

Cultural Impact on Digital Ecosystems: Exploring User Activity in Italy and the USA during the COVID-19 Pandemic

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Abstract

The COVID-19 pandemic significantly impacted people's lives, leading to an unprecedented amount of data generated on the Internet. In this paper, we present the results of an in-depth analysis of user behavior in the digital ecosystem in Italy and the USA during the first six months of the pandemic. Our objective is to verify whether different cultures have been able to significantly impact the searches carried out by users online and their interactions on social networks.

Keywords

Cultural impact, user behavior, social network, COVID-19

1. Introduction

The COVID-19 pandemic has impacted the lives of many of us [1]. Even those who have not been affected directly or indirectly by the virus have had to change their daily lives following the measures that several countries have adopted against the pandemic [2]. Apart from the direct impact on public health, the pandemic has resulted in a wide range of consequences across various domains. These include significant economic [3], social [4], political [5], and behavioral [6] effects, which have further complicated the global response to the crisis. Since the Web has been part of our lives for years, this phenomenon has affected users' digital activity. Several notable studies have been published regarding the impact of a disruptive phenomenon such as COVID-19 on users' activity on the Web and their interaction with each other (e.g., see [7, 8, 9]). Through the system proposed in [10], which relies on various technologies such as Machine Learning [11], Social Network and Sentiment Analysis [12], and Web Mining [13], we have extracted large volumes of data, analyzed them using automatic techniques, and represented them, thus allowing us to study the impact of the Coronavirus on people and their activities on the Web. In particular, we considered data relating to behavior on some of the most popular sites of web users in Italy and the United States. In this regard, several noteworthy studies have already considered users' activity on the Web belonging to specific contexts during

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the pandemic (e.g., see [14, 15, 16, 17, 18, 19]). To the best of our knowledge, however, this is the first study that relates web activity in Italy and the United States. In this paper, we present the results of an in-depth analysis of user behavior in the digital ecosystem in Italy and the USA during the first six months (January-June 2020) of the COVID-19 pandemic. Our objective is to verify whether and how different cultures have been able to significantly impact the searches carried out by users online and their interactions on social networks.

2. User activity analysis

Fortunately, the Covid-19 emergency that turned the lives of all of us upside down is now behind us. However, we remember well how the only way to stay in touch with the world in that period was to use digital communication. “A lot” answers the question, “How much are we talking about coronavirus on social media?”. We then carefully analyzed Internet traffic to three of the most popular sites (i.e., Google, Twitter, and Wikipedia) through Machine Learning methods based on mixed approaches of dictionaries and Bayesian classifiers. The various analyses have confirmed the exponential increase in Internet traffic during the pandemic, as highlighted in the literature (e.g., see [20]). In this study, through quantitative and qualitative analysis of digital traces on the Internet from January to June 2020 in Italy and the USA, we focused on the number and nature of social media events, such as information queries and distribution of analysis of social network topics.

2.1. Google

In a week of the coronavirus alarm, searches and queries on Google soared to exceeding +1000% globally, clearly showing users’ concerns and fears. The Coronavirus has aroused various interests, as evidenced by the co-occurrence networks of the keyword “coronavirus” shown in Figure 1. First, search for information regarding the infection in one’s territory, then the

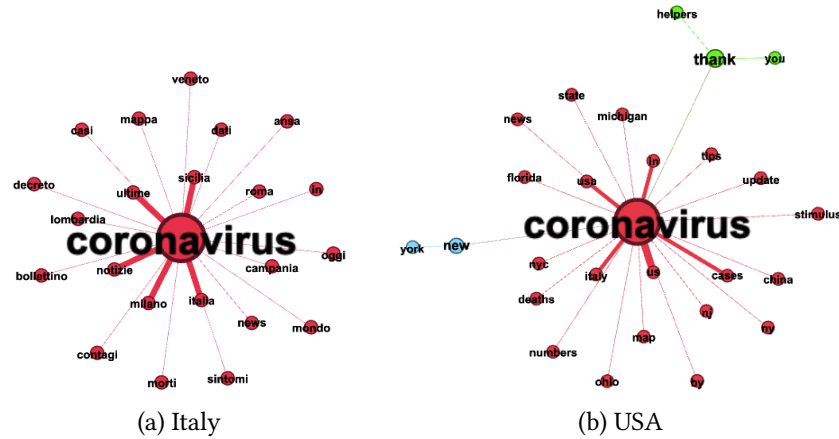


Figure 1: Networks of co-occurrences of the keyword “coronavirus” in searches and queries submitted on Google in Italy (a) and the USA (b) from January to June 2020.

world, and then on governments' containment and prevention measures. Users submitted Google queries such as "What is coronavirus?", "Is it lethal?", "How to prevent it?", "How is it spread?", "What are the symptoms?". The most searched topic in February 2020 on Google in Italy regarding COVID-19 was related to the symptoms, followed by news regarding the virus and the first cases of people who had contracted the virus (see Fig. 2). However, little

