Stylized Dialogue Response Generation Using Stylized Unpaired Texts

Appendix A. WDJN dataset

We collected a dataset WDJN from the Weibo dialogues and Jinyong's novels to capture the writing style of Jinyong. The training data of the WDJN dataset involves two parts:

The first part, i.e., $\mathcal{D}_p$, contains dialogue pairs collected from Weibo[1]. Specifically, we collected a large number of dialogues on Weibo and employed professional annotators to filter out dialogues that are either grammatically incorrect or semantically incoherent to the post. This filtering process yields 300K dialogues pairs. We regard the writing style of these dialogue pairs in $\mathcal{D}_p$ as style S_0

The second part, i.e., $\mathcal{D}_s$, contains texts extracted from Jinyong's novels. Particularly, we extracted the texts that are wrapped in quotation marks as $\mathcal{D}_s$. These texts are named as "spoken utterances" in our study since they are mostly utterances issued by characters. Note that these spoken utterances in $\mathcal{D}_s$ are unpaired, and we regard the writing style of these texts in $\mathcal{D}_p$ as style S_1.

The testing data of the WDJN dataset $\mathcal{D}_t$ also involves two parts: The first part contains 2.0K additional dialogue pairs collected from Weibo. These dialogues are filtered using the same scheme as the dialogues in $\mathcal{D}_p$. The second part contains 2.0K dialogue pairs extracted from Jinyong's novel. Specifically, we regard two consecutive spoken utterances as a dialogue pair, since most of these utterances form coherent conversations. Note that the texts in $\mathcal{D}_s$ do not overlap with the texts in $\mathcal{D}_t$

Also note that to prevent the model from copying stylistic phrases in the post when producing Jinyong style response in the testing phase, we erase the stylistic features related to Jinyong's writing from the posts in these 2.0K Jinyong style dialogues in $\mathcal{D}_t$ using the back translation approach (Zhang, Ge, and Sun 2020). Specifically, these posts are first translated into English using our internal translation tools and then translated back to Chinese. This scheme ensures that most of the stylistic features related to Jinyong's writing are erased. Moreover, we manually checked and revised these translation results to further improve the resulting posts' quality.

[1]Weibo is one of the largest Chinese social media

Appendix B. Implementation Details of Dialogue Models

For the stylized dialogue model, the encoder and decoder are 12-layer transformers with 768-dimensional hidden states and 12 attention heads. For the position-wise feed-forward networks, 3,072-dimensional inner states are used. Moreover, the context length is set to 512, and the Adam optimizer is used to train our model with $\beta_1 = 0.9$, $\beta_2 = 0.98$ and $\epsilon = 10^{-9}$. The maximum learning rate is set to 9.25e-5 and 2.25e-4 for the WDJN and TCFC datasets, respectively. The training starts with a $warmupstep$ of 1,000, and the learning rate is annealed proportionally to the inverse square root of the step number. Batch size for the WDJN and TCFC dataset is set to 180 and 120 respectively, and the training stops after 8,000 updates (TCFC) or 10 iteration epochs on $\mathcal{D}_p$ (WDJN). A character-level vocabulary of size 13,084 is used for the WDJN dataset, and the BPE vocabulary introduced by Zhang et al. (2019) is used for the TCFC dataset. Other settings of our Transformer model follow the work of Radford et al. (2018) (WDJN) and Zhang et al. (2019) (TCFC). The inverse dialogue model shares the same hyperparameter setting with the stylized dialogue model.

We share the weights of the encoder and decoder in each dialogue model and initialize these weights using a pretrained GPT model. Specifically, for the experiments on the WDJN dataset, we pre-train a Chinese GPT model using a dataset collected from a set of Chinese novels, which cover a variety of genres (including Comedy, Romance, Mystery). The final pretraining corpus contains about 0.5 billion tokens, and the pretraining process lasts for a week on 8 GTX1080Ti GPUs. For the experiments on the TCFC dataset, we use the pre-trained DialoGPT model (size 345M) introduced by Zhang et al. (2019) to initialize the encoder and decoder.

During the joint training process, the pseudo posts are decoded from the inverse dialogue model using the top-K ($K = 20$) sampling scheme with beam search. Specifically, the beam size and length penalty is set to 4 and 2.2, respectively, for the WDJN dataset, and 2 and 1.0, respectively, for the TCFC dataset. The maximum decoded sequence length is set to 50 and 45 for the WDJN and TCFC datasets, respectively.

