

Multimedia Appendix 2

The Daily Topic Trends on Social Media by Country

1. South Korea

Please refer to the "Basic Daily Trends – South Korea" subsection in the manuscript for the detailed descriptions.

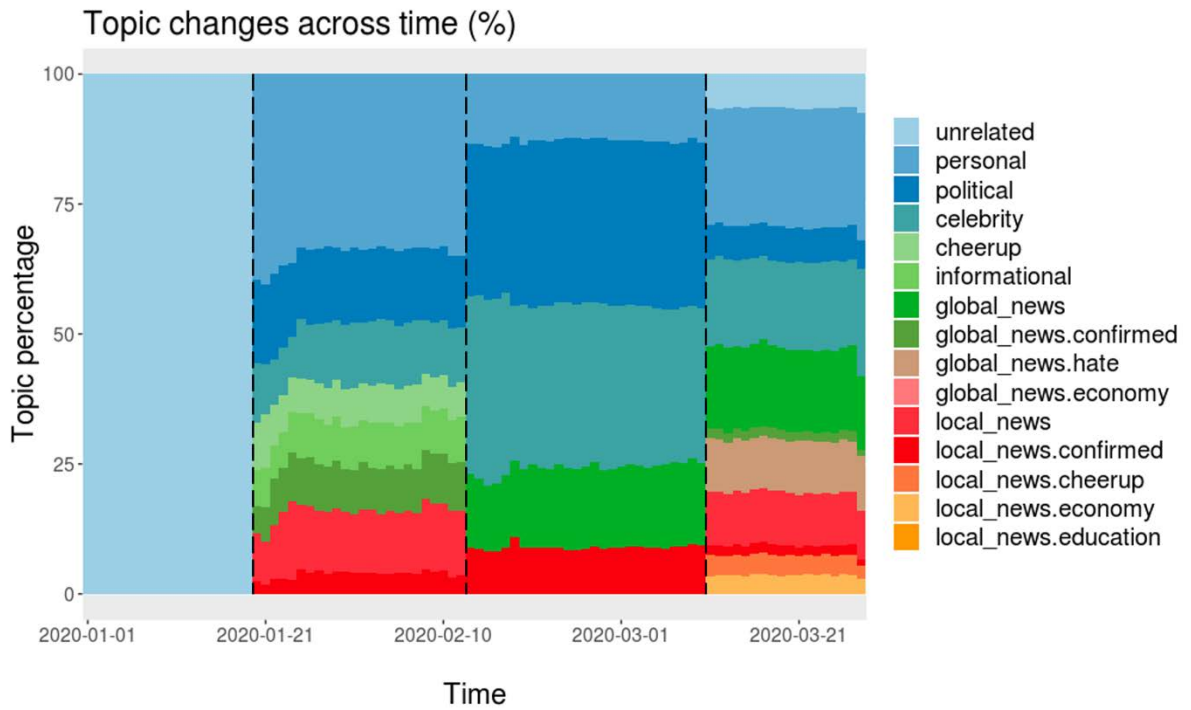


Figure MA3-1. Daily topic trends on Iran: based on % of tweets.

2. Iran

The top and middle plots in Figure MA3-2 illustrate two topic phases, their proportions, and daily topic frequencies in Farsi language tweets. Phase 0 includes global news about China and unconfirmed local news reflecting its fear of virus spread. Political issues take up a remarkable portion in this phase. At the time, the country was expecting to hold a congressional election. In phase 1, a significant increase in tweets occurs, where local news regarding the virus outbreak constitutes the majority. Notably, informational tweets about preventive measurements overshadow global news, which may be explained by disaster sociology. When people face a common disaster, naturally, more information is created and shared that is unverified. Another reason may be due to censorship of Twitter in Iran, where Iranian citizens can access Twitter via proxies due to its blocked access (i.e., hence there may be no large-scale public campaigns). However, political tweets are still widespread because of the reasons above and public dissatisfaction about the government's response to the epidemic. This finding is also highlighted in the bottom plot of Figure MA3-2 that the U.S. is the most mentioned name after Iran and China. One possible explanation is that the outbreak puts another strain on the frail relationship between Iran and the U.S.

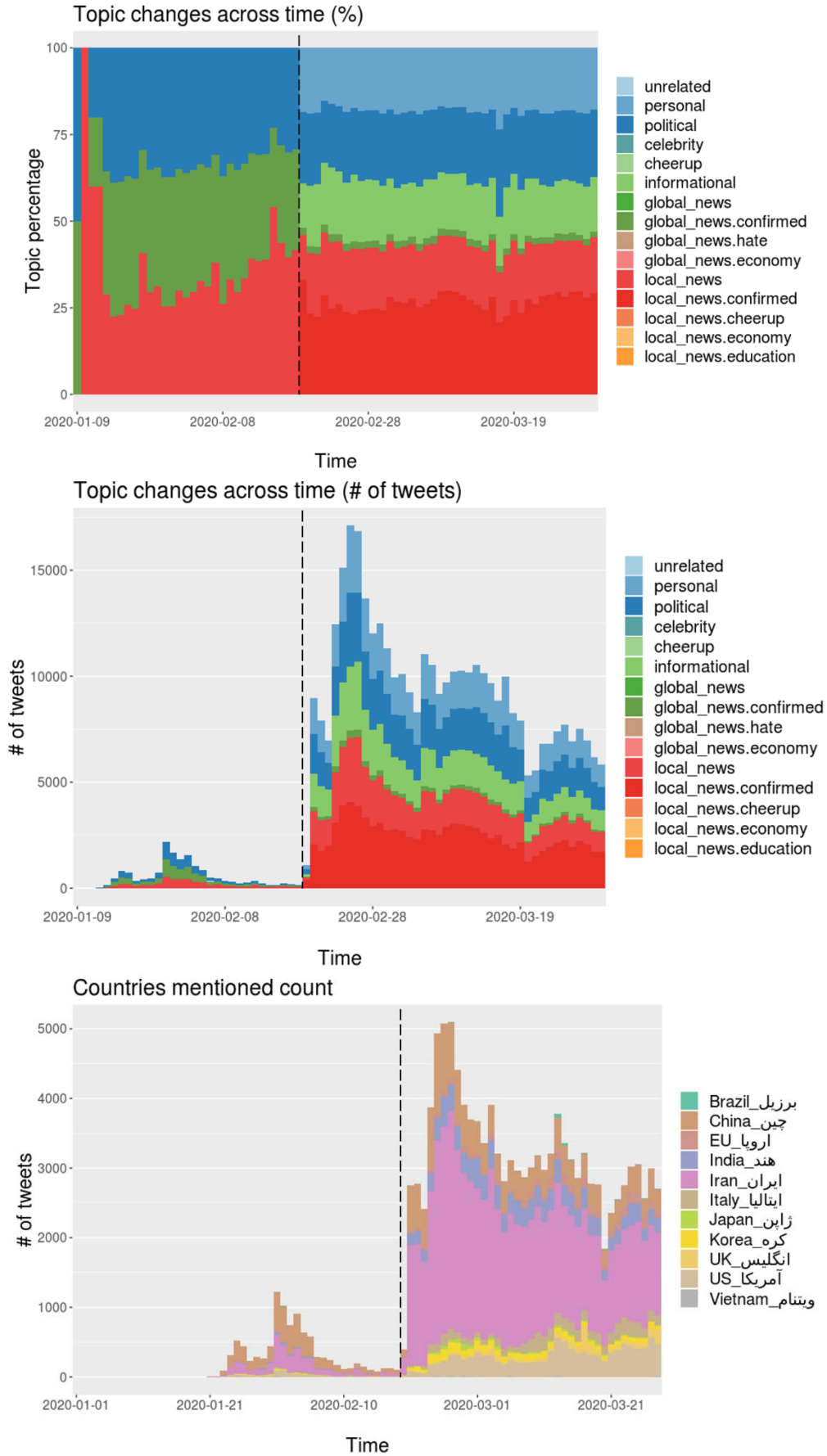


Figure MA3-2. Daily topic trends on Iran: based on % (top), based on # of tweets (mid), and based on # of tweets country names mentioned (bottom).