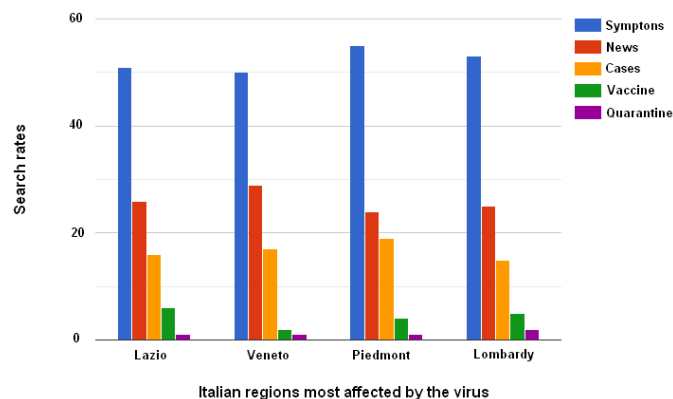


Figure 2: Most searched topics related to COVID-19 on Google in the Italian regions most affected by the virus in February 2020.

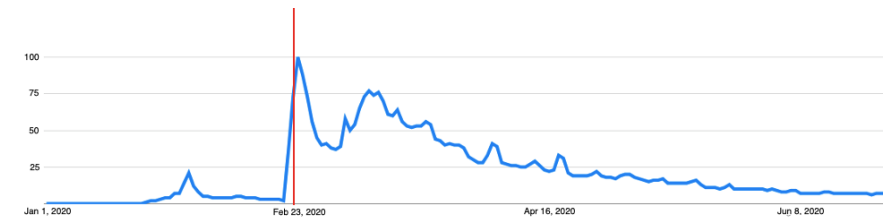
attention was paid to the possibility of a vaccine and quarantine, which, evidently, at that moment, seemed impractical or not yet clear to Italians. What is certain is that we spent a lot of time online looking for the information that quarantine pushed us to look for.

In Figure 3, we can observe the trend of searches for the term "Coronavirus" in the first six months of 2020. In Italy (see Fig. 3a), the first peak occurred on February 23, after the appearance of the first cases of COVID-19. The first significant peak occurred about a month later in the USA (see Fig. 3b): on March 12, 2020, the day Donald Trump suspended all flights from Europe.

Next, we studied the social perception of the Coronavirus by analyzing the peaks of searches on the Web relating to three key topics: "Masks", "Giuseppe Conte", "Self-certification" for Italy, and "Donald Trump", "Unemployment", "Protective mask" for the USA. We have identified five and six large time windows of interest on COVID-19, respectively (see Fig. 4). These windows concerned the implementation of important measures by the authorities in Italy and the USA, as well as the authorities' declarations regarding the presence of the virus in the world. The analysis of the terms used and searched for on Google highlighted how people from different parts of the world were united by the need to inform themselves and keep up to date in a global crisis never faced before.

2.2. Wikipedia

Wikipedia traffic is another indicator of social activity. We looked at the history of views on the "COVID-19" page. Both graphs in Figure 5 show a growing trend in the year's first two months. The following months were characterized by a notable decline in interest, perhaps due to the saturation of knowledge of the basic definitions of the disease. It is important to note how Italians informed themselves simultaneously on both Google and Wikipedia. Differently,

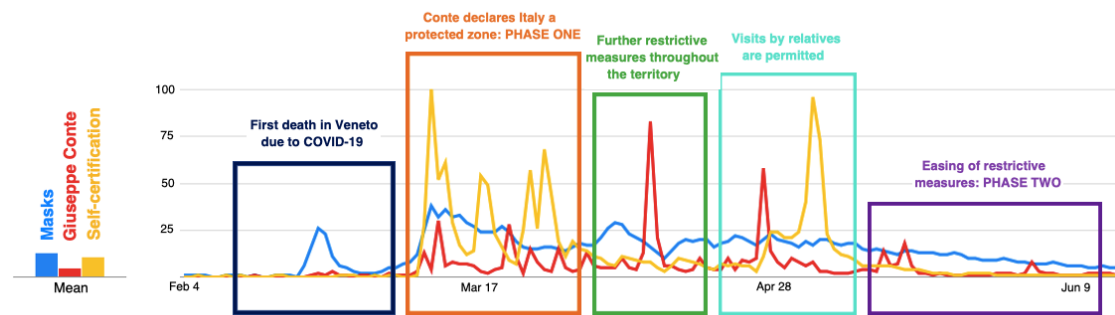


(a) Italy

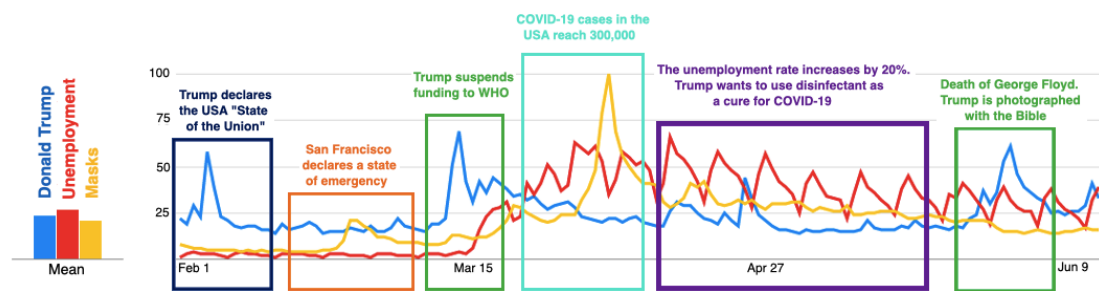


(b) USA

Figure 3: Trend of searches on Google in Italy (a) and the USA (b) in the first six months of 2020.



