INTEGRATION LEXICON WITH MACHINE LEARNING FOR SENTIMENT ANALYSIS

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1. Problem

- Building ML model for Twitter messages **sentiment classification task**. (SentiRuEval competition)
- **Sentiment class defines** for whole message, and shows relationship between message and company mentioned in it.
- For each domain this problem resolves separately:
  - BANK – bank companies;
  - TCC – telecommunication companies.
- Each message could be labeled with one of the following scores: {1, 0, -1}

2. Approach

- **Classifier:**
  - SVM/LR
    - Embedding: tf-idf
    - Use balanced collections
  - *Neural networks*
    - RNN, GRU, LSTM
    - Embedding: w2v models
- **Extra Features:**
  - Build Lexicons (see 3.) based on Corpora
- **Handcrafted features[1]**, amount:
  - UPPERCASE words
  - signs ('?', '!', '…')
  - $\sum, min, max$ for each Lexicon

3. Lexicons

Based on **pointwise mutual information** of terms t_1, t_2:

$$\boldsymbol{PMI}(t_1, t_2) = \log_2 \frac{P(t_1 \wedge t_2)}{P(t_1) \cdot P(t_2)}$$

Introducing **marker** as a second parameter of PMI function. Possible marker values: **Excellent**, **Poor**.

Semantic orientation is a function:

$$\boldsymbol{SO}(t) = PMI(t, \textbf{Excellent}) - PMI(t, \textbf{Poor})$$

- $sgn(SO(t))$ – determines the marker type of term t;
- $|SO(t)|$ – degree of belonging.

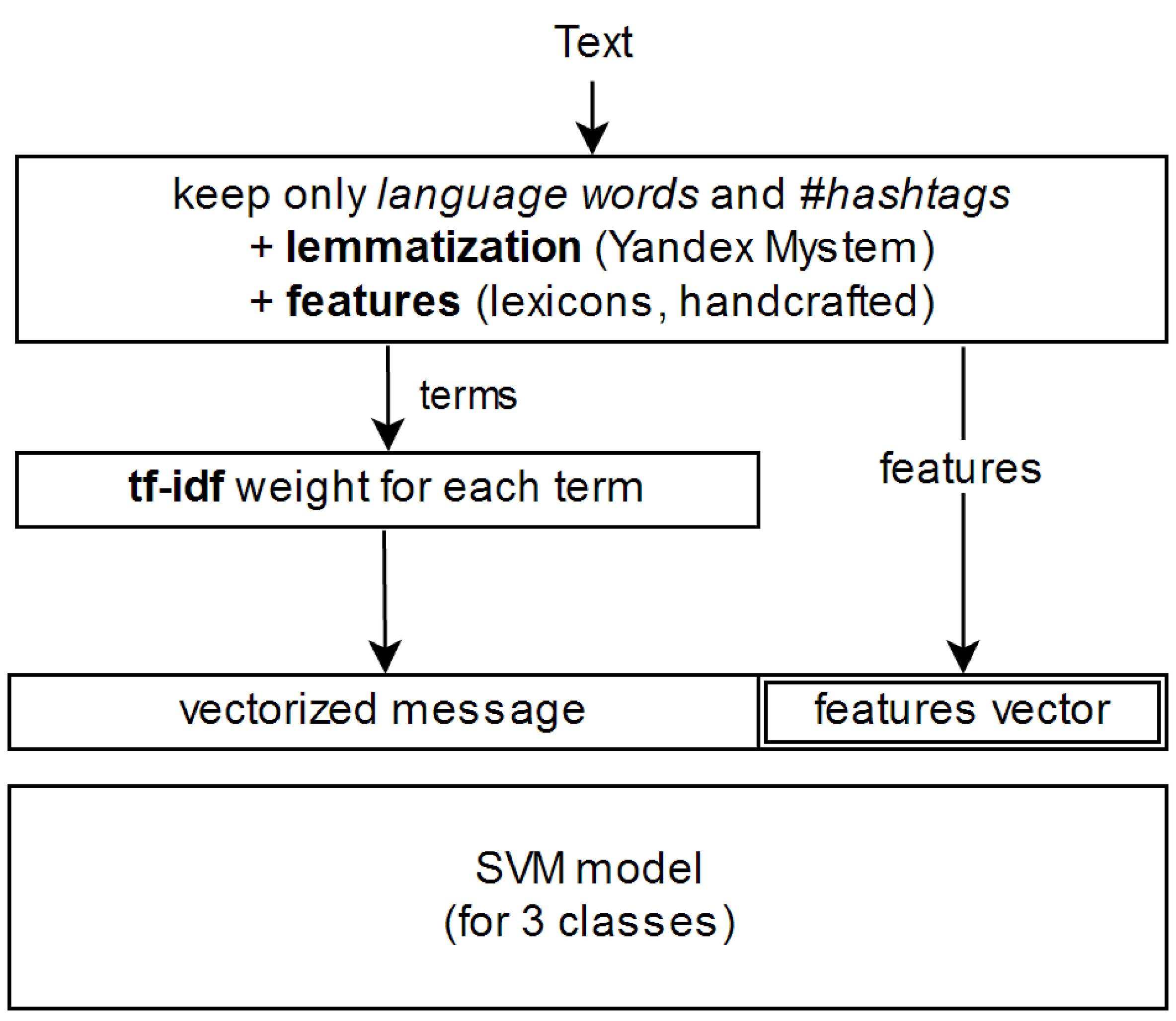
Building lexicon from messages of collection $K = K_{Excellent} \cup K_{Poor}$:

