

Distant supervision for emotion detection using Facebook reactions

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Abstract

We exploit the Facebook reaction feature in a distant supervised fashion to train a support vector machine classifier for emotion detection, using several feature combinations and combining different Facebook pages. We test our models on existing benchmarks for emotion detection and show that *employing only information that is derived completely automatically*, thus without relying on any handcrafted lexicon as it's usually done, we can achieve state-of-the-art results. The results also show that there is large room for improvement, especially by gearing the collection of Facebook pages, with a view to the target domain.

1 Introduction

In the spirit of the brevity of social media's messages and reactions, people have got used to express feelings minimally and symbolically, as with hashtags on Twitter and Instagram. On Facebook, people tend to be more wordy, but posts normally receive more simple "likes" than longer comments. Since February 2016, Facebook users can express more specific emotions thanks to the newly introduced *reaction feature* (see Section 2), so that now a post can be wordlessly marked with an expression of say joy or surprise rather than a simple like. It has been observed that this new feature helps Facebook to know much more about their users and exploit this information for targeted advertising (Stinson, 2016). However, interest in people's opinions, and how they feel isn't limited to commercial reasons, but invests social monitoring, too, including health care and education (Mohammad, 2016).

Obviously, emotions and opinions are not always expressed explicitly, so that there is high interest in developing systems towards their automatic detection. Creating manually annotated datasets for training supervised models, however, is not only costly, but also—especially in the case of opinions and emotions—difficult, due to the intrinsic subjectivity of the task (Strapparava and Mihalcea, 2008; Kim et al., 2010). Therefore, research has focused on unsupervised methods enriched with information derived from lexica, which are manually created (Chaffar and Inkpen, 2011; Kim et al., 2010). Since Go et al. (2009) have shown that happy and sad emoticons can be successfully used as signals for sentiment labels, *distant supervision*, i.e. using some reasonably safe signals as proxies for automatically labelling training data (Mintz et al., 2009), has been used also for emotion recognition, for example exploiting both emoticons and Twitter hashtags (Purver and Battersby, 2012), but mainly towards creating emotion lexica. Mohammad and Kiritchenko (2015) use hashtags, especially experimenting with more fine-grained emotion sets (up to almost 600 emotion labels), to create the large *Hashtag Emotion Lexicon*. Emoticons are used as proxies also by Hallsmar and Palm (2016), who use Word Embeddings to find which words are interchangeable with emoticons but also which emoticons are used in a similar context.¹

In our work, we take advantage of distant supervision by using Facebook reactions as proxies for emotion labels, which to the best of our knowledge hasn't been done yet, and we train a set of Support Vector Machine models for emotion recognition. Our models, differently from existing ones, exploit information which is *acquired entirely automatically*, and achieve state-of-the-art results for some of the emotion labels on existing, standard evaluation datasets. For explanatory purposes, related work is discussed further and more in detail when we describe the benchmarks for evaluation (Section 3) and

¹<http://instagram-engineering.tumblr.com/post/117889701472/emojineering-part-1-machine-learning-for-emoji>.

when we compare our models to existing ones (Section 5). We also explore and discuss how choosing different sets of Facebook pages as training data provides an intrinsic domain-adaptation method.

2 Facebook reactions dataset

For years, on Facebook people could leave comments to posts, and also “like” them, by using a thumbs-up feature to explicitly express a general, rather underspecified, approval. A “like” could thus mean “I like what you said”, but also “I like that you bring up such topic (though I don’t agree with the content of the article you linked)”.

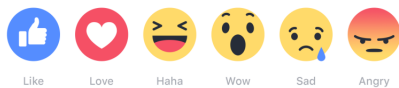


Figure 1: Facebook reactions

In February 2016, after a short trial, Facebook made a more explicit *reaction* feature available world-wide. Rather than allowing for the underspecified “like” as the only wordless response to a post, a set of more specific reactions was introduced, as shown in Figure 1: Like, Love, Haha, Wow, Sad and Angry. We use such reactions as proxies for emotion labels associated to posts.

