

# Mapping and Visualizing News Images for Media Research

Rahul Bhargava  
Center for Civic Media  
MIT  
Cambridge, MA, USA  
rahulb@mit.edu

Cindy Bishop  
Center for Civic Media  
MIT  
Cambridge, MA, USA  
csbishop@media.mit.edu

Ethan Zuckerman  
Center for Civic Media  
MIT  
Cambridge, MA, USA  
ethanz@mit.edu

## ABSTRACT

Technological and societal changes have led to greater use of and attention to images in online news coverage. While media scholars are moving from text-only approaches to include image analysis, the tools are still in an early stage of development. Even simple algorithmic image analysis techniques have much to offer these efforts. Leveraging our existing media analysis platform, Media Cloud, we investigate computational approaches that visualize photos from a corpus of news stories on the issue of abortion rights in the US during summer of 2019. We describe two prototype visualizations we created to support our research - Image Treemaps and Photos Spaces - and document initial findings from this analysis. We find evidence of the use of visual metonyms by Right-wing sources, supporting existing work from media scholars studying abortion. We also find diverging visual narratives based on political affinity of media sources, supporting existing work that documents the growth of divergent news ecosystems. We see potential for this method in decoding the signals encoded in online news imagery and discuss how future work could support that.

## CCS CONCEPTS

• Human-centered computing → Visualization; • Human-centered computing → Social media; • Computing methodologies → Image processing

## KEYWORDS

Media analysis, Journalism, Visualization, Machine Learning

## 1 Background and Related Work

Photos have long been a key component of journalism, recognized and honored with the Pulitzer Prize since the early 1940s [28]. Early journalistic photography made vivid the horrors of the Spanish American War (and made Pulitzer and his competitors profoundly wealthy.) The increased portability of cameras made possible the emergence of picture magazines like LIFE, which made photography the center of its journalism in 1936. Advances in print technology helped catapult images to mainstays of regular news dailies [2].

Given the centrality of imagery to contemporary journalism and the rapid transformations facing the imagery, there has been comparatively scarce literature studying trends in journalistic imagery. There has been much research, writing, and self-

reflection on the challenges to existing business models [27] and the decaying of professional ethical norms [22]. We have found less concentrated study on how these trends are affecting the use of images in news reporting. One study showed how positive or negative images accompanying a single neutral story would impact people's perceptions of obesity [13]. Another documented stronger reader engagement on stories that included images, particularly those depicting victimization [26]. More recent research is interrogating the use and spread of image memes as their own emergent rhetorical technique [9]. Meme-related work has sometimes received more widespread attention in journalistic venues, particularly when analyzing the history of a meme that was amplified by politicians such as "jobs not mobs" in 2018 [3]. The field of computational image processing has looked at news images, but has mostly focusing on photos of politicians and identifying "bias" or political leaning [12, 17].

In our time of news polarization and activism, we see a renewed importance of photos and emerging patterns of use. There are some relevant technological changes that may be impacting the use of photos in news stories. As bandwidth has grown, large headline images for stories have become more common. Additionally, there have been significant increases in readership from social media, where news stories featured as "cards" almost always highlight a photo and the headline of a story more than the full text. Beyond those technological changes, we have seen numerous examples of photos being central in contested framings of media narratives. Editors covering the 2014 protests in Ferguson struggled out loud on how to select images that accurately portrayed the situation [11]. This became a prominent enough issue that the longstanding Facing History education program specifically created curriculum around questions of how photos are, and should be, chosen in news reporting [21]. Similar questions led to the creation of the #IfTheyGunnedMeDown hashtag in 2014, where individual social media users questioned which images a newspaper would choose if one of the individuals was killed [20]. #IfTheyGunnedMeDown used imagery as an impetus for change and demanded that news organizations change their imagery - movements like this are impossible to study without analyzing accompanying imagery.

These examples suggest a growing need for research into how we can best leverage computational power to analyze news photos as part of the larger field of media analysis. Existing research has looked at images and impact, but we lack generalizable tools to support more broad use. One study looking at news depictions of

politicians found that newsroom endorsements correlated with positive imagery of candidates [1]. A case study of Flemish papers found little change in how local newsrooms practiced "visual gatekeeping" in their photo selection from a comparison of pre- and post-digital production practices [19]. The authors notably explained: "the photo desk's main task is to illustrate the news with visualizations, not to search for visual news." Returning to the emergent field of meme studies, we do find some examples to draw on for research on newspaper image use. The 2012 US presidential election gave us a number of meme examples that hinted at elements of how memes would come to function in our current media landscape [7]. Media scholars have built on Jenkin's idea of "spreadable media" to understand this role from a theoretical perspective [24]. Computational scholars have built prototypes of tools to analyze large sets of memes and look for emergent patterns over time [25], but these have yet to emerge as generalizable tools applicable to news media writ large.

