Studying Attention Models in Sentiment Attitude Extraction Task

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Introduction

Microbloging posts (Twitter)

- Mostly user reviews ⇒ considered a single object for analysis.

Analytical articles:

- Large amount of named entities (NE): Ukraine$_e$, Russia$_e$, Russian Federation$_e$;
- Has complicated structure:

  Trump$_e$ accused China$_e$ and Russia$_e$ of "playing devaluation of currencies"

Related:

- Text Analysis Conference (TAC), Knowledge Base Population (KBP) track[1];
- MPQA 3.0: sentiment attitudes towards entities and events;

1 https://tac.nist.gov/2014/KBP/Sentiment/index.html

Sentiment Attitude Extraction

1. Input (Context):

   «As is apparent in Washington$_{subj}$, there is no place for objectivity on the subject of Russia$_{obj}$, irrespective of facts and events»

2. Output (Extract):

   Washington $\rightarrow$ Russian, negative

Resources

RuSentRel: Contents

- 73 large analytical articles;
- **Text attitudes** – manual annotation, sentiment towards *named entities* (*NE*) as triplets $\langle Object, Subject, Label \rangle$, where:
  - Subject – *NE* or "author"
  - Object – *NE*
  - Label $\in$ {pos, neg}
- **Named Entities** – automatic (CRF based recognizer);
- List S of synonymous *NE* – manually implemented.

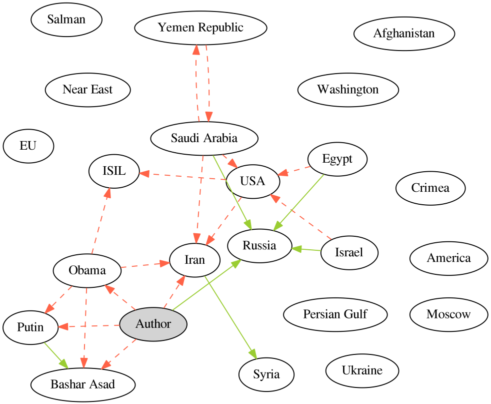


Figure 1: Document opinions

RuSentiFrames Lexicon Structure

Describes sentiments and connotations conveyed with a predicate in a verbal or nominal form.

1. Role Designation:
   - A0 is an argument exhibiting features of a Prototypical Agent;
   - A1 is a Theme.
2. Dimensions:
   - the attitude of the author of the text towards mentioned participants;
   - **polarity** – sentiment between participants;
   - **effects** to participants;
   - mental **states** of participants related to the described situation.

Frame	"Одобрить" (Approve)
roles	A0: who approves
	A1: what is approved
polarity	A0 → A1, pos, 1.0
	A1 → A0, pos, 0.7
effect	A1, pos, 1.0
state	A0, pos, 1.0
	A1, pos, 1.0

Table 1: Example description of frame "Одобрить" (Approve) in RuSentiLex lexicon.

Attention Models

Sentiment Attitude Extraction

1. Introducing **context attitude** – a pair <Subject, Object> its named entities within a context:

   «Talking about the separation of the Caucasus region_e due to the confrontation between Russia_{obj} and Turkey_{subj} is not necessary, although there is a danger»

2. We predict a sentiment label of a pair in **three-scale** format – positive, negative or *neutral* (extraction).

Context as a sequence of «terms»

Terms:

- Words;
- Entities (Masked);
- Frames;
- Tokens;

context
Talking about the separation of the Caucasus region$_{e}$ due to the confrontation between Russia$_{obj}$ and Turkey$_{subj}$ is not necessary, although there is a danger.

