Neural models for StanceCat shared task at IberEval 2017

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Abstract. This paper describes our participation in the *Stance and Gender Detection in Tweets on Catalan Independence (StanceCat)* task at IberEval 2017. Our approach was focused on neural models, firstly using classical and specific model from state of the art, then we introduce a new topology of convolutional network for text classification.

1 Introduction

The raising of social networks as worldwide means of communication and expression, is gaining lot of interest from company and academia, due to the huge availability of daily contents published by users. Focusing on academia perspective, especially in the Natural Language Processing field, the contents available in form of written text are really useful for the study of specific open problems, where the stance detection related to political events is an example, and the *Stance and Gender Detection in Tweets on Catalan Independence (StanceCat)* task at IberEval 2017 is a concrete application.

In *StanceCat*, the principal aim is to automatically detect if the text's author is in favor of, against, or neutral towards the Catalan Independence. Moreover, as a secondary aim, participants are asked to infer the author's gender.

To tackle the described problem we built a *stance&gender detection* system mainly decomposed in two modules: text pre-processing and classification model. During the system's tuning process, different design choices were explored trying to find the best modules' combination and from their anlysis some interesting insight can be drawn.

In the following sections we firstly describe the StanceCat task (Section 2), then we illustrate the module's design of developed stance&gender detection system (Section 3), after that, an evaluation of the tuning process for submitted systems is analysed (Section 4), finally, conclusion over the whole work are outlined (Section 5).

2 Task definition

The StanceCat shared task aim was to detect the author's gender and stance with respect to the target *independence of Catalonia* in tweets written in Spanish and/or Catalan, where participants is allowed in the detection of both stance and gender or only in stance detection.

Participants had access to a labelled corpus for each languages composed of 4319 tweets. We analysed it and find the following statistical informations presented in tables 1 and 2.

3 Systems description

In this section we describe the stance&gender detection systems. Organizing the system by modules, it can be divided in two blocks: text pre-preprocessing (Section 3.1) and classification model (Section 3.2).

Label	Favor	Neutral	Against	Total
ES	335	2538	1446	4319
CA	2648	1540	131	4319

Table 1: Statistical analysis of given corpus' tweets.

Tweets	Average	Deviation	Max
ES	14	3	23
CA	13	4	20

Table 2: Statistical analysis of given corpus' tweets.

3.1 Text pre-processing

Regarding the text pre-preprocessing, has to be mentioned that the corpus under observation can not be treated as proper written language, because computer-mediated communication (CMC) is highly informal, affecting diamesic[3] variation with creation of new items supposed to pertain lexicon and graphematic domains [6,7]. Therefore, our preprocessing follows two approaches: classic and microblogging related. As classic aproach we used stemming (i.e., ST), stopwords (i.e., SW) and punctuation removal (i.e., PR). For microblogging approach we focus our attention over the following items: (i) mentions (i.e., MT), (ii) smiley (i.e., SM), (iii) emoji (i.e., EM), (iv) hashtags (i.e., HT), (v) numbers (i.e., NUM), (vi) URL (i.e., URL) (vii) and Tweeter reserve-word as RT and FAV (i.e., RW). For each of these items we leave the possibility to be removed or substituted by constant string.
In relation to above approaches we implement them using the following tools: (i) NLTK [3] and (ii) Preprocessor[4].

3.2 Classification models

Following, we describe the neural models used for the classification module. Before introducing the models we describe the specific text representation used as input layer Section 3.2 (i.e., sentence-matrix).

Text representation To represent the text we used word embeddings as described by [4], where tweet elements like *words* and *word n-grams* are represented as vectors of real number with fixed dimension $|v|$. In this way a whole sentence s, with length $|s|$ its number of word, is represented as a *sentence-matrix* M of dimension $|M| = |s| \times |v|$. $|M|$ has to be fixed a priori, therefore $|s|$ and $|v|$ have to be estimated. $|v|$ was fixed to 300 following [4]. $|s|$ was estimated analyzing table 2, in details we decided to fix it as the sum of average length plus the standard deviation (i.e. $|s| = 17$ for both language), with this choice input sentences longer than $|s|$ are truncated, while shorter ones are padded with null vectors (i.e., a vector of all zeros).
Choosing words as elements to be mapped by the embedding function, raise some challenge over the function estimation related to data availability. In our case the available corpus is very small and estimated embeddings could lead to low performance. To solve this problem, we decided to used a pre-trained embeddings estimated over Wikipedia using a particular approach called *fastText* [4].

