

## A Appendix

### A.1 Two-phase Training

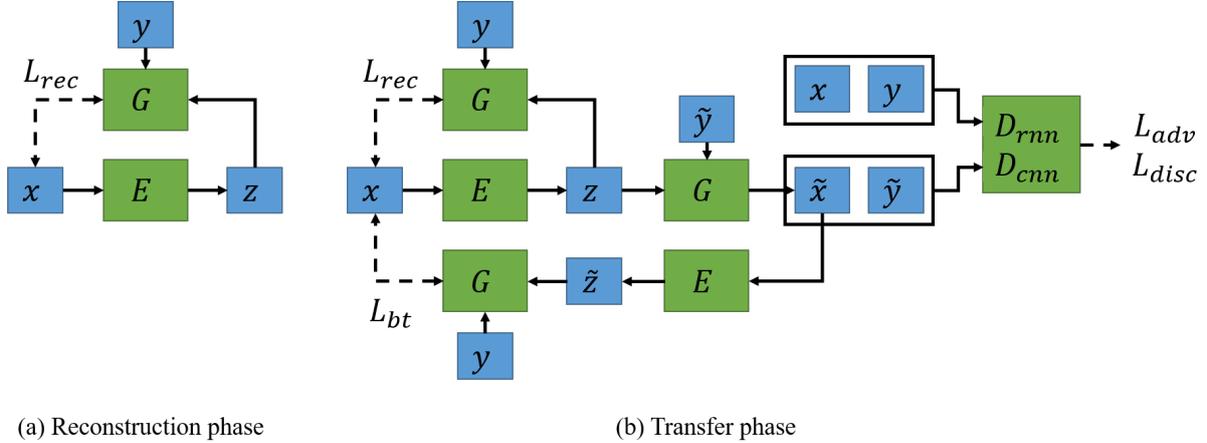


Figure 2: The diagram of two-phase training. (a) In reconstruction phase, we train our model with reconstruction loss  $L_{rec}$ . (b) In transfer phase, we train our model with reconstruction loss  $L_{rec}$ , back-translation loss  $L_{bt}$ , and adversarial loss  $L_{adv}$  and discrimination loss  $L_{disc}$ .

### A.2 Dataset Statistics

Table 5: The number of sentences of each attribute in three datasets.

Dataset	Attributes							
<i>YelpSent</i>	Negative	Positive						
	176787	267314						
<i>YelpTense</i>	Past		Present					
	Negative	Positive	Negative	Positive				
	219252	238560	200552	211566				
<i>AmaProd</i>	Book		Moive		Electronics		CD	
	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
	64424	73113	54169	64175	49658	57880	32596	43796

### A.3 Human Evaluation

To qualitatively evaluate the performances of our model, we compare it against 4 State-of-the-Art models: CAAE, MultiAttr, DAR, ContPrev. Each of the 5 models generates attribute-transferred sentences on *YelpSent*. We randomly select 20 source sentences and corresponding transferred sentences by each model. For each randomly selected source sentence, the 5 generated target sentences are shuffled and presented in a random order for comparisons. 8 people participate in the human evaluation, all with college-degree English proficiency. Participants are asked to compare and give scores to target sentences generated from each model, in terms of transfer attribute compatibility, content preservation, and fluency, respectively. Each aspect is rated on a 5-point Likert scale (1: lowest and 5: highest). Table 6 shows two demonstrative questions used in the human evaluation on *YelpSent*.

Table 6: Demonstrative questions used in the human evaluation on *YelpSent*

Transfer:	Negative → Positive
Source:	the food itself was overpriced and just okay .
Target:	(1) the food was delicious and the food was just okay . (2) the food was fresh and always fast . (3) the food itself was fresh and just okay . (4) the food was just delicious and . (5) so good !
Score:	Sentiment: (1)___ (2)___ (3)___ (4)___ (5)___ Content: (1)___ (2)___ (3)___ (4)___ (5)___ Fluency: (1)___ (2)___ (3)___ (4)___ (5)___
Transfer:	Positive → Negative
Source:	simply the best dive bar in valley .
Target:	(1) just the worst . (2) overnight i see that the price has gone up a dollar . (3) simply the worst dive bar in most . (4) probably the worst italian restaurant in the valley . (5) also the worst hotel in the bar in vegas .
Score:	Sentiment: (1)___ (2)___ (3)___ (4)___ (5)___ Content: (1)___ (2)___ (3)___ (4)___ (5)___ Fluency: (1)___ (2)___ (3)___ (4)___ (5)___

