



# Offensive language exploratory analysis

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## Abstract

In this paper we focus on the exploratory analysis of 21 different subgroups of hate speech. We use natural language processing techniques in order to find the underlying structure and connections/relations between the subgroups. We focus on data extracted from Twitter and online forums. First we use classic approaches, such as TF-IDF, BoW, and LDA, then we move on to more sophisticated methods, such as embeddings. We use both non-contextual embeddings, such as Word2Vec and GloVe, and contextual embeddings, such as BERT. We find out that [TODO: Describe the findings for the last submission.](#)

## Keywords

Hate speech, natural language processing, traditional methods, contextual and non-contextual embeddings, exploratory analysis, ...

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## Introduction

In the last few years social media grew exponentially and with it also the ability of people to express themselves online. Enabling people to write on different online platforms without even identifying themselves lead to a new era of freedom of speech. Despite this new medium for communication bringing many positive things, it also has its downside. Social media has become a place where heated discussions happen and often result in insults and hatred. It is an important task to recognize hate speech and to prevent it.

Hate speech is defined as *abusive or threatening speech or writing that expresses prejudice against a particular group, especially on the basis of race, religion, or sexual orientation* [1]. We can see that the definition is very vague. Having said that, the goal of our paper is to help distinguish different types of hate speech and find the specific keywords of its subgroups in order to explain its structure. This could help with its identification and classification. In this paper we focus on 21 subgroups of hate speech - *abusive, hateful, spam, general hate speech, profane, offensive, cyberbullying, racism, sexism, vulgar, homophobic, slur, harassment, obscene, threat, discredit, insult, hostile, toxic, identity hate and benevolent sexism*. The goal of this paper is to explore hate speech subgroups and understand the similarities and connections between them.

There has been done a lot of research regarding the hate speech, however, these works are usually focused on the classification of hate speech. One of the first works include [2] who

built the decision tree based classifier Smokey for abusive message recognition and classification. Some other works that focus mainly on classification include [3] who compare the classification accuracy of models trained on expert and amateur annotations, [4] who use convolutional neural networks for classification into four predefined categories, and [5] who use different natural language processing techniques for expanding datasets with emotional information for better classification. In the last years, especially deep learning models are often used for detection and classification of hate speech, such as [6] who propose a sophisticated method that is a combination of a deep neural network architecture with transfer learning. There is also a lot of related work that focuses on creating large datasets such as [7] who create a large-scale, multilingual, expert based dataset of hate speech.

What is less common in the research area of hate speech is analysis of relationships between different types of hate speech and the importance of specific keywords. Some examples include [8], who try to separate bullying from other social media posts and try to discover topic of bullying using topic modeling with Latent Dirichlet Allocation (LDA). [9] model hate speech against immigrants on Twitter in Spain. They try to find underlying topic of hate speech using LDA, discovering features of different dimensions of hate speech, including foul language, humiliation, irony, etc. [10] conduct a survey about hate speech detection and describe key areas that have been explored, regarding the topic modeling, as well as sentiment analysis.

This paper is organized as follows: we present the datasets of tweets and comments, and describe data preprocessing in Section 1, we perform the exploratory analysis by using many traditional and neural approaches in Section 2, and we show the final results and a scheme of hate speech in [TODO: Complete this in the last submission.](#)

## 1. Data

We use 7 publicly available datasets for our exploratory analysis. We combine datasets [3], [6], and [11] into one large dataset (referred to as Dataset SRB) as they include same categories of hate speech. We make labels *sexism*, *racism*, and *both* from [3] and [6]. The third dataset ([11]) that we use contains label *hostile sexism*, where marked tweets are already included in the first two datasets under *sexism*, and label *benevolent sexism*, which we rename to *benevolent*. We obtain a dataset with 6069 samples that are labeled either *sexism*, *racism*, *both*, or *benevolent*. The fourth dataset (referred to as Dataset AHS)[12] that we use has 3 categories - *abusive*, *hateful*, *spam*. As this is the original dataset no additional merging is needed. We obtain a dataset with 13776 tweets with the mentioned labels. Note that we exclude *None* label from both datasets, as we do not need it for the analysis. We show the distribution of individual categories from datasets SRB and AHS in Figures 1 and 2, respectively. Note that the numbers of samples might not match the numbers in the original papers, due to the Twitter removing the tweets, making them unavailable for us to analyze. We also provide an example for each label.

