

A County-level Dataset for Informing the United States' Response to COVID-19

Benjamin D. Killeen^{1,2}
killeen@jhu.edu

Jie Ying Wu¹
jieying@jhu.edu

Kinjal Shah²
kshah31@jhu.edu

Anna Zapaishchykova²
azapais1@jhu.edu

Philipp Nikutta²
pnikutt1@jhu.edu

Aniruddha Tamhane¹
atamhan3@jhu.edu

Shreya Chakraborty¹
schakr20@jhu.edu

Jinchi Wei²
jwei9@jhu.edu

Tiger Gao¹
tgao11@jhu.edu

Mareike Thies²
mthies1@jhu.edu

Mathias Unberath^{1,2}
unberath@jhu.edu

¹Department of Computer Science

²Laboratory for Computational Sensing and Robotics

Johns Hopkins University,

Baltimore, MD, United States

Abstract—As the coronavirus disease 2019 (COVID-19) becomes a global pandemic, policy makers must enact interventions to stop its spread. Data driven approaches might supply information to support the implementation of mitigation and suppression strategies. To facilitate research in this direction, we present a machine-readable dataset that aggregates relevant data from governmental, journalistic, and academic sources on the county level. In addition to county-level time-series data from the JHU CSSE COVID-19 Dashboard [1], our dataset contains more than 300 variables that summarize population estimates, demographics, ethnicity, housing, education, employment and income, climate, transit scores, and healthcare system-related metrics. Furthermore, we present aggregated out-of-home activity information for various points of interest for each county, including grocery stores and hospitals, summarizing data from SafeGraph [2]. By collecting these data, as well as providing tools to read them, we hope to aid researchers investigating how the disease spreads and which communities are best able to accommodate stay-at-home mitigation efforts.

Our dataset and associated code are available at https://github.com/JieYingWu/COVID-19_US_County-level_Summaries.

I. INTRODUCTION

COVID-19 has had a devastating impact on the United States' health care system, economy, and social wellbeing. Despite early promises of an "American Resurrection" by April 12, 2020 [4], social distancing measures remain in effect through the month of April, and many scientists and public health experts speculate they may last much longer. As of the time of writing, restrictions in Hubei province, China, where the disease originated in December, 2019, are only now gradually being lifted [5]. Confirmed COVID-19 cases, hospitalizations, and—unfortunately—deaths are increasing

Please direct inquiries to Benjamin D. Killeen, Jie Ying Wu, and Mathias Unberath.

An earlier version of this article appeared at <https://link.medium.com/N2azyHrq94>.

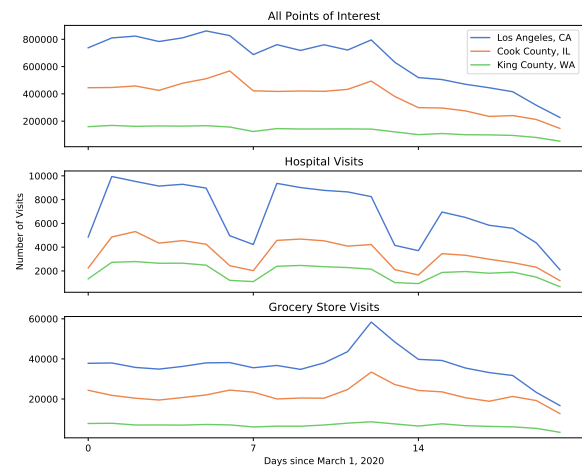


Fig. 1. Aggregated out-of-home activity consisting of visits to points of interest for selected counties with high incidence of COVID-19 cases. The periodic dip in hospital visits corresponds to weekends, when most hospitals have reduced hours. The decline in overall foot traffic can be seen to start on March 12 in these counties. Data from [2].

exponentially. Drastic interventions like social distancing are necessary to slow the spread of the disease, giving more time to

- provide treatment within our healthcare system's capacity,
- develop effective testing capability,
- establish sophisticated tracing mechanisms, and
- discover novel treatments for the virus.

