

SynTOD: Augmented Response Synthesis for Robust End-to-End Task-Oriented Dialogue System

Quang-Chieu Nguyen[†], Quang-Minh Tran[†], Khắc-Hoai Nam Bui^{*}

Viettel AI, Viettel Group, Vietnam

{chieunq, minhmq21, nambkh}@viettel.com.vn

1) Background

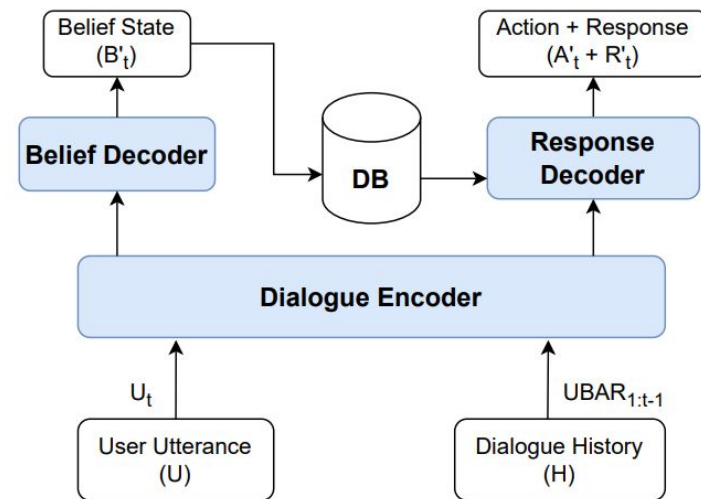
- Task-Oriented Dialogue (TOD) systems are developed to assist users in achieving some specific goals such as hotel booking or restaurant recommendation.
- Pipeline TOD has several modules: natural language understanding (NLU), dialogue state tracking (DST), dialogue policy (POL), natural language generation (NLG).
- End-to-end TOD models fine-tune pre-trained language models (T5, GPT) and combine loss functions of all modules (NLU, DST, POL, NLG).

1) Background

- End-to-end TOD

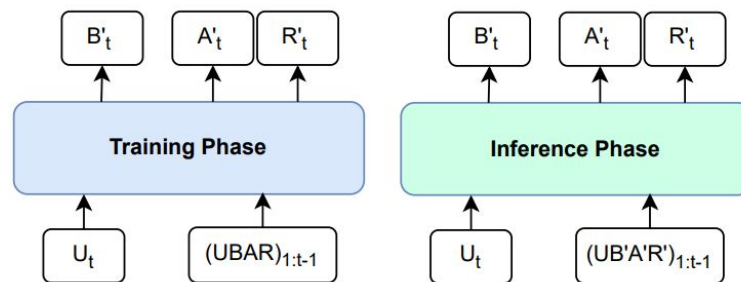
- U_t : User utterance at turn t
- B_t : Ground truth belief state at turn t
- A_t : Ground truth action at turn t
- R_t : Ground truth response at turn t
- $H_t = \text{UBAR}_{1:t-1}$: History of dialogue at turn t

- B'_t, A'_t, R'_t : Generated results of decoder at turn t



2) SynTOD

- Motivation:
 - There is a gap between the training and the inference process, which could lead to errors propagation in the real world, particularly when some of the generated states are incorrect



- Idea:
 - Utilizing the generated responses of the pre-trained TOD model as the additional samples for a robust end-to-end TOD system

