

HARVESTING SOCIAL SIGNALS TO INFORM PEACE PROCESSES IMPLEMENTATION AND MONITORING

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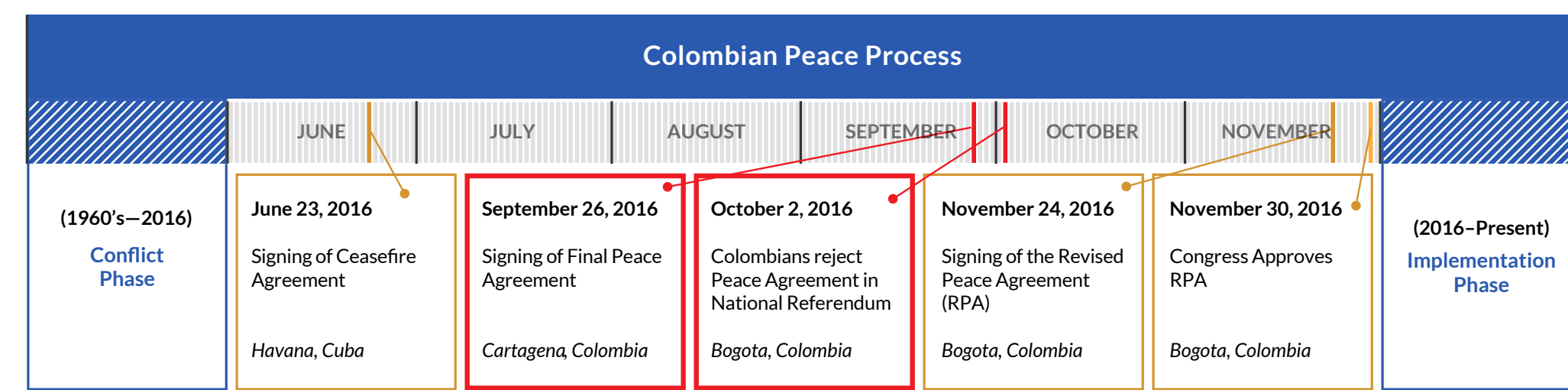


PROBLEM STATEMENT

Peace processes are complex, protracted, and contentious processes involving significant bargaining and compromising among various societal and political stakeholders. In civil war terminations, it is pertinent to measure the pulse of the nation to ensure that the peace process is responsive to citizens' concerns. Social media yields tremendous power as a tool for dialogue, debate, organization, and mobilization thereby adding more complexity to the peace process.

The Colombian peace agreement ended the longest fought armed conflict in the Western Hemisphere. Unlike any other civil war termination in recent history, the Colombian peace agreement was widely discussed and campaigned through social media. Social media platforms such as Twitter can be leveraged to harvest social signals to better understand these complex phenomena as well as to monitor peace processes as they unfold and forecast their outcomes to prevent catastrophic negative cascading effects.

In this research, we model social signals from Twitter to develop two indicators: 1) Inter-group polarization and 2) Public sentiment.



BACKGROUND

Peace processes, confounded by the challenge of a 40% chance of failure in the first 10 years of their implementation, also face the challenge of accurately capturing the pulse of the society to achieve a more successful implementation and monitoring.