This short paper shares processes and findings from our initial forays into tools to support analysis of photos of news as part of a media analysis pipeline. We built a corpus of images used in US media coverage of women's reproductive rights in mid 2019 as a case study. We selected the topic of abortion laws from a set of major news events due to the robust history of academic literature to draw on. We begin with a summary of our methodology, move on to sharing examples of computational approaches to analyzing the images and resulting findings, and close with suggestions for paths forward.

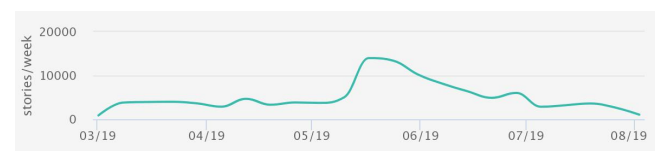
## 2 Data Collection and Methodology

Spring 2019 brought a wave of laws to limit abortion rights at the state-level in the US; from the so-called "heartbeat bill" in Georgia, the most populous southern state to file such legislation, to the "Human Life Protection Act" in Alabama. Women's reproductive rights, specifically related to abortion, raise complex and contentious issues in which media framing via images varies significantly. A significant actor in this debate is the religious Right, having framed their visual narrative in a very specific and effective manner. This is best summarized by Condit as follows [4]:

The metonymic reduction of the wide variety of developing human forms into a single entity - "the fetus as an unborn baby" - was a crucial rhetorical move. The pro-Life rhetors...wanted the American public to respond to the fetus as if it were one single distinct entity - a human baby'; therefore, they worked to generate a `_single_image` of the fetus.

To assess the use of photos in news reporting on these events, we created a corpus of news articles from US-based newspapers. This began by querying the Media Cloud platform<sup>1</sup>, which contains almost 1.5 billion news stories from the open web, and

regularly collects them from over 60,000 US and global media sources via RSS feeds. Our query selected all stories in this existing corpus that mentioned "abortion" between March 1, 2019 and August 1, 2019. We selected these dates based on patterns in news reporting and when the main state-level laws were being publicly debated. The Media Cloud system let us create a "Topic", which began with these stories existing in the database and then followed links in them, "spidering" for more stories that also mentioned "abortion". This resulted in a corpus containing 135,980 stories from 6,199 different media sources. The Media Cloud system automatically measured linking patterns between stories and the number of times each story was shared on Facebook (at the time of corpus creation). Additionally, roughly half of the media sources in this corpus had been classified according to existing partisanship measures, based on patterns of URL sharing among followers of Trump and Clinton during the 2016 US election [15].



**Figure 1: The total number of stories in our corpus, grouped by week of publication.**

With this corpus of news articles in hand, we validated and ran an automated extraction process to pull the "top image" from each to use for our research. Media Cloud does not natively extract and store images from stories it processes. This research is in part an early exploration into how to best support that becoming a standard system feature applied to every story. The goal of extracting a single image to analyze for each story is based on the classic patterns of print journalism and emerging norms of social sharing. Editorial practices for news in print typically pick one image to represent the headline of the article; our informal surveying of large news websites and short conversations with journalists led us to believe this pattern has migrated online.

Additionally, social media websites have created technological norms for adding metadata to an article's webpage, via HTML meta tags, to suggest which image the publisher would like the social media website to use to represent the story. We selected the Newspaper3k<sup>2</sup> Python library to extract the top image from each article. To validate their algorithm we created a set of 500 randomly chosen news stories from a set of large global sources within Media Cloud. A media researcher on our team reviewed each to assess which image they would qualitatively categorize as the "top image". Comparing the top image selected by Newspaper3k to the one our colleague choose showed that they matched 90% of the time, giving us confidence in using the automated algorithm.