*Racism* - "He can't be a server at our restaurant, that beard makes him look like a terrorist." Everyone laughs. #fuck-thanksgiving

*Sexism* - #katieandnikki stop calling yourselves pretty and hot..you're not and saying it a million times doesn't make you either...STFU

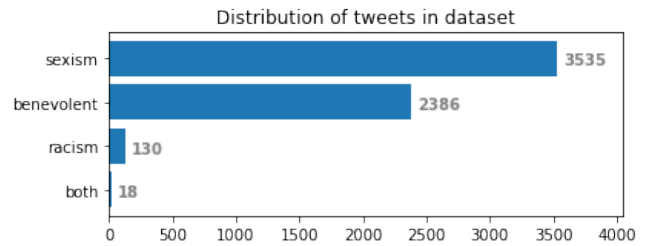
*Benevolent* - It's "NEXT to every successful man, there's a woman"

*Spam* - RT @OnlyLookAtMino: [!!] #WINNER trending #1 on melon search

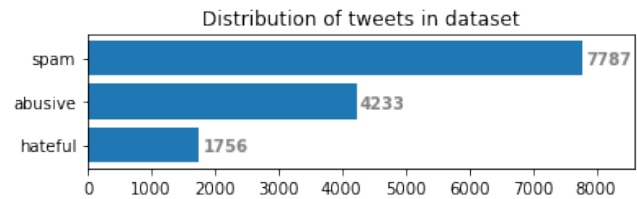
*Abusive* - You Worried About Somebody Bein Ugly... Bitch You Ugly...

*Hateful* - i hope leaders just kick retards that fake leave teams today

Additionally, we use the dataset of comments extracted from the League of Legends community [13]. We preprocess the dataset given in the SQL format to a more readable CSV form and keep only the posts that are annotated as harassment. We obtain 259 examples of cyberbullying examples. The sixth dataset that we use was designed for the problem of the hate speech identification and classification, but we use the labels



**Figure 1. Distribution of tweets in SRB dataset.** This figure shows the distribution of hate speech categories in the SRB dataset. We can see that *sexism* and *benevolent* are well represented, whereas *racism* and *both* are far less frequent. Original set contains more tweets labeled *racism*, but due to their removal we cannot obtain them.



**Figure 2. Distribution of tweets in AHS dataset.** We see that the *spam* is the most represented label in the dataset, which represents the majority of the dataset. This is followed by the *abusive* tweets and there is the least *hateful* tweets. We can see that categories in this dataset are well represented.

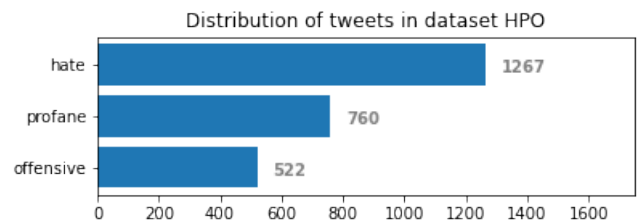
from the train and test set and merge them into one big dataset that we use for our analysis. It provides tags of *hatespeech*, *profane*, and *offensive*, so we refer to the dataset as HPO. It consists of 2549 tweets, distribution of which can be seen in Figure 3. We again provide an example for each of the labels.

*Cyberbullying* - plot twist she's a fggt

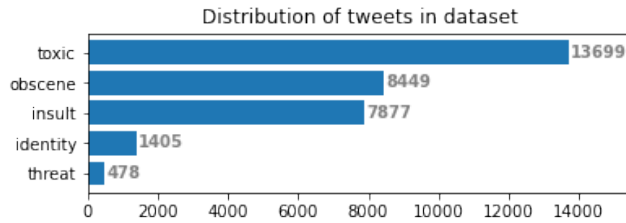
*Hatespeech* - Johnson you liar. You don't give a flying one for the Irish

*Offensive* - #FuckTrump And retired porn star Melania too.