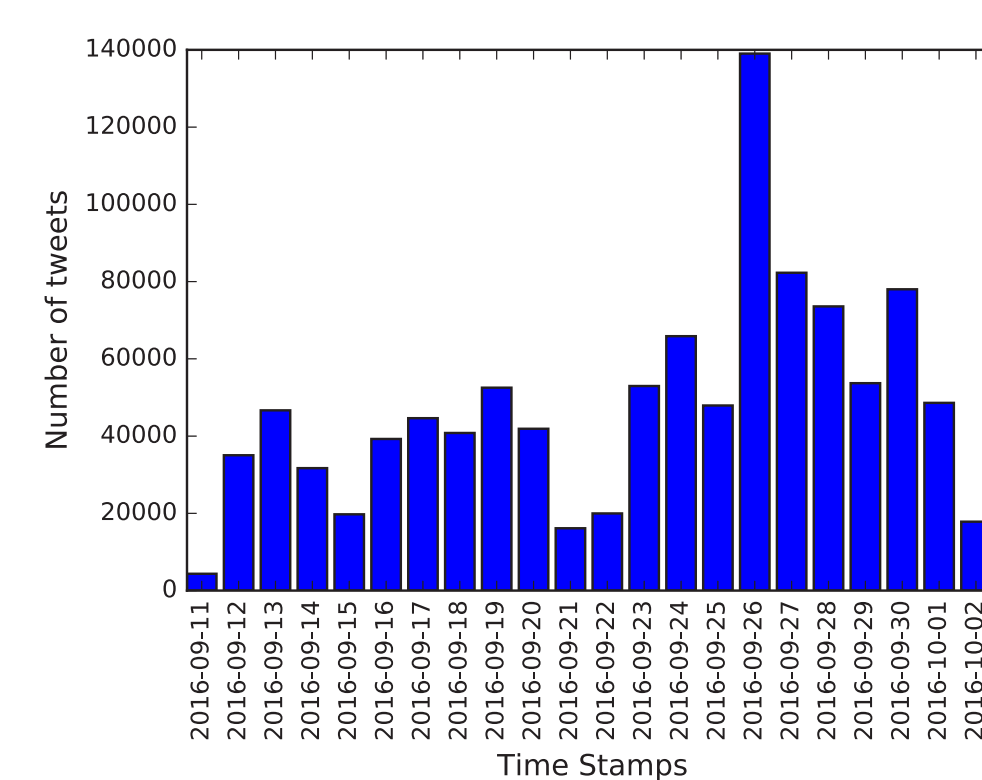
As of 2015, there are 50 active armed conflict dyads around the world. While military victory used to be the predominant conflict termination outcome during the Cold War, since 1989 there has been a significant increase in ceasefires, peace agreements, and other civil war outcomes. Out of 142 civil war terminations between 1989 and 2015, 69% of these terminations occurred through negotiated peace agreements. However, the likelihood of negotiated peace agreement failure is higher than other types of civil war outcomes. In general, negotiated peace settlements have a 23% chance of conflict reversion during the initial five years and 17% chance of reversion in the subsequent five years. On average, negotiated peace agreements last three and a half years before conflict resumes.

DATA

We studied the Colombian peace process by analyzing the political environment on Twitter three weeks prior to the referendum (October 2, 2016). The data was collected from September 11 to October 1, 2016. The dataset was limited to Spanish tweets.

We used a set of keywords related to substantive issues about the peace process as our tracking parameter. These issues included the signing of the final peace agreement, public perceptions towards the FARC, victims of conflict, and the public referendum. The tracking keywords were recommended by peacebuilding professionals with extensive local and contextual knowledge about Colombia.

| Date | Keywords |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 09/11 | colombia peace, farc, colombia referendum, colombia peace process, colombia displaced, havana peace process, colombia final agreement, colombia conflict victims, colombia missing persons, colombia united nations |
| 09/15 | colombia ceasefire, paz en colombia, farc, colombia referendum, colombia acuerdo final, colombia victimas del conflicto, fin del conflicto armado, proceso de paz de la habana, proceso de paz colombia, colombia desplazados |
| 09/26 | #firmadelapaz, paz en colombia, farc, colombia referendum, colombia acuerdo final, colombia victimas del conflicto, fin del conflicto armado, proceso de paz de la habana, proceso de paz colombia, colombia desplazados |

