Learning to Write with Cooperative Discriminators: Supplementary Material

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Abstract

We describe hyperparameters and details of our model training and evaluation.

3 The Learning Framework

3.1 Base Language Model

We use a 2-layer GRU (Cho et al., 2014) with a hidden size of 1024 for each layer. Following (Inan et al., 2017) we tie the input and output embedding layers' parameters. We use an Adaptive Softmax for the final layer (Grave et al., 2016), which factorizes the prediction of a token into first predicting the probability of k (in our case k = 3) clusters of words that partition the vocabulary and then the probability of each word in a given cluster. To regularize we dropout (Srivastava et al., 2014) cells in the output layer of the first layer with probability 0.2. We use mini-batch stochastic gradient descent (SGD) and anneal the learning rate when the validation set performance fails to improve, checking every 1000 batches. Learning rate, annealing rate, and batch size were tuned on the validation set for each dataset. Gradients are backpropagated 35 time steps and clipped to a maximum value of 0.25.

3.2 Cooperative Communication Models

For all the models except the entailment model, training is performed with Adam (Kingma and Ba, 2015) with batch size 64 and learning rate 0.01. The classifier's hidden layer size is 300. Dropout is performed on both the input word embeddings and the non-linear hidden layer before classification with rate 0.5.

Word embeddings are kept fixed during training for the repetition model, but are fine-tuned for all the other models.

3.2.2 Entailment Model

We mostly follow the hyperparameters of Parikh et al. (2016): Word embeddings are projected to a hidden size of 200, which are used throughout the model. Optimization is performed with AdaGrad (Duchi et al., 2011) with initial learning rate 1.0 and batch size 16. Dropout is performed at rate 0.2 on the hidden layers of the 2-layer MLPs in the model.

Our entailment classifier obtains 82% accuracy on the SNLI validation set and 68% accuracy on the MultiNLI validation set.

3.2.3 Relevance Model

The convolutional layer is a one-dimensional convolution with filter size 3 and stride 1; the input sequences are padded such that the input and output lengths are equal.

4 Experiments

4.1 Corpora

For the language model and discriminators we use a vocabulary of 100,000 words - we found empirically that larger vocabularies lead to better generation quality. To train our discriminators and evaluate our models, we use segments of length 10, using the first 5 sentences as context and the second 5 as the reference continuation. For TripAdvisor we use the first 10 sentences of reviews of length at least 10. For the BookCorpus we split books into segments of length 10. We select 20%of each corpus as held-out data (the rest is used for language model training). From the held-out data we select a test set of 2000 examples and two validation sets of 1000 examples each, one of which is used to train the mixture weights of the decoding objective. The rest of the held-out data is used to train the discriminative classifiers.

4.2 Baselines

CACHELM Due to memory constraints, we use a vocabulary size of 50k for CACHELM. Beam search decoding is used, with a beam size 5.

SEQGAN The implementation we used adds a number of modelling extensions to the original SeqGAN. In order to make training tractable, the vocabulary is restricted to 25k words, the maximum sequence length is restricted to 250, Monte Carlo rollouts to length 4, and the discriminator updated once for every 10 generator training steps. Greedy decoding sampling with temperature 0.7 was found to work better than beam search.

SEQ2SEQ Due to memory constraints, we use a vocabulary size of 50k for SEQ2SEQ. Beam search decoding is used, with a beam size 5.

4.3 Evaluation Setup

The forms used on Amazon Mechanical Turk are pictured in Tables 1, 2, 3, and 4.

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BookCorpus

this task you will be provided wi e'd like you to tell us whether yo	th 5 sentences from the middle of a boo u agree or disagree with the statements	ok, and 2 possible continu below, which compare a	ations. nd contrast the two continuations	5.
ank you!				
isk				
Beginning The cat figure leaned for formation Fext: who was in that room was in tha	nward and spoke quietly his voice resonati vas an assassin, sent by evil men to kill ou	ng in the room. You were ir r queen. Jared looked puzzl	i mortal danger when I chanced up ed and mordalayn paused. Do, do y	on you in the hospital. The creature you mean sophie?
Continuation:				
Continuation A What is wron	g with you?" "I don't know. I didn't know. know." "you have nothing to say.	I don't Continuation	DN B "I 'm sure he didn't mean to not. It was just a	kill him." She shook her head. "no, dream." "what happened?"
estion 1: Repetitiveness				
ompare the continuations base	d on their renetitiveness . A good cont	inuation DOFS NOT repe	at details from earlier in the cont	tinuation or from the first 5
entences.	u on their repetitiveness. A good com			
Repetition Good/Bad Examp	les (Expand/Collapse)			
Beginning				
" They'd been waiting for a wh	lo and Molicca had given in to temptati	on and was norusing a m	azzina rack in one of the mini-m	alls located a few feet from
They a been waiting for a win	ie and menssa nad given in to temptati	on and was perusing a ma	10azine rack in one or the mini-m	
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Table 1: The first half of the form for the BookCorpus human evaluation.