(a) Italy



(b) USA

Figure 4: Trend of searches on Google in Italy (a) and the USA (b) in the first six months of 2020.

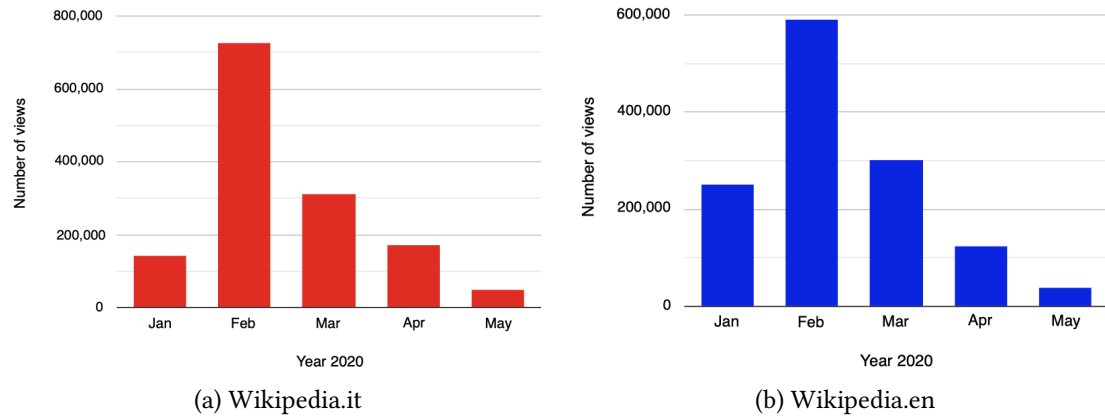


Figure 5: Number of views of the COVID-19 article on Wikipedia.it (a) and Wikipedia.en (b) in the first five months of 2020.

in the United States, the peak of Wikipedia searches is a month earlier than that of Google, showing the need for Americans to inform themselves long before the disease arrives on their territory. The pie charts displayed in Figure 6 represent the trending topics of June, which show people's apparent disinterest in issues related to the disease.

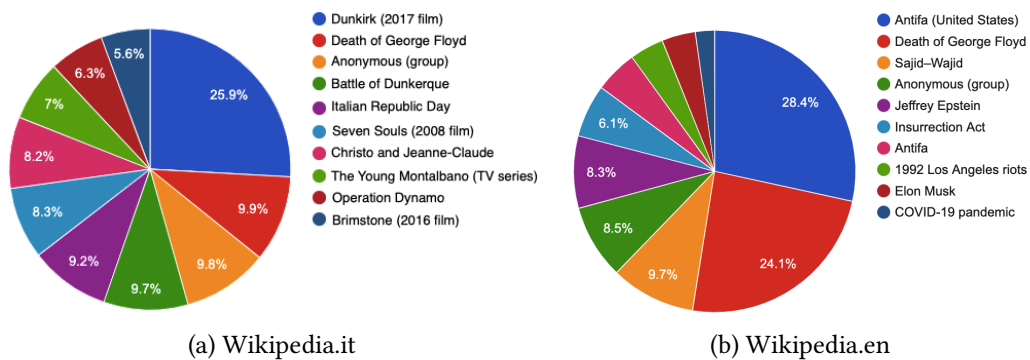


Figure 6: Articles viewed on Wikipedia.it (a) and Wikipedia.en (b) in June 2020.

2.3. Twitter

Since the beginning of the pandemic, attention to COVID-19 has also increased significantly on Twitter, with over 6 million tweets in the first two months of 2020. We monitored Twitter's data flow through the word cloud in this analysis shown in Figure 7. The more significant and prominent the keyword, the more often it is mentioned in tweets, retweets, and replies, and the more critical it is. Predictably, the most significant keyword is "coronavirus" followed by "Trump", "Brasil", "number" and "cases" all related to the epidemic.

In the graphs shown in Figure 8, we have reported the real-time extraction of Twitter data. Nodes represent users, and edges represent interactions between users and retweets. We used

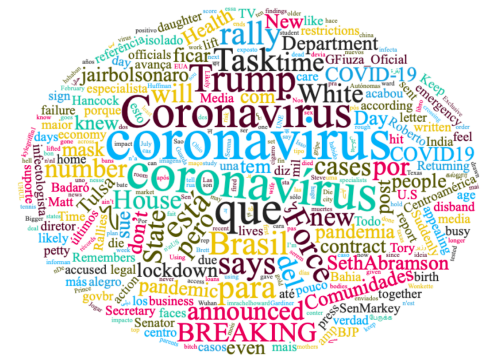


Figure 7: Word cloud related to tweets in the first two months of 2020.