<sup>1</sup> <https://mediacloud.org>

<sup>2</sup> <https://github.com/codelucas/newspaper/>

Based on the event-driven nature of this project, we picked five intervals to focus on for our research. These included:

- April 22 - 29: One month before the legislative wave
- May 13 - 20: The week with the most stories published
- May 27 - June 1: The week with the 2nd most stories published
- June 24 - July 1: One month after the passage of the Georgia law
- July 29 - August 5: Two months after the passage of the Georgia law

Unlike traditional newspaper analysis, images are displayed in different ways on different media, so the well-established approach of measuring how much space an image takes up doesn't hold in the domain of digital news reading. Layouts differ on mobile, desktop, and tablet interfaces, forcing us to focus less on the size of an image and more on the content. The following discussion shares approaches we took to analyzing these images to support our media research into this issue.

### 3 Approach 1: Image Treemaps

Our first approach to supporting research on news images builds on existing practices of measuring influence within Media Cloud. As mentioned previously, the system automatically adds metadata about linking between stories and media sources, as well as data about how many shares each story as received on Facebook. We created image-based treemaps sized by these metrics. Treemaps are an established approach to displaying information where the relative physical space a data-point takes up is determined by some quantitative data associated with it. To create image treemaps, we simply fill that space with the image, or a repeating pattern based on that image, instead of a color. Interactive versions show metadata about the story or image as tooltips when hovering over an image. In a research context, this allows for drilling down to discover more information as one investigates a corpus of images.

#### 3.1 Political Polarization

We found that these image tree maps depicted a visual grammar that matched our expectations of political polarization based on previous work on news coverage of abortion in the US. Looking at Figure 2, one can see that overall Left (blue border) and Right (red border) images varied widely, suggesting highly separated visual narratives. A pregnant Alabama resident was shot that week, causing her to have a miscarriage. The most shared stories on the Left featured her face, while the stories from the Right focused on politicians and other politically-affiliated men. This early finding of differing visual narratives echoes other work on non-overlapping media ecosystems emerging in the US [15].



**Figure 2: Image Treemap of top 30 stories in the week of June 24 - to July 1, sorted and sized by Facebook share counts. Blue/red borders indicate political affinity.**

#### 3.2 Visual Metonyms in Use

Prior work in abortion imagery in media provides the helpful concept of visual "metonyms" - images that serve to represent a larger set of concepts with which they are associated. Condit delves deeply into this phenomenon in her writing on abortion rhetoric in the US, arguing that images are conflated by the conservative media in such a way that babies come to represent all stages of embryonic development [4]. This is part of a larger pattern of commentators using phrases to reference issues metonymically [18]. At least as far as the visual language of abortion, the use of a metonymic image can symbolize a complex narrative to those with similar beliefs [4]. Despite long engagement with these issues the Left has had a more difficult time reducing the necessity of women's reproductive rights into a single image.



**Figure 3: Image Treemap of top 30 stories in the week of May 13-20, sorted and sized by Facebook share count.**

We find initial evidence of abortion-related visual metonyms in use, particularly from Right-leaning sources. Metonymic images evoke the idea of a baby while discussing laws around abortion rights. Figure 3 depicts this pattern in a week of particularly high levels of press coverage. The top most shared stories from the Right-leaning sources included newborn babies, cradles, pregnant women, babies sleeping, and a 3d image that evokes both ultrasound images and a newborn baby.

## 4 Approach 2: Photo Spaces

The prior approach focused in on the most shared stories in particular weeks in order to scaffold research into the visual language of abortion coverage in news on social media. Understanding the overall visual landscape of news coverage about this topic requires a different computational approach. To support these types of investigation, we extended Yin's work on visualizing popular online imageboards to create large scatterplots of images clustered by similarity of what they depict [25]. This technique makes secondary measures of influence or attention in order to highlight the content of the images.

Leveraging emerging work on neural nets and image embeddings enables us to analyze and compare large sets of images relatively quickly. A high-level overview of this pipeline looks like this:

1. Process images to standardize size, colors, and format
2. Analyze images to produce a tensor to represent it [16]
3. Pass each representation through the ResNet-50 model (pre-trained on ImageNet) to classify it, creating a multi-dimensional image embedding [5, 8]
4. Use UMAP to reduce dimensions quickly while preserving global distances [14]

The end result is a 2-dimensional position for each image, based on the distance similarity of embeddings within the entire corpus. Laying these out with thumbnails as a scatterplot can reveal clusters of similar images. Yin resolves the occlusion problem by further reducing the sample of images and mapping that to a matrix view. For now we choose to allow for further inspection, thresholding the images shown according to high share count. As such, we create an interactive thumbnail scatterplot that shows image and story metadata on rollover. In addition, we experimented with weighting the x-axis placement by political affinity of the media source (pulling image placement left or right). We call this prototype visualization the "photo space".