In the inference phase, we use the top-K ($K = 20$) de-

Dataset	Train		Test	
	S_0	S_1	S_0	S_1
Jinyong	94,893	90,167	5,107	4,892
TCFC	104,562	104,562	5,665	4,603

Table 1: Statistics of datasets for classifiers

coding scheme with beam search for the stylized dialogue models trained on the WDJN dataset. The beam size and length penalty is set to 4, and 2.0, respectively. For the stylized dialogue models trained on the TCFC dataset, a simple top-K sampling scheme with $K = 20$ is used.

The training of our model last for about 20 hours (WDJN) and 15 hours (TCFC) on 4 NVIDIA Quadro RTX 6000 GPUs. The number of parameters for our model are 191.01M (WDJN) and 248.88M (TCFC).

Note that due to the large computation loads to utilize the pre-training based method in our model and our baselines, we inherit most of the hyper-parameter settings from the previous studies, such as Radford et al. (2018); Zhang et al. (2019), and skip the hyper-parameter tuning process. Moreover, for fair comparisons, we use a fixed set of the hyper-parameters in all our experiments (including all the ablation models and the Transformer-based baselines).

Appendix C. Implementation Details of Style Classifiers

For style classifiers trained on the WDJN dataset, the response texts from Weibo dialogues and texts from Jinyong's novels are used as the positive and negative samples, respectively. For style classifiers on the TCFC dataset, the informal and formal texts provided in the GYAFC dataset (Rao and Tetreault 2018) are used as the positive and negative samples, respectively. Statistics of the train and test data are shown in Table 1.

The hyper-parameter settings and training details of each style classifier are given below:

BERT: We use the implementation provided by the "Transformers" library (Wolf et al. 2019). Specifically, our models follow the setting of "BERT-base" model, and the pre-trained weights "bert-base-chinese" and "bert-base-cased" are used for the WDJN and TCFC dataset, respectively. The fine-tuning process lasts for 3 epochs on our training data.

SVM: We first extract the embedding layer from the GPT model that is used to initialize our dialogue models, and map each token in the input sentence using this embedding layer to a 768-dimensional word vector. Then we average the embeddings of tokens from the same sentence and use the averaged vector as the sentence representation. A linear SVM classifier is built by taking these sentence representations as inputs. Specifically, the "LinearSVC" model with the default hyper-parameter setting in the "scikit-learn" library is used. The max iteration in the training process is set to 10,000 in our study.

Post:	Are they living together all the way? (他们一路住在一起吗？)
S_1 Response:	Where are they living all the way? (他们一路住在哪里？)
Post:	Mr. Cong Bian taught me. He was very clever. (从边先生教我他很聪明。)
S_1 Response:	Mr. Cong Bian taught me. (从边先生教我的。)
Post:	I'll help that girl find him later. (我以后会帮那个女孩找他。)
S_1 Response:	You'll help that girl find him later. (你以后会帮那个女孩找他。)

Table 2: Repeat phenomenon observed in WDJN Dataset. S_1 Responses are generated by our model.

Appendix C. Error Analysis

This appendix demonstrates some failure cases produced by our model.

As shown in Table 2, a "repeat" phenomenon is observed for the stylized dialogue model trained on the WDJN Dataset. Specifically, the model tends to copy phrases from the post when generating responses with style S_1, especially when the post exhibits some stylistic features related to S_1. This may be because that the texts in $\mathcal{D}_s$ and $\mathcal{D}_p$ of the WDJN dataset are from different domains, and the large discrepancy between these texts makes it hard for the inverse dialogue model to produce proper pseudo posts for some texts in $\mathcal{D}_s$. Therefore, the inverse dialogue model and stylized dialogue model fall into a sub-optimal solution of copying their inputs in order to minimize $\mathcal{L}_{inv}$. Some regularization terms can be designed to alleviate this issue, which we leave as a possible direction to explore in the future.

Note that the dialogue model trained on the TCFC dataset is free of this issue since the texts in $\mathcal{D}_s$ and $\mathcal{D}_p$ of the TCFC dataset are from the same domain.

Appendix D. More Cases

More outputs sampled from our stylized dialogue model are shown in Table 3.