3. Vietnam

There are six topic phases with Vietnam, and they are visualized as in the top and middle plots in Figure MA3-3. Phase 0 is related to global news because, in this period, Vietnam did not have any confirmed patients. From phase 1 to phase 5, topics diverged, and more public attention is on the local news. Phase 3 is an exception because there had been no new confirmed cases during this time period. Similar to phase 0, the public attention goes to global news when there is no increase in local patients. Phase 3 shows increased mentions of personal topics that most did not have in other phases. It was because a conflict event that related to Korean visitors made a huge of personal tweets.

Next, we show the number of tweets that mentioned countries as in the bottom plot of Figure MA3-3. The three most mentioned countries are Vietnam, Korea, and China. Vietnam and China were mentioned frequently across phases because Vietnam is the local, and China is the original place of the pandemic. Besides, Korea was mentioned in many tweets, but they concentrated only on Phase 3. This is similar to topics changes due to the Korean visitor event in Vietnam.

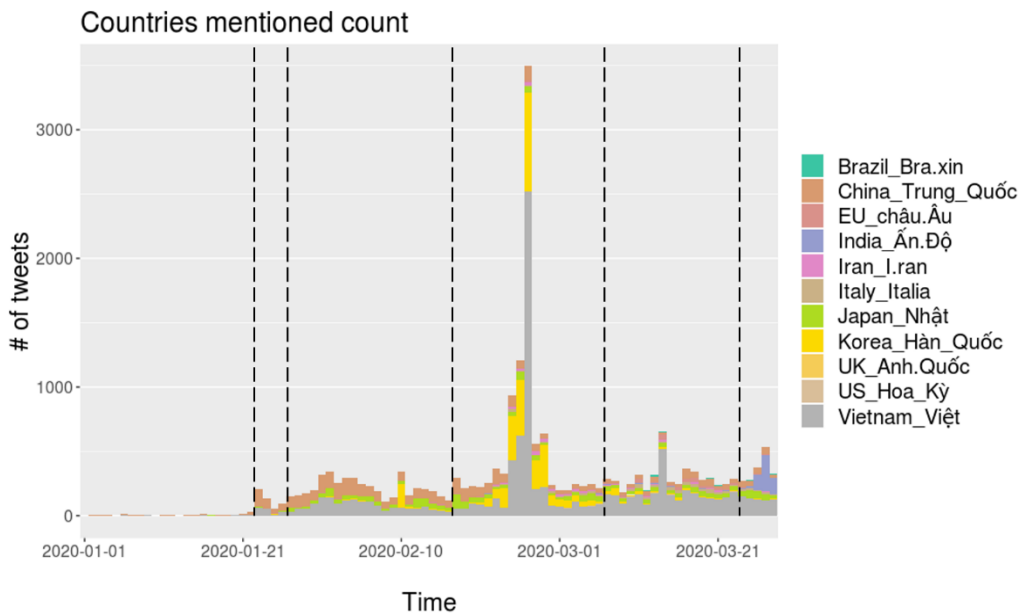
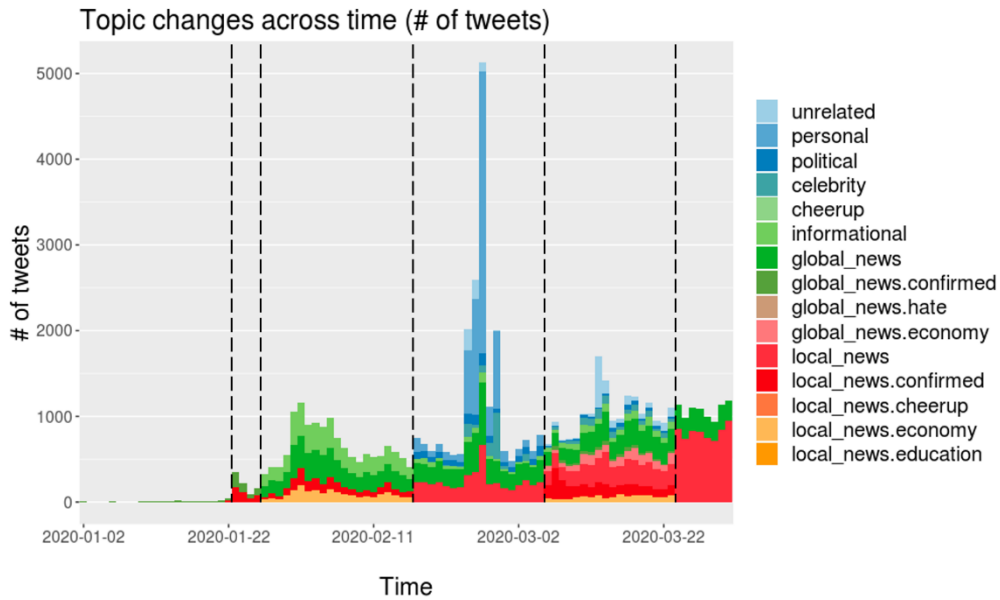
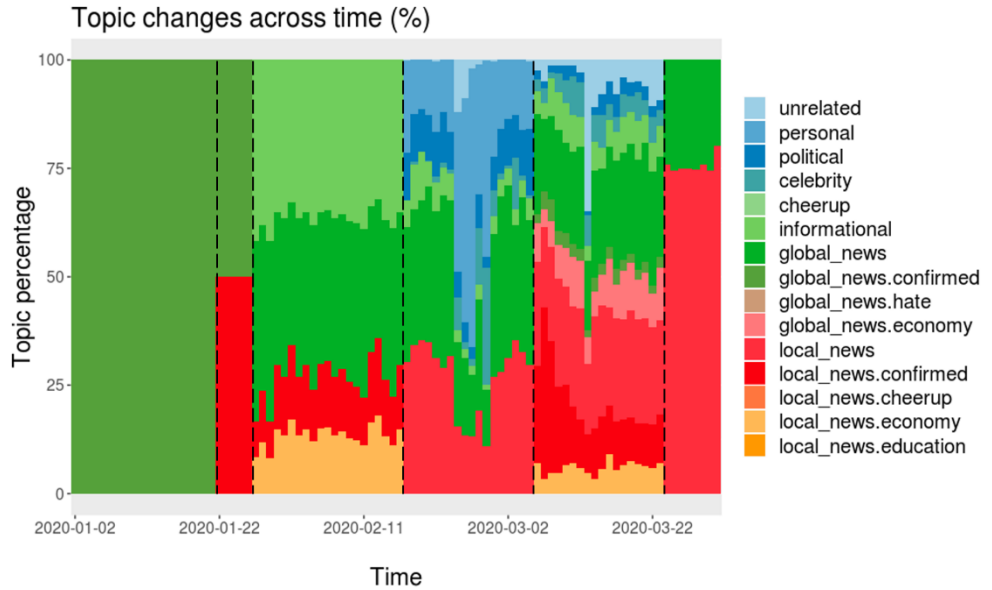


Figure MA3-3. Daily topic trends on Vietnam: based on % (top), based on # of tweets (mid), and based on # of tweets country names mentioned (bottom).