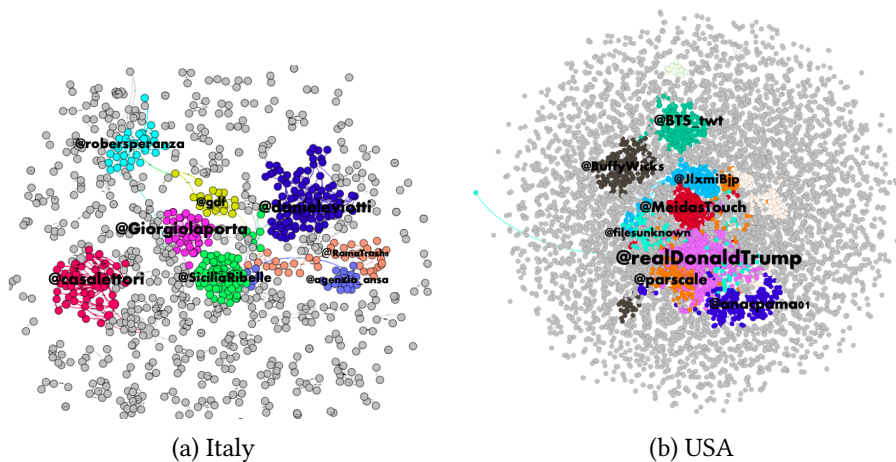


Figure 8: Result of clustering performed on tweets and retweets in Italy (a) and the USA (b). Nodes represent users, and edges represent interactions between users and retweets. The labels represent the centroids corresponding to the user cluster with the most interactions.

the unsupervised weighted Louvain algorithm [21] for community analysis; therefore, the clusters are indicated with different colors and represent users who have published at least one tweet with the same hashtag: retweets or independent tweets. The labels represent the centroids that indicate the user of the cluster with the most interactions, for example, Roberto Speranza and Donald Trump. Among the topics covered there are politics, current affairs, health, and entertainment.

Next, we evaluated the positive and negative sentiments of the tweets. We used COVID-19-related keywords to filter the Twitter stream and obtain tweets relevant to the pandemic. We then processed and analyzed them to identify subjective information in the texts. The distribution of sentiments regarding the topic of “coronavirus” was different, as shown in Figure 9. In Italy, it was mainly positive; however, the USA showed a decidedly negative sentiment. Further analysis revealed positive sentiment on the topic of “working from home”

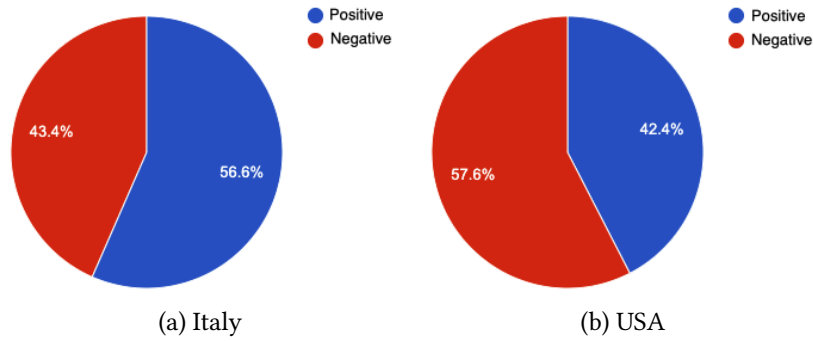


Figure 9: Sentiment of tweets with #COVID-19 in Italy (a) and the USA (b).

and the topic “social distancing” (see Fig. 10).

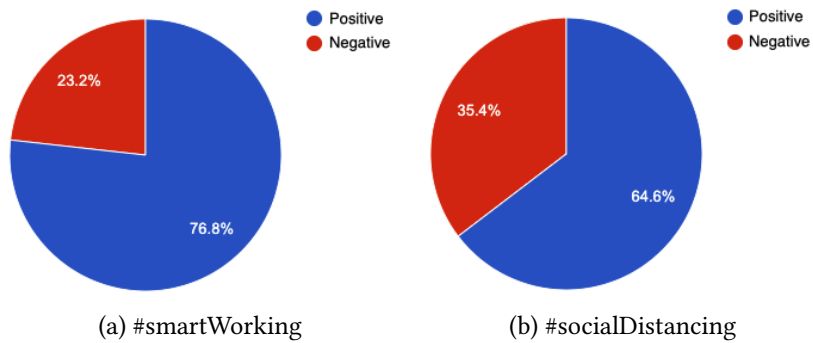


Figure 10: Sentiment in the USA of tweets with #smartWorking (a) and #socialDistancing (b).

