

Retrieve, Rerank and Rewrite: Soft Template Based Neural Summarization

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Outline

1 Introduction

2 Method

3 Experiments

4 Conclusion

Sentence Summarization

Definition

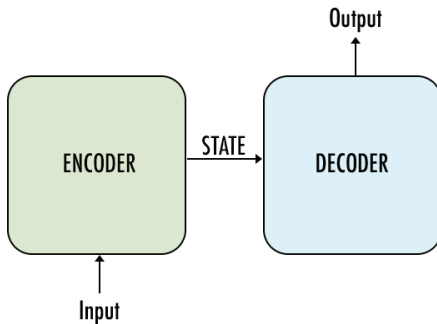
- Generate a shorter version of a given sentence
- Preserve its original meaning

Usage

Design or refine appealing headlines

Seq2seq Summarization

- Require less human efforts
- Achieve the state-of-the-art performance



Problems of Seq2seq Summarization

Solely depend on the source text to generate summaries

- Encounter error propagation
- Lose control
 - 3% of summaries ≤ 3 words
 - 4 summaries repeat a word for 99 times
 - Focus on extraction rather than abstraction

Template-based Summarization

- A traditional approach to abstractive summarization
- Fill an incomplete with the input text using the manually defined rules
- Be able to produce fluent and informative summaries

Template	[REGION] shares [open/close] [NUMBER] percent [lower/higher]
Source	hong kong shares closed down #.# percent on friday due to an absence of buyers and fresh incentives .
Summary	<i>hong kong shares close #.# percent lower</i>

Problems of Template-based Summarization

- Template construction is extremely time-consuming and requires a plenty of domain knowledge
- It is impossible to develop all templates for summaries in various domains

Motivation

Use actual summaries in the training datasets as **soft templates** to combine seq2seq and template-based summarization

Seq2seq Guide the generation of seq2seq

Template-based Automatically learn to rewrite from soft templates

Proposed Method

Re³Sum: consists of three modules: **R**etrieve, **R**erank and **R**ewrite.

- Use Information Retrieval to find out candidate soft templates from the training dataset (Retrieve).
- Extend the seq2seq model to jointly learn template saliency measurement (Rerank) and final summary generation (Rewrite)

Contributions

- 1 Introduce soft templates to improve the readability and stability in seq2seq
- 2 Extend seq2seq to conduct template reranking and template-aware summary generation simultaneously
- 3 Fuse the IR-based ranking technique and seq2seq-based generation technique, utilizing both supervisions
- 4 Demonstrate potential to generate diversely

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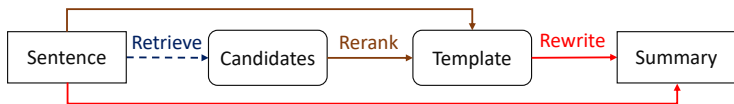
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Flow Chat

- Retrieve** Search actual summaries as candidate soft templates
- Rerank** Find out the most proper soft template from the candidates
- Rewrite** Generate the summary based on source sentence and soft template



Retrieve

Assumption: Similar sentences, similar summary patterns

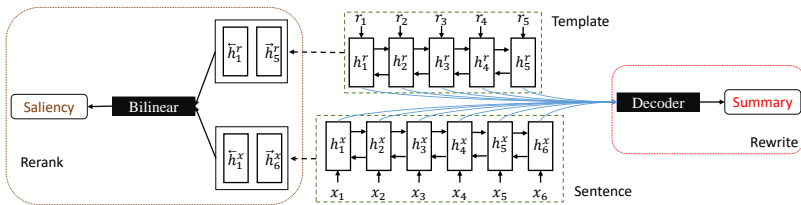
Input A sentence

Platform LUCENE

Output 30 actual summaries in the training dataset whose sources are the most similar to the input sentence

Jointly Rerank and Rewrite

Share encoders



Rerank

- Retrieve ranks templates according to the text similarity between sentences
- Rerank finds out the soft template most similar to the actual output summary

