Answer-guided and Semantic Coherent Question Generation in Open-domain Conversation

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● **Semantic coherence** ● **Dullness** ● **Deviation**

Post
I like cooking more and more.
Question candidates
What are your special dishes ? ✓ Are you good at making appetizers ? ✓ What do you mean? ✗ How about going singing? ✗
Answer
Wow, I am only skillful in cooking beef.

Table 1: A motivating example of CQG task, including the post, question, and answer. In question candidate set, we list two intriguing questions and the other two unappropriate questions. The green words indicate the semantic coherence phenomenon. The blue and red words state the dull and deviated responses respectively. Note that the questions asking about the special dishes or making appetizers are all reasonable, and there is no exact match between question and answer.

- We are the first to incorporate the answer factor into CQG task. The semantic coherence between questions and answers could guide the model to generate more appropriate questions.
- We propose two novel answer-guided semantic coherent CQG models, i.e. RL-CVAE and A-CVAE. The answer information is exploit- ed with reinforcement learning and adversarial learning respectively.
- .

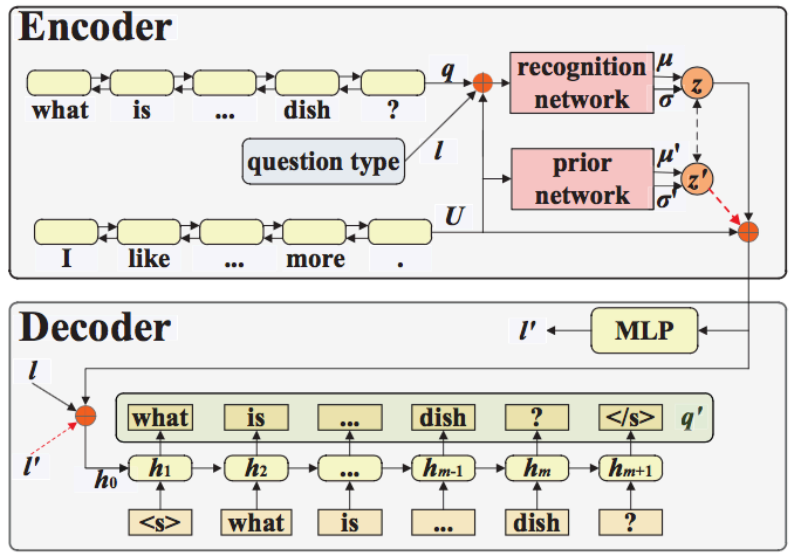
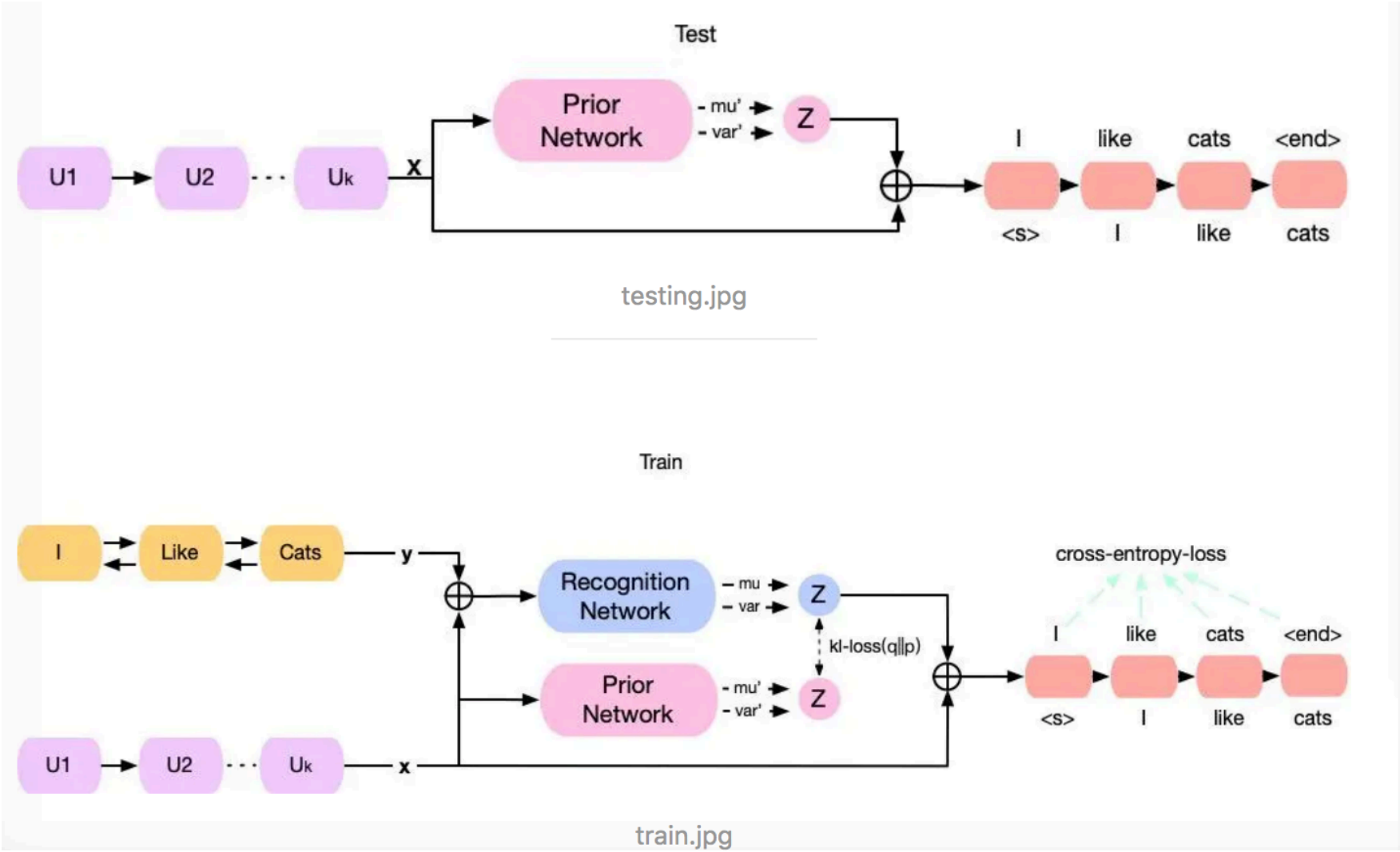