At the same time, the current mitigation strategies have had severe effects on society and the economy. Widespread closures of schools and daycares have left working parents with

arXiv:2004.00756v1 [cs.CY] 1 Apr 2020

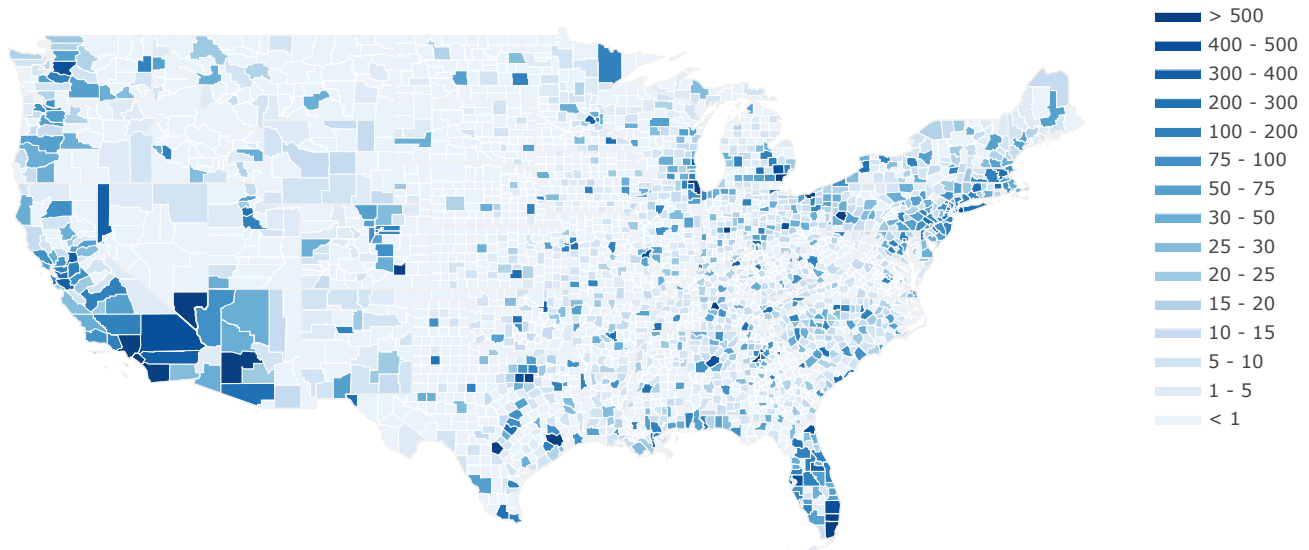


Fig. 2. Number of Intensive Care Unit (ICU) beds per county. Data from [3].

limited childcare options [6]; shuttered bars, restaurants, and entertainment venues have forced owners to lay off employees, predominantly in the service industry [7]; and a plummeting stock market has fueled fears of a recession which may far outlast the current crisis [8]. To combat these effects, representatives recently passed the largest economic stimulus package in U.S. history [9]. However, no stimulus can offset the effects of an indefinite quarantine. Determining when and how to roll back non-pharmaceutical interventions in a manner which is safe and responsible is of the utmost importance.

The initial quarantine period is necessary to avoid overwhelming our hospital systems. After this, we must balance reducing the risk of spread with the adverse economic consequences of millions of furloughed and unemployed people. To inform this process, we have curated a **machine-readable dataset** that aggregates data from governmental, journalistic, and academic sources on the county level. While most of these sources are freely available, there is significant work to align them and put them in a standard format that enables analysis. In addition to time-series data from [1], which details COVID-19 per-county infections and deaths, our dataset contains more than 300 variables that summarize population estimates, demographics, ethnicity, housing, education, employment and income, climate, transit scores, and healthcare system-related metrics. Further, we source a significant number of journal articles detailing implementation dates of interventions, including stay-at-home orders, school closures, and restaurant and entertainment venue closures [10]–[48]. Finally, we aggregate out-of-home activity data from [2] in each county, possibly measuring compliance with the aforementioned restrictions. Fig. 1 shows a sample of out-of-home activity for selected counties..

We hope that this dataset proves to be a useful resource to the community, facilitating important research on epidemiological forecasting. In particular, a machine learning approach to identify highly relevant factors may inform a graduated rollback of isolation measures and travel restrictions.

II. RELATED WORK

Because of the rapidly-evolving nature of the COVID-19 pandemic, the response from the data science community is ongoing and in flux. Here, we review some related efforts available at the time of this writing. As new articles are published every day, this is by no means an exhaustive review.