References

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		TCFC dataset	WDJN dataset
	Post	It starts like a love theme, and then I guess driving around	I don't want to persist at all, but what else can I do? (心中一百万个不想坚持可又有什么办法)
S_0	S2S	it's a great day to be a stripper	Perseverance means victory (坚持就是胜利)
	SFusion	Well, if you're being a mort fan you're being paired with a Thompson text ;-)	I think you should cheer up (我觉得好好加油)
	Ours	I don't understand why people like this	Perseverance means victory (坚持就是胜利)
	Human	this song was playing during that whole sequence it sounded really awesome to me lol	I am also tired of going to work recently (我最近也特别厌烦上班)
S_1	SLM	Lol it sounds good to me.	Perseverance means victory (坚持就是胜利)
	SRL	I'm not a fan of the new album	Perseverance means victory (坚持就是胜利)
	SFusion	Sometimes you can see the analogy of some time in the world . . .	I think I am too (我觉得我也是)
	S2S+BT	He is going to sure if she is talking about butfavorites. Love YouThank you.	Aunt is victory. (姑姑就是胜利。)
	S2S+CT	I'm going to if I think you're sorry Fresole and family combine? Gross! You know ...	Come on, and you can be air, to win the grass - couple come to where it is（坚持上你就是空气，胜利这草-夫妻到所在）
	S2S+PTO	I'/ going to sure if you re talking about but!! Love You!	Perseverance means victory (坚持就是胜利)
	Ours	It is a love song, it is a car song.	Although you are not willing to do this, there is no other choice. (你心中一百万个不愿，又有什么法子。)
	Human	This song was being played during the whole sequence, it sounded amazing to me	N/A
	Post	can we talk about how cute supergirl is * ^ *	Ulcers in the mouth, both sides. They hurt even when I open the mouth (嘴里起溃疡,都长在两边了,张嘴都会痛)
S_0	S2S	yes. yes we should i love that show so much	Me too on both sides (我也长了两边)
	SFusion	i was looking for her today and i was like oh well	Drink more water and eat some pears. They're good to your lung and throat. They hurt (多喝水,吃点梨,润肺润喉咙,疼了)
	Ours	I've heard that it's cute but I have no clue where to start	Oh, ulcers in the mouth (嘴里长溃疡了啊)
	Human	i adore kara and melissa benoist is doing such a good job i'm in love wth everything!!!	Too much grilled fish, need more nightclubs (烤鱼吃多了,夜店去少了)
S_1	SLM	I have no idea. I can't	I don't know either (我也不知道啊)
	SRL	it's a good show, don't hate	Me too on both sides (我也长两边)
	SFusion	i was thinking about going to prom today	Eat more vegetables and fruits (多吃水果多吃蔬果)
	S2S+BT	You love supergirl. Thank you for youpoints.	Me too on both sides. (我也长了两边。)
	S2S+CT	I love supergirl or Your pleasure is better for see. Damelori, so good videos are our cycle.	I've grown up too. Life lies here to see you two just now. Come on. (我也长大了，命这里躺在类适才见你两位，加油。)
	S2S+PTO	I love supergirl. excited for you.	Me too on both sides (我也长了两边)
	Ours	I don't know the name of the show, but I have a cute supergirl friend.	I wish it were me that had the ulcers. (我嘴里起溃疡，那也罢了。)
	Human	I absolutely adore Kara. Melissa Benoist is doing such a great job. I am loving everything.	N/A
	Post	I waited for so long then fainted and can't see you guys anymore	Leave here (离开这里)
S_0	S2S	oh no :(Are you still in France	What happened (什么情况啊)
	SFusion	i feel like this was about your day, and i'm going to see you in the sleep	You're not gonna sleep? You must be disappointed in love again (再不睡觉,你又失恋了呢)
	Ours	I'm sorry babe I can't see you either :(	Where are you going (你要去哪里)
	Human	no one will let me find my friend oh no	N/A
S_1	SLM	I thought you were gone for a bit.	What happened? (怎么了？)
	SRL	I'm here now and I was asleep!	Leaving here, not leaving my home (离开这里,不是离开自己的家)
	SFusion	did your number get cancelled? Do you need anything?	Where to open again is where (再不再开的地方就在哪里)
	S2S+BT	He is here for your loss.	What? (什么？)
	S2S+CT	It is here for your ;-) never took it is more unattractive, call an episode at Loves..	What energy I right, noon doesn't want to fight it has a name. (什么能量老衲对了，中午不好战挺有名字啦。)
	S2S+PTO	I.'/ here for the loss	What happened (什么情况啊)
	Ours	I am sorry to tell you, but I have never been able to see you in the same way.	If you leave here then you'll never come back again. (你离开这里，便是永远不回来的了。)
	Human	Oh no! No one will let me find my friend	Yes, yes (是，是。)

Table 3: More model outputs