Figure 1: The CVAE model incorporated with question type embedding. $\bigoplus$ denotes the vector concatenation operation. In training process, approximated poster latent variable z obtained from recognition network, together with true question type l and post utterance U are concatenated for decoder process. At the same time, red dashed arrows refer to inference process, where we replace z with prior latent variable z' obtained from prior network, and replace l with predicted question type l' in decoder process.


Test
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- 假设隐变量服从的是一个高维高斯分布且其方差为对角矩阵,
- reparameterion trick 重参数技巧
- 采样”这个操作就不用参与梯度下降了，改为采样的结果参与，使得整个模型可训练了。

$$\mathbf{z}^{(i)} = \boldsymbol{\mu}^{(i)} + \boldsymbol{\sigma}^{(i)} \odot \boldsymbol{\epsilon} \quad \text{且} \quad \boldsymbol{\epsilon} \sim \mathcal{N}(0, \mathbf{I})。$$

$$\begin{aligned}\mathcal{L}_{CVAE} = & -KL(p_R(z|U,q,l)||p_P(z|U)) \\ & +E_{p_R(z|U,q,l)} log p_D(q|z,U,l) \\ & +E_{p_R(z|U,q,l)} log p_L(l|z,U)\end{aligned} \quad (1)$$

GRU-MatchPyramid Model

- So we introduce bi-directional GRU into MatchPyramid model's word level to capture higher level's word semantic

- matching matrix

- BiLSTM-------CNN-----pooling------score

RL-CVAE

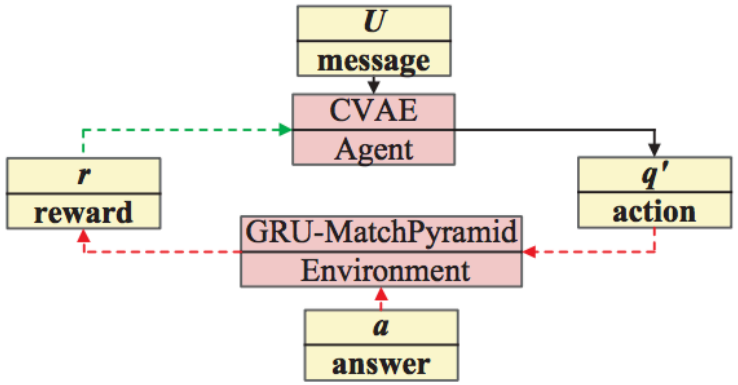

Figure 2: The CVAE with reinforcement learning (RL-CVAE). We formulate the CVAE model as an agent and pretrained GRU-MatchPyramid model as an environment in an RL framework. Solid arrows present the process of generating action q' (i.e. generated question) on the condition of state U (i.e. post). Red dashed arrows refer to agent's interaction process with the environment, where reward r is obtained by using action q' and answer a. Green dashed arrow refer to policy gradient optimization process with reward r.