4. India

Our model identified three topic phases for Hindi-written tweets (see the top and middle plots in Figure MA3-4). Note that our study is on Hindi tweets only, and this does not include tweets generated from India that are written in English or any other language.

In India, the starting phase mainly includes tweets focused on sharing information about COVID-19 and global news about COVID-19 in China. People tended to share the news about COVID-19 and useful information on how to be safe. In phase 1, the number of topics increases. To a large degree, much of the basic information about the disease is shared during this phase, yet we also observe rumors and misinformation. The daily tweet count spikes on January 30, 2020, when the first confirmed case was announced in India. Towards the end of Phase 1 is another spike, which is led by the government announcements on new measures to block the virus (e.g., temporarily halting the visa issuing to India).

In phase 2 shows a considerable number of tweets — the proportion of informational tweets decreases, whereas local news tweets confirm new cases and increase. A marked portion of the tweets consists of hateful comments and misinformation. The hateful comments were toward particular groups of people (e.g., vegetarians, religion, etc). There are relatively few mentions directly criticizing the government.

Phase 3 witnesses an increase in mentions of country names, especially Brazil and Europe, and China and, understandably, India, as depicted in the bottom plot in Figure MA3-4. This could be attributed to a growing number of the confirmed cases in Italy, Spain, and Brazil and the news surrounding the use of Hydroxychloroquine in Brazil. The U.S. also finds considerable mentions due to the same reasons.

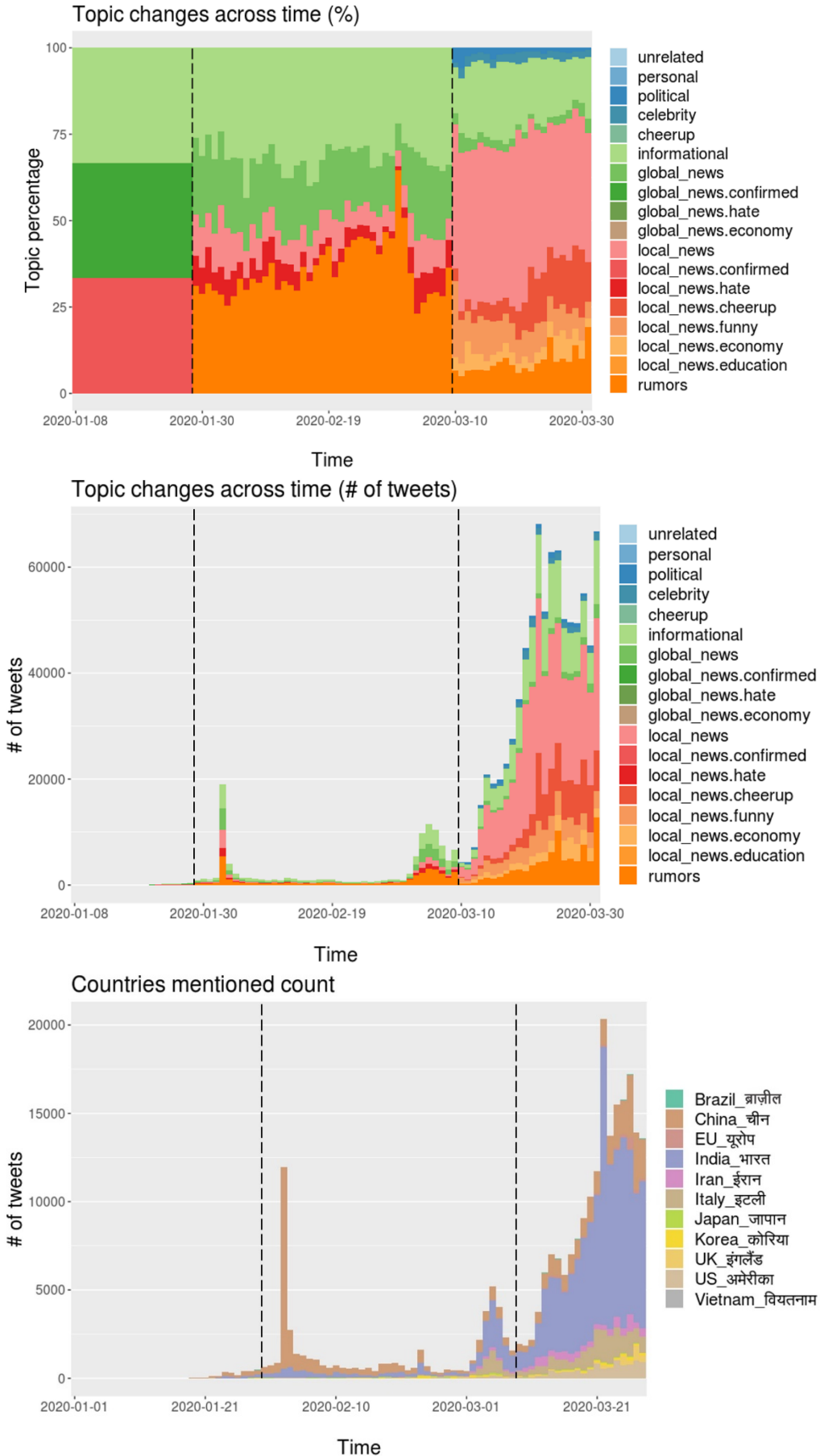


Figure MA3-4. Daily topic trends on India: based on % (top), based on # of tweets (mid), and based on # of tweets country names mentioned (bottom).

Method

[Step 3: Extract Topics – Model Topics] The Reliability of the Topic Modeling Results

Studies have utilized Twitter messages for risk communication at a different scale based on the literature survey below. Some utilize millions of messages, and to the other extreme, others utilize a thousand-scale message. For example, the research in [1] utilized LDA on 2,472 tweets, and [2] utilized 996 messages for topic modeling. Our data scale is similar; during peak times, there are far more messages that could be collected, and during low peak times, the messages are at a thousand-scale.

Regarding validation, the log-likelihood metric has been popularly used to quantify language models' quality [3]. A language model is a probability distribution over entire sentences or texts. This metric quantifies how well the model reconstructed the original document by comparing its word distribution with the original set. Perplexity (PPL), i.e., the normalized log-likelihood of a held-out test set, is an advanced language model metric. It quantifies randomness in the encoded information, similar to the entropy concept. The lower the value, the better it is at handling randomness. In this light, we can interpret low PPL to indicate better stability in reconstructing the documents since there would be a low probability of having different words when choosing the next possible token for multiple iterations.

In the case of South Korea, we reported a total of four topic phases. The number of tweets involved 507, 161K, 672K, and 366K (see Table 2) for each topic phase. The best (i.e., lowest) PPL computed for each topic phase was 23, 1296, 2120, and 2331, indicating that the model did not become particularly unstable for the first phase (i.e., when there are fewer tweets). Having much larger tweets (e.g., Phase 0 and Phase 2) also did not drastically increase the PPL value. This monotonic increase of PPL indicates that the model produces relatively stable topic model outcomes. We confirm that the same trend was observed in the four other countries.

[1] Yin J, Wang J. A Dirichlet multinomial mixture model-based approach for short text clustering. In proc. of the ACM SIG International Conference on Knowledge Discovery and Data Mining (KDD), 2014.