2) SynTOD

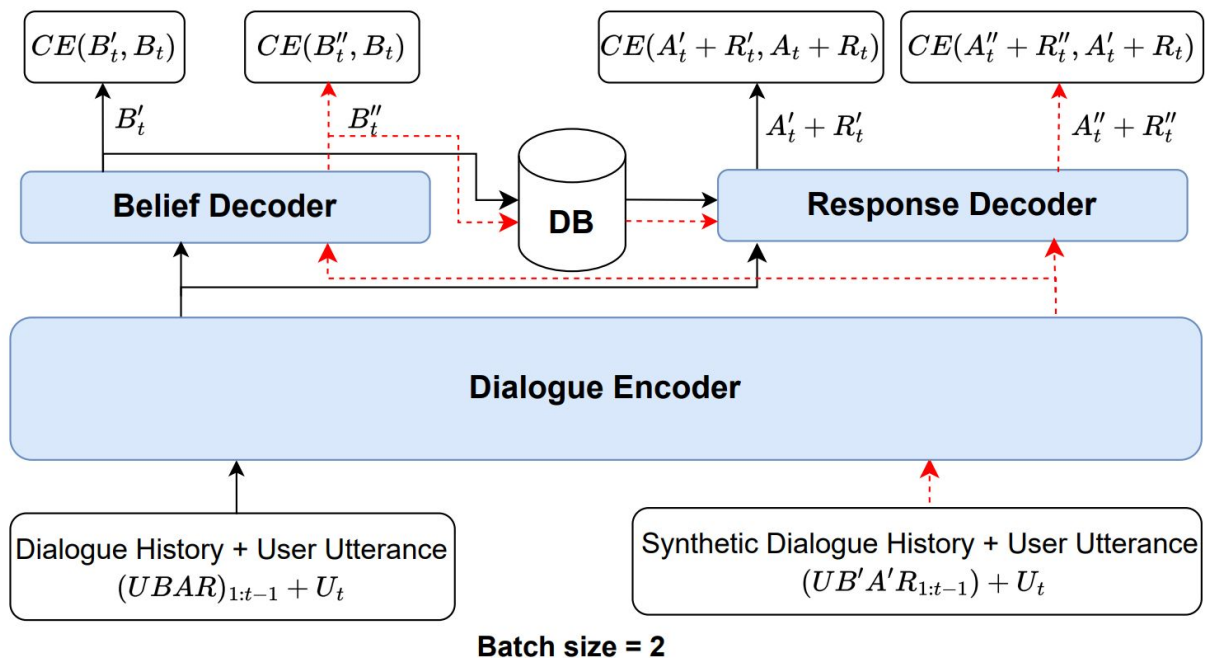


Figure 3: The overview of the proposed model (SynTOD) with batch size = 2. The black and dashed red lines refer to our model flow when the inputs are original and synthesis dialogues, respectively. CE denotes cross-entropy loss function. B' denotes the belief state output of the original dialogue, and B'' is the belief state output of the synthesis dialogue. Similar meaning for action (A) and response (R).

3) Experiment & setup

- Dataset
 - Benchmark on two popular TOD datasets: MultiWoz 2.1 and MultiWoz 2.2
- Backbone
 - T5 (Raffel et al., 2020)
 - MTTOD (Lee, 2021)
 - PPTOD (Su et al., 2022)
- Evaluation metrics
 - Inform
 - Success
 - BLEU
 - Combined score = $(\text{Inform} + \text{Success}) * 0.5 + \text{BLEU}$

4) Result

Model	MultiWOZ 2.1				MultiWOZ 2.2			
	Inform	Success	BLEU	Combined	Inform	Success	BLEU	Combined
T5	92,1	81,9	19,05	106,05	78,3	70,5	18,57	92,97
MTTOD	92,4	83.0	18,47	106,17	79.0	72,2	18,43	94,03
PPTOD	91.4	82.5	18.88	105.83	80,3	73,8	18,38	95,43
Ours:								
+ T5	93.3	83.4	19.82	108.17	84.1	73.0	17.82	96.37
+ MT-TOD	92.1	83.6	18.58	107.43	82.8	73.0	18.48	96.38
+ PPTOD	92.7	84.3	19.30	107.80	85.7	73.0	17.73	97.08

Table 1: Reported results on MultiWOZ 2.1 and MultiWOZ 2.2 with end-to-end evaluation. Bold texts indicate the best results.

4) Result

Our Model	Size	Inform	Success	BLEU	Combined
+ T5	small - 60 M	93,3	83,4	19,82	108.17
	base - 220 M	93,7	84,8	19,5	108.75
+ MT-TOD	small - 102 M	92,1	83,6	18,58	107,43
	base - 360.9 M	92,4	83,1	19,65	107,40
+ PPTOD	small - 60 M	92,7	84,3	19,30	107,80
	base - 220 M	93,7	84,1	19,54	108,44

Reported results on MultiWOZ 2.1 of the proposed approach with different backbone versions (i.e., small and base). Bold texts indicate the best results of each version, respectively.

4) Result

Model	Backbone(size)	Combined
SimpleTOD	DistilGPT2(82 M)	92.98
UBAR	DistilGPT2(82 M)	105.70
MTTOD*	T5 _{small} (102.2 M)	103.99
	T5 _{base} (360.9M)	107.50
RSTOD*	T5 _{small} (105.5 M)	108.34
PPTOD†	T5 _{small} (60 M)	101.52
	T5 _{base} (220 M)	102.26
GALAXY	UniLM(340 M)	105.92
GALAXY†	UniLM(340 M)	110.76
TOATOD	T5 _{small} (60 M)	104.54
	T5 _{base} (220 M)	109.32
SynTOD	T5 _{small} (60 M)	108.17
	T5 _{base} (220 M)	108.75

Reported results on MultiWOZ 2.1 Compared with state-of-the-art end-to-end models. The values with * are from (Cholakov and Kolev, 2022). Other results are from the respective papers. † denotes pre-trained TOD models

5) Conclusion

- In this paper, we propose a new strategy to incorporate synthesis data for the training process to enable the TOD models to be more robust, which helps to minimize the gap between the training and inference process
- Experiments show the effectiveness of the proposed method in various strong baseline models.