

Multi-task Learning for Natural Language Generation in Task-Oriented Dialogue

Chenguang Zhu, Michael Zeng, Xuedong Huang
Microsoft Speech and Dialogue Research Group, Redmond, WA, USA

Introduction

- Natural Language Generation (NLG) is the final step in task-oriented dialogue pipeline
- Its readability and informativeness directly impact users' perception of the system
- Existing methods struggle to achieve high fluency and variation
- We utilize the language model as an unconditioned auxiliary task to generate natural responses

Formulation

- Meaning Representations (MR)** are slot-value pairs offering information category and content
 - E.g. $\{(area, south), (name, The Phoenix)\}$
- Dialogue acts (DA)** indicate types of system actions
 - E.g. *inform/request/confirm*
- Response** is the desired natural language output
 - E.g. *The Phoenix is a restaurant in the south of city.*

Model

- Seq2seq model generates response with maximum likelihood conditioned on input \mathcal{I}

$$p(w_1, \dots, w_n | \mathcal{I}) = \prod_{t=1}^n p(w_t | w_1, \dots, w_{t-1}; \mathcal{I})$$

- Language model as unconditioned probability

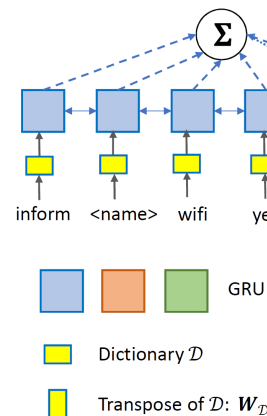
$$p^{LM}(w_1, \dots, w_n) = \prod_{t=1}^n p^{LM}(w_t | w_1, \dots, w_{t-1})$$

- Both tasks share decoder parameters and use a linear combination for loss function

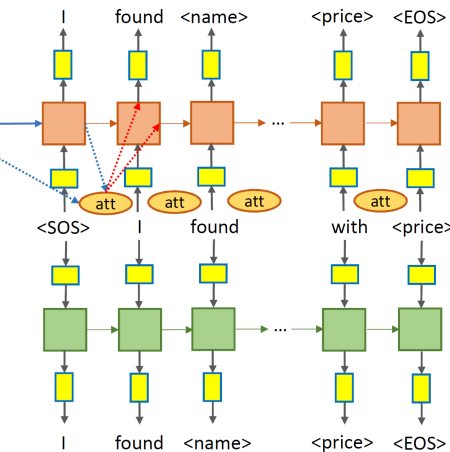
$$\mathcal{L}(\theta) = \mathcal{L}^{NLG}(\theta) + \alpha \mathcal{L}^{LM}(\theta)$$



Dialogue Act (DA) and Meaning representation (MR)



Attention-based NLG



Language model

Generated Examples

MR	name[The Cricketers], eatType[restaurant], food[Chinese], priceRange[high], customer rating[1 out of 5], area[riverside], familyFriendly[no], near[All Bar One]
Answer	The high priced Chinese restaurant The Cricketers, is based in the riverside area near to the All Bar One. It is not child friendly and has a customer rating of 1 out of 5.
w/o LM	The Cricketers is a restaurant providing Chinese food in the high price range. It is located in the riverside. It is near All Bar One. Its customer rating is 1 out of 5.
NLG-LM	The Cricketers is a Chinese restaurant in the riverside area near All Bar One. It is not children friendly and has a high price range and a customer rating of 1 out of 5.
MR	name[The Phoenix], eatType[restaurant], food[French], priceRange[cheap], area[riverside], familyFriendly[yes], near[Raja Indian Cuisine]
Answer	The Phoenix is a cheap family friendly French pub and a restaurant located near Raja Indian Cuisine near riverside
w/o LM	The Phoenix is a family friendly French restaurant near Raja Indian Cuisine in the riverside area. It has a cheap price range.
NLG-LM	The Phoenix is a cheap, family friendly French restaurant near Raja Indian Cuisine in the riverside area.
MR	inform, name[kensington park hotel], dogsallowed[yes]
Answer	kensington park hotel is a nice place where dogs are allowed
w/o LM	the kensington park hotel allows dogs
NLG-LM	kensington park hotel is a nice place where dogs are allowed

Experiments

Datasets

- E2E-NLG dataset with 51.2K samples
- RNNLG dataset, including TV, Laptop, Hotel and Restaurant, with 14.1K, 26.5K, 8.7K and 8.5K samples
- Use official evaluation scripts from E2E-NLG and RNNLG

Result (BLEU-4)

Model	E	TV	L	H	R
TGen	0.659	/	/	/	/
Slug	0.662	0.529	0.524	/	/
SCLSTM	/	0.527	0.512	0.848	0.752
RALSTM	/	0.541	0.525	0.898	0.779
w/o LM	0.673	0.609	0.560	0.927	0.734
NLG-LM	0.684	0.617	0.586	0.939	0.795

Result (NIST on E2E-NLG)

Model	TGen	Slug	w/o LM	NLG-LM
NIST	8.609	8.613	8.581	8.626

Running Time Comparison

	NLG-LM	w/o LM
Per-batch	618.87s	500.64s

Conclusion

- Propose multi-task learning model NLG-LM for response generation in task-oriented dialogues
- Incorporate language model as an unconditioned auxiliary task
- Achieve state-of-the-art results on five public datasets