We collected Facebook posts and their corresponding reactions from public pages using the Facebook API, which we accessed via the Facebook-sdk python library². We chose different pages (and therefore domains and stances), aiming at a balanced and varied dataset, but we did so mainly based on intuition (see Section 4) and with an eye to the nature of the datasets available for evaluation (see Section 5). The choice of which pages to select posts from is far from trivial, and this is actually an interesting aspect of our approach, as by using different Facebook pages one can intrinsically tackle the domain-adaptation problem (See Section 6 for further discussion on this). The final collection of Facebook pages is as follows: FoxNews, CNN, ESPN, New York Times, Time magazine, Huffington Post Weird News, The Guardian, Cartoon Network, Cooking Light, Home Cooking Adventure, Justin Bieber, Nickelodeon, Spongebob, Disney.

For each selected page, we downloaded the latest 1000 posts, or the maximum available if there are fewer, from February 2016, retrieving the counts of reactions for each post. The output is a JSON file containing a list of dictionaries with a timestamp, the post and a reaction vector with frequency values. The emotion vectors must then be turned into an emotion label.³

In the context of this experiment, we made the simple decision of associating to each post the emotion with the highest count, ignoring like as it is the default and most generic reaction people tend to use. Therefore, for example, to the first post in Figure 2, we would associate the label sad, as it has the highest score (284) among the meaningful emotions we consider, though it also has non-zero scores for other emotions. At this stage, we didn’t perform any other entropy-based selection of posts, to be investigated in future work.

```
[
  {
    "created_time": "2016-06-19T01:40:00+0000",
    "message": "Walt Disney World representatives said they plan to put up fencing and signs at all resorts and waterways.",
    "reactions": [5073, 4483, 60, 22, 54, 284, 170, 0]
  },
  {
    "created_time": "2016-06-19T01:00:00+0000",
    "message": "Charlene and Joseph Handrik face more than 550 counts of animal cruelty.",
    "reactions": [2256, 1011, 16, 6, 123, 409, 691, 0]
  }
]
```

Figure 2: Sample of resulting JSON file. The order of values/reactions is total, like, love, haha, wow, sad, angry, thankful.

3 Emotion datasets

Three datasets annotated with emotions are commonly used for the development and evaluation of emotion detection systems. In order to compare our performance to state-of-the-art results, we have used them as well. In addition to a description of each dataset, we provide an overview of the emotions used, their distribution, and how we mapped them to those we obtained from Facebook posts in Section 3.4.

²<https://pypi.python.org/pypi/facebook-sdk>

³Note that `thankful` was only available during specific time spans related to certain events, as Mother’s Day in May 2016.

3.1 Affective Text dataset

Task 14 at SemEval 2007 (Strapparava and Mihalcea, 2007) was concerned with the classification of emotions and valence in news headlines. The headlines were collected from several news websites including Google news, The New York Times, BBC News and CNN. The used emotion labels were *Anger, Disgust, Fear, Joy, Sadness, Surprise*, in line with the basic emotions of Ekman’s standard model (Ekman, 1992). Valence was to be determined as positive or negative. Classification of emotion and valence were treated as separate tasks. Emotion labels were not considered as mutually exclusive, and each emotion was assigned a score from 0 to 100. Training/developing data amounted to 250 annotated headlines, while systems were evaluated on another 1000. Evaluation was done using two different methods: a fine-grained evaluation using Pearson’s r to measure the correlation between the system scores and the gold standard. With a coarse-grained method, each emotion score was converted to a binary label, and precision, recall, and f-score were used for evaluation. As it is done in most works that use this dataset (Kim et al., 2010; Chaffar and Inkpen, 2011; Calvo and Mac Kim, 2013), we treat this as a classification problem (coarse-grained). This dataset has been extensively used for the evaluation of various unsupervised techniques (Strapparava and Mihalcea, 2008), but also for testing different supervised learning techniques and feature portability (Mohammad, 2012).