2.4. Google, Wikipedia and Twitter

When taken individually, these social media sites provide helpful information for understanding users’ interests and opinions. However, it is possible to obtain even richer information by cross-referencing and comparing these data. The first appearance of each trend displayed in the two pie charts shown in Figure 11 is a helpful analysis to establish the responsiveness of each site to changes during the pandemic. For both countries, Twitter emerged as the most responsive source to new trends, followed immediately by Google and a small percentage of trends on Wikipedia. From this, users first tend to comment on events and topics of various nature and interact with other users, and only then inform themselves on Google and reliable sources such as Wikipedia.

Before the appearance of the disease in Italy, the three sources were mainly used to research, comment, and discuss entertainment, followed closely by sports and politics (see Fig. 12). If no one, or almost no one, was interested in health before the pandemic after the appearance of the first coronavirus patients, trending topics on this topic have seen rapid growth in interest on all fronts, as shown in Figure 13. The need for knowledge has become saturated in the next phase

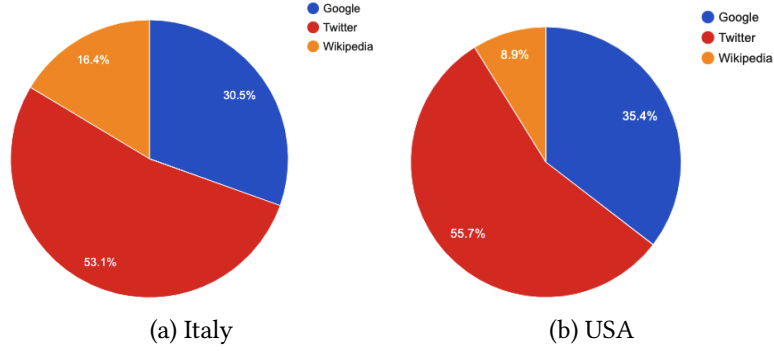


Figure 11: First appearance of social media trends in Italy (a) and the USA (b).

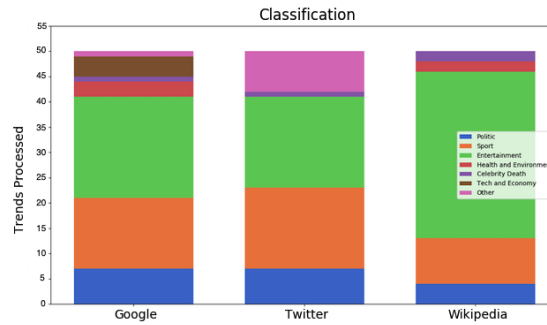


Figure 12: Classification of 50 trending topics of Google, Twitter, and Wikipedia in Italy in January 2020.

of mitigation and coexistence with the virus. Still, the need to inform ourselves and discuss the policies adopted by governments during the recovery from the economic crisis has increased.

If COVID-19 has completely disrupted Italians' real and virtual lives, those of Americans have not changed much over time (see Fig. 14). This different behavior was undoubtedly also due to the different policies adopted by the US administration towards the pandemic [22]. The trends in the United States did not change at the beginning or the height of the epidemic despite still counting several million cases.

3. Conclusions

In the face of the pandemic, there has been an unprecedented flood of information on the Web. Through our system, we monitored the performance of the top trend categories on the Internet's three most popular social media sites in Italy and the USA from January to June 2020.

This analysis, therefore, allowed us to highlight the impact that different cultures have had on the behavior of users on the Web following the same event. We do hope that it can contribute to the development of interactive techniques, which, taking these aspects into account, can provide the user with increasingly satisfying and socializing experiences. Consider, for instance, recommender systems [23, 24] capable of suggesting diverse items, ranging from products for

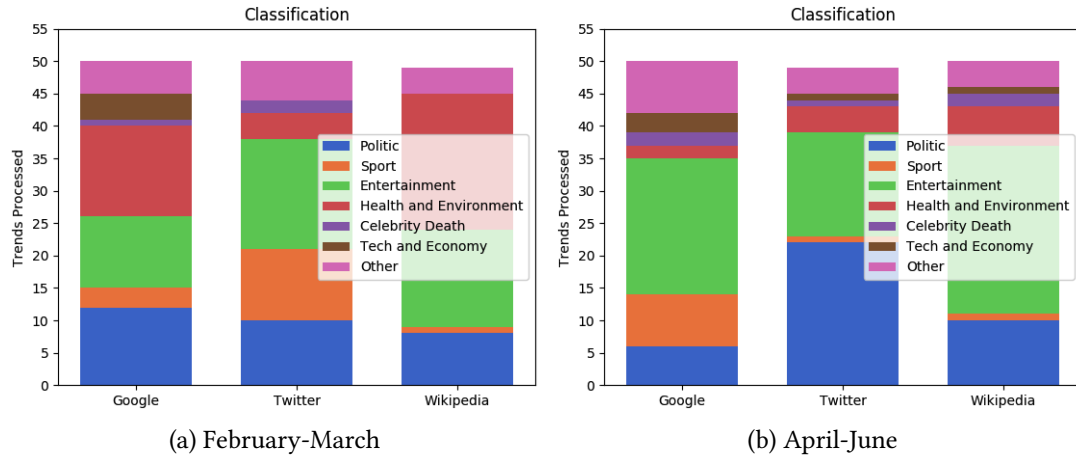


Figure 13: Classification of 50 trending topics of Google, Twitter, and Wikipedia in Italy in the months of February-March (a) and April-June (b) 2020.