*Profane* - Fuck Trump and anybody who voted for that Lyin POS! #FuckTrump



**Figure 3. Distribution of tweets in HPO dataset.** The most used label is *hatespeech*. It is followed by *profane* and then *offensive*, which have a similar number of tweets.



**Figure 4. Distribution of tweets in TOITI.** We see that most of the comments are labeled as *toxic*. Around half of them are *obscene* and around half are also labeled as *insult*. *Identity hate* and *threat* are far more uncommon in this dataset.

We also use the dataset of Wikipedia comments [14], that are marked as either *toxic*, *sever toxic*, *obscene*, *identity hate*, *threat*, and *insult*. We merge the first two categories into *toxic*. It is important to note that each comment in this dataset might have multiple labels, so the results for those tags might be similar. Original dataset contains 159571 tweets, 16225 of which are labeled. We show the distribution of the labels in Figure 4. We denote this dataset as TOITI in the future text.

Threat - SHUT UP, YOU FAT POOP, OR I WILL KICK YOUR ASS!!!

Obscene - you are a stupid fuck and your mother's cunt stinks

Insult - Fuck you, block me, you faggot pussy!

Toxic - What a motherfucking piece of crap those fuckheads for blocking us!

Identity - A pair of jew-hating weiner nazi schmucks.

### 1.1 Data preprocessing

Before applying any methods we first preprocess all of our data. We remove retweet text RT, hyperlinks, hashtags, taggings, new lines, and zero length tweets. We further filter out tokens that do not contain letters, e.g., raw punctuation.

## 2. Methodology

We start the analysis with more traditional approaches, and continue with neural approaches.

### LDA

We use Latent Dirichlet Allocation (LDA) in combination with Bag-of-Words (BoW) and TF-IDF in hopes of finding obvious topics from all the provided comments / tweets. We try to determine 15 different topics, which is the same as the number of labels we have in our datasets. Results using BoW and TF-IDF are similar, however, we cannot clearly distinguish between the topics and connect obtained topics to the existing labels, aside from one topic, which is related to sexism. Top 5 most related words are: *penis*, *rape*, *image*, *live*, *vagina*.

### TF-IDF

We continue with the analysis of datasets with a traditional method TF-IDF as we want to see the most relevant words for each category of offensive language that we have in the dataset. We show the results in Table 1. We can see that some of the categories have similar unigrams that achieved the highest TF-IDF score. An example of categories with the same highest scored unigrams are *insult* and *obscene*. This makes it harder to differentiate between the categories. It is important to note, that such examples might also occur due to subjective labeling in the provided datasets, as well as people not clearly differentiating between these categories. Most datasets are not labeled by experts, but with the help of platforms such as FigureEight or Amazon Mechanical Turk. From the results in Table 1, we could assume that most people perceive categories such as *insult* and *obscene* or *threat* and *toxic* similarly. On the other hand, categories such as *spam* or *cyberbullying* are clearly differentiable from other categories. We can also see a lot of categories including Trump related words (*hatespeech*, *profane*, and *offensive*). Those categories are taken from the same dataset, and we can see that such labels will contain words that are related. So the words connected to those labels might also be connected to some bigger topic, which depends on the annotator's choice from where to extract the tweets / comments.

category	unigrams with highest TF-IDF score
racism	peopl, white, terror, man, look
sexism	feminazi, women, think, sexist, notsexist
benevolent	women, classi, sassi, nasti, gonna
abusive	know, stupid, shit, like, idiot
hateful	peopl, trump, nigga, like, idiot
spam	giveaway, game, enter, work, home
cyberbullying	one, guy, good, gone, go
hatespeech	world, trumpisatrait, trump, shameonicc, peopl
identity hate	fuck, shit, littl, like, one
insult	delet, go, ass, stupid, bitch
obscene	delet, go, stupid, bitch, ass
offensive	trumpisatrait, like, douchebag, fucktrump, get
profane	trump, shit, say, resist, peopl
threat	fuck, get, die, want, find
toxic	fuck, get, bitch, want, block