[2] Weng J, Lim EP, Jiang J, He Q. TwitterRank: finding topic-sensitive influential twitterers. In proc. of the ACM International Conference on Web Search and Data Mining (WSDM), 2010.

[3] Fisher D, Kozdoba M, Mannor S. Topic modeling via full dependence mixtures. In proc. of the International Conference on Machine Learning (ICML), 2020.

[Step 4: Extract Topics – Label Topics] The Intercoder Reliability of Topic Labeling

We had recruited a total of 5 annotators, two were Koreans, and the others were Iranian, Vietnamese, and Indian. All were multi-lingual and spoke fluent English. The researchers and annotators first met and decided the coding scheme based on a sample of 1,000 tweets and 30 pre-identified keywords by topic for each topic phase. The observed agreement between the two Korean annotators (i.e., accuracy) was 0.788 with the Cohen's kappa coefficient of 0.766. This task was a multi-classification with a maximum of 2 labels by topic, indicating that if one label from a multi-labeled topic was correct, only half a score (0.5) is counted. Only when both labels match, we give a full score. Given the multi-classification environment, we can say that the inter-coder reliability is reasonably good enough to proceed. The topics and keywords were discussed with the other annotators, who independently participated in the labeling task in their languages.

The Labeled List of Major (i.e., 75% Percentile) Topics by Country and the Top 10-occurring Words Therein

1. South Korea (Language: Korean)

1-1. Phase 0

| Topic | Top-k words (k = 10) | labels |
|-------|--|-----------|
| 1 | 가온, 진짜, 루나, 너무, 날개, 캐스, 해서, 나라, 라폰젤, 라고 Gaon, real, Luna, too, wings, Cass, so, Narae, Rapunzel, called | unrelated |

1-2. Phase 1

| Topic | Top-k words (k = 10) | labels |
|-------|---|---|
| 2 | 나가, 바이러스, 해서, 진짜, 근데, 너무, 인데, 요즘, 친구, 만나 get out, virus, because, real, however, too, (stop-words), recently, friend, meet | personal |
| 3 | 마스크, 바이러스, 예방, 신종, 착용, 손소독제, 미세먼지, 소독, 감염, 손씻기 mask, virus, prevention, new type, wearing, hand sanitizer, micro dust, disinfection, infection, handwashing | informational |
| 6 | 신종, 뉴스, 다음, 환자, 일본, 확진자, 감염, 퇴원, 국내, 크루즈선 new type, news, Daum, patient, Japan, confirmed person, infection, discharged from hospital, domestic, cruise ship | global_news/confirmed |
| 9 | 바이러스, 신종, 감염, 가능, 전염, 중국, 사스, 전파, 메르스, 환자 virus, new type, infection, possible, transmission, China, SARS, spread, MERS, patient | informational |
| 13 | 신종, 정부, 국민, 대통령, 대응, 문재인, 뉴스, 바이러스, 총리, 다음 new type, government, citizens, president, response, Moon Jae-in, news, virus, prime minister, next | political |
| 14 | 확진자, 지역, 동네, 나왔, 병원, 바이러스, 환자, 근처, 학원, 저희 confirmed person, area, neighborhood, came out, hospital, virus, patient, nearby, private academy, us | personal |
| 16 | 확진자, 신종, 국내, 환자, 발생, 추가, 확진, 바이러스, 속보, 감염 confirmed person, new type, domestic, patient, outbreak, additional, confirmed, virus, breaking news, infection | local_news/confirmed |
| 17 | 진짜, 바이러스, 새끼, 걸리, 존나, 시발, 마스크, 남자, 씨발, 근데 real, virus, bitch, infected, damn, fucking, mask, man, fuck, however | personal |
| 18 | 출처, 네이버, 뉴스, 신종, 연합뉴스, 속보, 확진자, 경제, 국내, 발생 source, Naver, news, new type, Yonhap News, breaking news, confirmed person, economy, domestic, outbreak | local_news/confirmed, global_news/confirmed |
| 19 | 중국, 코로나바이러스, 진짜, 심각, 걱정, 세요, 무섭, 한국, 무서워, 중국인 China, Coronavirus, real, serious, worry, (stop-words), scary, Korea, scared, Chinese | personal |
| 20 | 진짜, 취소, 너무, 콘서트, 근데, 여행, 걱정, 이번, 인데, 해서 (real, canceled, too, concert, however, travel, worry, this time, (stop-words), so | celebrity |
| 23 | 감기, 기침, 병원, 증상, 독감, 아프, 그냥, 걸리, 해서, 바이러스 cold, cough, hospital, symptoms, flu, ill, just, take it, do, virus | informational |

| | | |
|----|---|-----------------------|
| 25 | 바이러스, 신종, 취소, 합니다, 연기, 행사, 예정, 입니다, 드립니다, 공지 virus, new type, cancel, do, postponed, event, planned, (stop-words), give, notice | local_news |
| 29 | 중국, 정부, 한국, 중국인, 국민, 문재인, 입국, 나라, 북한, 시진핑 China, government, Korea, Chinese, citizens, Moon Jae-in, entrance to company, country, North Korea, Xi Jinping | political |
| 30 | 중국, 신종, 사망자, 확진자, 사망, 출처, 블로그, 확진, 뉴스, 발생 China, new type, dead person, confirmed person, death, source, blog, confirmed, news, occurrence | global_news/confirmed |
| 32 | 조심, 세요, 마스크, 바이러스, 건강, 다들, 요즘, 해요, 합니다, 감기 beware, (stop-words), mask, virus, health, everybody, nowadays, let's do, I do, cold | cheerup |
| 34 | 신종, 대응, 바이러스, 확산, 뉴스, 지원, 감염증, 코로나바이러스, 기자, 위해 new type, response, virus, spread, news, support, infectious disease, Coronavirus, reporter, for | local_news |
| 36 | 바이러스, 신종, 해서, 나라, 이번, 너무, 인데, 상황, 중국, 인지 virus, new type, so, country, this time, too, (stop-words), situation, China, whether | political, personal |

1-3. Phase 2

| Topic | Top-k words (k = 10) | labels |
|-------|--|----------------------|
| 3 | 진짜, 신천지, 걸리, 바이러스, 해서, 새끼, 그냥, 마스크, 너무, 근데 real, Shincheonji, infected, virus, because, bitch, just, mask, too, however | political |
| 6 | 학교, 진짜, 학원, 확진자, 나가, 해서, 인데, 근데, 연기, 개학 school, real, private academy, confirmed person, go out, because, (stop-words), however, acting, starting school | personal |
| 9 | 확진자, 대구, 확진, 신천지, 환자, 발생, 추가, 뉴스, 병원, 검사 confirmed person, Daegu, confirmed, Shincheonji, patient, outbreak, additional, news, hospital, examination | local_news/confirmed |
| 11 | 한국, 일본, 중국, 뉴스, 검사, 다음, 미국, 바이러스, 감염, 확진자 Korea, Japan, China, news, examination, Daum, USA, virus, infection, confirmed person | global_news |
| 12 | 진짜, 잠잠, 너무, 빨리, 만나, 나가, 언제, 근데, 해서, 제발 real, calm, too, quickly, meet, go out, when, however, by doing so, please | celebrity |
| 14 | 신천지, 정부, 대구, 중국, 국민, 문재인, 사태, 나라, 한다, 대통령 Shincheonji, government, Daegu, China, citizens, Moon Jae-in, situation, country, do, president | political |