3.2 Fairy Tales dataset

This is a dataset collected by Alm (2008), where about 1,000 sentences from fairy tales (by B. Potter, H.C. Andersen and Grimm) were annotated with the same six emotions of the Affective Text dataset, though with different names: *Angry, Disgusted, Fearful, Happy, Sad, and Surprised*. In most works that use this dataset (Kim et al., 2010; Chaffar and Inkpen, 2011; Calvo and Mac Kim, 2013), only sentences where all annotators agreed are used, and the labels *angry* and *disgusted* are merged. We adopt the same choices.

3.3 ISEAR

The ISEAR (International Survey on Emotion Antecedents and Reactions) is a dataset created in the context of a psychology project of the 1990s, by collecting questionnaires answered by people with different cultural backgrounds. Student respondents, both psychologists and non-psychologists, were asked to report situations in which they had experienced all of 7 major emotions (*joy, fear, anger, sadness, disgust, shame and guilt*). In each case, the questions covered the way they had appraised the situation and how they reacted. The final dataset contains reports on seven emotions, by approximately 3000 respondents from all over the world. In total there are 7665 sentences labelled with an emotion, making this the largest testset out of the three we use.

3.4 Overview of datasets and emotions

We summarise datasets and distribution from two viewpoints. First, because there are different sets of emotions labels in the datasets and Facebook data, we need to provide a mapping and derive a subset of emotions that we are going to use for the experiments. This is shown in Table 1, where in the “Mapped” column we report the final emotions we use in this paper: *anger, joy, sadness, surprise*. Second, the distribution of the emotions for each dataset is different, as can be seen in Figure 3.

In Figure 4 we also provide the distribution of the emotions *anger, joy, sadness, surprise* per Facebook page, in terms of number of posts (recall that we assign to a post the label corresponding to the majority emotion associated to it, see Section 2). We can observe that for example pages about news tend to have

Table 1: Mapping emotions

Affect. T.	Fairy tales	ISEAR	Facebook	Mapped
Anger	Angry-Disgusted	Anger	Angry	ANGER
Disgust	Angry-Disgusted	Disgust		ANGER
Fear	Fearful	Fear		
Joy	Happy	Joy	Haha, Love	JOY
Sadness	Sad	Sadness	Sad	SADNESS
Surprise	Suprised		Wow	SURPRISE
		Shame		
		Guilt		

more sadness and anger posts, while pages about cooking and tv-shows have a high percentage of joy posts. We will use this information to find the best set of pages for a given target domain (see Section 5).

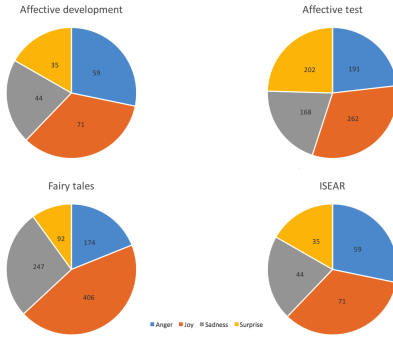


Figure 3: Distribution of emotions in the datasets

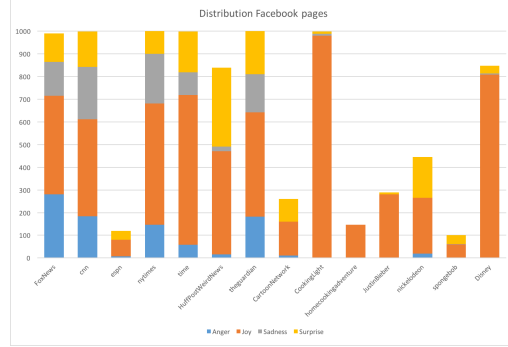


Figure 4: Distribution of posts per page

4 Model

There are two main decisions to be taken in developing our model: (i) which Facebook pages to select as training data, and (ii) which features to use to train the model, which we discuss below. Specifically, we first set on a subset of pages and then experiment with features. Further exploration of the interaction between choice of pages and choice of features is left to future work, and partly discussed in Section 6. For development, we use a small portion of the Affective data set described in Section 3.1, that is the portion that had been released as development set for SemEval’s 2007 Task 14 (Strapparava and Mihalcea, 2007), which contains 250 annotated sentences. All results reported in this section are on this dataset. The test set of Task 14 as well as the other two datasets described in Section 3 will be used to evaluate the final models.