**Figure 4. "Photo Space" visualization of the top 1000 stories, based on Facebook shares.**

This photo space visualization supports research into patterns of visual narratives in a large image corpus. For example, if the previously discussed hypothesis regarding metonymy holds true we should see a cluster of baby and sonogram images, mostly from Right-leaning media sources. In Figure 4 we do find evidence supporting this in analyzing the top 1000 stories about

abortion shared on Facebook., More baby-related visuals emerge from Right-leaning news sources: mother and baby, empty bassinet, newborns, fetuses. In contrast, we see more oppression-related visuals from Left-leaning sources: references to Margaret Atwood's *The Handmaid's Tale*, tape over a woman's mouth, a juxtaposition of all the white men voting for the Alabama abortion ban



**Figure 5. A zoomed-in view of a cluster of baby-related images. Those highlighted in red are from Right-leaning media sources. The numbers on images are internal ids used for debugging purposes.**

These clusters are more apparent in high resolution renderings of the photo space, as shown in Figure 5. Most of the baby-related photos in this area are from Right-leaning sources, including adorable smiles, baby burritos, and mothers gazing lovingly at their children. These initial observations suggest images are being used as metonyms, ignoring stages of development, using images of blastocyst, embryo, fetus, baby interchangeably. Women who grow and birth babies have far less visual representation, and when included are generally from Left-leaning sources.

These image space prototypes clearly require more algorithmic pipeline work and design iteration, but suggest a productive path forward as an approach to representing a larger corpus of images to allow interrogation of patterns of image use in media coverage.

## 5 Conclusion and Future Work

This short paper documents two computational approaches to supporting research on images used in media representation and shares initial findings related to coverage of the contentious issue

of abortion rights in the US. Using these prototype techniques, we find:

1. Diverging patterns of image use in Right and Left leaning media sources, reinforcing theories of non-overlapping media ecosystems;
2. Evidence supporting the practice of metonymy in the visual depiction of abortion-related stories.

Based on these findings we believe that these techniques can augment media analysis pipelines by adding in image-based analytic approaches. As communication is compressed into ever-smaller and shorter-form snippets, we are likely to see images playing a more significant and symbolic role along divergent ideologies, especially when encoded into memes.

We plan to continue these experiments to iterate on approaches to image-based analysis in the Media Cloud system. Full integration would allow for a larger community of media researchers to study the continued emergence of images as a media on their own, as they flow across websites and social media platforms. While we acknowledge possible benefits from some sophisticated algorithmic approaches trained on larger corpora, we believe progress in media studies can be made by refining these comparatively simple tools and interfaces for use by media scholars. Through rapid prototyping and testing of these techniques by media analysts, we believe we can both support original scholarship and better define the problems of journalistic image analysis for computer scientists focused on the creation of novel algorithms.

There are several paths for expanding this work to support more robust and automated analysis. Iterating on the approach to image similarity might allow a dashboard that showcases emerging visual narratives over time. This becomes an especially compelling idea when one takes into account concerns about "shallow-fake" technologies - tools that make it quick and easy to create doctored images [10]. While some argue that the concerns over faked images is "hype and hyperbole" [23], there is growing evidence that the spread of doctored images themselves has had significant and deadly impact in places like India already [6]. Building tools that help us analyze the content, influence, and spread of images can help us respond to the growing impact of this "visual news".

## ACKNOWLEDGMENTS

The authors would like to thank Anissa Pierre for her help validating the Newspaper3k algorithms, Leon Yin for his inspiration and code examples, and Dan Minty for formatting and production help.