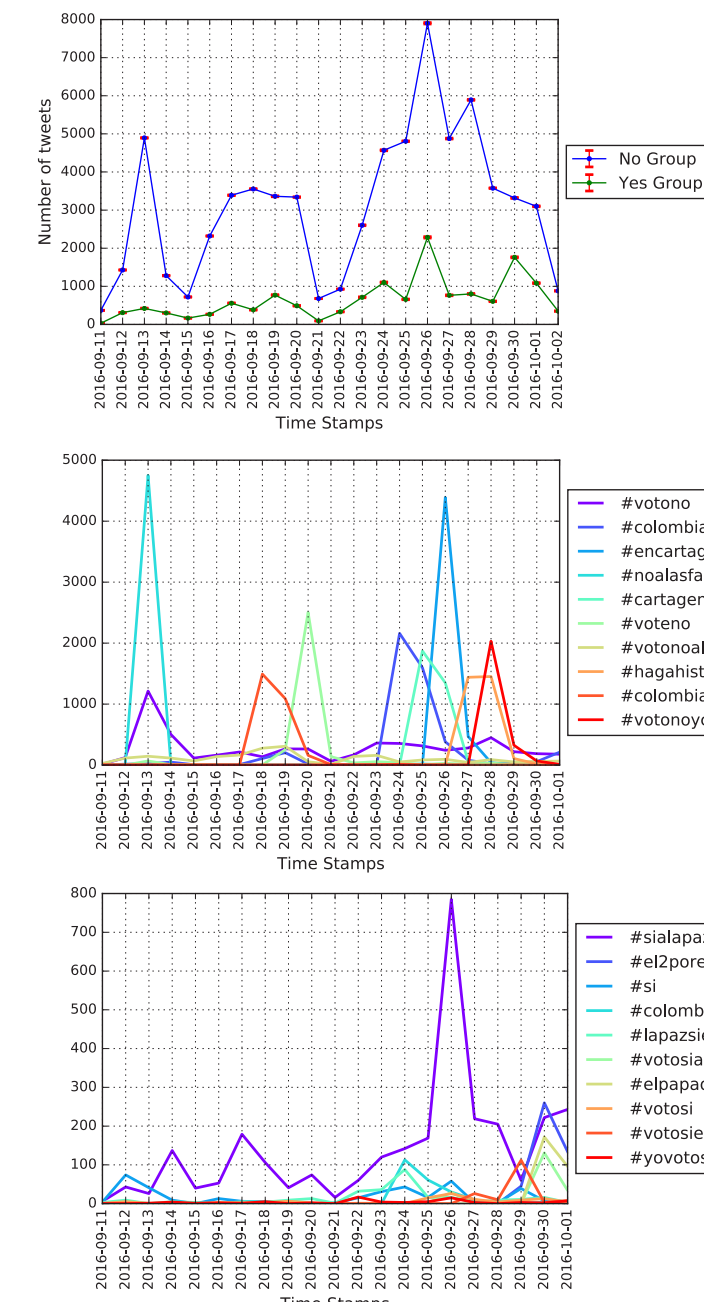


INTER-GROUP POLARIZATION

Hashtag spread and evolution

We observe that Colombians were divided between Yes and No camps, with the No tweets dominating political conversations with their consistent and well-organized campaign leading up to the referendum on October 2, 2016.

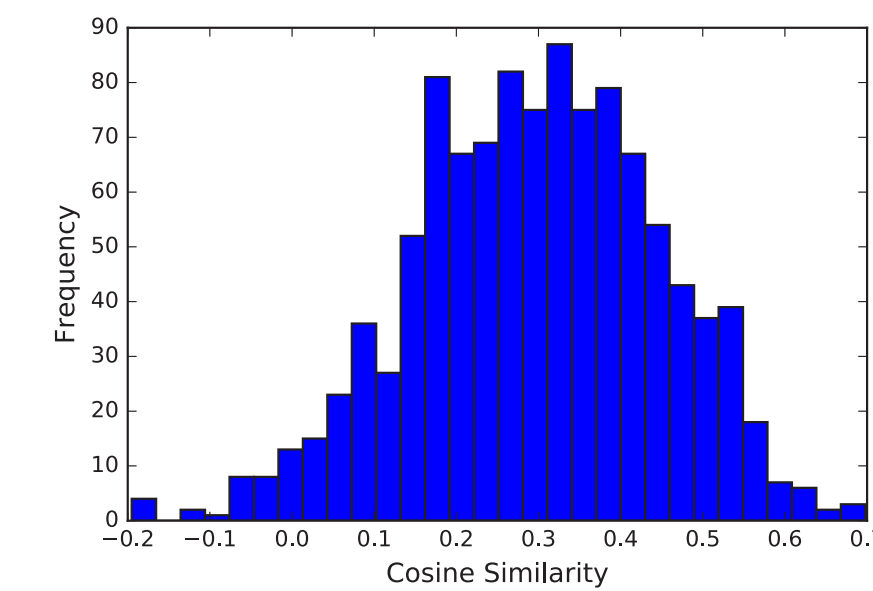
No group dominated the social media conversations related to the peace process based on their higher daily volumes, wider No-related hashtag use by diverse users, and greater popularity and prominence of No group tweets compared to their Yes counterparts.