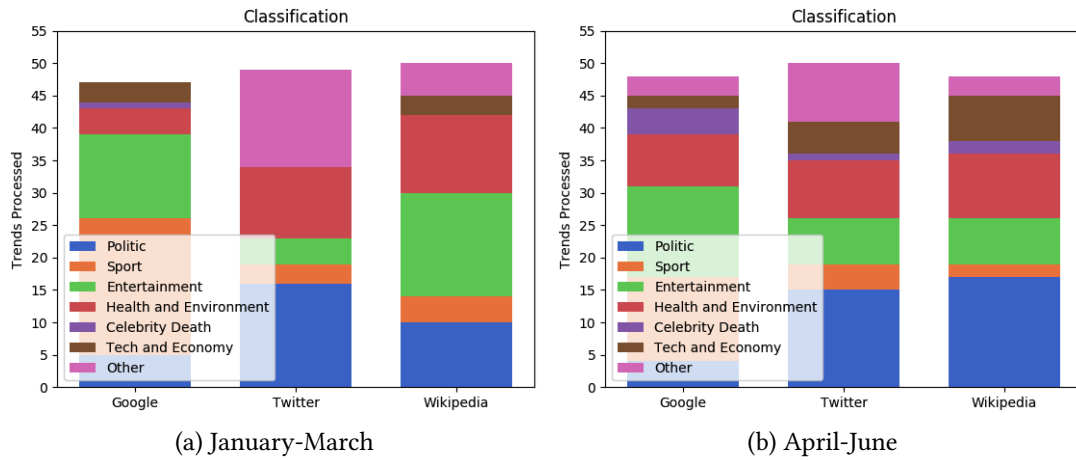


Figure 14: Classification of 50 trending topics of Google, Twitter, and Wikipedia in the USA in the months of January-March (a) and April-June (b) 2020.

purchase [25] and movies to watch [26] to music to listen to [27], books to read [28], news articles to stay updated [29], and scientific papers to study [30, 31]. Moreover, such systems can extend their functionality to recommend potential social connections for the user [32]. Additionally, they can propose points of interest [33, 34], such as cultural, artistic or tourist venues [35, 36, 37] like museums [38, 39] or restaurants [40, 41], along with itineraries [42, 43] and multimedia resources and applications to enhance the overall user experience [44, 45]. We also hope that the results of our study can contribute to research relating to the best strategies that government institutions must adopt [46, 47] and how they must communicate them to their citizens [48, 49] if situations similar to the COVID-19 pandemic should, unfortunately, arise again.

References

- [1] H. Alizadeh, A. Sharifi, S. Damanbagh, H. Nazarnia, M. Nazarnia, Impacts of the covid-19 pandemic on the social sphere and lessons for crisis management: a literature review, *Natural Hazards* (2023) 1–26.
- [2] E. Alzueta, P. Perrin, F. C. Baker, S. Caffarra, D. Ramos-Usuga, D. Yuksel, J. C. Arango-Lasprilla, How the covid-19 pandemic has changed our lives: A study of psychological correlates across 59 countries, *Journal of Clinical Psychology* 77 (2021) 556–570.
- [3] A. D. Kaye, C. N. Okeagu, A. D. Pham, R. A. Silva, J. J. Hurley, B. L. Arron, N. Sarfraz, H. N. Lee, G. E. Ghali, J. W. Gamble, et al., Economic impact of covid-19 pandemic on healthcare facilities and systems: International perspectives, *Best Practice & Research Clinical Anaesthesiology* 35 (2021) 293–306.
- [4] N. P. Mishra, S. S. Das, S. Yadav, W. Khan, M. Afzal, A. Alarifi, M. T. Ansari, M. S. Hasnain, A. K. Nayak, et al., Global impacts of pre-and post-covid-19 pandemic: Focus on socio-economic consequences, *Sensors International* 1 (2020) 100042.
- [5] C. A. Tisdell, Economic, social and political issues raised by the covid-19 pandemic, *Economic Analysis and Policy* 68 (2020) 17–28.
- [6] J. Xiong, O. Lipsitz, F. Nasri, L. M. Lui, H. Gill, L. Phan, D. Chen-Li, M. Iacobucci, R. Ho, A. Majeed, et al., Impact of covid-19 pandemic on mental health in the general population: A systematic review, *Journal of Affective Disorders* 277 (2020) 55–64.
- [7] D. Vargo, L. Zhu, B. Benwell, Z. Yan, Digital technology use during covid-19 pandemic: A rapid review, *Human Behavior and Emerging Technologies* 3 (2021) 13–24.
- [8] J. Suh, E. Horvitz, R. W. White, T. Althoff, Disparate impacts on online information access during the covid-19 pandemic, *Nature Communications* 13 (2022) 7094.
- [9] M. J. Butt, A. K. Malik, N. Qamar, S. Yar, A. J. Malik, U. Rauf, A survey on covid-19 data analysis using ai, iot, and social media, *Sensors* 23 (2023) 5543.
- [10] G. Conti, G. Sansonetti, A. Micarelli, An analysis of trends and connections in google, twitter, and wikipedia, in: C. Stephanidis, M. Antona (Eds.), *HCI International 2020 - Posters*, Springer International Publishing, Cham, 2020, pp. 154–160.
- [11] L. Vaccaro, G. Sansonetti, A. Micarelli, An empirical review of automated machine learning, *Computers* 10 (2021) 1–27.
- [12] D. F. Gurini, F. Gasparetti, A. Micarelli, G. Sansonetti, iscur: Interest and sentiment-based community detection for user recommendation on twitter, in: V. Dimitrova, T. Kuflik, D. Chin, F. Ricci, P. Dolog, G.-J. Houben (Eds.), *User Modeling, Adaptation, and Personalization*, Springer International Publishing, Cham, 2014, pp. 314–319.
- [13] F. Gasparetti, A. Micarelli, G. Sansonetti, Exploiting web browsing activities for user needs identification, in: *2014 International Conference on Computational Science and Computational Intelligence, CSCI 2014*, volume 2, 2014, pp. 86–89.
- [14] A. Rovetta, L. Castaldo, The impact of covid-19 on italian web users: a quantitative analysis of regional hygiene interest and emotional response, *Cureus* 12 (2020).
- [15] F. Gallè, E. A. Sabella, L. Bianco, M. Maninchedda, B. Barchielli, F. Liguori, G. Da Molin, G. Liguori, G. B. Orsi, S. Ferracuti, et al., How the covid-19 pandemic has impacted daily life? assessing the use of web resources for recreational activities in the italian adult population, *International Journal of Environmental Research and Public Health* 19 (2022).