4.1 Selecting Facebook pages

Although page selection is a crucial ingredient of this approach, for the experiments described here we took a rather simple approach, by first selecting the pages that would provide training data based on intuition and availability, then choosing different combinations according to results of a basic model run on development data, and eventually testing feature combinations, still on the development set.

For the sake of simplicity and transparency, we first trained an SVM with a simple bag-of-words model and default parameters as per the Scikit-learn implementation (Pedregosa et al., 2011) on different combinations of pages. Based on results of the attempted combinations as well as on the distribution of emotions in the development dataset (Figure 3), we selected a *best model* (**B-M**), namely the combined set of Time, The Guardian and Disney, which yields the highest results on development data. Time and The Guardian perform well on most emotions but Disney helps to boost the performance for the Joy class.

4.2 Features

In selecting appropriate features, we mainly relied on previous work and intuition. We experimented with different combinations, and all tests were done on the development portion of the Affective Text dataset, using the pages for the best model (B-M) described above as training data. Results are in Table 2. Future work will further explore the simultaneous selection of features and page combinations.

Standard textual features We use a set of basic text-based features to capture the emotion class. These include a tf-idf bag-of-words feature, word (2-3) and character (2-5) ngrams, and features related to the presence of negation words, and to the usage of punctuation.

Affect Lexicons this feature is used in all unsupervised models as a source of information, and we mainly use it to assess its contribution, but eventually don’t include it in our final model.

We used the NRC10 lexicon as lexicon because it performed best in the experiments by (Mohammad, 2012), which is built around the emotions anger, anticipation, disgust, fear, joy, sadness, and surprise, and the valence values positive and negative. For each word in the lexicon, a boolean value indicating presence or absence is associated to each emotion. For a whole sentence, a global score per emotion can be obtained by summing the vectors for all content words of that sentence included in the lexicon, and used as feature.

Word Embeddings As additional feature, we also included Word Embeddings, namely distributed representation of words in a vector space which have been exceptionally successful in boosting performance in a plethora of NLP tasks. We use three different embeddings:

- *Google embeddings*: pre-trained embeddings trained on Google News and obtained with the skip-gram architecture described in (Mikolov et al., 2013). This model contains 300-dimensional vectors for 3 million words and phrases.
- *Facebook embeddings*: embeddings that we trained on our scraped Facebook pages for a total of 20,000 sentences. Using the `gensim` library (Řehůřek and Sojka, 2010), we trained the embeddings with the following parameters: window size of 5, learning rate of 0.01 and dimensionality of 100. We filtered out words with frequency lower than 2 occurrences.
- *Retrofitted embeddings*: Retrofitting (Faruqui et al., 2015) has been shown as a simple but efficient way of informing trained embeddings with additional information rather than including it directly at the training stage, as it's done for example to create sense-aware (Iacobacci et al., 2015) or sentiment-aware (Tang et al., 2014) embeddings.⁴ In this work, we retrofit general embeddings to include information about emotions, so that emotion-similar words can get closer in space. Both the Google as well as our Facebook embeddings were retrofitted with lexical information obtained from the NRC Lexicon. Note that differently from the previous two types of embeddings, the retrofitted ones do rely on handcrafted information in the form of a lexical resource.

4.3 Results on development set

We report precision, recall, and f-score on the development set. The average f-score is reported as *micro-average*, to better account for the skewed distribution of the classes as well as in accordance to what is usually reported for this task (Mohammad and Kiritchenko, 2015).