Despite significant public interest, government agencies have yet to publish a county-level data source for cases of COVID-19. As such, [1], [63], [64] constitute the most up-to-date and reputable collection of COVID-19 cases across the United States, hosted by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University, the New York Times, and crowdsourced individuals, respectively. These efforts focus on current, hard data gathered from local government publications and reputable journalistic sources. Other efforts focus on gleaning related information from a variety of sources, including social media. [65] tracks COVID-19 related tweets in an effort to understand the conversation and possible misinformation surrounding the pandemic. Johns Hopkins University, University of Maryland, and George Washington University has also started a collaboration to track COVID-19 through social media [66]. In just the last week, people have launched 2290 Kaggle challenges related to the virus.

Much recent work has focused on using machine learning and data science tools to understand the virus. [67] uses

| Data Type | Source | Availability |
|---|---------------------|---------------------|
| COVID-19 Infections COVID-19 Related Deaths Time-series | [1] | — |
| 2020 Date of COVID-19 Interventions, <i>e.g.</i> stay-at-home order | [10]–[48] | — |
| March, 2020 Out-of-home Activity Time-series | SafeGraph [2] | — |
| 2018 Population Estimates | Census [49] | 97-100% |
| 2014-2018 Educational Attainment | Census [50] | 100% |
| 2018 Estimated Poverty Level | USDA [51] | 97% |
| 2018 Employment and Income | USDA [52] | 99% |
| 2019 Precipitation and Temperature | NOAA [53] | 86% (37.8% imputed) |
| 2010 Housing and Density | Census [54] | 99% |
| 2018 Age Group Demographics | Census [55] | 97% |
| 2018 Household Demographics | Census [55] | 25% |
| 2018 Ethnic Group Demographics | Census [56] | 97% |
| 2019 Healthcare Capacity: Physicians, NPs, PAs | AAMC, KFF [57]–[59] | 86-97% |
| 2019 Healthcare Capacity: ICU Beds | KFF [3], [60] | 92-97% |
| 2019 Public Transit Scores | CNT [61] | 95% |
| 2016 Crime Rates | DOJ [62] | 97% |

TABLE I
DATA SOURCE DESCRIPTIONS AND PERCENTAGE OF COUNTIES INCLUDED FOR STATIC DATA

data from the Diamond Princess cruise ship, where an early outbreak took place, to estimate the reproductive number R_0 of the virus. [68] implements active learning methods to detect new outbreaks of the virus, incorporating new data types without having to retrain. [69], [70] focus on understanding the current pandemic in its early stages, compensating for the inherent uncertainty in novel disease.

III. DATASET

We describe the structure of our dataset, which includes each component in its raw form as well as a narrowed-down, machine-readable form conducive to a machine-learning approach. Table I summarizes the sources and availability for each type of data, and a full description of each variable can be found in our repository.

A. County Descriptors

We populate a CSV file with 348 variables for 3220 county-equivalent areas (as well as the fifty states, District of Columbia, and the whole United States) with numerous types of data, including population, education, economic, climate, housing, health care capacity, public transit, and crime statistics. Each area is uniquely identified by its Federal Information Processing Standard (FIPS) code, a five digit number where they first two digits designate the state, and the last three digits describe the county-equivalent. Our sources include the United States Census Bureau [49], [50], [55], [56], the United States Department of Agriculture (USDA) Economic Research Service [51], [52], the National Oceanic and Atmosphere Administration (NOAA) [53], the Association of American Medical Colleges (AAMC) [57], the Henry J. Kaiser Family Foundation (KFF) [3], [58], [59], the Center for Neighborhood Technology (CNT) [61], and the Bureau of Justice Statistics, Department of Justice (DOJ) [62]. Perhaps most relevant to the ongoing effort to mitigate the effects of COVID-19 in the U.S. is county-level healthcare system capacity. The dataset includes detailed counts for each type of medical practitioner as well as the number of Intensive Care Unit beds in each county, shown in Fig. 2.