$$S: \{\, (t, SO(t)) \mid t \in K_{Excellent} \cup K_{Poor} \}$$

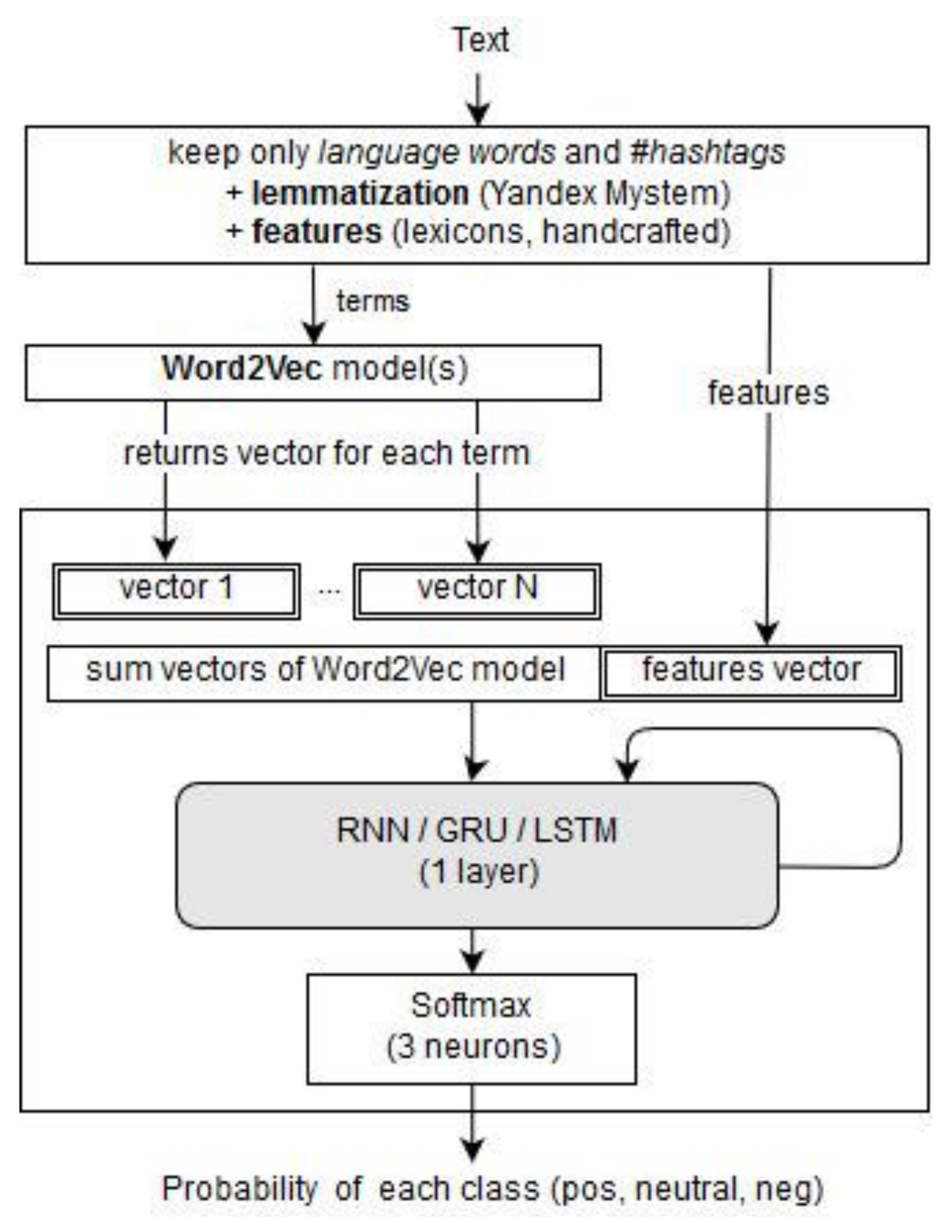
- $K_{Excellent}$ -- messages labeled **Excellent**.
- K_{Poor} -- messages labeled **Poor**.