1-4. Phase 3

| Topic | Top-k words (k = 10) | labels |
|-------|--|--------------------|
| 1 | 진짜, 잠잠, 만나, 빨리, 너무, 언제, 얼른, 같이, 진정, 언니 real, calm, meet, soon, too, when, quickly, together, sedate, sister | celebrity |
| 2 | 극복, 뉴스, 방역, 위해, 위한, 기자, 성금, 기부, 전달, 지역 overcoming, news, preventive measures, in order to, for, reporter, donation, donate, delivery, area | local_news/cheerup |

| | | |
|----|---|--|
| 4 | 입국,여행,한국,미국,유럽,확진,해외,검사,자가격리,확진자 entrance to country, travel, Korea, USA, Europe, confirmed, overseas, examination, self quarantine, confirmed person | local_news, global_news |
| 12 | 나라, 진짜, 번방, 바이러스, 라고, 해서, 한국, 너무, 인데, 그냥 country, real, n-th room, virus, (stop-words), say so, Korea, too, (stop-words), just | global_news/hate |
| 16 | 국민, 정부, 총선, 문재인, 대통령, 나라, 언론, 대한민국, 정치, 선거 citizens, government, general election, Moon Jae-in, president, country, media, Korea, politics, election | political |
| 24 | 조심, 세요, 감사, 건강, 합니다, 해요, 너무, 많이, 생일, 행복 be careful, (stop-words), thank you, health, I do, let's do, too, much, birthday, happy | unrelated |
| 26 | 바이러스, 한국, 사태, 나라, 세계, 상황, 미국, 국가, 한다, 정부 virus, Korea, event, country, world, situation, USA, nation, do, government | global_news |
| 28 | 진짜, 새끼, 시발, 존나, 걸리, 씨발, 미친, 제발, 그냥, 마스크 real, bitch, fucking, damn, infected, fuck, crazy, please, just, mask | personal |
| 31 | 취소, 진짜, 근데, 연기, 올해, 인데, 언제, 이번, 상황, 해서 canceled, real, however, postponed, this year, (stop-words), when, this time, situation, by doing so | local_news |
| 32 | 지원, 재난, 경제, 긴급, 기본소득, 추경, 지급, 위기, 정부, 피해 support, disaster, economy, emergency, basic income, supplementary budget, payment, crisis, government, damage | local_news/economy |
| 33 | 한국, 뉴스, 다음, 검사, 미국, 대응, 나라, 세계, 키트, 진단키트 Korea, news, Daum, examination, USA, response, country, world, test kit, diagnosis kit | global_news |
| 35 | 해서, 나가, 진짜, 요즘, 너무, 인데, 근데, 친구, 마스크, 엄마 so, go out, really, these days, too, (stop-words), however, friend, mask, mom | personal |
| 36 | 진짜, 콘서트, 제발, 빨리, 너무, 취소, 세요, 공연, 눈치, 무대 real, concert, please, quick, too, cancel, please, performance, sense, stage | celebrity |
| 42 | 확진자, 사망자, 발생, 현황, 확진, 사망, 추가, 뉴스, 기준, 증가 confirmed person, dead person, occurrence, status, confirmation, death, additional, news, standard, increase | local_news/confirmed, global_news/confirmed |

2. Iran (Language: Farsi)

2-1. Phase 0

| Topic | Top-k words (k = 10) | labels |
|-------|---|-------------------------------------|
| 1 | كرونا، وپروس، كرونا، چين، ايران، كرونا وپروس، چيني، داره، ميشه، خفاش Corona, Virus, China, Iran, Coronavirus, Chinese, (stop-words), Bat | global_news/confirmed, political |
| 2 | ووھان، في، الصين، كورون، كرونا، الصينيه، مدينه، فيروس، على، الى Wuhan, (non-word), China, Corona, City, (non-words and stop-words) | local_news |

2-2. Phase 1

| Topic | Top-k words (k = 10) | labels |
|-------|--|-------------------------------------|
| 0 | كرونا، في، الله، على، لا، كورون، عن، ووھان، كل، اللهم Corona, (non-words and stop-words), God, Wuhan, Total | local_news, informational |
| 2 | كرونا، نفر، وپروس، ايران، مبتلا، بيمارستان، بهداشت، آمار، قم، كرونا وپروس Corona, Person, Virus, Iran, Infected, Hospital, Health, Statistics, Qom (city), Coronavirus | local_news/confirmed |
| 3 | كرونا، ايران، وپروس، كرونا، كرونا وپروس، كشور، چين، شيوع، امريكا، دولت Corona, Iran, Virus, Coronavirus, Country, China, Outbreak, The United States, Government | global_news/confirmed, political |
| 4 | كرونا، كرونا وپروس، كرونا، ايران، وپروس، قم، حرم، امام، خدا، الله Corona, Coronavirus, Iran, Virus, Qom, Shrine, Imam, God | political, personal |

3. Vietnam (Language: Vietnamese)

3-1. Phase 0

| Topic | Top-k words (k = 10) | labels |
|-------|---|-----------------------|
| 15 | bệnh,viêm,việt,trung_quốc,trung,phổi,corona,virus,quốc (disease, inflammation, Vietnamese, Chinese, central, lung, corona, virus, China) | global_news/confirmed |

3-2. Phase 1

| Topic | Top-k words (k = 10) | labels |
|-------|---|--|
| 2 | nhiễm,trung_quốc,trung,quốc,việt,phát_hiện,cách_ly,vũ_hán,dương_tín h,bệnh_viện (infected, Chinese, China, Chinese, Vietnamese, detected, quarantined, Wuhan, positive, hospital) | local_news/confirmed, global_news/confirmed |

3-3. Phase 2

| Topic | Top-k words (k = 10) | labels |
|-------|---|---|
| 0 | dịch,khẩu_trang,việt,cô_đơn,đại_dịch,trung_quốc,covid,ảnh_hưởng,bất_động_sản,thị_trường (disease, mask, Vietnamese, loneliness, pandemic, China, covid, impact, real estate, market) | local_news/confirmed, local_news/economy |
| 1 | dịch,trung_quốc,viêm,phổi,việt,trung,vũ_hán,nhiễm,dịch_bệnh,quốc (disease, China, inflammation, lung, Vietnamese, Chinese, Wuhan, infected, epidemic, Chinese) | informational, global_news |
| 2 | dịch,ngủ,chống,học_sinh,covid,phòng,khẩu_trang,phòng_chống,phòng_dịch,trường (disease, absence from school, against, pupils, COVID, prevention, mask, prevention, epidemic prevention, school) | informational, global_news |