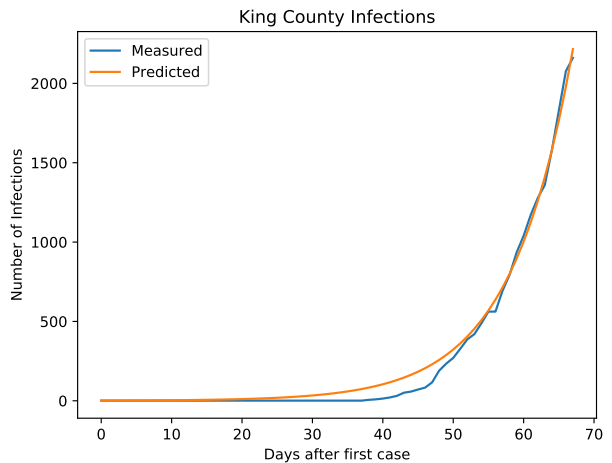


Fig. 3. In its early stages, an epidemic can be modeled exponentially, as shown here for the number of COVID-19 infections in Kings County, WA, which had a growth factor of 0.113. Infections data from [1].

For the most part, these basic descriptive variables are unaltered from their original state. Where appropriate, missing values have been imputed with the state-wide average, detailed in Table I.

B. Interventions

Our dataset describes mitigation efforts taken at the state level, including stay-at-home advisories, banning large gatherings, public school closures, and restaurant and entertainment venue closures. For machine readability, we provide each date of implementation as a Gregorian ordinal, *i.e.* the integer number of days starting at January 1, Year 1 CE, consistent with standard software libraries. Moreover, these data are provided according to the same county-level row ordering as our county descriptor data (see Sec. III-A). Interventions made at the state level have been assigned to each county in that state, and we include county-level interventions wherever

possible An intervention is designated NA if the county or state has not yet enacted it.

C. Out-of-home Activity

We have aggregated point-of-interest location data gathered from user's smartphones to show out-of-home activity, using raw data from [2]. For privacy and IP reasons, our dataset does not include user location data in its raw form but rather in several time-series files summarizing county-level activity. Fig. 1 shows the time-series for selected counties which have a high incidence of COVID-19 cases. The decline in overall activity on May 12 corresponds to an increased media attention and stay-at-home advisories in those areas. At the same time, a spike in grocery store visits points to a panic-buying spree which has since subsided.

D. Disease Spread

Finally, we provide time-series data for the cumulative number of COVID-19 confirmed cases and related deaths, from [1]. This data begins on January 22, 2020. It should be noted that epidemiological modeling efforts may want to consider the uncertainty surrounding U.S. testing [71], on which these data are based. At the time of this writing, efforts to improve the availability of COVID-19 tests are ongoing, but the current strategies prioritize patients with severe symptoms. Thus, modeling efforts may wish to take into account random subsampling of the true population, where untested individuals still spread the virus. This is especially true given that nearly half of all COVID-19 infections may be asymptomatic [72].

Fig. 3 shows the infections in King County, WA collected by [1]. King County had an early confirmed cases of the virus, and the exponential curve illustrates the rapid growth currently taking place there as a result.

IV. DISCUSSION

This extreme growth reinforces the need for constant vigilance and continued intervention efforts everywhere. Although the curve of measured infections in Fig. 3 would flatten as the population approaches herd immunity, it would require almost everyone in the U.S. to be infected. If that happens too quickly, it will completely overwhelm our healthcare system. The number of individuals who will ultimately be infected—and the number of deaths that will result—depend on the interventions reinforced now. At the same time, the economic impact of these interventions, which is not evenly distributed across counties, cannot be ignored. It depends on the characteristic qualities of each area—very different, for example, New York as opposed to Silicon Valley. The former has a large population in the entertainment and service industries, which will need financial support during quarantine, whereas the latter is dominated by large tech firms, whose employees can adapt to working from home. By providing the socioeconomic attributes of each county, the spread of COVID-19 confirmed cases, and the ongoing response in a machine-readable format, we hope to inform the decisions made to most effectively protect each area.

ACKNOWLEDGMENT

Thank you to all our sources, especially the JHU CSSE COVID-19 Dashboard for making their data public and SafeGraph, for providing researchers their data for COVID-19 related work.

