



A Multi-Agent Communication Framework for Question-Worthy Phrase Extraction and Question Generation



Siyuan Wang¹, Zhongyu Wei¹, Zhihao Fan¹, Yang Liu², Xuanjing Huang³

¹ School of Data Science, Fudan University, China

² LAIX Inc., China

³ School of Computer Science, Fudan University, China

AAAI 2019

Introduction

Given a sentence, our research aims to identify question-worthy phrases first and generate questions with the assistance of these phrases.

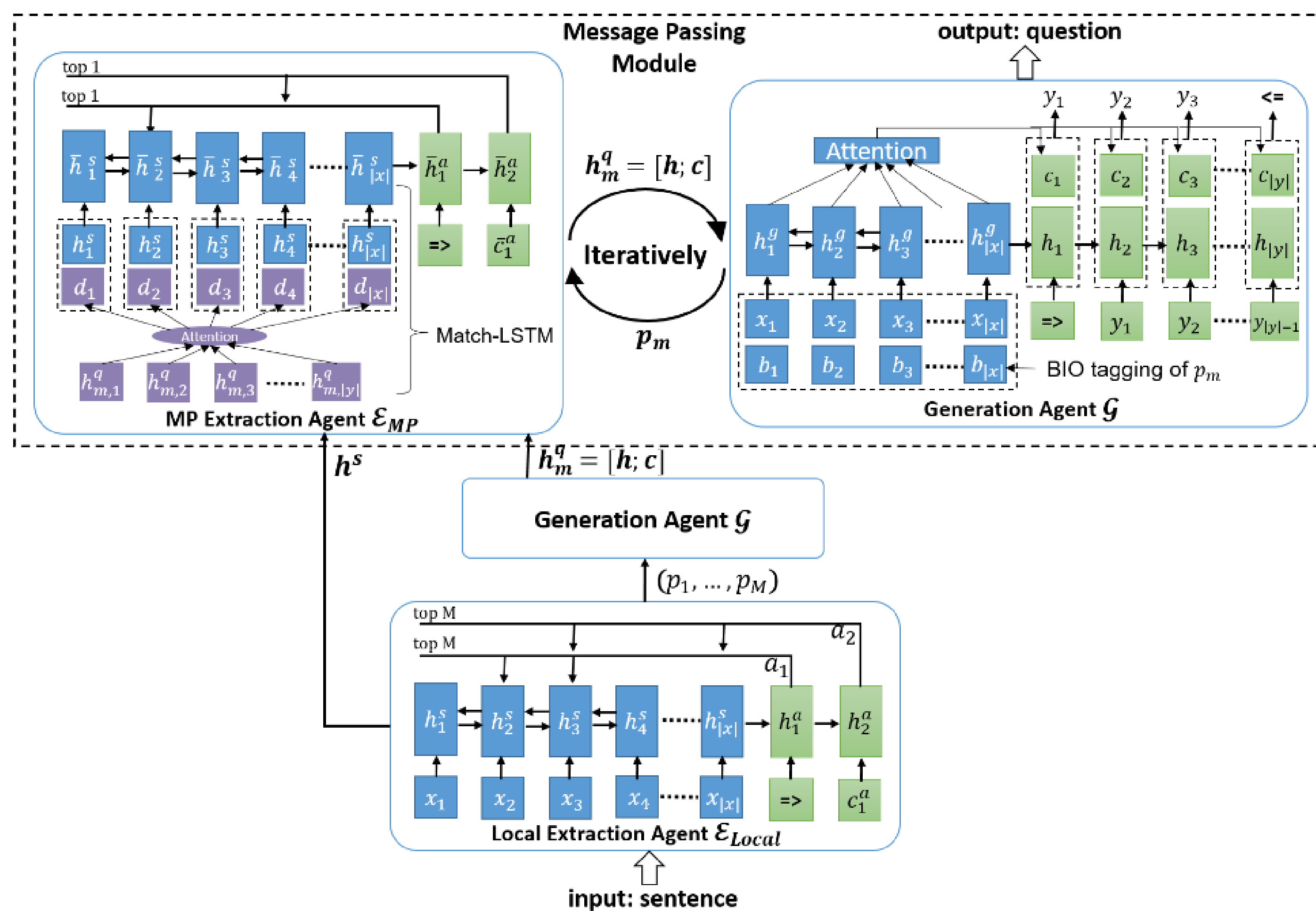
Oxygen is used in cellular respiration and released by **photosynthesis**, which uses the energy of **sunlight** to produce oxygen from **water**.