| Group | Hashtag | Daily Volume | Variability | Influence | Popularity | Prominence |
|-----------|-------------------------|---------------|---------------|-----------------|-----------------|----------------|
| No Group | #votono | 5.628 (1.095) | 3.825 (1.209) | 10.154 (1.202) | 28.870 (5.216) | 11.797 (3.162) |
| | #colombiavotano | 4.848 (2.460) | 5.115 (2.382) | 8.650 (3.874) | 27.917 (6.655) | 16.172 (4.248) |
| | #encartagenadecimosno | 4.699 (4.199) | 8.801 (5.732) | 17.033 (14.040) | 47.426 (15.312) | 8.248 (5.202) |
| | #noalafarc | 4.589(4.543) | 9.587 (6.552) | 1.497 (1.131) | 49.008 (20.975) | 6.558 (1.805) |
| | #cartagenapitano | 3.160 (2.151) | 3.751 (2.245) | 14.486 (6.997) | 55.229 (14.326) | 8.703 (6.264) |
| | #voteno | 3.081 (2.377) | 5.279 (3.154) | 4.973 (3.444) | 21.704 (6.199) | 6.988 (1.761) |
| | #votonoalplebiscito | 2.237 (0.332) | 1.205 (0.263) | 5.006 (0.748) | 35.452 (6.181) | 11.163 (2.585) |
| | #hagahistoriavoteno | 2.888 (1.903) | 2.910 (1.918) | 16.537 (9.635) | 53.469 (17.421) | 3.225 (1.253) |
| | #colombiaconelno | 2.651 (1.721) | 3.015 (1.733) | 10.066 (5.935) | 33.334 (11.219) | 8.570 (4.395) |
| | #votonoycorrijoacuerdos | 2.331 (1.950) | 4.069 (2.582) | 13.306 (9.768) | 49.326 (18.922) | 8.399 (3.895) |
| | #sialapaz | 2.888 (0.728) | 2.483 (0.758) | 6.476 (1.680) | 17.702 (5.094) | 11.972 (4.371) |
| | #el2porelsi | 0.437 (0.274) | 0.503 (0.263) | 5.535 (2.700) | 46.170 (23.032) | 13.984 (5.422) |
| | #si | 0.358 (0.095) | 0.415 (0.091) | 0.863 (0.238) | 23.754 (6.430) | 4.232 (0.891) |
| | #colombiavotasi | 0.209 (0.121) | 0.233 (0.123) | 1.689 (0.835) | 34.223 (14.063) | 7.097 (1.841) |
| Yes Group | #lapaziescontigo | 0.271 (0.087) | 0.252 (0.083) | 0.583 (0.204) | 28.428 (6.959) | 11.494 (3.114) |
| | #votosialapaz | 0.208 (0.129) | 0.302 (0.159) | 1.802 (1.009) | 40.842 (18.029) | 5.547 (1.422) |
| | #elpapadicesi | 0.270 (0.184) | 0.331 (0.197) | 4.678 (2.239) | 55.791 (29.443) | 15.850 (9.711) |
| | #votosi | 0.105 (0.029) | 0.096 (0.020) | 0.246 (0.078) | 16.556 (7.065) | 2.811 (0.766) |
| | #votosie12deoctubre | 0.152 (0.108) | 0.267 (0.145) | 1.559 (1.042) | 26.933 (18.998) | 4.266 (1.332) |
| | #yovotosi | 0.074 (0.020) | 0.094 (0.021) | 0.180 (0.057) | 15.668 (8.173) | 4.077 (1.502) |