REFERENCES

- [1] E. Dong, H. Du, and L. Gardner, "An interactive web-based dashboard to track COVID-19 in real time," *The Lancet Infectious Diseases*, vol. 0, no. 0, Feb. 2020.
- [2] SafeGraph, "Footprint data," safeGraph, a data company that aggregates anonymized location data from numerous applications in order to provide insights about physical places. To enhance privacy, SafeGraph excludes census block group information if fewer than five devices visited an establishment in a month from a given census block group.
- [3] "Millions of older americans live in counties with no ICU beds as pandemic intensifies," *Kaiser Health News*, Mar. 2020.
- [4] M. Vazquez, N. Valencia, J. Acosta, and K. Liptak, "Trump says he wants the country 'opened up and just raring to go by Easter,' despite health experts' warnings," <https://www.cnn.com/2020/03/24/politics/trump-easter-economy-coronavirus/index.html>.
- [5] V. Wang and S.-L. Wee, "China to ease coronavirus lockdown on hubei 2 months after imposing it," *The New York Times*, Mar. 2020.
- [6] "Map: Coronavirus and School Closures - Education Week," *Education Week*, Mar. 2020.
- [7] B. Casselman, S. Maheshwari, and D. Yaffe-Bellany, "Layoffs Are Just Starting, and the Forecasts Are Bleak," *The New York Times*, Mar. 2020.
- [8] S. Clement and D. Balz, "Poll finds recession fears high amid layoffs and pay cuts from coronavirus fallout," https://www.washingtonpost.com/politics/poll-finds-recession-fears-high-amid-layoffs-and-pay-cuts-from-coronavirus-fallout/2020/03/26/00c412ba-6f5e-11ea-b148-e4ce3fd85b5_story.html.
- [9] "House gives final passage to \$2 trillion coronavirus stimulus bill," <https://www.nbcnews.com/politics/congress/house-gives-final-passage-2-trillion-coronavirus-stimulus-bill-n1170281>.
- [10] Carter, "'It's over.' NC bars, restaurants close to the public, leaving employees with uncertainty," <https://www.newsobserver.com/news/coronavirus/article241284781.html>, library Catalog: www.newsobserver.com.
- [11] S. Carroll, "62 coronavirus cases in Arkansas; governor extends school closure, bans restaurant dine-in," <https://katv.com/news/local/coronavirus-cases-rise-to-46-in-arkansas>, Mar. 2020, library Catalog: katv.com.
- [12] C. Hansen, "Alabama Governor Closes Nonessential Businesses as Coronavirus Spreads," <https://www.usnews.com/news/national-news/articles/2020-03-27/alabama-gov-kay-ivey-closes-nonessential-businesses-as-coronavirus-spreads>, library Catalog: www.usnews.com.
- [13] R. Rettner, "Arkansas: Latest updates on coronavirus," <https://www.livescience.com/coronavirus-arkansas.html>, library Catalog: www.livescience.com.
- [14] S. Mook, "Burgum closes bars, restaurants amid coronavirus concerns; schools to stay closed indefinitely," <https://www.grandforksherald.com/news/education/5007393-Burgum-closes-bars-restaurants-amid-coronavirus-concerns-schools-to-stay-closed-indefinitely>, library Catalog: www.grandforksherald.com.
- [15] Z. Anderson, "Coronavirus Florida: Governor closes all restaurants and gyms," <https://www.heraldtribune.com/news/20200320/coronavirus-florida-governor-closes-all-restaurants-and-gyms>, library Catalog: www.heraldtribune.com.
- [16] K. Staff, "Coronavirus in Nebraska, Iowa: The latest headlines and resources to keep you informed," <https://www.ketv.com/article/coronavirus-covid19-nebraska-omaha-latest/31213658>, Mar. 2020, library Catalog: www.ketv.com.
- [17] A. Soga, "Coronavirus in Vermont: Governor orders bars, restaurants closed," <https://www.burlingtonfreepress.com/story/news/2020/03/16/coronavirus-vermont-burlington-mayor-orders-24-hour-restaurant-bar-closure/5062491002/>, library Catalog: www.burlingtonfreepress.com.
- [18] A. Kite, K. Hardy, J. Smith, and S. Vockrodt, "Coronavirus shuts Kansas City restaurants, leaving staff unemployed, yearning for work," <https://www.kansascity.com/news/coronavirus/article241494536.html>, library Catalog: www.kansascity.com.