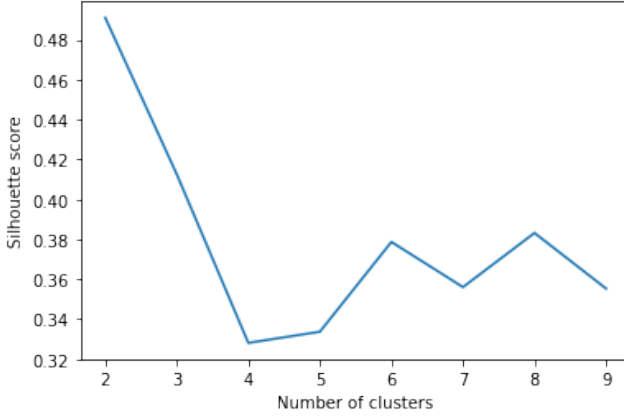
**Table 1.** Table shows 5 highest scoring unigrams for each label we investigate. We choose the parameters, which we believe provide us the most meaningful unigrams, so we consider words that appear in at least 5% and less than 60% of the documents.

### Non-contextual word embeddings

For each of the category labels we try to find the 30 most similar words and use their embeddings to infer the similarities and differences between the subgroups. For this task we use pre-fitted Word2Vec ([15], [16]), GloVe [17], and FastText ([18]). We visualize the results with the help of t-SNE. Because of this we cannot interpret distances between the labels from the visualization. However, we can still infer that the labels that are intertwined are more similar than those that are nicely separable from one another.







**Figure 6. Silhouette score.** Example of silhouette scores for different numbers of clusters. We use the second peak ( $k = 6$ ) instead of first ( $k = 2$ ), as we want to get more clusters.

IDF as seen before. *Benevolent sexism* is also close. We can see that *cyberbullying* and *spam* are clustered together in both clusterings and that *threat* and *toxic* are also very similar. From the results of hierarchical clustering we can see that *offensive* is also close to them.

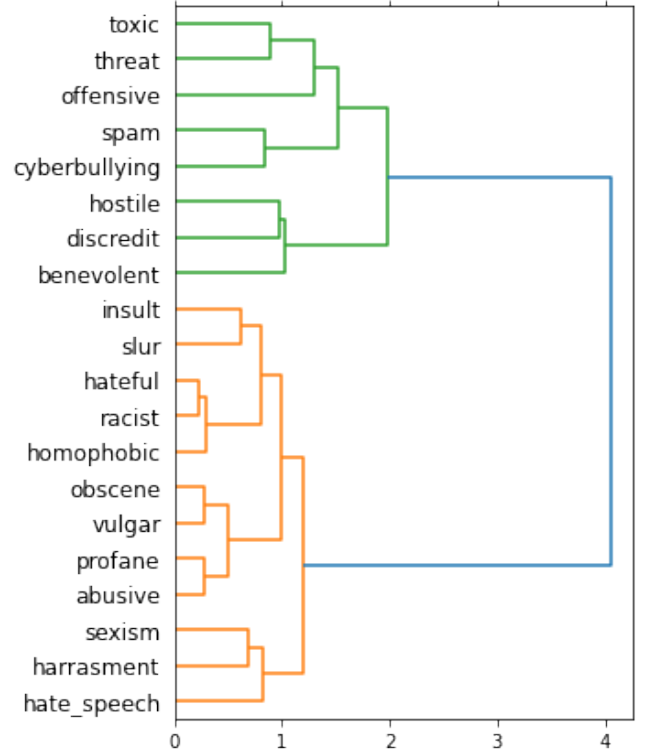
Comparing the hierarchical clustering results of GloVe and FastText embeddings to Word2Vec embeddings, we can see that we always get almost the same two main clusters as those in Figure 7, so we do not show figures with those results.