- Specifically, for each question (ground truth) and answer pair (q,a) in the conversation generation training data, we randomly sample five negative questions q−, chosen from other posts' ground-truth responses.

$$\mathcal{L}_{coh} = max(\triangle - s(q,a) + s(q^{-},a),0) \quad (6)$$

$$r = \frac{{r_0}^{+} - min(R^{-}, {r_0}^{+})}{max(R^{-}, {r_0}^{+}) - min(R^{-}, {r_0}^{+})} \quad (7)$$

A-CVAE

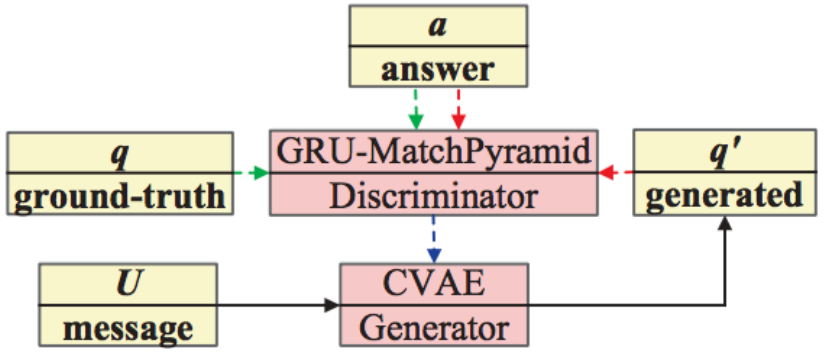

Figure 3: The CVAE with adversarial learning (A-CVAE). We formulate the CVAE as a generator and GRU-MatchPyramid as a discriminator using GAN. Solid arrows present the generation process of question q' conditions on post utterance U. Red dashed arrows refer to the adversarial learning process of negative instance (i.e. q' and answer a), and green dashed arrows refer to the positive instance (i.e. ground-truth question q and a). Blue dashed arrow refer to the back-propagation of the discriminator to the generator.

Question Generation Evaluation				
Models	RubA	RubG	Dist2	PPL
Seq2Seq	0.614	0.574	0.008	63.02
CVAE	0.682	0.649	0.112	20.39
STD	0.658	0.613	0.010	28.75
HTD	0.689	0.654	0.114	26.02
CVAE (qt)	0.688	0.652	0.114	20.03
A-CVAE	0.715	0.661	0.123	19.51
RL-CVAE	**0.720**	**0.668**	**0.185**	**16.93**

Table 2: Evaluation result of question generation.

无监督网络训练
负采样

The similarity is calculated via cosine similarity, and the relatedness is obtained by a neural network pretrained via utterance matching method

the geometric averaging (RubG) and arithmetic averaging (Ru- bA)

- Dataset 1160000 pair from reddit

- we categorize questions into 9 type- s, i.e. “what”, “when”, “where”,“who”,“why” “how”,“can (could)”,“do (did, does)”,“is (am, are, was, were)” according to interrogative words that are the most significant features to distinguish question types.

Models	A	S	W	Sum
seq2seq	0.486	0.208	0.196	0.890
CVAE	0.458	0.484	0.408	1.350
STD	0.504	0.322	0.272	1.098
HTD	0.528	0.486	0.406	1.420
CVAE(qt)	0.462	0.508	0.468	1.438
A-CVAE	0.540	0.578	0.514	1.632
RL-CVAE	**0.542**	**0.602**	**0.526**	**1.670**

Table 6: Results of human evalution based on criteria of appropriateness (A), semantic coherence (S) and willingness to answer (W).

Post	Generated Question	Answer
that's definitely a third party seller at amazon and not amazon .	Seq2Seq: is it a good thing? CVAE: and how is this an official app? STD: how do you like amazon? HTD: are you heavily subscribed to amazon? CVAE(qt): can you get the link? i'm just using the amazon box. **RL-CVAE: what's the difference between a third party seller and amazon ?** **A-CVAE: does the third party seller ship amazon fulfillment?**	it's still third seller so amazon usually ships the item as it was shipped to them but in a box. i would buy directly from amazon.
i don't know why so many people don't realize the duke o death is only free for returning players.	Seq2Seq: what's your point? CVAE: are you just about having fun? STD: what's the difference? HTD: are you returning player? CVAE(qt): are there any members in your opinion? **RL-CVAE: how much is it for normal players?** **A-CVAE: how to realize that? i'm on the list of returning players.**	it's 660k for normal players. and in the newswire they said all the returning player stuff would be free for returning players.