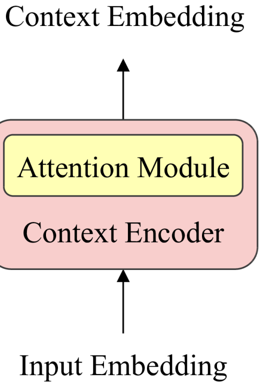
↓

terms
Talking about the separation of the E_{e} due to the confrontation$_{neg}$ between E_{obj} and E_{subj} is not-necessary$_{neg}$ <COMMA> although there is a danger <DOT>

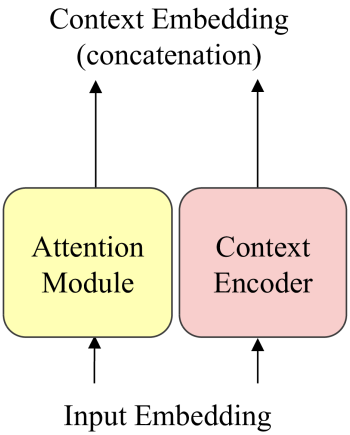
Input embedding

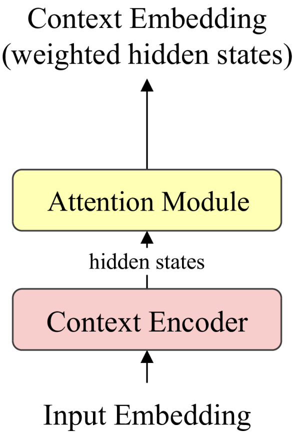
1. Pretrained Word2Vec model (size of 1000);
2. Additional parameters (size of 5 each):
   - **Distance embedding** – is vectorized distance in terms from attitude participants of entry pair (E_{obj} and E_{subj} respectively) to a given term;
   - **Closest to synonym** distance embedding – is a vectorized abs. distance in terms from a given term towards the nearest entity, synonymous to E_{obj} and E_{subj};
   - **Part-of-speech** embedding;
   - `A0`$\rightarrow$`A1` **polarity** embedding – is a vectorized «positive» or «negative» value for frame entries in RuSentiFrames

What is Attention?



Attention embed options





Attention Modules (Types and References)

- **Based on input embedding**: AttCNN[1] (PCNN[2]);
- **Based on hidden states**: IAN[3]; Att-BLSTM[4] (BiLSTM as an encoder);

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[1] Yatian Shen and Xuanjing Huang. "Attention-Based Convolutional Neural Network for Semantic Relation Extraction". In: *Proceedings of COLING 2016, the 26th International Conference on Computational Linguistics: Technical Papers* (Dec. 2016), pp. 2526–2536.

[2] Nicolay Rusnachenko and Natalia Loukachevitch. "Using convolutional neural networks for sentiment attitude extraction from analytical texts". In: *EPiC Series in Language and Linguistics* 4 (2019), pp. 1–10.

[3] Dehong Ma et al. "Interactive attention networks for aspect-level sentiment classification". In: *arXiv preprint arXiv:1709.00893* (2017).

[4] Peng Zhou et al. "Attention-based bidirectional long short-term memory networks for relation classification". In: *Proceedings of the 54th Annual Meeting of the ACL (Volume 2: Short Papers)* (2016), pp. 207–212.

Multi-Layer Perceptron (MLP) Based Attention (AttCNN)

1. Feature f: attitude ends, frames;

$$h_i = [x_i, f]$$

2. Weight calculation:

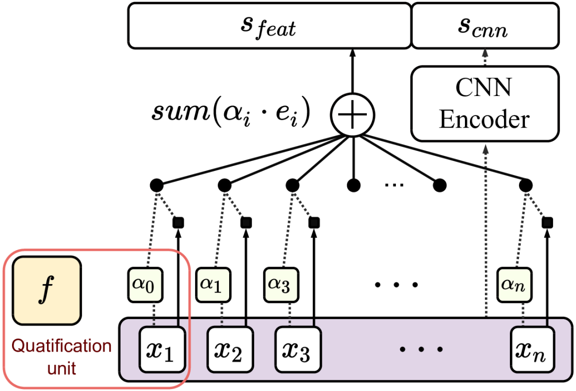
$$u_i = W_a\,(\tanh(W_{we} \cdot h_i + b_{we})) + b_a$$