Looking at  $k$ -means clustering of Word2Vec and GloVe embeddings we see that pairs of *abusive*, *vulgar*, *racist*, *homophobic*, *profane*, *slur*, *obscene*, *hateful* and *insult*, and *discredit* and *hostile* always appear in the same two clusters, so we can conclude that they are related. We do not include the results of FastText  $k$ -means clustering, as its silhouette score is  $\leq 0.30$  for all possible  $k$ , whereas in the first two, the score is often  $> 0.30$ .

We try to apply this same approach to the words with highest TF-IDF scores from each subgroup, however, the obtained clusters provide no useful understanding, so we omit those results.

cluster	components
1	offensive
2	abusive, vulgar, racist, homophobic, profane, slur, harassment, obscene, hateful, insult, sexism, hate speech
3	discredit, hostile, benevolent
4	cyberbullying, spam
5	threat, toxic

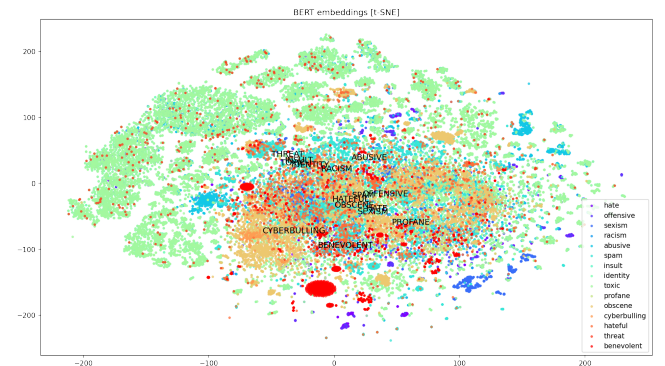
**Table 2.  $K$ -means clustering of average Word2Vec embeddings of labels' 30 nearest words.** Table shows five clusters obtained with 5-means clustering. We determine  $k = 5$  using silhouette score.



**Figure 7. Hierarchical clustering of average Word2Vec embeddings of labels' 30 nearest words.**

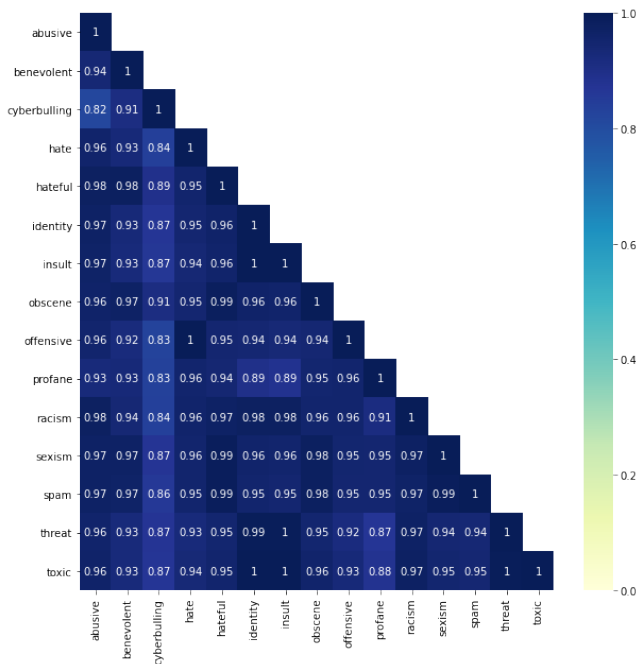
### Contextual word embeddings

We move on to contextual embeddings and we focus on BERT. We use the pretrained BERT base cased model [19] and convert tweets and comments from our dataset to BERT embeddings. We first append them – This is <label> and compute the embeddings. From obtained embeddings of each vector, we compute an average representation from the vectors that belong to the tokens of the label. We average the obtained representation of each label and use cosine similarity to compute the similarity between those label representations. We show the obtained similarity matrix in Figure 9. We can see high similarities between most of the subgroups of hate