- [16] T. Chen, L. Peng, B. Jing, C. Wu, J. Yang, G. Cong, The impact of the covid-19 pandemic on user experience with online education platforms in china, *Sustainability* 12 (2020).
- [17] J. Soekiman, T. D. Putranto, D. Susilo, E. M. A. Garcia, Economic sector during the covid-19 pandemic: Indonesian instagram users behaviour., *Webology* 18 (2021).
- [18] J. T. Mueller, K. McConnell, P. B. Burow, K. Pofahl, A. A. Merdjanoff, J. Farrell, Impacts of the covid-19 pandemic on rural america, *Proc. of the National Acad. of Sciences* 118 (2021).
- [19] P. K. Jena, Impact of pandemic covid-19 on education in india, *International Journal of Current Research (IJCR)* 12 (2020).
- [20] M. Effenberger, A. Kronbichler, J. I. Shin, G. Mayer, H. Tilg, P. Perco, Association of the covid-19 pandemic with internet search volumes: a google trendstm analysis, *International Journal of Infectious Diseases* 95 (2020) 192–197.
- [21] V. D. Blondel, J.-L. Guillaume, R. Lambiotte, E. Lefebvre, Fast unfolding of communities in large networks, *Journal of Statistical Mechanics: Theory and Experiment* 2008 (2008).
- [22] S. Bergquist, T. Otten, N. Sarich, Covid-19 pandemic in the united states, *Health Policy and Technology* 9 (2020) 623–638.
- [23] F. Gasparetti, G. Sansonetti, A. Micarelli, Community detection in social recommender systems: a survey, *Applied Intelligence* 51 (2021) 3975–3995.
- [24] L. Rokach, B. Shapira, F. Ricci, *Recommender Systems Handbook*, Springer, 2022.
- [25] C. Bologna, A. C. De Rosa, A. De Vivo, M. Gaeta, G. Sansonetti, V. Viserta, Personality-based recommendation in e-commerce, in: *CEUR Workshop Proceedings*, volume 997, CEUR-WS.org, Aachen, Germany, 2013.
- [26] C. Biancalana, F. Gasparetti, A. Micarelli, A. Miola, G. Sansonetti, Context-aware movie recommendation based on signal processing and machine learning, in: *Proceedings of the 2nd Challenge on Context-Aware Movie Recommendation, CAMRa '11*, ACM, New York, NY, USA, 2011, pp. 5–10.
- [27] M. Onori, A. Micarelli, G. Sansonetti, A comparative analysis of personality-based music recommender systems, in: *CEUR Workshop Proceedings*, volume 1680, CEUR-WS.org, Aachen, Germany, 2016, pp. 55–59.
- [28] H. Alharthi, D. Inkpen, S. Szpakowicz, A survey of book recommender systems, *Journal of Intelligent Information Systems* 51 (2018) 139–160.
- [29] S. Caldarelli, D. F. Gurini, A. Micarelli, G. Sansonetti, A signal-based approach to news recommendation, in: *CEUR Workshop Proceedings*, volume 1618, CEUR-WS.org, Aachen, Germany, 2016, pp. 1–4.
- [30] H. A. M. Hassan, G. Sansonetti, F. Gasparetti, A. Micarelli, Semantic-based tag recommendation in scientific bookmarking systems, in: *Proceedings of the 12th ACM Conference on Recommender Systems*, ACM, New York, NY, USA, 2018, pp. 465–469.
- [31] H. A. M. Hassan, G. Sansonetti, F. Gasparetti, A. Micarelli, J. Beel, Bert, elmo, use and infersent sentence encoders: The panacea for research-paper recommendation?, in: *Proc. of ACM RecSys 2019 Late-Breaking Results*, volume 2431, CEUR-WS.org, 2019, pp. 6–10.
- [32] D. Feltoni Gurini, F. Gasparetti, A. Micarelli, G. Sansonetti, Temporal people-to-people recommendation on social networks with sentiment-based matrix factorization, *Future Generation Computer Systems* 78 (2018) 430–439.
- [33] G. Sansonetti, Point of interest recommendation based on social and linked open data, *Personal and Ubiquitous Computing* 23 (2019) 199–214.

