Automatic detection of morphological paradigms using corpora information

Alexey Sorokin[1,2,3], Irina Khomchenkova[1]

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Dialogue
22nd International Conference on Computational Linguistics
Moscow, RSUH, 4th June, 2016

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  - How to detect a paradigm?

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песок	**песок**
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песку	**песк**у
песок	**песок**
песком	**песк**ом
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песку	**пес**к**у**	1+2+у
песок	**пес**о**к**	1+о+2
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LCS = песк	x_1 = пес	x_2 = к

- Abstract paradigm:

  1+о+2#1+2+а#1+2+у#1+о+2#1+2+ом#1+2+е#...

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- Abstract paradigm:

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- Words *кусок*, *моток*, ... have the same abstract paradigm.

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grammeme	variant 1	variant 2
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род.мн	**песков**	**песков**
...	...	...
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- Then we minimize the total length of gaps.
- Finally, we minimize the number of length 0 gaps.

Automatic detection of paradigms

- We encode inflection tables by abstract paradigms.
- How to detect a paradigm by a word form, especially if it's a non-vocabulary one?

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- Rules don't remove the ambiguity.
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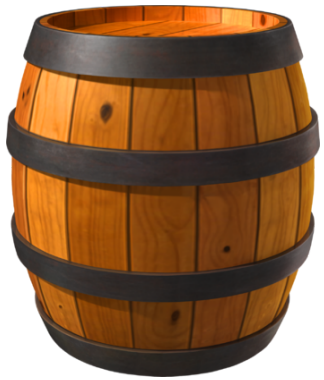

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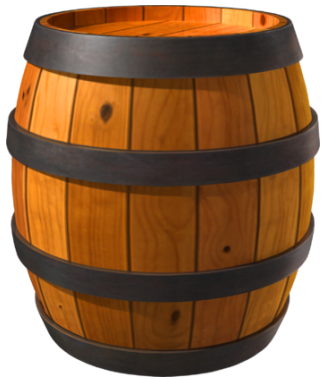

  - *голос* vs *колос* vs *волос*
- We will detect paradigms with machine learning.
- Our goal: to evaluate the quality of this method.

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Initial data

Initial data: inflection tables from wiktionary.org

	наст.	прош.	повелит.
Я	желáю	желáл желáла	—
Ты	желáешь	желáл желáла	желáй
Он Она Оно	желáет	желáл желáла желáло	—
Мы	желáем	желáли	—
Вы	желáете	желáли	желáйте
Они	желáют	желáли	—
Пр. действ. наст.	желáющий		
Пр. действ. прош.	желáвший		
Деепр. наст.	желáя		
Деепр. прош.	желáв, желáвши		
Пр. страд. наст.	желáемый		
Пр. страд. прош.	желáнный		
Будущее	буду/будешь… желáть		

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- Nouns and verbs are classified separately.

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арка	1	0	1	0	0	1	...
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$$\max_i P(c(L) = c_i | f_j(L) = 1)$$

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- Classification algorithm — logistic regression.

Results of classification

- 50% of training data, 5-fold random partition.

	Per-table	Per-form
Nouns	77.38	93.50
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Main errors:

Animacy	*швед, одиночка*
Gender of nouns ending with *-ль*	*артель, дизель*
Forms of imperative mood	*будоражить*(**будоражи*)
Root alternation	*отозвать*(**отозву*)
Stress and e/ё	*свистнуть*(**свистнёшь*)

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- Features: logarithmic probabilities according to basic classifier and to character n-gram model.
- We use 5-grams, trained on word forms from training set.

Task	No character scores		Character scores as features	
Nouns	77.38	93.50	77.42	93.50
Verbs	76.30	88.86	80.37	90.92

- No improvement for nouns...

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  - Discrepancy between expected frequency of word forms and the observed one.

$$D(\mathcal{N}, \mathcal{P}) = \sum_j q_j \log \frac{q_j}{p_j} \cdot \log N$$

q_j	—	frequency of j-th word form of predicted paradigm (relative, among all of its word forms)
p_j	—	expected relative frequency of j-th word form of predicted paradigm
N	—	total frequency of paradigm word forms

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Final results

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Method	Nouns		Verbs	
Basic	77.38	93.50	76.30	88.83
+ngrams	77.42	93.50	80.37	90.92
+counts	80.21	95.34	84.30	93.81
+counts+divergencies	82.73	95.67	83.66	93.73
+counts+divergencies+ngrams	**82.80**	**95.71**	**86.51**	**95.66**

Comparison with other systems

SIGMORPHON 2016 Shared Task: Morphological Reinflection

Language	Winner	Our system	Place
Arabic	95.47	83.52	3
Finnish	96.8	87.86	5
Georgian	98.5	94.8	4
German	95.8	94.22	3
Hungarian	99.3	89.82	5
Russian	91.46	89.67	3
Spanish	98.84	98.76	3
Turkish	98.93	92.03	3

Спасибо за внимание!

Thank you for attention!