Table 2: Results on the development set

	anger	joy	sadness	surprise	
Feature	prec,rec,f	prec,rec,f	prec,rec,f	prec,rec,f	avg f
Tf-idf	0.57,0.22,0.32	0.44,0.51,0.47	0.41,0.25, 0.31	0.22,0.49,0.30	0.368
Lexicon	0.28,0.08,0.13	0.43,0.37,0.40	0.31,0.30, 0.30	0.20,0.51,0.29	0.297
Token n-grams(2,5)	0.00,0.00,0.00	1.00,0.01,0.03	0.00,0.00, 0.00	0.17,1.00,0.29	0.172
Character n-grams(2,5)	0.50,0.03,0.06	0.39,0.73,0.51	0.38,0.07, 0.12	0.17,0.31,0.22	0.325
All features	0.40,0.03,0.06	0.35,0.97,0.52	0.62,0.11, 0.19	1.00,0.03,0.06	0.368
Google (G) embeddings	0.41,0.49,0.45	0.56,0.46,0.51	0.48,0.57, 0.52	0.22,0.17,0.19	0.445
Facebook (FB) embeddings	0.33,0.15,0.21	0.31,0.45,0.37	0.23,0.11,0.15	0.20,0.31,0.24	0.273
Retrofitted G-embeddings	0.36,0.20,0.26	0.42,0.48,0.45	0.30,0.25, 0.27	0.20,0.34,0.26	0.330
Retrofitted FB-embeddings	0.07,0.02,0.03	0.34,0.86,0.49	0.36,0.09,0.15	0.17,0.03,0.05	0.321
tf-idf + G-emb	0.42,0.46,0.44	0.45,0.49,0.47	0.49,0.41, 0.44	0.29,0.26,0.27	0.426
All features + G-emb	0.63,0.29,0.40	0.43,0.83,0.56	0.46,0.27, 0.34	0.33,0.17,0.23	0.450
All features – Lexicon + G-emb	0.62,0.34,0.44	0.43,0.85,0.57	0.57,0.30, 0.39	0.36,0.14,0.20	0.469

⁴Training emotion-aware embeddings is a strategy that we plan to explore in future work.

From Table 2 we draw three main observations. First, a simple tf-idf bag-of-words mode works already very well, to the point that the other textual and lexicon-based features don't seem to contribute to the overall f-score (0.368), although there is a rather substantial variation of scores per class. Second, Google embeddings perform a lot better than Facebook embeddings, and this is likely due to the size of the corpus used for training. Retrofitting doesn't seem to help at all for the Google embeddings, but it does boost the Facebook embeddings, leading to think that with little data, more accurate task-related information is helping, but corpus size matters most. Third, in combination with embeddings, all features work better than just using tf-idf, but removing the Lexicon feature, which is the only one based on hand-crafted resources, yields even better results. Then our best model on development data relies *entirely on automatically obtained information*, both in terms of training data as well as features.

5 Results

In Table 3 we report the results of our model on the three datasets standardly used for the evaluation of emotion classification, which we have described in Section 3.

Our best model (**B-M**) relies on subsets of Facebook pages for training, which were chosen according to their performance on the development set as well as on the observation of emotions distribution on different pages and in the different datasets, as described in Section 4. The feature set we use is our best on the development set, namely all the features plus Google-based embeddings, but excluding the lexicon. This makes our approach completely independent of any manual annotation or handcrafted resource. Our model's performance is compared to the following systems, for which results are reported in the referred literature.

Kim et al. (2010) experiment with four different unsupervised techniques that rely on lexicon-derived information. In Table 3 we report the scores for their best average performing approach, namely a CNMF-based categorical classification. They made the decision not to deal with `surprise` because this emotion is not present in the ISEAR dataset.

Strapparava and Mihalcea (2008) experiment with several models based on a core LSA model and, in their best performing model (`LSA-all emotion words`) whose results we report in Table 3, also information from lexical resources both in their general (WordNet (Fellbaum, 1998)) and emotion-aware (WordNet Affect (Strapparava et al., 2004)) form.

Danisman and Alpkocak (2008) experiment with a supervised approach, training a model using the ISEAR dataset and testing it on the Affective text dataset. They only report results per category in terms of f-score, without further specification of how precision and recall contribute.

