Can Symbol Grounding Improve Low-Level NLP? Word Segmentation as a Case Study

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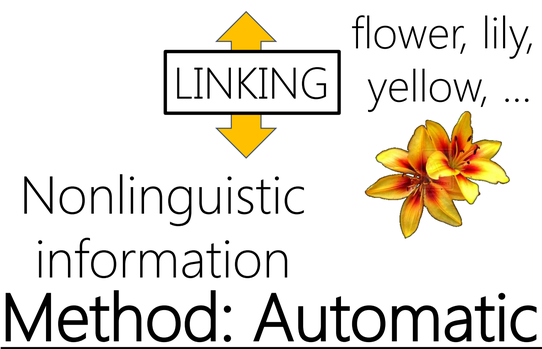
Symbol Grounding for Text Associated with Multi-Modal Information



Japanese word segmentation
- To segment sentences to words

文を単語に分割する
→文 / を / 単語 / に / 分割 / する

Domain adaptation for word segmentation
Proposed: Generating a term dictionary
→Symbol grounding result improves the performance of word segmentation

Method: Automatic Term-Dictionary Generation

Commentary for Shogi (Japanese chess)
- ❑Written in Japanese
- ❑Many terms associated to game states

Corpus: a set of pairs of a Shogi state and a comment

1. pseudo-Stochastically Segmented Corpora [Mori and Takuma, 2004]

p_{bi}: probability of boundary (by baseline segmenter)

p_{b1} p_{b2} p_{b3} p_{b4} p_{b5} p_{b6} p_{b7} p_{b8} p_{b9} p_{b10}
…|四|間|に|飛|車|を|振|る|。|…

Stochastically Segmented Corpora include probable candidate words

…|四|間|に|飛|車|を|振|る|。|…
$p_{b1}(1-p_{b2})p_{b3}$ $p_{b4}(1-p_{b5})p_{b6}$ $p_{b7}p_{b8}$

generating deterministically segmented corpora (in this experiment, 4 times)

広瀬は四間に飛車を振る (Hirose selected forth-file Ro…) → Baseline Segmenter → 飛|車|を|振|る|。 / 飛 車|を|振|る|。 / 飛 車|を|振 る|。 / 飛|車|を 振|る|。

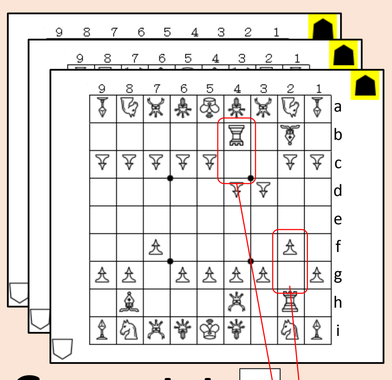
Commentaries

2. Symbol Grounding

Training multi-layer perceptron to choose terms for the state with collect fragments

Terms for the state:
Terms and features of the states have strong correlations

Correct fragments:
Candidates with wrong fragments appear randomly

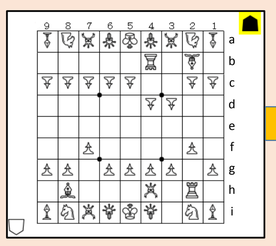


Input: features of Shogi states
a) positions of pieces
b) pieces captured
c) combinations of a) & b)
d) other heuristics

(1, 0, 0, 1, …, 0) → 100-dimensional

Output: words which will appear in the comments for the states

飛 (fly)
車 (chariot)
飛車 (Rook)
を



|四 間|に|飛|車|を|振 る|
0.8 0.1 0.2 0.1 0.05 0.2
|四|間 に|飛 車|を|振|る|
0.6 0.002 0.7 0.05 0.4 0.3
|四 間 に|飛|車 を|振|る|
0.001 0.3 0.002 0.4 0.3

higher scores:
terms for the state & collect fragments

Default Resource + 飛車 → Re-training → Term Dictionary → Adapted Segmenter

四間飛車を選択。
四 間|飛 車|を|選 択|。

3. Dictionary Generation

Selecting word candidates by summation of the scores
- Top N word candidates
- Tuning N by measuring the accuracies on the development set
- In this experiment, $N = 127$

Evaluation

Corpus specifications

		# of sent.	# of words	# of char.
Training	BCCWJ	56,753	1,324,951	1,911,660
	Newspaper	8,164	240,097	361,843
	Conversation	11,700	147,809	197,941
Development	Shogi-dev.	170	2,501	3,340
Test	BCCWJ-test	6,025	148,929	212,261
	Shogi-test	3,299	24,966	32,481

Accuracy on Shogi commentaries

	Recall	Precision	F-Measure
Baseline	90.12	91.43	90.77
+ Sym. Gro.	90.60	91.66	91.13

Accuracy on BCCWJ

	Recall	Precision	F-Measure
Baseline	98.99	99.06	99.03
+ Sym. Gro.	99.03	99.01	99.02

Target domain: Our framework successfully acquired new words

General domain: Our framework did not cause a severe performance degradation

Conclusion

Symbol grounding can improve word segmentation
- ➢ The method requires a small amount of annotated data
  - ➢ only to tune the hyperparameter
- ➢ The framework is general: It is worth testing on other tasks

Future Work

To apply our approach to other tasks
To deal with other types of non-textual information
- ➢ e.g.) images, economic indices