[3] The variation in a language across medium of communication (e.g. Spanish over the phone versus Spanish over email)

[4] Preprocessor is a preprocessing library for tweet data written in Python, https://github.com/s/preprocessor

Convolutional Neural Network. Convolutional Neural Networks (CNN) are considered state of the art in many text classification problem. Therefore, we decide to use them in a simple architecture composed by a convolutional layer, followed by a *Global Max Pooling* layer and two dense layers.

Dilated KIM. This model is our new topology of CNN. It can be seen as an extension of Kim's model [1] using the dilation ideas from computer graphics field [13].
The original Kim's model is a particular CNN where the convolutional layer has multiple filter widths and feature maps. The complete architecture is illustrated in Figure 1, here the input layer (i.e., sentence-matrix) is processed in a convolutional layer of multiple filters with different width, each of these results are fed into *Max Pooling* layers and finally the concatenation of them (previously flatten to be dimensional coherent) is projected into a dense layer. Our extension is to use a dilated filters in combination with normal ones, the intuition is that normal filter capture *adjacent words* features, while dilated one are able to capture relations between *non adjacent words*. This behaviour can't be achieved by the original Kim's model, because, even though the filters size can be changed, they will capture only features from adjacent words.
Luca ho bisogno dei dati veri dei filtri Regarding the architectural references in [1], the filter's number $|f|$ and their dimension (k, d), where k is the kernel size and d the dilation's unit, was optimized leading to the following results: $|f| = 4, f_1 = (2 \times 2, d), f_2 = (3 \times 3, d), f_3 = (5 \times 5, d), f_4 = (7 \times 7, d)$.

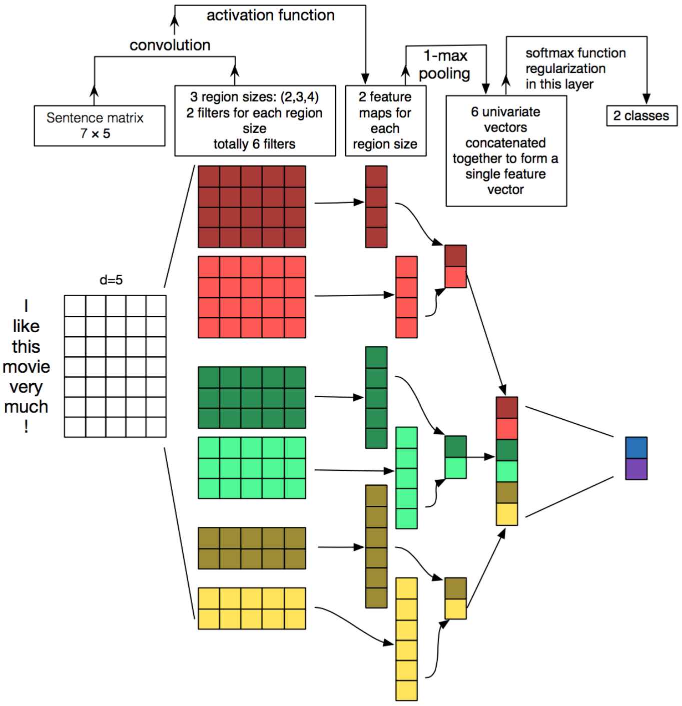
activation function
convolution
1-max pooling
softmax function regularization in this layer
Sentence matrix 7 × 5
3 region sizes: (2,3,4) 2 filters for each region size totally 6 filters
2 feature maps for each region size
6 univariate vectors concatenated together to form a single feature vector
2 classes
d=5
I
like
this
movie
very
much
!