3-4. Phase 3

| Topic | Top-k words (k = 10) | labels |
|-------|--|-------------------------|
| 0 | dịch,hàn_quốc,chống,việt,cách_ly,bình,trận,hợp_tác,phòng_chống,cập_nhật (epidemic, Korean, anti, Vietnamese, quarantine, stop_word, stop_word, cooperation, prevention, update) | global_news, local_news |
| 3 | bánh_mì,đất_nước,thượng_đẳng,ngon,xin_lỗi,chúng_tôi,ngáo,nổi_ting, bánh,đòi_hỏi (bread, country, elite, delicious, sorry, us, stop_word, famous, cake, demanding) | personal |
| 4 | virus,vietnam,korea,ting,news,việt,south,ngừa,trend,that (virus,Vietnam,stop-word, stop-word, stop-word, Vietnamese, stop-word, prevention, stop-word, stop-word) | personal, global_news |

| | | |
|----|---|---------------------------|
| 6 | dịch,việt,quốc_gia,th_giới,hàng,ngon,du_lịch,trung_tâm,phòng_chống,c hủng_tôi (disease, Vietnamese, nation, world, commodity, delicious, travel, central, prevention, stop-word) | personal |
| 8 | việt,anh_chị,chăm_sóc,sức_khoẻ,cảm_ơn,video,giúp,người,reply,letuy (Vietnamese, stop-word, care, health, thank, video, help, people, reply, stop-word) | personal |
| 9 | dịch,việt,cách_ly,chống,phòng,du_lịch,hàn_quốc,công_dân,nhân_viên, hàng (disease, Vietnamese, quarantine, prevention, travel, Korea, citizens, employees, goods) | political |
| 15 | virus,dịch,trung_quốc,th_giới,đại_dịch,trung,kinh_t,lây_lan,có_thể,toàn _cầu (virus, epidemic, china, world, pandemic, central, economic, spread, stop-word, global) | local_news, global_news |
| 20 | trend,hashtag,động,hi_vọng,chúng_mình,tốt_đẹp,trích,hàn_quốc,trend_ th,concert (trend, hashtag, dynamic, hope, stop-word, nice, inject, korean, stop-word, concert) | personal |
| 22 | dịch,bác_sĩ,virus,chống,codonqua,việt,hàn_quốc,tung,ảnh_hưởng,ngâ n_hàng (disease, doctor, virus, anti, stop-word, vietnamese, korea, launching, influence, banking) | local_news, global_news |
| 23 | hàn_quốc,việt,idol,daegu,stan,bánh_mì,du_lịch,cách_ly,đừng,có_thể (Korean, Vietnamese, idol, daegu, stop-word, bread, tourism, quarantine, stand, stop-word) | personal |
| 24 | trend,tweet,đừng,hashtag,nhắc,châu,lạnh,bạn_bè,đánh_giá,hashtag (trend, tweet, stop-word, hashtag, stop-word, stop-word, cold, friends, reviews, hashtag) | unrelated |
| 25 | nhễm,virus,hàn_quốc,tử_vong,dịch,trường_hợp,ngghi,việt,cập_nhật,tin h_hình (infection, virus, korean, death, epidemic, case, suspect, vietnamese, update, situation) | global_news |
| 28 | việtnamtuệtnhất,chánccácbạnthượngđẳng,du_lịch,dịch,thượng_đẳng,c ách_ly,người_ta,hạ_long,việtnamquyếtthắngđạidịch,tham_quan (stop-word,stop-word, travel, epidemic, superiority, isolation, people, Ha Long, stop-word, visit) | personal |
| 30 | việt,chúng_tôi,xin_lỗi,tôn_trọng,xem_lại,thượng_đẳng,xúc_phạm,bánh_ mì,sự_thật,đất_nước (Vietnamese, us, sorry, respect, review, superiority, insult, bread, truth, country) | personal |
| 34 | chúng_tôi,đất_nước,việt,cách_ly,đừng,thượng_đẳng,dịch,hàn_quốc,ph át_triển,đổi_xử (us, country, vietnamese, quarantine, stop-word, superiority, translation, korea, development, treatment) | personal |
| 35 | nhễm,bệnh_nhân,việt,virus,bệnh,điều_trị,xuất_viện,bệnh_viện,trung_q uốc,thuốc (infection, patient, Vietnamese, virus, disease, treatment, hospital discharge, hospital, china, medicine) | informational, local_news |
| 36 | thông_báo,music,bighit,show,tip_tục,quảng_bá,sự_kiện,bùng,sân_khấu ,info (announcement, music, big hit, show, resume, promotion, event, flare, stage, info) | celebrity |
| 38 | virus,dính,dịch,phòng_dịch,nhễm,hàng,khác_thường,vắng_vẽ,khẩu_tr ang,hàn_quốc (virus,infection, epidemic, epidemic, infection, commodity, unusual, deserted, mask, Korea) | personal |

| | | |
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| 39 | tiền,army,hoàn,concert,virus,ảnh_hưởng,bighit,giúp_đỡ,đóng_góp,hỗ_t_rợ (Money, army, refund, concert, virus, effect, big hit, help, donation, support) | celebrity |
| 41 | chống,dịch,nghĩ,học_sinh,trưa,trường,trở_lại,phòng_dịch,phòng,sinh_vi_ên (prevention, disease, vacation, pupils, lunch, school, back, prevention, prevention, students) | local_news |
| 43 | đẩy_lùi,việt,cách_ly,kimchi,dịch,virus,dịch_bệnh,suốt,bảo_vệ,phòng (repel, vietnamese, quarantine, stop-word, translation, virus, epidemic, transparent, protection, prevention) | global_news, local_news |
| 45 | thượng_đẳng,việt_thức,dịch,cách_ly,quốc,thằng,đừng,con_người,anh_chị (supreme, Vietnamese, awakening, disease, quarantine, nation, guy, stop-word, people, brothers and sisters) | personal |

3-5. Phase 4

| Topic | Top-k words (k = 10) | labels |
|-------|--|---|
| 1 | virus,việt,dịch_bệnh,tin_tức,nhiễm,news,tổng_hợp,ting,có_thể,đại_dịch (virus, Vietnamese, epidemic, news, infection, news, synthesis, stop-word, can, epidemic) | local_news, global_news |
| 4 | hoãn,dương_tính,dịch,chính_thức,cầu_thủ,bóng_đá,league,châu,giải,lo_lắng (postponement, positive, epidemic, official, player, football, league, continent, league, anxiety) | celebrity |
| 8 | đại_dịch,kinh_t,toàn_cầu,th_giới,dịch,có_thể,suy_thoái,kòkòrò,ipinlè,pà_jáviri (pandemic, economic, global, world, epidemic, stop-word, recession, no mean, no mean, no mean) | global_news/economy |
| 10 | chống,dịch,việt,chính_phủ,đồng,phòng_chống,cảm_ơn,ủng_hộ,cuộc_c_hin,tất_cả (against, epidemic, Vietnamese, government, copper, prevention, thanks, support, war, all) | local_news, global_news |
| 11 | dịch,đóng_cửa,dừng,du_lich,hoạt_động,nhân_viên,phòng_dịch,hàng_l_oạt,phim,cửa_hàng (disease, shutdown, stop, travel, activity, employee, epidemic room, series, film, store) | local_news, global_news |
| 16 | dịch,cách_ly,chống,phòng,phòng_chống,dịch_bệnh,công_tác,hà_nội,tậ_p_trung,bệnh_viện (epidemic, quarantine, prevention, prevention, epidemic, work, Hanoi, concentration, hospital) | local_news, global_news |
| 17 | bệnh_nhân,nhiễm,việt,chuyn,cách_ly,hành_khách,điều_trị,bệnh_viện,b_ệnh,khẩn (patient, infected, transient, transient, passenger, treatment, hospital, sick, urgent) | local_news/confirmed, global_news/confirmed |
| 24 | dịch,chịch,thời,virus,codonqua,thất_nghiệp,like,share,nuôi,follow (epidemic, fuck, time, virus, alone, unemployment, like, share, feed, follow) | unrelated |
| 26 | xô_corona,dương_tính,hoang_mang,covid_xách,virus,th_giới,chồng,đ_ường,xử_l_dịch (corona, positive, confused, covid, carry, virus, world, husband, stop-word, handle) | unrelated |
| 28 | dịch,chống,phòng_chống,bảo_vệ,khẩu_trang,virus,giúp,cộng_đồng,đề_kháng,vệ_sinh (disease, prevention, prevention, protection, masks, viruses, help, community, resistance, hygiene) | informational |
| 29 | dịch,đóng_cửa,việt,châu,phong_tòa,lây_lan,nhập_cảnh,biên_giới,news_canada (epidemic, closure, vietnamese, continental, blockade, spread, entry, border, news, Canada) | political |

