Translating Phrases in Neural Machine Translation

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Outline

- Motivation
- Related Work
- Approach
- Experiments
- Conclusion

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Motivation

- Phrases play an important role in natural language understanding and machine translation.
  - Neural machine translation is an approach to machine translation that uses a large neural network.

- However, the word-by-word generation philosophy in NMT makes it difficult to translate multi-word phrases.

Motivation

- Phrases are much better than words as translation units in SMT and have made a significant advance in translation quality.

- Can we translate phrases in NMT?

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Related Work

- the Combination of NMT and SMT

1st Workshop on Neural Machine Translation (and Generation)

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Call for Papers

The workshop is broad in scope and invites original research contributions on topics that include, but are not limited to the following:

- Incorporating linguistic insights: syntax, alignment, reordering, etc.
- Combining NMT & SMT
- Handling resource-limited domains
- Utilizing more data in NMT: monolingual, multilingual resources
- Multi-task learning for NMT
- NMT for mobile devices
- Analysis and visualization of NMT models
- Beyond sentence-level translation
- Beyond maximum-likelihood estimation
- **Neural Machine Generation**

Related Work

- Sentence-Level Combination:
  - Pre-Translation for Neural Machine Translation (COLING 2016)
  - Neural System Combination for Machine Translation (ACL2017)

Related Work

- Word-Level Combination:
  - Improved Neural Machine Translation with SMT Features (AAAI2016)
  - Syntactically Guided Neural Machine Translation (ACL2016)
  - Incorporating Discrete Translation Lexicons into Neural Machine Translation (EMNLP2016)
  - Neural Machine Translation Advised by Statistical Machine Translation (AAAI2017)

Related Work

- Phrase-Level Combination:

Related Work

- Phrase-Level Combination:
  - Neural Machine Translation Leveraging Phrase-based Models in a Hybrid Search (EMNLP2017)

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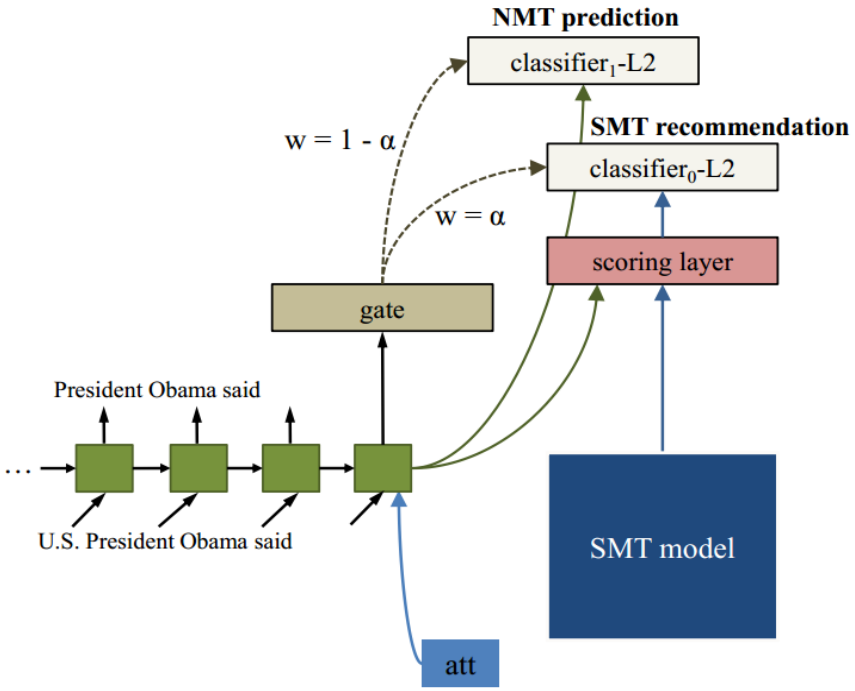
Approach

- Previous work: Neural Machine Translation Advised by Statistical Machine Translation(AAAI2017)