#### A.4 Model and Training Settings

The settings of our model and training are similar to the previous works (Shen et al., 2017; Yang et al., 2018; Logeswaran et al., 2018). For our encoder-decoder ( $E, G$ ), we use two GRU recurrent networks with 300 units. For our discriminator  $D_{rnn}$ , we use a bi-directional GRU with 300 units for each direction. We set the size of word embedding to be 100. All attributes are jointly represented as a one-hot vector, and we use a linear projection to generate a 100-dimensional embedding vector. For optimization, we use the Adam optimizer (Kingma and Ba, 2014). The training hyper-parameters are selected based on the results on the validation set, and we use grid search to choose the best configuration. The learning rate is selected from  $\{1e-3, 5e-4, 1e-4\}$ . The batch size is selected from  $\{32, 64, 128, 256\}$ . The weight of the adversarial loss  $L_{adv}$  is selected from  $\{1, 3, 5, 10\}$ .

## A.5 Quantitative Comparison

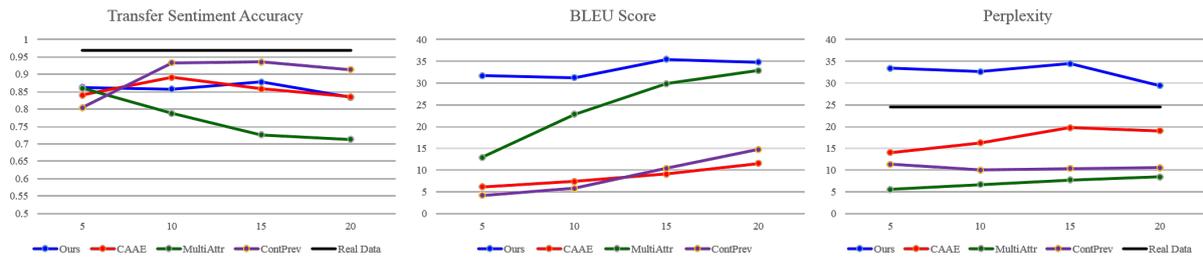


Figure 3: The curves of transfer sentiment accuracy, BLEU score, and perplexity among our models and other state-of-the-arts on *YelpSent*.

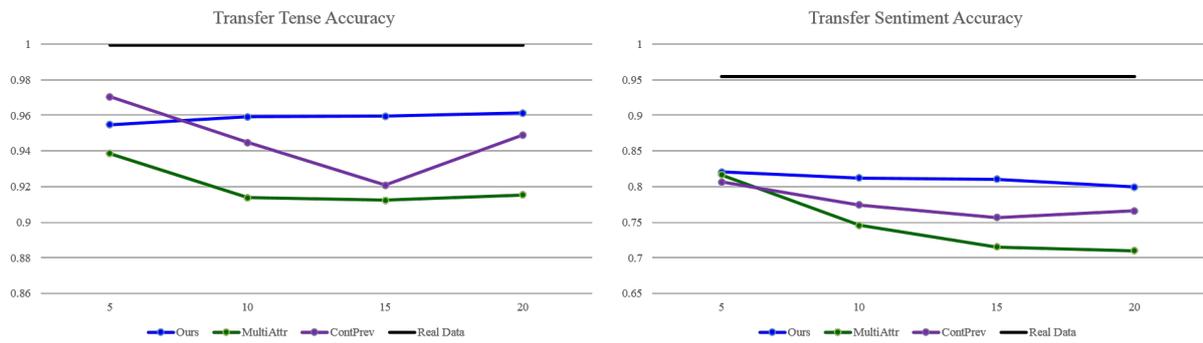


Figure 4: The curves of transfer sentiment and tense accuracy among our models and other state-of-the-arts on *YelpTense*.

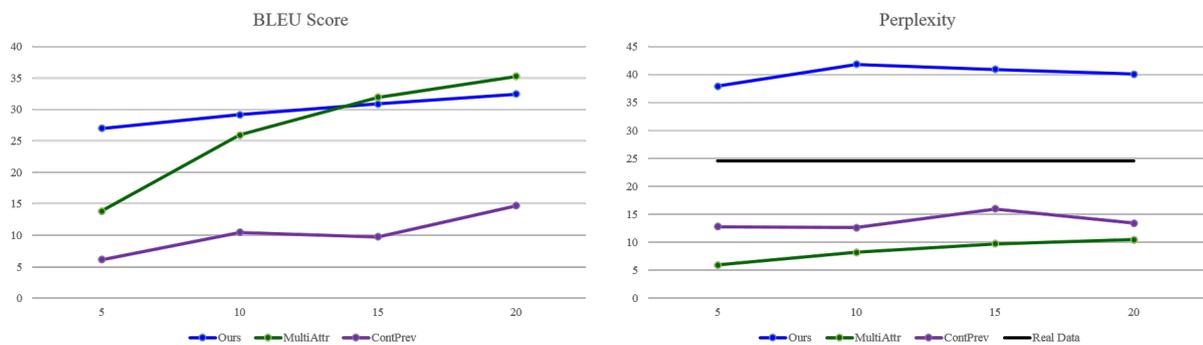


Figure 5: The curves of BLEU score and perplexity among our models and other state-of-the-arts on *YelpTense*.