We have mentioned that the selection of Facebook pages is relevant and can be also thought of as a tool for domain adaptation in accordance with the characteristics of the target domains/datasets (see also Section 2 and Figures 3–4). Although we believe that such an interesting aspect will require deeper investigation (see Section 6), we preliminary test this assumption by developing and comparing two more models: a model that uses a combination of pages that we expect will perform best on the fairy tales dataset (**FT-M**), and a model that uses a combination of pages that should perform best on the ISEAR dataset (**ISE-M**). The feature set is the same for all three models.

FT-M The sentences in the Fairy Tales dataset are quite different compared to the news headlines in the development set. Looking at the distribution in this dataset, as can be seen in Figure 3, `Joy` is the most frequent class. We selected the pages `HuffPostWeirdNews`, `ESPN` and `CNN` for this model especially looking at the performance for the emotions that are most frequent in this dataset.

ISE-M As described in Section 3.3, the sentences in the ISEAR collection are different compared to the two other datasets. Looking at the distribution in Figure 3 and according to performance on relevant emotions (we took into account the absence of `Surprise` in this dataset), we selected the pages `Time`, `The Guardian` and `CookingLight` for this model.

Table 3: Results on test datasets.

	Affective Text			Fairy Tales			ISEAR		
	P	R	F	P	R	F	P	R	F
ANGER									
B-M	0.50	0.35	0.41	0.33	0.04	0.07	0.72	0.06	0.11
FT-M	0.51	0.30	0.38	0.27	0.02	0.04	0.57	0.10	0.17
ISE-M	0.48	0.35	0.40	0.36	0.05	0.08	0.74	0.06	0.11
(Strapparava and Mihalcea, 2008)	0.06	0.88	0.12						
(Kim et al., 2010)	0.29	0.26	0.28	0.77	0.56	0.65	0.41	0.99	0.58
(Danisman and Alpkocak, 2008)			0.24						
JOY									
B-M	0.39	0.85	0.54	0.49	0.77	0.60	0.41	0.79	0.53
FT-M	0.41	0.77	0.54	0.49	0.69	0.58	0.42	0.63	0.50
ISE-M	0.39	0.82	0.53	0.48	0.81	0.60	0.40	0.83	0.54
(Strapparava and Mihalcea, 2008)	0.19	0.90	0.31						
(Kim et al., 2010)	0.77	0.58	0.65	0.80	0.76	0.78	0.39	0.01	0.01
(Danisman and Alpkocak, 2008)			0.50						
SADNESS									
B-M	0.51	0.21	0.30	0.43	0.39	0.41	0.50	0.39	0.44
FT-M	0.53	0.28	0.37	0.50	0.24	0.33	0.79	0.28	0.41
ISE-M	0.49	0.21	0.29	0.43	0.34	0.38	0.51	0.38	0.44
(Strapparava and Mihalcea, 2008)	0.12	0.87	0.22						
(Kim et al., 2010)	0.50	0.45	0.48	0.71	0.82	0.77	0.37	0.01	0.25
(Danisman and Alpkocak, 2008)			0.37						
SURPRISE									
B-M	0.20	0.05	0.08	0.12	0.04	0.06			
FT-M	0.25	0.17	0.20	0.14	0.33	0.19			
ISE-M	0.27	0.08	0.12	0.17	0.04	0.07			
(Strapparava and Mihalcea, 2008)	0.08	0.95	0.14						
(Kim et al., 2010)									
(Danisman and Alpkocak, 2008)									
AVERAGE (micro f-score)									
B-M	0.409			0.459			0.411		
FT-M	0.412			0.408			0.336		
ISE-M	0.405			0.460			0.422		

In Table 3 we report averages only for our models, since not all approaches deal with the same sets of emotions overall and we cannot easily compute them. We discuss results both in terms of how our models fair with respect to other systems as reported the literature, as well as how they compare to one another with a view to the selection of Facebook pages.