Word associations

Even though both groups used the same words, understanding the usage and context of these words is crucial to deciphering public opinion. Using word embeddings, we observed that although there exists a significant word-usage overlap between the content generated by both groups, the same words are used in dissimilar contexts marked by relatively lower cosine similarity scores.



| Word | Yes Group Associations | Yes Group PMI | No Group Associations | No Group PMI |
|------------|-----------------------------------------------|---------------|-------------------------------------------------|--------------|
| Santos | gusta, desarmar, paras, derrotadas | -1.367 | santos-farc, comandante, aprobar, narcoasesinos | 0.145 |
| Uribe | seguridad, despiden, desmovilizadas, mentiras | 0.282 | viudas, odio, acepta, firmando | -0.070 |
| Timochenko | confirma, atenci, familias, secreta | -0.097 | asustaba, susto, ratificado, ofrezco | 0.019 |
| Plebiscito | votar, quiero, aprobar, puedo | -0.521 | propaganda, papa, narcoasesinos, ganarnos | 0.081 |
| Farc | Timochenko, invito, promover, acabe | -0.420 | impuesto, libros, constitucional, rechaza | 0.069 |
| Acuerdo | gobierno, final, firman, apoyan | -0.054 | final, gobierno, comunicado, acuerdos | 0.011 |
| Paz | acuerdos, firmar, retos, apoyamos | 0.676 | apoya, insisten, alcanzar, entender | -0.22 |

Emergent topic

- We observed that the majority of the topics are related to the FARC. The topics are also related to Santos and Uribe as well as the national referendum and various aspects/provisions of the peace agreement such as victims of conflict, women, disarmament, prisoners of war, reparations, institutions, and justice.

| Yes Group | | No Group | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Topic | Context | Topic | Context |
| entrevista, exguerrillero, vivo, encargado, rutas, exclusiva, paz, farc, cuenta, septiembre, coca, asesinos, nacional, universidad, agenda, alapaz, balas, dejamos, martes, dinero | Rodrigo "Timochenko" Londono's exclusive interview with The Observer | pagar, impuestos, privilegios, financiar, farc, tener, colombianos, golpe, presidente, fiscal, consejo, campanazo, ciudadanos, victimas, petici, reunidos, justicia | Fiscal conservatives on issues related to economic incentives for FARC combatants |
| paz, acuerdo, firma, nueva, mundo, guerra, farc, final, cartagena, acaba, apoyan, nico, mas, buenos, artistas, alcanzar, asegura, objetivo, sociales, plena | President Santos and Timochenko sign peace agreement in Cartagena | gobierno, paz, farc, acuerdo, reparaci, santos, no, estable, ello, duradera, acuerdos, mentiras, lograr, comunicado, verdadera, vox, instituciones, victimas, contempla | Peace agreement expected to achieve stable and lasting peace |
| no, farc, paz, victimas, armas, uribe, gusta, santos, desplazados, inocentes, desarmen, gustan si, dejen, bendici, paras, van, gente | Victims of conflict, displaced people, and disarmament of paramilitaries | octubre, no, acuerdos, farc, santos, guerrilla, masivamente, votando, redireccion, representantes, devuelto, latina, nicocampo, capo, descubierto, reencogemos | Calls for President Santos and FARC to renegotiate peace agreement |
| farc, paz, oportunidad, acuerdo, venes, sociedad, volver, doy, ahora, guerra, puede, terminaci, no, conflicto, final, cerca, gobierno, firman | Final peace agreement and termination of war | dinero, farc, narcoti, fico, no, secuestros, reparar, monos, victimas, violadores, asesinos, colombianos, mosles, risita, psicopatas, real, exigen | Depicting FARC as killers, terrorists, narco-traffickers, kidnapers, and corrupt |

- The No group topics appear to be more polarized and negatively charged containing accusatory words such as extortion, abduction, drug traffickers, bloodthirsty, killers, and psychopaths whereas the Yes group topics include more positive and neutral words such as forgiveness, support, favour, and peace.