- [19] W. B. L. J. Feuer, Noah Higgins-Dunn, "Coronavirus: NY, NJ, CT coordinate restrictions on restaurants, limit events to fewer than 50 people," <https://www.cnn.com/2020/03/16/new-york-new-jersey-and-connecticut-agree-to-close-restaurants-limit-events-to-less-than-50-people.html>, Mar. 2020, library Catalog: www.cnn.com.
- [20] G. Hiatt, "D.C. Adds 'Stay-at-Home' Order on Same Day as Maryland and Virginia," <https://dc.eater.com/2020/3/15/21180673/dc-mayor-muriel-bowser-coronavirus-response-eliminate-bar-seats-limit-table-size>, Mar. 2020, library Catalog: dc.eater.com.
- [21] P. Svitek, "Gov. Greg Abbott closes bars, restaurants and schools as he anticipates tens of thousands could test positive for coronavirus," <https://www.texastribune.org/2020/03/19/texas-restaurants-bars-closed-greg-abbott/>, Mar. 2020, library Catalog: www.texastribune.org.
- [22] KCCI, "Gov. Reynolds issues state of public health disaster emergency, closing Iowa businesses," <https://www.kcci.com/article/gov-reynolds-issues-state-of-public-health-disaster/31700874>, Mar. 2020, library Catalog: www.kcci.com.
- [23] A. J. Capuano, "In Missouri, no dining-in at restaurants, groups of 10 or more banned amid coronavirus," <https://ktvo.com/news/local/missouri-no-dining-in-at-restaurants-groups-of-10-or-more-banned-amid-coronavirus>, Mar. 2020, library Catalog: ktvo.com.
- [24] B. Tobin, D. Ghabour, D. Costello, and M. Glowicki, "Kentucky Derby postponed, restaurants restricted as state tries to control spread of virus," <https://www.courier-journal.com/story/news/2020/03/16/coronavirus-kentucky-beshear-orders-restaurants-bars-close/5057062002/>, library Catalog: www.courier-journal.com.
- [25] HNN, "LIST: Here's how the state and each island is responding to coronavirus," <https://www.hawaiinewsnow.com/2020/03/18/list-bar-closures-cruise-ship-screening-here-are-all-iges-covid-directives/>, library Catalog: www.hawaiinewsnow.com.
- [26] "LIVE UPDATES: Here's the latest on the coronavirus in Forsyth County and Georgia," <https://www.forsythnews.com/news/health-care/heres-latest-coronavirus-georgia/>, library Catalog: www.forsythnews.com.
- [27] J. Helminiak, "Local bars, resaurants, gyms, theaters react to coronavirus," <https://www.peninsulaclarion.com/news/local-bars-resaurants-gyms-theaters-react-to-coronavirus/>, Mar. 2020, library Catalog: www.peninsulaclarion.com.
- [28] WGME, "Maine bars, restaurants ordered to close to dine-in customers, coronavirus cases increase," <https://wgme.com/news/coronavirus/gov-mills-mandates-maine-bars-restaurants-close-to-dine-in-customers>, Mar. 2020, library Catalog: wgme.com.
- [29] "Map: Coronavirus and School Closures - Education Week," *Education Week*, Mar. 2020.
- [30] A. Ganuchau, "Mayors scramble to know: Does Gov. Reeves' coronavirus declaration clash with local orders?" <https://mississippitoday.org/2020/03/25/mayors-scramble-to-know-does-gov-reeves-coronavirus-declaration-clash-with-local-orders/>, Mar. 2020, library Catalog: mississippitoday.org.
- [31] A. Press, "Montana Extends School, Restaurant Closures 2 More Weeks," <https://www.usnews.com/news/best-states/montana/articles/2020-03-22/evidence-of-community-spread-in-montanas-gallatin-county>, library Catalog: www.usnews.com.
- [32] M. Etehad and L. K. Peterson, "Nevada orders all casinos, bars, restaurants closed as U.S. coronavirus cases surge," <https://www.latimes.com/world-nation/story/2020-03-17/las-vegas-to-close-all-casinos-at-midnight>, Mar. 2020, library Catalog: www.latimes.com.
- [33] WHDH, "New Hampshire bans dine-in restaurant meals until April 7," library Catalog: whdh.com.
- [34] K. Media, "New restrictions for New Mexico restaurants and bars to begin Monday," Mar. 2020, library Catalog: www.krqe.com.
- [35] B. Webb, "Phoenix, Tucson order closures of bars, restaurants," <https://www.fox10phoenix.com/news/phoenix-tucson-order-closures-of-bars-restaurants1>, Mar. 2020, library Catalog: www.fox10phoenix.com.
- [36] A. Kludt and B. Houck, "Restaurants and Bars Shuttered Across the U.S. in Light of Coronavirus Pandemic," <https://www.eater.com/2020/3/15/21180761/coronavirus-restaurants-bars-closed-new-york-la-chicago>, Mar. 2020, library Catalog: www.eater.com.