Compared to other systems, our models are globally competitive, given that **B-M** is entirely unsupervised. Overall, the unsupervised but heavily lexicon-based best model of (Kim et al., 2010) performs well on all emotions, excluding surprise, which they do not address (thus also making their classification task slightly easier). Differently from existing systems, our models appear rather balanced in terms of performance on the different emotions as well as in precision and recall, and are able to deal well with the variance of the datasets.

On the Affective Text dataset, we have the highest precision for all emotions but joy, though on this emotion our models have very good recall. The highest recall for all emotions for this dataset is reported in (Strapparava and Mihalcea, 2008), together with extremely low precision. Such skewed performance

for all emotions can only be explained if different emotion-specific models were trained rather than a single multiclass model, but this is not described as such in the paper. The authors state that their models are completely unsupervised, which is true in terms of training data, but they nevertheless augment them with information derived from hand-crafted resources.

On the Fairy Tales dataset, (Kim et al., 2010) Chaffar and Inkpen (2011) also used the Fairy tales dataset to evaluate a supervised model using features like bag-of-words, N-grams and lexical emotion features, but report cross-validated results using accuracy only, and are therefore harder to compare.

On the ISEAR dataset, which is the largest, our models perform best for all emotions but *anger*, for which however we achieve the highest precision with all our models, and a reasonable precision.

From the perspective of comparing our models, we do not observe any real correlation between our best performances and the models designed to best perform on a given dataset. For example, **B-M** was expected to perform best on the Affective Text, but it is outperformed by **FT-M** in the precision of detecting anger and sadness, and overall for the detection of surprise. Generally, by looking at averages, it seems that our best performing model across datasets is **ISE-M**. However, the extremely large variance among scores for the same emotion on the three datasets, highlights the differences among such datasets and the need to better tailor training data to different domains. The large discrepancy in detecting different emotions in the same dataset also deserves further investigation. We discuss such issues further in the next section, with a view to future work.

6 Discussion, conclusions and future work

We have explored the potential of using Facebook reactions in a distant supervised setting to perform emotion classification. The evaluation on standard benchmarks shows that models trained as such, especially when enhanced with continuous vector representations, can achieve state of the art results without relying on any handcrafted resource. An interesting aspect of our approach is the view to domain adaptation via the selection of Facebook pages to be used as training data.

We believe that this approach has a lot of potential, and we see the following directions for improvement. Feature-wise, we want to train emotion-aware embeddings, in the vein of work by Tang et al. (2014), and (Iacobacci et al., 2015). Retrofitting FB-embeddings trained on a larger corpus might also be successful, but would rely on an external lexicon.

The largest room for yielding not only better results but also interesting insights on extensions of this approach lies in the choice of training instances, both in terms of Facebook pages to get posts from, as well as in which posts to select from the given pages. For the latter, one could for example only select posts that have a certain length, ignore posts that are only quotes or captions to images, or expand posts by including content from linked html pages, which might provide larger and better contexts (Plank et al., 2014). Additionally, and most importantly, one could use an entropy-based measure to select only posts that have a strong emotion rather than just considering the majority emotion as training label. For the former, namely the choice of Facebook pages, which we believe deserves the most investigation, one could explore several avenues, especially in relation to *stance*-based issues (Mohammad et al., 2016). In our dataset, for example, a post about Chile beating Colombia in a football match during the Copa America had very contradictory reactions, depending on which side readers would cheer for. Similarly, the very same political event, for example, would get very different reactions from readers if it was posted on Fox News or The Late Night Show, as the target audience is likely to feel very differently about the same issue. This also brings up theoretical issues related more generally to the definition of the emotion detection task, as it's strongly dependent on personal traits of the audience. Also, in this work, pages initially selected on availability and intuition were further grouped into sets to make training data according to performance on development data, and label distribution. Another criterion to be exploited would be *vocabulary overlap* between the pages and the datasets.

Lastly, we could develop single models for each emotion, treating the problem as a multi-label task. This would even better reflect the ambiguity and subjectivity intrinsic to assigning emotions to text, where content could be at same time joyful or sad, depending on the reader.

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