Polarized Users

- We categorize the users into three classes: Yes users (only Yes tweets), No users (only No tweets), and Undecided users (mixture of Yes and No tweets showing no distinct preference towards either group).
- We studied the users' inter-class similarity based on the content they shared through their tweets and observed that users belonging to the No and Undecided groups share overlapping content. However, the Yes group's content is remarkably different.
- After comparing the No and Yes group users, we observed greater reach and more activity among No users, confirming the prominence of the No group prior to the referendum with the Undecided users being the most active group.

PUBLIC SENTIMENT

Sentiment analysis can play a pivotal role in discerning public perception about a peace process and can be instrumental in predicting the outcome of a referendum.

Of the entire collection of tweets in our dataset, we utilized a subset of 2,142 human-labeled tweets to evaluate our sentiment analysis model. These tweets were manually labeled by a native Spanish speaker based on the sentiment polarity of the adjectives and adverbs contained in the message. We assumed a binary opposition (positive or negative) in the polarity of the sentiment.

We used tweet, content, and user-based features to train various machine learning models to predict sentiment of the tweet.

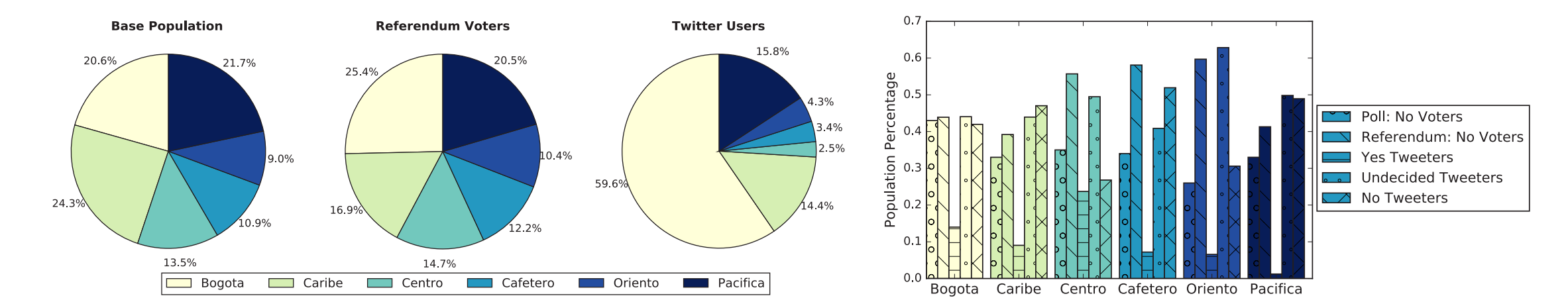
| Category | Features |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tweet-Based | Retweet (yes/no), # of mentions, # of hashtags, # of yes group hashtags, # of no group hashtags, # of urls, # of positive (+ve) emoticons, # of negative (-ve) emoticons, # of words, # of positive (+ve) words, # of negative (-ve) words, Retweet count, Favorite count, Parts of speech information: [# of nouns, pronouns, adjectives, verbs, adverbs, prepositions, interjections, determiners, conjunctions, punctuations.] |
| Content-Based | TFIDF representation of the tweet v/s Tweet represented across topics computed by LDA |
| User-Based | Follower count, Friends count |