| | | |
|----|--|--|
| 33 | nhiễm,việt,ghi_nhận,bệnh_nhân,công_bố,trường_hợp,bệnh,tổng_số,dương_tính,nâng (infection, transient, patient, statement, case, illness, total, positive, increase) | local_news/confirmed |
| 37 | dịch,ảnh_hưởng,doanh_nghiệp,tiền,thị_trường,có_thể,thời,đại_dịch,kinh_t,ỗ_trợ (disease, impact, business, money, market, can, era, pandemic, economic, support) | global_news/economy, local_news/economy |
| 38 | xét_nghiệm,âm_tính,nhiễm,kt_quả,dương_tính,tip_xúc,bệnh_nhân,tình_hình,nhân_viên,trump (test, negative, infection, result, positive, exposure, patient, situation, employee, Trump) | local_news, global_news |
| 41 | virus,đại_dịch,trung_quốc,dịch,th_giới,mượn,diệt,sống,chúng_ta,nhạc (virus, pandemic, China, translation, world, borrow, destroy, live, us, music) | local_news, global_news |
| 42 | nhiễm,bệnh_nhân,hà_nội,cách_ly,dương_tính,liên_quan,tip_viên,bạch,tip_xúc,trúc (infection, patient, hanoi, isolated, positive, related, flight attendant, no mean, contact, no mean) | local_news/confirmed |
| 43 | virus,nhiễm,việt,trung_quốc,lây_nhiễm,chống,pháp,dính,hàn_quốc,new_s (virus, infection, vietnamese, China, infection, anti, french, infection, Korean, news) | local_news, global_news |
| 44 | dịch,theo_dõi,ứng_dụng,nhiễm,nghi,phun,cách_ly,khử_trùng,phòng_dịch,dịch_vụ (disease, monitoring, application, infection, suspicion, spray, isolation, disinfection, epidemic prevention, service) | local_news |
| 45 | thuốc,virus,chữa,điều_trị,vaccine,thử_nghiệm,chống,ngừa,bệnh,sốt_rét (medicine, virus, cure, treatment, vaccine, testing, prevention, prevention, disease, malaria) | global_news |

3-6. Phase 5

| Topic | Top-k words (k = 10) | labels |
|-------|---|-------------------------|
| 5 | dịch,đại_dịch,ảnh_hưởng,thời,doanh_nghiệp,bất_động_sản,ỗ_trợ,có_thể,tiền,thị_trường (disease, pandemic, impact, fashion, business, real estate, assistance, can, money, market) | local_news |
| 9 | nhiễm,bệnh_nhân,việt,bệnh_viện,bệnh,cách_ly,bạch,xét_nghiệm,hà_nội,dương_tính (Infection, patient, Vietnamese, hospital, illness, quarantine, transparency, test, positive, positive) | local_news, global_news |
| 12 | dịch,virus,chống,đại_dịch,th_giới,news,cập_nhật,nhiễm,trung_quốc,hàng (disease, virus, anti, pandemic, world, news, updates, infected, China, goods) | local_news, global_news |
| 14 | dịch,chống,phòng_chống,phòng,cách_ly,việt,đồng,thủ_tướng,ủng_hộ,dịch_bệnh (epidemic, prevention, prevention, quarantine, Vietnamese, bronze, prime minister, advocacy, epidemic) | local_news |

4. India (Language: Hindi)

4-1. Phase 0

| Topic | Top-k words (k = 10) | labels |
|-------|--|--|
| 2 | कोरोना, वायरस, संदिग्ध, चीन, भर्ती, अस्पताल, मरीज, भारत, सामने, बिहार Corona, Virus, Suspected, China, Admitted, Hospital, Patient, India, As opposed (This word might have other meanings based on context), Bihar (Bihar is a state in India) | global_news/confirmed, local_news/confirmed, informational |

4-2. Phase 1

| Topic | Top-k words (k = 10) | labels |
|-------|--|-----------------------------------|
| 2 | कोरोना, वायरस, बंद, स्कूल, खाने, मार्च, दिल्ली, चिकन, मांस, आदेश Corona, virus, close, school, to eat, march (procession), Delhi, meat (and chicken), order | local_news, rumors |
| 4 | होली, होगी, कोरोना, वायरस, होगा, गाय, गोबर, वातावरण, शुद्ध, कंडे Holi (is a festival in India), ST, corona, virus, ST, cow dung, environment, pure, eggs | local_news, global_news |
| 5 | कोरोना, वायरस, बचाव, क्या, बचने, उपाय, सावधानी, रहें, लक्षण, कैसे Corona, virus, prevent, ST, preventive, way, precaution, ST, symptoms, ST | informational |
| 6 | वायरस, परमात्मा, खाना, मांस, हम, क्या, आदेश, चलते, अन्य, भयंकर Virus, The Divine, food (it could a noun or a verb), meat, ST, ST, order, to walk (depends on context), others, severe | rumors |
| 8 | होली, गोबर, कोरोना, गाय, वायरस, कंडे, जलाने, नष्ट, रंगों, पलाश Holi, cow dung, corona, cow, virus, prickles, to burn, destroy, colors, pliers (not sure though) | local_news, rumors, informational |
| 9 | कोरोना, वायरस, चीन, भारत, सरकार, दुनिया, चपेट, अमेरिका, क्या, रोक Corona, virus, China, India, government, world, grip, USA, ST, to ban/stop. | global_news |
| 12 | कोरोना, वाइरस, वजह, गलत, वोट, फैल, वायरस, चाइना, दिल्ली, गोश्त Corona, virus, reason, wrong, vote, spread, virus, China, Delhi, meat | informational |
| 14 | कोरोना, वायरस, पीएम, नमस्ते, मोदी, आदत, मीडिया, झेल, बचें, हमें Corona, virus, P.M. (prime minister), Namaste, Modi, habit, media, fraud/trick, to be careful, ST | rumors |
| 15 | बंद, मांस, खाना, चीन, वरना, वायरस, पड़ेगा, कोरोना, जबरदस्ती, साधना stop/ban, meat, food, China, otherwise, virus, ST, corona, forcefully/forced, meditation | rumors |
| 19 | कोरोना, हाथ, नमस्कार, करवा, नमस्ते, वायरस, शाकाहारी, संस्कृति, सनातन, भारतीय Corona, hand (in context of someone's involvement in something), Namaskar (greeting, salutation), doing (context - who is supporting this), Namaste, virus, vegetarian, culture, Sanatan (Sanatan dharma - eternal duties incumbent upon people in Hinduism), Indian | informational, rumors |
| 20 | कोरोना, वायरस, मरीज, संदिग्ध, अस्पताल, जांच, दिल्ली, भारत, लोगों, गए Corona, virus, patient (medical context), suspected, hospital, tests, Delhi, India, people, ST | informational, local_news |