- What life process produces oxygen in the presence of light?
- Photosynthesis uses which energy to form oxygen from water?
- From what does photosynthesis get oxygen?

Contributions:

- Propose to generate multiple questions given input sentence without ground-truth answers.
- Extract question-worthy phrases from the input sentence and generate questions based on such information.
- Develop a multi-agents communication framework to learn the two tasks simultaneously.

Framework



Multi-Agent Communication Framework

- Local Agent:** it applies pointer network boundary model to extract question-worthy phrases.
- Generation Agent:** it is based on seq-to-seq model with attention mechanism, takes both sentence and an phrase as input, to generate a question.
- MP Extraction Agent:** it employs Match-LSTM and Pointer Network, taking question information from the generation agent.

Dataset

Stanford Question Answering Dataset (SQuAD)

- Answers, extractive from sentences, are treated as target question-worthy phrases.
- We have totally 61623 sentences corresponding to 90682 questions.
- More than 30% sentences have multiple questions.

Question Number	Sentence Quantity
1	41,356
2	14,499
3	3,921
4	1,198
≥ 5	649
in total	61,623

Distribution of number of questions per sentence

Experiments

Comparison of Extraction Models

- Metrics:** EM(ExactMatch), F1 score, Average numbers of phrases.
- Comparative Models**
 - \mathcal{E}_{NER} : extract name entities as question-worthy phrases
 - \mathcal{E}_{Local} : the local extraction agent
 - \mathcal{E}_{MP} : the extraction agent in message passing module

Model	EM	F1	Avg.# of phrases
\mathcal{E}_{NER}	13.12%	17.33	0.86
\mathcal{E}_{Local}	24.27%	38.63	1.43
\mathcal{E}_{MP}	<u>35.77%</u>	<u>46.71</u>	1.38

Results of different extraction models. (underline: significance test, $p < 0.01$)

Comparison of Generation Models

- Metrics:** BLEU 1-4, METEOR, ROUGE_L.
- Comparative Models**
 - NQG_{Rule} : a rule-based model applying an overgenerate-and-rank approach
 - NQG_{Pure} : a pure version of QG using Seq2Seq model with attention
 - NQG_{NER} : take phrases from \mathcal{E}_{NER} as assistance to generate questions
 - NQG_{Local} : question generation using phrases from \mathcal{E}_{Local}
 - NQG_{MP} : the generation agent in MP module, using phrases from \mathcal{E}_{MP}
 - NQG_{Answer} : answer-aware, use the ground truth of answers to generate questions, upper bound

Model	BLEU-1	BLEU-2	BLEU-3	BLEU-4	METEOR	ROUGE _L
NQG_{Rule}	38.15	21.03	14.15	9.98	13.38	29.00
NQG_{Pure}	43.83	23.80	14.46	9.05	14.63	36.50
NQG_{NER}	44.00	23.79	14.52	9.22	14.89	36.32
NQG_{Local}	44.36	24.58	15.23	9.76	15.15	37.00
NQG_{MP}	<u>45.70*</u>	<u>25.87*</u>	<u>16.33*</u>	<u>10.56*</u>	<u>15.76*</u>	<u>38.09*</u>
NQG_{Answer}	47.49	27.81	17.9	11.81	16.84	40.23

Results of different generation models. (underline: significance test, $p < 0.01$; *: $p < 0.05$)

Case Study

	Sample1	Sample2
Input	the panthers finished the regular season with a 15-1 record, and quarterback cam newton was named the nfl most valuable player (mvp).	next to the main building is the basilica of the sacred heart.
Phrases	E_{NER} : panthers, <blank>. E_{MP} : 15, quarterback cam newton.	E_{NER} : sacred heart. E_{MP} : next to the main building.
Questions	Ground Truth: what was the ratio in 2015 for the carolina panthers during their regular season? which carolina panthers player was named most valuable player? NQG_{NER} : who won the regular season? who was named the nfl most valuable player? NQG_{MP} : how many wins did the panthers win during the regular season? who was named the nfl most valuable player?	Ground Truth: the basilica of the sacred heart at notre dame is beside to which structure? NQG_{NER} : what is next to main building? NQG_{MP} : where is the basilica of prayer?

Conclusion

- We propose to extract question-worthy phrases and use such information for better question generation.
- We introduce a multi-agent communication framework to learn tasks of phrase extraction and question generation simultaneously.
- Our framework is able to generate multiple questions given input sentence without any ground-truth answers.