| Model | Precision | Recall | F1 | AUC | Accuracy | |
|--------|-----------|--------|-------|-------|----------|-------|
| RF | 0.758 | 0.808 | 0.782 | 0.833 | 0.776 | |
| SVM | 0.700 | 0.546 | 0.614 | 0.691 | 0.657 | |
| LR | 0.698 | 0.714 | 0.706 | 0.781 | 0.703 | |
| BDT | 0.747 | 0.761 | 0.754 | 0.805 | 0.752 | |
| ADB | 0.726 | 0.742 | 0.734 | 0.800 | 0.731 | |
| NB | 0.507 | 0.990 | 0.667 | 0.708 | 0.508 | |
| Random | 0.509 | 0.518 | 0.513 | 0.515 | 0.510 | |
| TF-IDF | RF | 0.775 | 0.855 | 0.813 | 0.872 | 0.804 |
| | SVM | 0.498 | 1.000 | 0.665 | 0.311 | 0.498 |
| | LR | 0.763 | 0.752 | 0.757 | 0.831 | 0.759 |
| | BDT | 0.733 | 0.808 | 0.768 | 0.819 | 0.757 |
| | ADB | 0.769 | 0.766 | 0.768 | 0.834 | 0.769 |
| | NB | 0.503 | 0.990 | 0.667 | 0.709 | 0.508 |
| | Random | 0.54 | 0.542 | 0.542 | 0.517 | 0.543 |

| Category | Feature | Rank | Importance |
|----------------|-------------------|----------|------------|
| Tweet-Based | # of urls | 3 | 0.033828 |
| | # of words | 5 | 0.030204 |
| | # of adverbs | 7 | 0.026511 |
| | Retweet Count | 9 | 0.025328 |
| | # of -ve words | 10 | 0.024828 |
| | # of verbs | 11 | 0.023937 |
| | # of nouns | 12 | 0.023884 |
| | # of prepositions | 14 | 0.019435 |
| | # of determiners | 15 | 0.019146 |
| | # of pronouns | 16 | 0.018563 |
| | # of conjunctions | 17 | 0.017391 |
| | # of adjectives | 18 | 0.016357 |
| | Retweet (Yes/No) | 19 | 0.016096 |
| | # of mentions | 20 | 0.015319 |
| # of +ve words | 21 | 0.015026 | |
| # of hashtags | 23 | 0.012907 | |
| Favorite count | 27 | 0.008885 | |
| Content-Based | farc | 1 | 0.046813 |
| | no | 2 | 0.035412 |
| | paz | 8 | 0.025678 |
| | plebiscito | 13 | 0.021809 |
| | acuerdo | 22 | 0.014143 |
| | si | 24 | 0.012487 |
| | conflicto | 25 | 0.011719 |
| | santos | 26 | 0.009293 |
| fin | 28 | 0.00872 | |
| proceso | 29 | 0.008644 | |
| armado | 30 | 0.007174 | |
| User-Based | Follower count | 4 | 0.030893 |
| | Friend count | 6 | 0.028845 |

RELEVANCE TO OUTCOME

While the polls predicted an overwhelming Yes victory, our results not only indicate a dominance of the No opinion, but our No and Undecided vote results are closer to the referendum outcome results than the polling predictions. Additionally, the Undecided users compensate where No user volumes are not able to model the referendum results closely, thereby highlighting the level of doubt and uncertainty among Colombia's political milieu.



Based on these results, we believe that social media platforms can be leveraged to provide better predictions towards election and referendum outcomes as demonstrated in the case of Colombia and Brexit where conventional polling mechanisms recently failed to capture public opinion and sentiment towards major processes and events of great social, economic, and political impact.

CONCLUSION

Our study demonstrates how social media can be used to understand complex and emergent socio-political phenomena in the context of civil war termination through negotiated peace settlements. We believe that, prior to the October 2, 2016 national referendum, had pro-accord stakeholders used social media as a tool or as a platform to listen and understand public opinion and sentiment toward the Colombian peace agreement, the outcome of the referendum could have been different and in the longer term it may also result in a more successful implementation of the peace process.

Although we restrict our study to the Colombian peace process, our work can be easily extended to develop a concurrent social media based model for monitoring the implementation of peace agreements to understand public (dis)satisfaction with the delivery or lack of delivery of a specific reform and stipulations negotiated in a peace agreement.