4. SVM Model

- Implementation: $LibSVM$ [3]



5. Neural Networks



- Implementation: Theano(Python) [4]
- Optimization params:
  - X – input matrix (each row is vectorized message of train collection)
  - $rl_{curr}, rl_{def}, rl_{min}$ -- current, default, minimal values of regression coefficient respectively.
  - $grad\,(*)$ -- back propagation function
- Optimization approach (SGD):
  1. **Shuffle rows of X**
  2. Calculate *loss*
     1. $rl_{curr} := rl_{curr} * 0.5$, if *loss* greater than on previous step;
     2. Optimize otherwize (for each matrix/vector M of the model):
        $M := -rl_{curr} * grad(\text{M})$
  3. If $rl_{curr} < rl_{min}$, then $rl_{curr} := rl_{def}$.
  4. Go to next epoch

Save result after some amount of epoch. Find the best model.

6. Results

- BANK, measure: $F_{1-macro}(neg, pos)$

Model	Embedding	Training collection (B/I)*	Features	Lexicons	Result
Baseline	-	-	-	-	**18.00**
SVM	tf-idf	I	-	-	48.00
SVM	tf-idf	I	+	-	50.24
SVM	tf-idf	B	+	*all*	52.83
RNN**	$w2v, W1$	I	+	*all*	43.00
GRU**	$w2v, W2$	I	+	*all*	39.13
LSTM**	$w2v, W2$	I	+	*all*	49.00
LSTM**	$w2v, W2, W3$	I	+	*all*	51.40
LSTM	$w2v, W2, W3$	I	+	*all*	**55.32**

- TCC , measure: $F_{1-macro}(neg, pos)$

Model	Embedding	Training collection (B/I)*	Features	Lexicons	Result
baseline	-	-	-	-	**21.00**
SVM	tf-idf	I	-	-	50.90
SVM	tf-idf	I	+	-	50.69
SVM	tf-idf	B	+	*all*	**55.46**
LSTM	$w2v, W2$	I	+	*all*	50.41

* Used balanced (B) and imbalanced (I) version of training collections

** Disabling shuffle during optimization

All datasets presented in **section 7.**

7. Data & Collections Lexicons

Lexicons	Description	Terms
L_1	*Twitter* (using streaming API, jan-july 2016) (AUTO)	236 091
L_2	SentiRuLex (MANUAL)	10 668
L_3	Yu. Rubtsova short message corpus (AUTO + MANUAL)	112 814

Model	Source	Messages	Embedding size
W_1	Twitter	5 000 000	300
W_2	Twitter	10 000 000	500
W_3	banki.ru	200 000	500

Imbalanced train collections

BANK	1 354 (15%)	4 870 **(55.4%)**	2 550 (29%)	8 783
TCC	704 (7%)	6 756 **(74.22%)**	1 741 (19%)	9 102

Balanced train collections

BANK	14610
TCC	20268

References

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