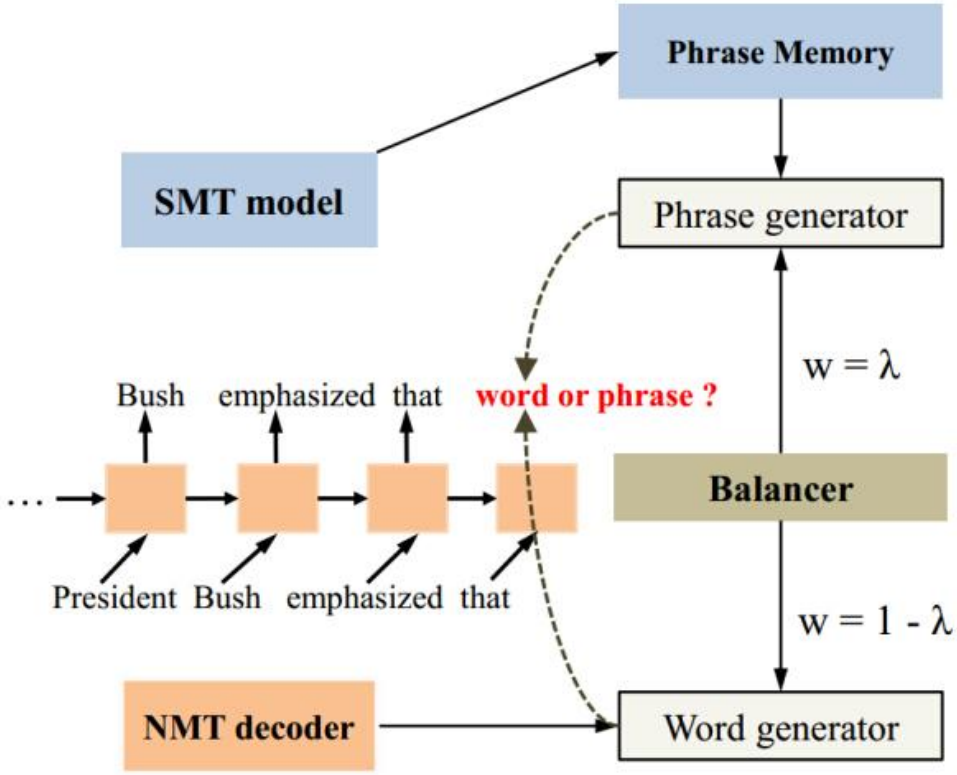
Approach

- Previous work: Neural Machine Translation Advised by Statistical Machine Translation(AAAI2017)

  - SMT word Recommendations
  - Scoring Layer
  - Gating Mechanism/Combination

Approach

- Proposed Architecture



Approach

- Phrase Memory

  ➢Writes to Phrase Memory

  SMT model writes *relevant target phrases* to the phrase memory.

  ➢Reads Phrase Memory

  NMT model reads and scores the target phrases in the phrase memory.

Approach

- Relevant target phrases
- Source: 布什总统强调美国政府坚持一个中国政策、遵守中美三个联合公报。
- NMT partial translation: *President Bush emphasized that* □
- Relevant phrases (Adequacy & Coverage):

  √

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  × President Bush, The Iraq War

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SMT pre-translates the source chunks and scores the target phrases.

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SMT writes relevant phrases into Phrase Memory：

the United States,
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…….

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NMT reads Phrase Memory and scores phrases. NMT chooses to generate word or phrases in Phrase Memory.

Approach

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- Neural network based balancer:
  - The trade-off between word generation mode and phrase generation mode is balanced by a weight λ.

Approach

- The probability of generating y is calculated by

$$P(\mathbf{y}|\mathbf{x}) = \prod_{w_k \in \mathbf{w}} (1 - \lambda_{t(w_k)}) P_{word}(w_k) \times \prod_{p_l \in \mathbf{p}} \lambda_{t(p_l)} P_{phrase}(p_l)$$

- where balancing weight λ is computed by

$$\lambda_i = \sigma(f_b(s_i, y_{i-1}, c_i))$$

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Experiments

- 1.25M LDC data, NIST test sets (Chinese-English)

SYSTEM	NIST04	NIST05	NIST08	Avg
Moses	34.74	31.99	23.69	30.14
RNNSearch	37.80	34.70	24.93	32.48
+memory	38.21	35.15	25.48†	32.95
+memory +chunking tag	38.83‡	35.72‡	26.09‡	33.55

- Systems:
  - Moses (phrase-based SMT model): 4-gram language models using KenLM; GIZA++; minimum error rate.
  - RNNSearch (NMT Baseline): Bahdanau et al., 2015
  - Our model is integrated into RNNSearch

Experiments

- Syntactic Categories of Generated Phrases

Type	All		New	
	Total	Correct	Total	Correct
NP	81.0%	38.7%	46.0%	11.5%
VP	8.0%	1.7%	6.5%	0.8%
QP	10.8%	4.1%	6.2%	0.9%
Others	0.2%	0%	0.2%	0%
Sum	100%	44.5%	58.9%	13.2%

  - Percentages of phrase categories to the total number of generated ones.

Experiments

- Number of Words in Generated Phrases

Words	All		New	
	Total	Correct	Total	Correct
2	66.2%	33.6%	34.9%	9.1%
3	20.7%	8.4%	13.4%	3.2%
4	7.4%	1.9%	5.4%	0.6%
⩾5	5.7%	0.6%	5.2%	0.3%

  - Percentages of phrases with different word counts to the total number of generated ones.

Experiments

- Limitations:
  - SMT translation
  - Chunking error
  - Word generation

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Shallow			
Deep			

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    - Neural Machine Translation Leveraging Phrase-based Models in a Hybrid Search (EMNLP2017)
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Conclusion

- We have presented a novel model to translate source phrases and generate target phrase translations in NMT by integrating the phrase memory into the encoder-decoder architecture.

- Experiment results on Chinese-English translation have demonstrated that the proposed model can improve the translation performance.

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