- [37] R. Nunes, "RI Restaurants Closed Amid Community Spread Of Coronavirus," <https://patch.com/rhode-island/newport/coronavirus-ri-dine-restaurants-closed-2-weeks>, Mar. 2020, library Catalog: patch.com.
- [38] S. Mervosh, D. Lu, and V. Swales, "See Which States and Cities Have Told Residents to Stay at Home," *The New York Times*, Mar. 2020.
- [39] L. Ruskin, "State bans restaurant dining as Alaska's confirmed coronavirus cases grow to 6," Mar. 2020, library Catalog: www.alaskapublic.org.
- [40] C. Gross, "State to Restrict Bars and Restaurants Statewide Starting at 8PM," <https://www.ny1.com/nyc/all-boroughs/coronavirus/2020/03/16/bars-restaurants-gyms-movie-theaters-casinos-new-york-state>, library Catalog: www.ny1.com.
- [41] Axios, "States order bars and restaurants to close due to coronavirus," <https://www.axios.com/ohio-governor-bars-restaurants-coronavirus-26e4b6e3-7f65-4f6a-abf9-f3940220cc6f.html>, library Catalog: www.axios.com.
- [42] B. Kelman and J. McGee, "Tennessee governor orders restaurants, bars closed except for takeout and delivery; gyms closed over coronavirus," <https://www.tennessean.com/story/news/health/2020/03/22/tennessee-governor-restaurants-bars-closed-takeout-and-delivery/2892481001/>, library Catalog: www.tennessean.com.
- [43] A. Lee, "These states have implemented stay-at-home orders. Here's what that means for you," <https://www.cnn.com/2020/03/23/us/coronavirus-which-states-stay-at-home-order-trnd/index.html>, library Catalog: www.cnn.com.
- [44] T. Semerad, "Utah Orders Restaurants, Bars to Close All Dining to Curb Coronavirus," <https://www.sltrib.com/news/2020/03/18/utah-orders-restaurants/>, library Catalog: www.sltrib.com.
- [45] A. Spiegel, "Virginia Restaurants and Bars Close for Dine-In Service to Help Curb Coronavirus," Mar. 2020, library Catalog: www.washingtonian.com.
- [46] E. C. Wida, "Which states have closed restaurants and bars due to coronavirus?" <https://www.today.com/food/which-states-have-closed-restaurants-bars-due-coronavirus-t176039>, library Catalog: www.today.com.
- [47] Star-Tribune, "Wyoming cancellations and closures caused by coronavirus," https://trib.com/news/state-and-regional/health/wyoming-cancellations-and-closures-caused-by-coronavirus/article_228b1e3a-56b6-5e09-a351-3bcb8825e7f3.html, library Catalog: trib.com.
- [48] M. Specia, "What You Need to Know About Trump's European Travel Ban," *The New York Times*, Mar. 2020.
- [49] United States Census Bureau, "2018 Population Estimates." [Online]. Available: <https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkml>
- [50] —, "Selected social characteristics in the united states: 2018 acs 1 year data estimate profiles." [Online]. Available: <https://data.census.gov/cedsci/table?q=dp02&hidePreview=true&tid=ACSDP1Y2018.DP02&vintage=2018&g=0400000US36.050000&tp=true&y=2018>
- [51] United States Department of Agriculture Economic Research Service, "Poverty estimates for the U.S., States and counties, 2018." [Online]. Available: <https://www.ers.usda.gov/data-products/county-level-data-sets/download-data/>
- [52] —, "Unemployment and median household income for the U.S., states and counties, 2007-18." [Online]. Available: <https://www.ers.usda.gov/data-products/county-level-data-sets/download-data/>
- [53] National Oceanic and Atmospheric Administration, "NOAA's Climate Division Database." [Online]. Available: <ftp://ftp.ncdc.noaa.gov/pub/data/cirs/climdiv/>
- [54] United States Census Bureau, "Population and housing unit counts: 2010." [Online]. Available: <https://www.census.gov/library/publications/2012/dec/cph-2.html>
- [55] —, "Selected Social Characteristics in the United States: Households By Type." [Online]. Available: <https://data.census.gov/cedsci/table?q=dp02&hidePreview=true&tid=ACSDP1Y2018.DP02&vintage=2018&g=0400000US36.050000&tp=true&y=2018>
- [56] —, "Annual County Resident Population Estimates by Age, Sex, Race, and Hispanic Origin: April 1, 2010 to July 1, 2018 (CC-EST2018-ALLDATA)." [Online]. Available: https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-detail.html#par_textimage_1383669527
- [57] American Association of Medical Colleges, "State physician workforce data report," 2019.
- [58] "Professionally active primary care physicians by field," *KFF's State Health Facts*, Mar. 2019.
- [59] "Professionally active specialist physicians by field," *KFF's State Health Facts*, Mar. 2019.