3. Attention Embedding:

$$\alpha = softmax(u)$$

$$\hat{s} = \sum_{i=1}^{n} x_i \cdot \alpha_i$$

$$s_{feat} = avg_{j=1..k}(\hat{s})$$



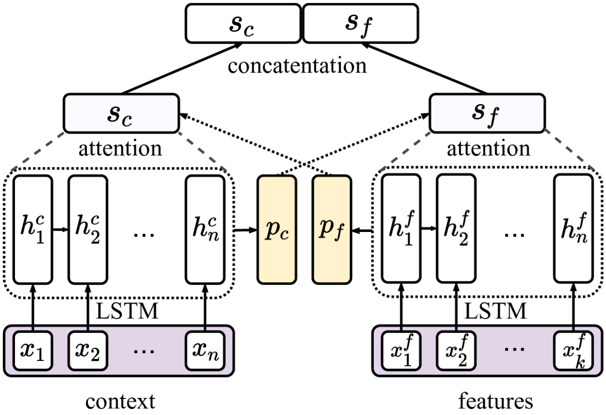
Interactive Attention Network (IAN)

1. Feature (p): avg. pooling across:
   - Context (p_c);
   - Aspects (Features) (p_f);
2. Weight calculation:

$$u_i^c = \tanh(h_i^c \cdot W_f \cdot p_f + b_f)$$
$$u_j^f = \tanh(h_j^f \cdot W_c \cdot p_c + b_c)$$

3. Result Embedding:

$$s_c = \sum_{i=1}^{n} \alpha_i^c \cdot h_i^c \qquad s_f = \sum_{j=1}^{k} \alpha_j^f \cdot h_j^f$$



Self-Based Attention

1. Hidden state **w**.

$$h_i = \overrightarrow{h_i} + \overleftarrow{h_i},\ i \in \overline{1..n}.$$

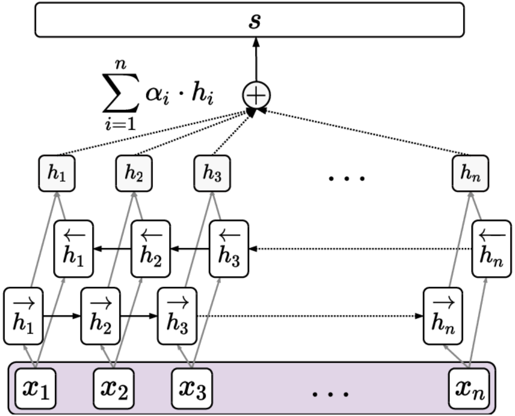
2. Attention (Att-BLSTM):

$$m_i = \tanh(h_i)$$

$$u_i = m_i^T \cdot \mathbf{w}$$

$$\alpha = softmax(u)$$

$$s = \tanh(H \cdot \alpha)$$



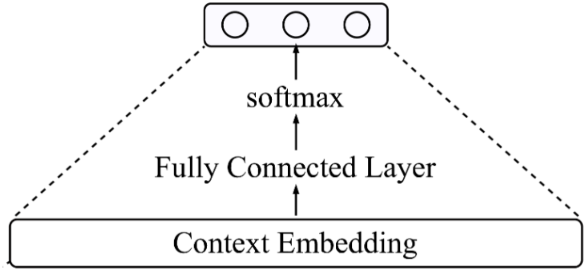
Output Class Probabilities

- s – is a context embedding;

$$r = W_r \cdot \tanh(s) + b_r$$

$$o = softmax(r)$$

$$label = argmax(o)$$



Experiments

Experiment Details

1. Experiment format:
   - Three-scale – positive, negative or *neutral* (extraction).
2. Output: document level opinions;
3. Evaluation formats:
   - Measure: F1-score;
   - 3-Fold CV average results (F_{avg});
   - Fixed Test separation of RuSentRel[2] (F_{test}).
4. Model groups: AttPCNN, IAN, Att-BLSTM;