- [34] G. Sansonetti, F. Gasparetti, A. Micarelli, F. Cena, C. Gena, Enhancing cultural recommendations through social and linked open data, *User Modeling and User-Adapted Interaction* 29 (2019) 121–159.
- [35] A. De Angelis, F. Gasparetti, A. Micarelli, G. Sansonetti, A social cultural recommender based on linked open data, in: *Adjunct Publication of the 25th Conference on User Modeling, Adaptation and Personalization*, ACM, New York, NY, USA, 2017, pp. 329–332.
- [36] G. Sansonetti, F. Gasparetti, A. Micarelli, Cross-domain recommendation for enhancing cultural heritage experience, in: *Adjunct Publication of the 27th Conference on User Modeling, Adaptation and Personalization*, Association for Computing Machinery, New York, NY, USA, 2019, pp. 413–415.
- [37] F. Ricci, Recommender systems in tourism, in: *Handbook of e-Tourism*, Springer, 2022, pp. 457–474.
- [38] A. Ferrato, C. Limongelli, M. Mezzini, G. Sansonetti, Using deep learning for collecting data about museum visitor behavior, *Applied Sciences (Switzerland)* 12 (2022).
- [39] M. Mezzini, C. Limongelli, G. Sansonetti, C. De Medio, Tracking museum visitors through convolutional object detectors, in: *Adjunct Publication of the 28th Conference on User Modeling, Adaptation and Personalization*, ACM, New York, NY, USA, 2020, pp. 352–355.
- [40] C. Biancalana, F. Gasparetti, A. Micarelli, G. Sansonetti, An approach to social recommendation for context-aware mobile services, *ACM Trans. Intell. Syst. Technol.* 4 (2013).
- [41] N. Sardella, C. Biancalana, A. Micarelli, G. Sansonetti, An approach to conversational recommendation of restaurants, in: C. Stephanidis (Ed.), *HCI International 2019 - Posters*, Springer International Publishing, Cham, 2019, pp. 123–130.
- [42] D. D’Agostino, F. Gasparetti, A. Micarelli, G. Sansonetti, A social context-aware recommender of itineraries between relevant points of interest, in: *HCI International 2016*, volume 618, Springer International Publishing, Cham, 2016, pp. 354–359.
- [43] A. Fogli, G. Sansonetti, Exploiting semantics for context-aware itinerary recommendation, *Personal and Ubiquitous Computing* 23 (2019) 215–231.
- [44] A. Micarelli, A. Neri, G. Sansonetti, A case-based approach to image recognition, in: *Proceedings of the 5th European Workshop on Advances in Case-Based Reasoning*, volume 1898 of *EWCBR ’00*, Springer-Verlag, Berlin, Heidelberg, 2000, pp. 443–454.
- [45] G. Sansonetti, F. Gasparetti, A. Micarelli, Using social media for personalizing the cultural heritage experience, in: *Adjunct Proceedings of the 29th ACM Conference on User Modeling, Adaptation and Personalization*, ACM, New York, NY, USA, 2021, p. 189–193.
- [46] N. J. Foss, Behavioral strategy and the covid-19 disruption, *Journal of Management* 46 (2020) 1322–1329.
- [47] D. Allain-Dupré, I. Chatry, V. Michalun, A. Moisio, The territorial impact of covid-19: managing the crisis across levels of government, *OECD Policy Responses to Coronavirus (COVID-19)* 10 (2020).
- [48] R. J. Dheer, C. P. Egri, L. J. Treviño, A cross-cultural exploratory analysis of pandemic growth: The case of covid-19, *Journal of International Business Studies* 52 (2021) 1871–1892.
- [49] B. Redbird, L. Harbridge-Yong, R. D. Mersey, The social and political impact of the covid-19 pandemic: An introduction, *RSF: The Russell Sage Foundation Journal of the Social Sciences* 8 (2022) 1–29.