## REFERENCES

- [1] Barrett, A. and Barrington, L. 2005. Bias in Newspaper Photograph Selection. *Political Research Quarterly*. 58, 4 (Dec. 2005), 609–618.
- [2] Carlebach, M. 1994. The Origins of Photojournalism in America. *Journal of American History*. 80, 4 (Mar. 1994), 1469–1470. DOI:<https://doi.org/10.2307/2080659>.
- [3] Collins, K. and Roose, K. 2018. Tracing a Meme From the Internet's Fringe to a Republican Slogan. *The New York Times*.
- [4] Condit, C. 1994. *Decoding Abortion Rhetoric: COMMUNICATING SOCIAL CHANGE*. University of Illinois Press.
- [5] Deng, J. et al. 2009. ImageNet: A Large-Scale Hierarchical Image Database. (2009), 8.
- [6] Garimella, K. and Eckles, D. 2017. *Image based Misinformation on WhatsApp*. In Proceedings of the Thirteenth International AAAI Conference on Web and Social Media (ICWSM 2019).
- [7] Graeff, E. 2013. Binders Full of Election Memes: Expanding Political Discourse. Digital Media and Learning Conference, Chicago, IL, 14 March 2013. Lecture.
- [8] He, K. et al. 2016. Deep Residual Learning for Image Recognition. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (2016), 770–778.
- [9] Jenkins, H. et al. 2013. *Spreadable Media: Creating Value and Meaning in a Networked Culture*. NYU Press.
- [10] Johnson, B. 2019. Deepfakes are solvable—but don't forget that "shallowfakes" are already pervasive. *MIT Technology Review*.
- [11] Kennedy, R. and Schuessler, J. 2014. Ferguson Images Evoke Civil Rights Era and Changing Visual Perceptions. *New York Times*.
- [12] Lobinger, K. and Brantner, C. 2015. Likable, funny or ridiculous? A Q-sort study on audience perceptions of visual portrayals of politicians. *Visual Communication*. 14, 1 (Feb. 2015), 15–40. DOI:<https://doi.org/10.1177/1470357214554888>.
- [13] McClure, K.J. et al. 2011. Obesity in the News: Do Photographic Images of Obese Persons Influence Antifat Attitudes? *Journal of Health Communication*. 16, 4 (Apr. 2011), 359–371. DOI:<https://doi.org/10.1080/10810730.2010.535108>.
- [14] McInnes, L. et al. 2018. UMAP: Uniform Manifold Approximation and Projection for Dimension Reduction. *arXiv:1802.03426*. arXiv preprint, (Dec. 2018).
- [15] Network Propaganda: Manipulation, Disinformation, and Radicalization in American Politics: Yochai Benkler, Robert Faris, Hal Roberts: 9780190923631: Amazon.com: Books: 2018. Accessed: 2019-12-12.
- [16] Paszke, A. et al. 2019. PyTorch: An Imperative Style, High-Performance Deep Learning Library. *Advances in Neural Information Processing Systems 32* (2019), 8024–8035.
- [17] Peng, Y. 2018. Same Candidates, Different Faces: Uncovering Media Bias in Visual Portrayals of Presidential Candidates with Computer Vision. *Journal of Communication*. 68, 5 (Oct. 2018), 920–941. DOI:<https://doi.org/10.1093/joc/iqu041>.
- [18] Polletta, F. and Callahan, J. 2017. Deep stories, nostalgia narratives, and fake news: Storytelling in the Trump era. *American Journal of Cultural Sociology*. 5, 3 (2017), 392–408.
- [19] de Smaele, H. et al. 2017. Visual Gatekeeping – Selection of News Photographs at a Flemish Newspaper. *Nordicom Review*. 38, s2 (Nov. 2017), 57–70. DOI:<https://doi.org/10.1515/nor-2017-0414>.
- [20] Stampler, L. 2014. #IfTheyGunnedMeDown Hashtag Responds to Michael Brown Shooting. *Time*.
- [21] The Power of Images: <https://www.facinghistory.org/resource-library/facing-ferguson-news-literacy-digital-age/power-images>. Accessed: 2019-12-12.
- [22] White, A. 2017. *Ethics in the News*. Ethical Journalism Network.
- [23] Leetaru, K. Why Would Deep Fakes Be Any More Damaging Than Fake Text? 2019. <https://www.forbes.com/sites/kalevleetaru/2019/08/28/why-would-deep-fakes-be-any-more-damaging-than-fake-text/>. Accessed: 2019-12-12.
- [24] Wiggins, B.E. and Bowers, G.B. 2015. Memes as genre: A structural analysis of the memescape. *New Media & Society*. 17, 11 (Dec. 2015), 1886–1906. DOI:<https://doi.org/10.1177/1461444814535194>.
- [25] Yin, L. 2019. *Disinfo-Doppler*. <https://github.com/yinleon/Disinfo-Doppler>
- [26] Zillmann, D. et al. 2001. Effects of Photographs on the Selective Reading of News Reports. *Media Psychology*. 3, 4 (Nov. 2001), 301–324. DOI:[https://doi.org/10.1207/S1532785XMEP0304\\_01](https://doi.org/10.1207/S1532785XMEP0304_01).
- [27] 2006. Challenges to the Newspaper Industry. *Pew Research Center's Journalism Project*.
- [28] 2019. Pulitzer Prize for Photography. *Wikipedia*.