2 `https://miem.hse.ru/clschool/results`

Results

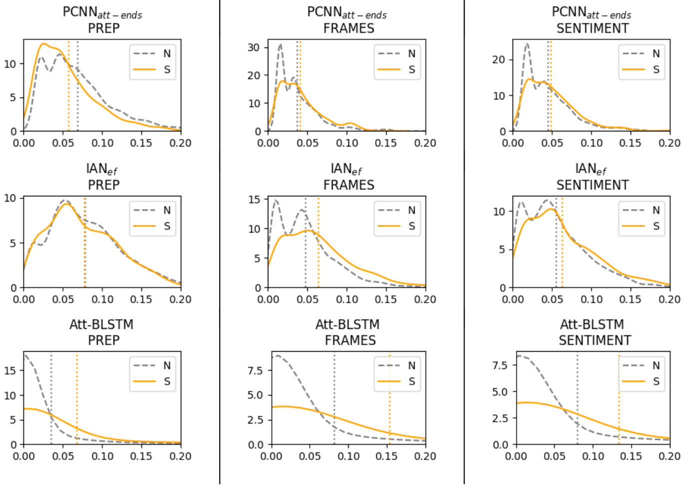
Model	$F1_{avg}$	$F1^1_{cv}$	$F1^2_{cv}$	$F1^3_{cv}$	$F1_{test}$
Att-BLSTM	**0.314**	**0.35**	0.27	**0.32**	**0.35**
BiLSTM	0.286	0.32	0.26	0.28	0.34
IAN_{ef}	0.289	0.31	0.28	0.27	0.32
IAN_{ends}	0.286	0.31	0.26	0.29	0.32
LSTM	0.284	0.28	0.27	0.29	0.32
AttPCNN_{e}	0.297	0.32	**0.29**	0.28	**0.35**
AttPCNN_{ef}	0.289	0.31	0.25	0.31	0.31
PCNN	0.285	0.29	0.27	0.30	0.32

Weight Distribution Analysis

1. **Term groups** presented in analysis:
   - Frames;
   - Words $\rightarrow$ Prepositions, Sentiment[3];
2. **Context-level weight** of a particular term group is a weighted sum of terms which both appear in the context and belong to the corresponding term group.
3. We utilize distributions (ρ_S, ρ_N) of context-levels weights across:
   - Sentiment contexts (S) – contexts labeled with positive or negative labels;
   - Neutral contexts (N) – contexts labeled as neutral;

3 Contains words and expressions of the Russian language with sentiment labels

Weight Distribution Analysis



Weight distribution visualization on sentiment contexts

Att-BLSTM
$\underline{E}_{subj}$ также должный предоставлять дополнительный экономический помощь $\underline{E}_{obj}$
$\underline{E}_{subj}$ also should provide additional economic assistance $\underline{E}_{obj}$
...
$\underline{E}_{subj}$, в свою очередь , приходиться идти на силовой демонстрация , чтобы принуждать $\underline{E}_{obj}$ к поиск компромисс
$\underline{E}_{subj}$, in turn , have to go to millitary demonstration , to force $\underline{E}_{obj}$ to seek compromises
...
E спасать $\underline{E}_{obj}$ от $\underline{E}_{subj}$ и E , но ее больше не ждать за европейский стол для почетный гость
E saves $\underline{E}_{obj}$ from $\underline{E}_{subj}$ and E , but she is no longer waiting at the European table for honored guest

Conclusion

1. We consider sentiment attitude extraction task as three-scale classification onto the following classes: positive, negative, neutral.
2. We study the attention-based neural networks. The application of attentive context encoders illustrates the classification improvement in 1.5-5.9% range by F1;
3. Model with self-attentive encoders (Att-BLSTM) illustrates the greatest discrepancy in weight distributions on sentiment and neutral contexts across all the term groups presented in the analysis;

Links

- RuSentRel: `https://github.com/nicolay-r/RuSentRel/tree/v1.1`
- RuSentiFrames: `https://github.com/nicolay-r/RuSentiFrames/tree/v1.0`
- Experiments: `https://github.com/nicolay-r/attitude-extraction-with-attention`
- Word2Vec News embedding[4];

4 `http://rusvectores.org/static/models/rusvectores2/news_mystem_skipgram_1000_20_2015.bin.gz`