restroom	recreation	zoo	park	867	<div></div>
42	contributor	filer	officeholder	political	payee	instruction	406	<div></div>
28	student	teacher	academic	kindergarten	immigrant	preschool	865	<div></div>
9	imp	assessor	taxpayer	petition	determination	preliminary	106	<div></div>
52	airport	hotel	industry	manufacturing	business	aviation	1155	<div></div>
35	findings	tank	string	carcinogen	waste	lust	361	<div></div>
22	blanket	medicare	procurement	undistributed	award	payroll	528	<div></div>
20	thickness	fitting	ductile	conduit	valve	conductor	2446	<div></div>
47	department	authority	dpt	police	citywide	sanitation	205	<div></div>
51	credit	post	bbl	app	download	month	66	<div></div>
11	obesity	sugary	epidemic	calorie	drink	sensible	99	<div></div>
36	amt	invoice	acct	unencumbered	exp	encumbrance	219	<div></div>
15	allegation	complainant	doc	allege	lobbyist	defendant	1727	<div></div>
60	wetland	specie	species	vernal	riparian	vegetation	2953	<div></div>
49	taxable	deed	res	value	homestead	book	98	<div></div>
10	trust	revocable	planned	mfr	apportionment	living	433	<div></div>
1	agreement	franchisee	successor	covenant	redemption	hereof	637	<div></div>
21	thence	plat	plot	easement	maker	corner	950	<div></div>
3	mitigation	impact	significant	adverse	environmental	substantial	511	<div></div>
8	bio-	fugitive	emission	exhaust	unmitigated	coal	955	<div></div>
46	pickup	tow	taxicab	driver	speeding	cab	932	<div></div>
12	poverty	householder	rouge	baton	parish	disability	260	<div></div>
19	race	islander	micron	occupied	error	margin	208	<div></div>
23	allocation	disc	subtotal	yon	admin	fin	359	<div></div>
53	marijuana	landlord	nuisance	tenant	cannabis	dispensary	793	<div></div>
18	queue	perm	delay	peak	flt	adj	232	<div></div>
54	councilman	whereas	alderman	resolved	ordain	councilwoman	971	<div></div>
25	savings	neighborhood	matrix	village	excise	ltd	183	<div></div>
50	col	applied	dist	monoxide	occupancy	valuation	312	<div></div>
55	persona	para	sin	horas	reusable	ante	3687	<div></div>
45	technician	assistant	aide	incumbent	supervisor	analyst	790	<div></div>
4	audit	procedure	auditor	implemented	ensure	internal	617	<div></div>
48	tax	levy	increment	assessed	deduction	sale	492	<div></div>
44	bike	bicycle	pedestrian	sidewalk	bicyclist	curb	876	<div></div>
30	mixed	waterfront	orient	density	envision	development	714	<div></div>
6	deductible	grievance	actuarial	copay	coinsurance	dependent	946	<div></div>
38	asset	governmental	assets	investment	maturity	financial	485	<div></div>
34	contracted	outlay	char	bud	actual	contractual	422	<div></div>
32	compare	figure	trend	comparison	benchmark	satisfied	839	<div></div>
39	introduced	absent	digest	preside	council	voting	625	<div></div>
58	ave	tad	combo	blossom	fwy	blvd	1515	<div></div>
14	endorsed	budget	endorse	proposed	adjustment	forecast	303	<div></div>
56	homelessness	homeless	affordable	affordability	supportive	low-	672	<div></div>
7	initiative	strategy	outreach	goal	stakeholder	focus	702	<div></div>
37	homicide	burglary	robbery	arrest	theft	assault	2050	<div></div>

Table 4: NEW: 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.