## A.6 Qualitative comparison

Table 7: Samples of polarity style transfer on *YelpSent*, *AmaSent*

<i>YelpSent</i> : negative → positive	
Original	the egg drop soup smelled like a wet dog and looked pretty gross too .
Our model	the egg drop soup smelled like a marvelous dog and pretty delicious pretty !
CAAE	the beef pork and a bit perfectly perfectly and a fresh too like great bread !
DAR	i recommend the sushi bar whenever seats are available .
MultiAttr	the green beans are a must , and it 's so good !
ContPrev	the egg roll with a fresh and fresh and super delicious .
<i>YelpSent</i> : positive → negative	
Original	they work with various dietary restrictions , make excellent dishes for large groups .
Our model	they only work with minimal profession , only want large dishes for groups .
CAAE	they do n't work , their chips or and i were more with _num_ .
DAR	very disappointed with this vet center .
MultiAttr	they do n't care with their customers , or any other options for lunch .
ContPrev	they charge me for _num_ minutes , for _num_ minutes .
<i>AmaSent</i> : negative → positive	
Original	would not suggest purchase of batteries with charger .
Our model	would definitely purchase with my computer with charger .
CAAE	will be worth any of of love .
DAR	it runs cool and the stock ( is worth plug .
MultiAttr	i would definitely recommend this for any of the cables .
ContPrev	would recommend for these products .
<i>AmaSent</i> : positive → negative	
Original	i highly recommend this to anyone who is looking for a similar solution .
Our model	i wouldn't recommend this to anyone who is looking for a similar solution .
CAAE	i could recommend this book to anyone to be a lot of a disappointment .
DAR	original package but seems the item was previously used .
MultiAttr	i would recommend this book to anyone who is a little reliable .
ContPrev	i wouldn't recommend this to anyone who is a .

Table 8: Samples of multiple-attribute style transfer on *YelpTense*, and *AmaProd* dataset

<i>YelpTense</i> : (past, negative) → (present, positive)	
Original	i think that's really ridiculous especially when their service sucked .
Our model	i think it's really great especially when their service rocks .
MultiAttr	i think that's really worth the time when their service is awesome .
ContPrev	i really love how much .
<i>YelpTense</i> : (past, positive) → (present, negative)	
Original	they were extremely professional and clean with the repairs .
Our model	they are extremely unprofessional and dirty with the repairs .
MultiAttr	they are extremely unprofessional and not professional with the repairs .
ContPrev	they are extremely unprofessional and not .
<i>YelpTense</i> : (present, positive) → (past, negative)	
Original	this place is a definite must try when you go to vegas .
Our model	this was a total disappointment try if you went to to vegas .
MultiAttr	this place is a must try if you go to vegas when you go .
ContPrev	this place was a must try to go to the .
<i>YelpTense</i> : (present, negative) → (past, positive)	
Original	and the food at the farm is almost inedible .
Our model	and the food at the house was almost fantastic .
MultiAttr	and the food at the bar is almost almost packed .
ContPrev	the food and the chicken was delicious as well .
<i>AmaProd</i> : (book, negative) → (movie, positive)	
Original	i really do feel i wasted my time on this egotistical book .
Our model	i really did i look my time for this dvd christmas movie .
MultiAttr	i really really really enjoy my time on this movie .
ContPrev	i really i have this movie in my car .
<i>AmaProd</i> : (electronic, positive) → (CD, negative)	
Original	i purchased this mount a few months ago .
Our model	i hate this cd a few months ago .
MultiAttr	i bought this album a few years ago .
ContPrev	this cd sucks .
<i>AmaProd</i> : (book, positive) → (movie, negative)	
Original	the author kept my attention throughout the entire book .
Our model	the film could've my attention throughout the entire movie .
MultiAttr	the movie kept me glued to the entire entire movie .
ContPrev	the film gets too long .
<i>AmaProd</i> : (electronic, negative) → (CD, positive)	
Original	the ac module will not fit in a standard wall box .
Our model	the american artist will always enjoy a recording in her life .
MultiAttr	the junk <sub>ζ</sub> junk <sub>ζ</sub> will not be the best in the world of the album .
ContPrev	the junk <sub>ζ</sub> junk <sub>ζ</sub> album will a great job in the .