**Figure 8. BERT embeddings.** T-SNE visualization of BERT embeddings of labels.

speech. The one that differs the most from the other groups is *cyberbullying*. We can also see that *profane* is slightly less similar to *identity*, *insult*, *threat*, and *toxic*, however, the similarity score is still between 0.87 and 0.89. For all other combinations the similarity score is  $\geq 0.90$ . We also visualize the embeddings with the help of t-SNE in Figure 8 and we show the labels on the mean points of each subgroup. We can see that all subgroups are tightly connected and it is hard to distinguish between them. However, we can see that *cyberbullying* is a little bit more compact and not as dispersed as others, which might be a reason behind slightly different similarity scores. It is also interesting that some labels, although being dispersed, have some small clusters which stand out and might indicate special subgroups within those subgroups of hate speech. Example of such subgroup is *benevolent sexism*.



**Figure 9. Cosine similarities between average representations of label embeddings.**

Using sentence transformers [20] we obtain embeddings for each tweet / comment without the `This is <label>` appendix. For each label we try to find the keywords that describe subgroups of hate speech the most. We do this by first embedding the tweets / comments using BERT and separately embedding the sub-phrases from documents. For each document we then try to find the most similar sub-phrases with the help of embeddings and cosine similarity. For each label we provide three of the most common keywords obtained from the documents. We show the keywords in Table 3.

category	BERT keywords
racism	racistreading, terroristreligion, terroristnationpakistan, faithlessfaggotboy, racisttrying
sexism	godlesswomen, sexlifeless, bitchmattythewhite, onlyallwomen, bitchesvagina
benevolent	sexyolderwomen, girlsbeautiful, bitchmattythewhite, womenattractmenattracted, happywomenday
abusive*	misogynistic, hatemyowngender, hatefultrump, selfishmotherfuckers, faithlessfaggotboy
hateful*	misogynistic, hatemyowngender, selfishmotherfuckers, terroristhasreligion, faithlessfaggotboy
spam	100million, enjoyed, enjoying, fridaymotivation, saturdaynightonline
cyberbullying*	whoremonger, selfishmotherfuckers, faithlessfaggotboy, bitchmattythewhite, boycottfoxnews
hatespeech*	doctors.against.assault, trumpobstructedjustice, trumpfascism, terroristnationpakistan, doctorsfightback
identity hate	whoremonger, gaywad, nazisnotwelcome, racisttrying, racistreading
insult*	whoremonger, selfishmotherfuckers, boycottfoxnews, killyourself, cocksuckerfuck
obscene*	boycottfoxnews, whoremonger, killyourself, selfishmotherfuckers, cocksuckerfuck
offensive*	trumpobstructedjustice, trumpfascism, selfishmotherfuckers, murdermystery, terroristhasreligion
profane*	trumpfascism, trumpobstructedjustice, faithlessfaggotboy, selfishmotherfuckers, doctors.against.assault
threat	killyourself, murdering, whoremonger, hatemongers, murdermystery
toxic*	boycottfoxnews, selfishmotherfuckers, killyourself, whoremonger, nazisnotwelcome

**Table 3. BERT keywords.** Table shows 5 most important keywords for each hate speech subgroup found with BERT. Note: categories that have an \* contain also 2 keywords (dumbdonnythedraftdodgingdotart and worstsecretaryofstateinushistory) but we omit them in order to obtain clearer representation of categories.

## Discussion

In the last submission we are going to discuss the findings and provide the schema of hate speech.