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|----|--|--|
| 21 | कोरोना, बहिष्कार, स्वदेशी, वायरस, मलेरिया, व्हायरस, विदेशी, नाही, मरें, अपनाये, Corona, boycott, indigenous, virus, malaria, viruses, foreign, ST, die, adopt | informational, global_news, local_news |
| 26 | कोरोना, देश, जाये, सालों, गद्दारों, जय, नही, ठीक, भड़काऊ, जाए Corona, country, go, (its an offensive word), traitors, to hail, ST, correct, provocative, ST | local_news/hate |
| 30 | कोरोना, चीन, भारत, पाकिस्तान, रोना, सोना, टन, वायरस, कर्ज, पड़ोसी Corona, China, India, Pakistan, cry, gold, ton, virus, debt, neighbor | local_news/hate, global_news |
| 31 | गंदगी, मनुष्य, खाते, पशु, मांस, रहते, पक्षी, खाने, वायरस, फैला Garbage, humans, eat, animals, meat, ST, birds, eat, viruses, spread | informational |
| 34 | परमात्मा, आदेश, आपदाएं, वायरस, कोरोना, चीन, जैसी, प्रकार, उल्लंघन, आया The Divine, order, disasters, virus, corona, China, ST, type, violation, ST | rumors |
| 36 | कोरोना, वायरस, हाथ, दूरी, मुँह, नाक, उससे, बार, साबुन, बुखार Corona, virus, hand, distance, mouth, nose, ST, ST, soap, fever | informational, rumors |
| 42 | जी, कोरोना, योगी, बना, हज, जनता, हाउस, अस्पताल, बेड, अपील Yes, corona, yogi (most probably in context of Chief Minister of Uttar Pradesh state in India), ST, Haj (holy pilgrimage of Muslims), public, house, hospital, bed, appeal | local_news |
| 44 | कोरोना, वायरस, अल्लाह, चीन, अब, क्या, चपेट, नमाज़, नमाज़, लगा Corona, virus, Allah (Muslims call The Divine as Allah), China, now, what, grip, Namaz (Muslims' prayer), Namaz (Muslims' prayer), felt | global_news, rumors |
| 45 | भगवान, इलाज, जाने, आगे, बचने, आ, साइंस, कितनी, लो, संविधान The Divine, cure, ST, next/forward, escape, ST, science, how much, ST, constitution | rumors |
| 47 | होली, कोरोना, वायरस, रंग, हाथ, बार, नमस्ते, वैदिक, पलाश, डरने Holi, corona, virus, color, hand, this time, Namaste, Vedic, pliers, to fear | informational |
| 49 | वायरस, कोरोना, भारत, खतरा, वापस, जान, चीन, यहां, देखकर, मेरी Virus, corona, India, threat, back, life (most probably in context of fearing for his life), China, ST, seeing, ST | local_news, global_news, rumors |

4-3. Phase 2

| Topic | Top-k words (k = 10) | labels |
|-------|---|---|
| 0 | कोरोना, वायरस, भारत, टेस्ट, किट, क्या, दवा, सरकार, इलाज, तैयार Corona, virus, India, test, kit, ST, medicine, government, cure, ready | informational, rumors, local_news/cheerup |
| 1 | कोरोना, वायरस, बंद, मार्च, स्कूल, चलते, सरकार, स्थगित, आदेश, रद्द Corona, virus, closed, march, school, moving, government, postponed, order, canceled | informational, local_news |
| 8 | कोरोना, सरकार, वायरस, आर्थिक, पैकेज, मोदी, करोड़, लाख, राहत, रही Corona, government, virus, financial, package, Modi, crore (1 crore = 10 million), lakh (1 lakh = 100,000), relief | local_news/economy |
| 9 | कोरोना, लोग, मर, गरीब, भूख, क्या, देश, सरकार, नही, मजदूर Corona, people, dead, poor, hungry, what, country, government, no, laborers | local_news, local_news/economy |
| 10 | कोरोना, वायरस, बचाव, लेकर, जी, संक्रमण, श्री, जिला, बैठक, मुख्यमंत्री Corona, virus, rescue, ST, ST, infection, ST, district, meeting, Chief | local_news |

| | | |
|----|---|---------------------------|
| | Minister | |
| 12 | कोरोना,रहें,वायरस,सुरक्षित,पालन,हम,बचाव,सरकार,देश,सावधानी Corona, stay, virus, safe, obey, ST, rescue, government, country, caution | informational |
| 13 | कोरोना,करोड़,लाख,दान,लड़ने,देश,रुपये,राहत,मदद,कोष Corona, crore, lakh, donation, fight, country, rupee (INR currency), relief, help, fund | local_news/cheerup |
| 14 | कोरोना,जी,सरकार,जाए,लोग,वायरस,नहीं,चाहिए,देश,निवेदन Corona, ST, government, go, people, virus, ST, want, country, request | local_news, informational |
| 15 | कोरोना,देश,हम,जय,भारत,जी,हारेगा,जीतेगा,सब,श्री Corona, country, we, to hail, India, ST, will lose, will win, ST, ST | local_news/cheerup |
| 17 | कोरोना,सरकार,देश,दिल्ली,रही,केजरीवाल,क्या,लोगों,लोग,भारत Corona, government, country, Delhi, ST, Kejriwal (Arvind Kejriwal, Chief Minister of Delhi), ST, people, people, India | local_news, rumors |
| 22 | कोरोना,सरकार,कांग्रेस,राहुल,गांधी,वायरस,जी,गायब,देश,मोदी Corona, government, congress, Rahul, Gandhi, (Rahul Gandhi is leader of the main opposition party in India) virus, law, missing, country, Modi | local_news, political |
| 24 | कोरोना,वायरस,मौत,संख्या,भारत,देश,संक्रमित,लोगों,अब,मामले Corona, virus, death, number, India, country, infected, people, now, case | local_news, global_news |
| 27 | कोरोना,विश्व,संस्कृति,महामारी,आज,प्रार्थना,नववर्ष,वायरस,संकल्प,माँ Corona, world, culture, pandemic, today, prayer, new year, virus, resolve, mother | rumors |
| 36 | कोरोना,वायरस,मीडिया,गो,खतरनाक,इलाज,मूत्र,अब,सोशल,न्यूज़ Corona, virus, media, go, dangerous, cure, (cow) urine, nowST social, news | informational |
| 37 | कोरोना,पॉजिटिव,वायरस,कनिका,मरीज,कपूर,अस्पताल,संदिग्ध,जांच,रिपोर्ट Corona, positive, virus, Kanika (Kanika Kapoor is an India celebrity) , patient, camphor, hospital, suspected, investigation, report | celebrity, local_news |
| 38 | कोरोना,जनता,कर्फ्यू,बजे,प्रधानमंत्री,जी,मार्च,देश,मोदी,वायरस Corona, public, curfew, a time unit, Prime minister, ST, march, country, Modi, virus | local_news |
| 39 | कोरोना,नहीं,क्या,देश,वायरस,लोग,अब,वो,मोदी,पता Corona, ST, ST, country, virus, people, now, ST, Modi, to know (could have other contextual meanings) | local_news |
| 40 | कोरोना,वायरस,मास्क,लोग,रही,पुलिस,नहीं,लोगों,डाउन,दे Corona, virus, mask, people, ST, police, ST, people, down, give | informational, local_news |
| 41 | कोरोना,जिहाद,देश,वायरस,मुस्लिम,भारत,पाकिस्तान,अब,लोग,बम Corona, jihad (means holy war, but most probably it is used here in some derogatory context), country, virus, Muslim, India, Pakistan, ST, people, bomb(s) | rumors |
| 45 | कोरोना,वायरस,अब,क्या,करो,आज,आ,सब,नहीं,दिन Corona, virus, now, what, do, today, come, all, no, day | local_news/funny |