Model: Bilinear network

$$s(\mathbf{r}, \mathbf{x}) = \text{sigmoid}(\mathbf{h}_r \mathbf{W}_s \mathbf{h}_x^T + b_s)$$

Rewrite

- A soft template accords with the facts in the input sentences
- Use Seq2seq to generate more faithful and informative summaries

Concatenate the encoders of sentence and template

$$\mathbf{H}_c = [\mathbf{h}_1^x; \dots; \mathbf{h}_{-1}^x; \mathbf{h}_1^r; \dots; \mathbf{h}_{-1}^r]$$

Use attentive RNN decoder to generate summaries

$$\mathbf{s}_t = \text{Att-RNN}(\mathbf{s}_{t-1}, y_{t-1}, \mathbf{H}_c),$$

Learning

- Cross Entropy (CE) for Rerank
- Negative Log-Likelihood (NLL) for Rewrite
- Add the above two costs as the final loss

$$\begin{aligned}J_R(\theta) &= \text{CE}(s(\mathbf{r}, \mathbf{x}), s^*(\mathbf{r}, \mathbf{y}^*)) \\ &= -s^* \log s - (1 - s^*) \log(1 - s) \\ J_G(\theta) &= -\log(p(\mathbf{y}^* | \mathbf{x}, \mathbf{r})) \\ &= -\sum_t \log(\mathbf{p}_t[y_t^*]) \\ J(\theta) &= J_R(\theta) + J_G(\theta)\end{aligned}$$

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Setting

Dataset Gigaword (sentence, headline) pairs

Framework OpenNMT

Dataset	Train	Dev.	Test
Count	3.8M	189k	1951
AvgSourceLen	31.4	31.7	29.7
AvgTargetLen	8.3	8.3	8.8
COPY(%)	45	46	36

ROUGE Performance

Re³Sum significantly outperforms other approaches

Model	ROUGE-1	ROUGE-2	ROUGE-L
ABS [†]	29.55*	11.32*	26.42*
ABS+ [†]	29.78*	11.89*	26.97*
Featseq2seq [†]	32.67*	15.59*	30.64*
RAS-Elman [†]	33.78*	15.97*	31.15*
Luong-NMT [†]	33.10*	14.45*	30.71*
OpenNMT	35.01*	16.55*	32.42*
Re ³ Sum	37.04	19.03	34.46

Linguistic Quality Performance

- Low LEN_DIF and LESS_3 → Stable
- Low COPY → Abstractive
- Low NEW_NE and NEW_UP → Faithful

Item	Template	OpenNMT	Re ³ Sum
LEN_DIF	2.6±2.6	3.0±4.4	2.7±2.6
LESS_3	0	53	1
COPY(%)	31	80	74
NEW_NE	0.51	0.34	0.30
NEW_UP	0.38	0.19	0.11

Effects of Template

- Performance highly relies on templates
- The rewriting ability is strong

Type	ROUGE-1	ROUGE-2	ROUGE-L
+Random	32.60	14.31	30.19
+First	36.01	17.06	33.21
+Max	41.50	21.97	38.80
+Optimal	46.21	26.71	43.19
+Rerank(Re ³ Sum)	37.04	19.03	34.46

Generation Diversity

OpenNMT Beam search n-best outputs

Re³Sum Provide different templates

Source	anny ainge said thursday he had two one-hour meetings with the new owners of the boston celtics but no deal has been completed for him to return to the franchise .
Target	ainge says no deal completed with celtics
Templates	major says no deal with spain on gibraltar roush racing completes deal with red sox owner
Re ³ Sum	ainge says no deal done with celtics ainge talks with new owners
OpenNMT	ainge talks with celtics owners ainge talks with new owners

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Conclusion

- Introduce soft templates as additional input to guide seq2seq summarization
- Combine IR-based ranking techniques and seq2seq-based generation techniques to utilize both supervisions
- Improve informativeness, stability, readability and diversity

Thank you