## References

- [1] *hate speech*. Lexico.com.
- [2] Ellen Spertus. Smokey: Automatic recognition of hostile messages. In *Aaai/iaai*, pages 1058–1065, 1997.
- [3] Zeerak Waseem. Are you a racist or am i seeing things? annotator influence on hate speech detection on twitter. In *Proceedings of the first workshop on NLP and computational social science*, pages 138–142, 2016.
- [4] Björn Gambäck and Utpal Kumar Sikdar. Using convolutional neural networks to classify hate-speech. In *Proceedings of the first workshop on abusive language online*, pages 85–90, 2017.
- [5] Ricardo Martins, Marco Gomes, Jose Joao Almeida, Paulo Novais, and Pedro Henriques. Hate speech classification in social media using emotional analysis. In *2018 7th Brazilian Conference on Intelligent Systems (BRACIS)*, pages 61–66. IEEE, 2018.
- [6] Marian-Andrei Rizoiu, Tianyu Wang, Gabriela Ferraro, and Hanna Suominen. Transfer learning for hate speech detection in social media. *arXiv preprint arXiv:1906.03829*, 2019.
- [7] Yi-Ling Chung, Elizaveta Kuzmenko, Serra Sinem Tekiroglu, and Marco Guerini. Conan-counter narratives through nichesourcing: a multilingual dataset of responses to fight online hate speech. *arXiv preprint arXiv:1910.03270*, 2019.
- [8] Jun-Ming Xu, Kwang-Sung Jun, Xiaojin Zhu, and Amy Bellmore. Learning from bullying traces in social media. In *Proceedings of the 2012 conference of the North American chapter of the association for computational linguistics: Human language technologies*, pages 656–666, 2012.
- [9] Carlos Arcila Calderón, Gonzalo de la Vega, and David Blanco Herrero. Topic modeling and characterization of hate speech against immigrants on twitter around the emergence of a far-right party in spain. *Social Sciences*, 9(11):188, 2020.
- [10] Anna Schmidt and Michael Wiegand. A survey on hate speech detection using natural language processing. In *Proceedings of the fifth international workshop on natural language processing for social media*, pages 1–10, 2017.
- [11] Akshita Jha and Radhika Mamidi. When does a compliment become sexist? analysis and classification of ambivalent sexism using twitter data. In *Proceedings of the second workshop on NLP and computational social science*, pages 7–16, 2017.
- [12] Antigoni Founta, Constantinos Djouvas, Despoina Chatzakou, Ilias Leontiadis, Jeremy Blackburn, Gianluca Stringhini, Athena Vakali, Michael Sirivianos, and Nicolas Kourtellis. Large scale crowdsourcing and characterization of twitter abusive behavior. In *Proceedings of the International AAAI Conference on Web and Social Media*, volume 12, 2018.
- [13] Uwe Bretschneider and Ralf Peters. Detecting cyberbullying in online communities. 2016.
- [14] Ellery Wulczyn, Nithum Thain, and Lucas Dixon. Ex machina: Personal attacks seen at scale. In *Proceedings of the 26th International Conference on World Wide Web*, WWW ’17, pages 1391–1399, Republic and Canton of Geneva, CHE, 2017. International World Wide Web Conferences Steering Committee.
- [15] Tomas Mikolov, Kai Chen, Greg Corrado, and Jeffrey Dean. Efficient estimation of word representations in vector space. *arXiv preprint arXiv:1301.3781*, 2013.
- [16] Tomas Mikolov, Ilya Sutskever, Kai Chen, Greg Corrado, and Jeffrey Dean. Distributed representations of words and phrases and their compositionality. *arXiv preprint arXiv:1310.4546*, 2013.
- [17] Jeffrey Pennington, Richard Socher, and Christopher D. Manning. Glove: Global vectors for word representation. In *Empirical Methods in Natural Language Processing (EMNLP)*, pages 1532–1543, 2014.
- [18] Piotr Bojanowski, Edouard Grave, Armand Joulin, and Tomas Mikolov. Enriching word vectors with subword information. *arXiv preprint arXiv:1607.04606*, 2016.
- [19] Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. BERT: pre-training of deep bidirectional transformers for language understanding. *CoRR*, abs/1810.04805, 2018.
- [20] Nils Reimers and Iryna Gurevych. Sentence-bert: Sentence embeddings using siamese bert-networks. In *Proceedings of the 2019 Conference on Empirical Methods in Natural Language Processing*. Association for Computational Linguistics, 11 2019.