Fig. 1: [8] Illustration of a Convolutional Neural Network (CNN) architecture for sentence classification

Recurrent neural network. Long Short Term Memory (LSTM) and Bidirectional LSTM are types of Recurrent Neural Network (RNN) aiming at capture features expressed by gap length. **Che ne dici se ci spari dentro una references del tuo prof?** This behaviour suggest us to use them for the stance detection, in particular we use straightforward architectures made of an embedded input layer followed by an LSTM layer of 128 units, terminated by a dense layer for both normal and bidirectional models.

4 Evaluation

In this section we are going to illustrate the evaluation of developed systems regarding the modules design reported in section 3. First we illustrate the metric proposed by organizers for system's evaluation (Section 4.1), then we outline empirical results produced by a 10-fold cross validation over the given data set (Section 4.2), finally we report our performance at the shared task (Section 4.3).

4.1 Metrics

System evaluation metrics were given by the organizers and reported here in the following equations (1) to (6). Their choice was to use an $F_{1-macro}$ measure for stance detection, due to class unbalance, while a categorical accuracy for the gender detection.

$$Gender = accuracy = \frac{\sum TP + \sum TN}{\sum sample} \quad (1)$$

$$F_1 = 2 \cdot \frac{precision \cdot recall}{precision + recall} \quad (4)$$

$$Stance = \frac{F_{1-macro}(Favor) + F_{1-macro}(Against)}{2} \quad (2)$$

$$precision = \frac{1}{|L|} \sum_{l \in L} Pr(y_l, \hat{y}_l) \quad (5)$$

$$F_{1-macro}(L) = \frac{1}{|L|} \sum_{l \in L} F_1(y_l, \hat{y}_l) \quad (3)$$

$$recall = \frac{1}{|L|} \sum_{l \in L} R(y_l, \hat{y}_l) \quad (6)$$

where L is the set of classes, y_l is the set of correct label and $\hat{y}_l$ is the set of predicted labels.

4.2 Fine tuning process

Following, we describe the fine tuning process over possible combinations of pre-processing (Table 3), then we compare Kim's model against our extension (Table 4) and finally report the improvement over the use of a *data augmentation* technique (Table 5). For brevity of information only the evaluation of Kim's model over Spanish stance detection is reported, in details, the results are calculated from averaging three runs of a 10-fold cross validation over the complete data set. Nevertheless, the results obtained after the fine tuning process for all the models are reported in section 4.3, where their development performances are compared against the ones obtained in the *StanceCat* task.

Notations used in Table 3 refer to the one introduced in Section 3.1, where the listing of a notation means its use for the reported result. Regarding the tweet specific pre-processing, all the items have been substituted, with the exception for URL and RW that have been removed. We report the contribution of each analysed pre-processing alone.

Luca to fill the table preprocessing with correct results

Table 3: Pre-processing fine tuning for the Kim's model from a three run of 10-fold cross validation over the development set. Results are in terms of average $F_{1-macro}$ score. The processing technique that brought a model's improvement has its result in bold.

Models	Pre-processing									
	Nothing	ST	SW	URL	RW	MT	HT	NUM	EM	SM
Kim	0.543	0.528	**0.557**	**0.571**	0.533	**0.558**	0.540	**0.554**	0.537	0.539

Luca qui tocca a te mettere prima i dati nella tabella e poi mettere gli insight in maniera di concetto e poi io ci do una forma da paper

OLD from COSET From the analysis of Table 3 no absolute conclusion can be drawn, meaning that it wasn't possible to find a combination of pre-processing that gives the best performance for all the model, meaning that each model is highly sensible to the performed combination. Nevertheless, some relative observation can be made:

- SW (i.e., removing spanish stop words) and NUM (i.e., substitute numbers with a constant string) leads to performance improvement to all the model respect to no pre-processing at all,
- ST (i.e., stemming) and HT (i.e., substitute hashtags with a constant string) decrease the performance of both models respect to no-preprocessing at all,

NEW for StanceCat

- insight

Table 4: Comparison of Kim's and Dilated Kim respect their best pre-processing tuning for stance&gender detection task. Results are averaged after three run of 10-fold cross validation over the development set in terms of averaged $F_{1-macro}$ score.