#	Top Word 1	Top Word 2	Top Word 3	Top Word 4	Top Word 5	Top Word 6	Tokens assigned
115	garland	celebration	blog	dream	sorry	copyright	994
52	dog	legislator	spay	neuter	animal	microchip	761
44	copy	record	mail	request	notice	notify	120
98	neighborhood	community	resident	safe	life	quality	95
88	war	professor	sister	bachelor	daughter	soldier	2516
43	camp	yoga	camper	fun	librarian	library	1080
42	infection	tuberculosis	breastfeed	hepatitis	vaccine	condom	1608
72	drinking	water	contaminant	reservoir	pipeline	irrigation	216
84	say	ask	explain	reply	horn	advise	454
18	player	coach	game	umpire	ball	shirt	1595
61	unanimously	motion	prince	adjourn	carry	ken	192
63	mosquito	spray	rodent	pesticide	repellent	pest	851
81	effluent	sludge	lbs	mercury	wastewater	gal	540
60	shall	deem	forth	unless	except	thereof	119
69	ethic	candidate	lobbyist	filer	political	officeholder	355
33	think	really	something	thing	just	go	826
119	firefighter	fire	chief	police	captain	patrol	248
37	physician	nursing	medical	nurse	outpatient	medicaid	352
5	home	homeowner	alarm	detector	monoxide	header	209
23	proposer	bidder	subcontractor	bid	contractor	subcontract	239
116	councilor	alderman	councilwoman	alderwoman	quill	councilors	268
15	trademark	borough	new	immigration	immigrant	pour	274
67	discrimination	disability	gender	religion	accommodation	origin	373
117	asthma	overdose	obesity	hospitalization	diabetes	prevalence	659
94	duct	valve	sprinkler	combustible	splice	conductor	778
58	event	firework	parade	press	holiday	troy	335
70	whereas	hereby	resolve	duly	authorize	therefore	202
30	disaster	emergency	preparedness	evacuation	dispatch	homeland	365
38	student	parent	school	teacher	academic	youth	354
93	city	fort	worth	manager	hall	charter	16
75	online	click	plain	website	download	learn	165
3	value	market	productivity	customize	yrs	index	126
49	recycling	recycle	garbage	waste	trash	landfill	408
111	franchisee	indemnify	arise	harmless	breach	party	307
17	snow	plow	tornado	flood	pothole	crew	552
89	vend	food	meat	utensil	calorie	vending	1174
45	application	applicant	certificate	must	license	permit	151
85	runoff	sanitary	infiltration	storm	drainage	drain	241
106	equipment	boiler	fleet	crane	mechanic	fuel	539
8	invoice	payment	card	credit	account	cash	187
13	class	test	adobe	embed	reader	acrobat	312
108	cigarette	senate	tobacco	consumer	smoking	ban	542
25	coal	hazard	hazardous	toxic	radiation	substance	288
86	groundwater	sample	asbestos	analytical	remediation	remedial	345
1	golf	exhibit	lessee	course	lessor	lease	401
9	para	persona	ante	horas	junta	sin	635
24	phone	name	page	address	glen	cove	158
7	energy	renewable	solar	electricity	climate	efficiency	399
66	plat	thence	easement	pud	tract	subdivision	230
57	dwell	unit	remodel	condominium	dwelling	residential	167
95	roof	masonry	porch	exterior	would	brick	611
26	fee	charge	per	cost	plus	rate	102
51	chapter	code	violation	subsection	article	sec	151
59	zoning	conditional	zone	cannabis	overlay	district	241
101	height	foot	square	feet	setback	frontage	124
96	house	cemetery	burial	butler	funeral	barber	472
65	ballot	vista	ranch	canyon	silicon	voter	518
120	bend	fir	hometown	twelfth	exceptional	rodeo	271
36	aviation	airport	airline	runway	aircraft	hangar	429
34	plan	planning	comprehensive	master	review	amendment	42

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	
82	com	mar	spec	jun	est	comm	1388	<div></div>
22	server	software	wireless	technology	desktop	broadband	430	<div></div>
80	artist	art	artwork	exhibition	artistic	sculpture	1099	<div></div>
113	trench	thickness	compaction	concrete	slab	excavation	766	<div></div>
87	respondent	survey	census	racial	demographic	score	427	<div></div>
83	homeless	homelessness	supportive	client	transitional	encampment	229	<div></div>