- [60] Henry J. Kaiser Family Foundation, "Special data request," *KFF's State Health Facts*, Mar. 2019.
- [61] Center for Neighborhood Technology, "Alltransit performance score." [Online]. Available: <https://alltransit.cnt.org/data-download/>
- [62] Bureau of Justice Statistics, Department of Justice, "United states crime rates by county." [Online]. Available: <https://www.icpsr.umich.edu/icpsrweb/>
- [63] The New York Times, "We're Sharing Coronavirus Case Data for Every U.S. County," *The New York Times*, Mar. 2020.
- [64] A. Madrigal, J. Hammerbacher, E. Kissane, and COVID Tracking Project Team, "The covid tracking project." [Online]. Available: <https://covidtracking.com/>
- [65] E. Chen, K. Lerman, and E. Ferrara, "COVID-19: The First Public Coronavirus Twitter Dataset," *arXiv:2003.07372 [cs, q-bio]*, Mar. 2020.
- [66] [Online]. Available: <http://www.socialmediaforpublichealth.org/covid-19/>
- [67] S. Zhang, M. Diao, W. Yu, L. Pei, Z. Lin, and D. Chen, "Estimation of the reproductive number of novel coronavirus (COVID-19) and the probable outbreak size on the Diamond Princess cruise ship: A data-driven analysis," *International Journal of Infectious Diseases*, vol. 93, pp. 201–204, Apr. 2020.
- [68] K. C. Santosh, "AI-Driven Tools for Coronavirus Outbreak: Need of Active Learning and Cross-Population Train/Test Models on Multitudinal/Multimodal Data," *Journal of Medical Systems*, 2020.
- [69] S. J. Fong, G. Li, N. Dey, R. G. Crespo, and E. Herrera-Viedma, "Composite Monte Carlo Decision Making under High Uncertainty of Novel Coronavirus Epidemic Using Hybridized Deep Learning and Fuzzy Rule Induction," *ArXiv*, 2020.
- [70] S. Fong, G. Li, N. Dey, R. G. Crespo, and E. Herrera-Viedma, "Finding an Accurate Early Forecasting Model from Small Dataset: A Case of 2019-nCoV Novel Coronavirus Outbreak," *International Journal of Interactive Multimedia and Artificial Intelligence*, vol. 6, no. 1, p. 132, 2020.
- [71] I. Scher, "The US is severely under-testing for coronavirus as death toll and new cases rise," <https://www.businessinsider.com/the-us-is-not-testing-enough-people-for-covid-19-2020-3>, library Catalog: www.businessinsider.com.
- [72] J. Gale, "Coronavirus Cases Without Symptoms Spur Call for Wider Tests," *Bloomberg*, Mar. 2020. [Online]. Available: <https://www.bloomberg.com/news/articles/2020-03-22/one-third-of-coronavirus-cases-may-show-no-symptom-scmp-reports>