Models	Stance		Gender	
	ES	CA	ES	CA
Kim	0.625(±0.019)	0.602(±0.019)	0.625(±0.019)	0.602(±0.019)
Dilated Kim	0.675(±0.049)	0.635(±0.049)	0.675(±0.049)	0.635(±0.049)

As before, Luca qui tocca a te mettere prima i dati nella tabella (devi trovare tu la coerenza rispetto al fatto della data augmentation) e poi mettere gli insight in maniera di concetto e poi io ci do una forma da paper

NEW for StanceCat

- insight

In table 5 we report a complete overview of the evaluated models in respect to their best configurations of text pre-processing and word embedding. As can be seen, best performances are obtained by FastText and Kim's models, while recurrent models have the worst performance.

4.3 Competition results

For the system's submission, participants where allowed to send more than a model till a maximum of 5 possible runs, therefore in tables 6 and 7 we report our best performing systems (tuned following the process in section 4.2) for the StanceCat shared task.

Unfortunately, due to a submission error caught only after the official result were published, we didn't manage to be properly evaluated (the minus simbol in tables 6 and 7), therefore

Table 5: Data augmentation study for Dilated Kim's model over the Spanish stance detection development dataset. Results are averaged after three run of 10-fold cross validation over the development set in terms of averaged $F_{1-macro}$ score.

System	Nothing	Gaussian noise	Batch normalization
Dilated Kim	0.556 (± 0.012)	0.556 (± 0.012)	0.556 (± 0.012)

Table 6: Comparison of the best tuning model for the stance detection respect development and test set. The reported ranking refers to the absolute position over all submissions.

System	Development		Test			
	ES	CA	ES		CA	
			Score	Ranking	Score	Ranking
LSTM	0.443(±0.012)	0.489(±0.012)	-	-	-	-
Bi-LSTM	0.564(±0.035)	0.566(±0.035)	0.410	17/31	0.386	20/31
CNN	0.539(±0.030)	0.566(±0.030)	-	-	-	-
Kim	0.625(±0.019)	0.602(±0.019)	-	-	-	-
Dilated Kim	0.675(±0.049)	0.635(±0.049)	-	-	-	-

after the closing we asked organizers to evaluate some of our model to see how they would had performed (the test columns).

Luca put some comments over the result in relation to the dilated kim model also to updates the data in the gender and to change the variance in stance detection.

Table 7: Comparison of the best tuning model for the gender detection respect development and test set. The reported ranking refers to the absolute position over all submissions.

System	Development		Test			
	ES	CA	ES		CA	
			Score	Ranking	Score	Ranking
LSTM	0.443(±0.012)	0.489(±0.012)	-	-	-	-
Bi-LSTM	0.564(±0.035)	0.566(±0.035)	0.410	17/31	0.386	20/31
CNN	0.539(±0.030)	0.566(±0.030)	-	-	-	-
Kim	0.625(±0.019)	0.602(±0.019)	-	-	-	-
Dilated Kim	0.675(±0.049)	0.635(±0.049)	-	-	-	-

5 Conclusions

In this paper we have presented our participation in the IberEval2017 Classification Of Spanish Election Tweets (COSET) shared task. Five distinct neural models were explored, in combination with different types of preprocessing and text representation. From the systems evaluation it wasn't possible to find a combination of pre-processing that gives the best performance for all the models, meaning that each model is highly sensible to the pipeline combination. Regarding the analysed text representation, the setting of sentence matrix to non-static always leads to good performance as a result of the specific text under observation (i.e., a CMC corpus). Moreover, the use of pre-trained word embedding is always suggested even when not available of the language under observation but of a similar language (i.e., is possible to take advantage of transfer learning between similar languages). Moreover, we outline a not so promising performance of the recurrent model, meaning that for this task the word order (a feature well captured by LSTM family model) seams not so prominent as other tasks.

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