20	noise	fugitive	receptor	exhaust	vibration	emission	376	<div></div>
35	landlord	tenant	owner	property	rent	lien	205	<div></div>
105	beach	orange	arena	rainier	ocean	resort	457	<div></div>
2	yon	bay	gen	sou	coliseum	estuary	385	<div></div>
6	redevelopment	land	developer	parcel	development	area	70	<div></div>
104	riparian	wetland	habitat	marsh	floodplain	grassland	968	<div></div>
41	tax	exemption	taxable	deduction	levy	taxpayer	172	<div></div>
68	economy	workforce	economic	sector	industry	innovation	332	<div></div>
28	figure	table	scenario	margin	analysis	appendix	207	<div></div>
110	bond	maturity	debt	issuer	redemption	obligation	232	<div></div>
102	sidewalk	curb	pole	crosswalk	ramp	sign	237	<div></div>
118	project	phase	construction	completion	improvement	complete	45	<div></div>
78	parking	tow	vehicle	garage	car	motor	210	<div></div>
71	actuarial	retiree	retirement	pension	deductible	unfunded	239	<div></div>
91	prune	tree	forestry	deer	shrub	planting	1240	<div></div>
114	incumbent	exam	supervision	supervise	examination	ability	432	<div></div>
16	park	recreation	playground	zoo	trail	picnic	290	<div></div>
53	waterfront	boat	shoreline	maritime	dock	barge	800	<div></div>
76	felony	violent	offender	gang	theft	inmate	783	<div></div>
4	courtyard	realm	design	facade	proponent	articulation	608	<div></div>
100	division	manage	staffing	oversee	management	analyst	100	<div></div>
97	mitigation	impact	adverse	significant	alternative	propose	132	<div></div>
11	historic	landmark	revival	archaeological	preservation	historical	876	<div></div>
77	million	fiscal	forecast	revenue	quarter	billion	138	<div></div>
74	board	chairperson	secretary	member	appoint	executive	118	<div></div>
47	allegation	complainant	misconduct	bias	complaint	allege	580	<div></div>
92	sick	employee	wage	overtime	grievance	bargaining	260	<div></div>
10	ave	avenue	south	east	west	blvd	189	<div></div>
112	grant	loan	funding	program	recipient	federal	85	<div></div>
56	downtown	mall	midtown	uptown	hotel	shopping	414	<div></div>
14	yes	agency	successor	oversight	attachment	describe	125	<div></div>
40	bicycle	bike	transit	bicyclist	lane	bus	315	<div></div>
62	affordable	housing	affordability	income	household	moderate	188	<div></div>
99	memorandum	resolution	council	legislation	entitle	commission	173	<div></div>
19	governmental	accounting	asset	statement	financial	net	156	<div></div>
103	permission	ayes	correspondence	bid	smith	demolition	203	<div></div>
107	appropriated	dollars	thousand	ongoing	matrix	justification	117	<div></div>
12	approach	difficult	achieve	challenge	critical	often	257	<div></div>
46	variance	fence	setback	exception	yard	applicant	136	<div></div>
90	audit	auditor	procedure	internal	auditing	documentation	226	<div></div>
64	density	urban	corridor	village	orient	transit	165	<div></div>
21	goal	strategy	outreach	priority	strategic	implementation	105	<div></div>
73	parish	rouge	baton	hogan	councilman	thereto	482	<div></div>
29	comment	draft	discussion	feedback	discuss	presentation	168	<div></div>
32	budget	expenditure	appropriation	fund	endorse	balance	129	<div></div>
54	aye	absent	khan	nay	berry	voting	344	<div></div>
39	mode	accessibility	tab	focus	else	alt	117	<div></div>
109	auburn	buffalo	ward	brown	announce	casino	177	<div></div>
50	news	warren	lovely	release	leader	proud	498	<div></div>
79	digest	proposal	sander	reappoints	metropolitan	gray	236	<div></div>
27	bankruptcy	plaintiff	creditor	trial	court	supreme	810	<div></div>
31	agenda	speaker	item	committee	chair	divided	146	<div></div>
48	consolidated	contingency	reinvestment	inc	contract	authorize	134	<div></div>
55	suspect	shoot	fatal	homicide	stopper	pronounce	512	<div></div>

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.