Compare the continuations based on ti sentences (as opposed to being generic Relevance Good/Bad Examples Beginning "She was left with a scar on her show	neir relevance with t or unrelated). (Expand/Collapse)	he beginning. A good continuation sh	nould provide a specific and logical e	xtension to the first five
Relevance Good/Bad Examples Beginning "She was left with a scar on her shot	(Expand/Collapse)			
Beginning "She was left with a scar on her show				
"She was left with a scar on her shou				
	ulder, the only remine	der of that night, a night filled with fe	ear, but also with the revelation of Re	oberto's love for her."
The following continuation is GOOI) as it continues th	e beginning in a detailed and sen	sical way.	
"The doctor assured her that wit	h time it too would fa	de. She kept her hair over the should	der to cover it from public view"	
The following continuation is BAD	as it is <u>generic</u> and	difficult to relate back to the beg	jinning.	
• <u>She didir t want to be here.</u> She	<u>coulant stay.</u> She h	<u></u>		
tatement: Continuation A is LESS re	elevant (more generi	c or unrelated) than Continuation E	3.	
Strongly Agree	Agree	They're roughly the same	Actually, Continuation B is a little	Continuation B is much MO
,		,	MORE generic or unrelated	generic or unrelated than Continuation A
the to Conference				
stion 4: Confusion				
mpare the continuations based on ho	ow confusing they a	re. A good continuation is clear and u	inderstandable.	
Confusion Good/Bad Examples	Expand/Collapse)			
Reginning				
'It is with great regret that I find mys found myself, I have tried to bear in mi	self standing before to nd my abilities and co	his court this morning. I have always ontrol my impulses."	tried to conduct myself honorably.	In every situation I have ever
The following continuation is GOOD	because it is clear	and understandable.		
 "Mister Morgan however, and I do provoked my patience by slashin. 	o sincerely regret his	comatose state, would not let the ma	atter, as presented before the court	in detail, rest. He continuous
The following continuation is BAD b	ecause it is confus	ing and hard to understand.		
 "<u>I don't know what I've done or v</u> 	vhat I can do, but I d	o it. You can do it. I know you do"		
atement: Continuation A is MORE c	onfusing than Conti	nuation B.		
0	0	0	0	0
Strongly Agree	Agree	They're roughly the same	Actually, Continuation B is a little MORE confusing	Continuation B is much MOI confusing
al Question: Overall Quality				
Which continuation do you think is bet	ter overall given the	e beginning?		
tatement: Continuation A is overall	a WORSE ending for	r the beginning than Continuation B		
	a words chaing to			
Disagree (Continuation B is overall W	ORSE)			
Both endings would be equally good (or	bad)			
anks! If you have any feedback or c	omments for us, fee	el free to leave them here:		

Table 2: The second half of the form for the BookCorpus human evaluation.

TripAdvisor

Instructions						
In this tack you will	be provided with the firs	t E contoncos of a botal ray	viow and 3 page	sible continuation	or for the review	
In this task you will	be provided with the firs	t 5 sentences of a noter rev	view, and z pos	sible continuation	is for the review.	
We'd like you to tel	l us whether you agree of	r disagree with the stateme	ents below, whic	h compare and o	contrast the two continuations.	
Thank you!						
Task						
Basing We stay	ed at the hampton inn for a	a week in mid-aug and thoug	ht the hotel was	very good. Had re	quested a room on a high floor that overlooked the pool, and t	his was
Text: wave wi	what we got. The room was	s clean and spacious, althoug	h surprisingly did	in't have either a	safe or a fridge. We had arrived in orlando in the middle of a he	eat
them as	a makeshift drinks cooler!	te find 903 and really needed	Somewhere to c		on, etc. 50 we ended up having to order a second ice backet a	nu use
Continuation:						
	The staff at the front der	sk were very friendly, and he	lped us with			
	our bags, even though we and we had no problem	e didn't use them, they were s. The hotel is in a great local	very helpful, tion, on the		We also didn't drink the tap water (there's a tesco nearby about \$ 1, 50 to wash & restock, and they'll store your lug	y! It's gage if
	edge of the old town, and	only about a 15 minute walk	to the heart		you're staying for more than one night and don't want to sp	end an
Continuation A	it is just a short bus ride	or a cab ride to the old town.	All in all, we	Continuation I	eat, etc. I would probably stay here again because of its lo	cation,
	recommend this hotel to	our friends, and wouldn't hes	, and would sitate to stay		but don't be fooled by the "free breakfast " - this notel does the " continental breakfast ", with " fresh " fruit juice, " cerea	al, " or "
	here again. The only thin	I would say is that you nee wi-fi	ed to pay for		milk " and " do-it-yourself " waffles. I'm a sucker.	
Question 1: Repe	titiveness					
Compare the con	tinuations based on the	ir repetitiveness . A good	continuation DC	DES NOT repeat	details from earlier in the continuation or from the beginni	ng of
the review.						
Repetition Go	od/Bad Examples (E	<u>xpand/Collapse)</u>				
Beginning						
"The pool is v	ery nice with a lazy river.	н				
The following	continuation is GOOD a	is it does not repeat pre	vious content.			
 "Our kids 	had a good time. There's	; beach volleyball, bikes, go	olfing, etcplus	s you get to enjo	y the activities the Ritz has"	
The following	continuation is BAD as	it <u>repeats</u> many words a	and phrases.			
• " <u>The pool</u>	<u>is great</u> , and the gym is	well equipped. <u>The pool is</u>	<u>very nice</u> , and a	nice place to re	lax"	
Statement: Con	tinuation A repeats itse	elf MORE than Continuati	on B.			
Strongly	Agree	Agree	They're rough	ly the same	Actually, Continuation B repeats Continuation B repeats	
				,		itself
					itself a little MORE much MORE than Continu	itself Iation A
					itself a little MORE much MORE than Continu	itself Iation A
					itself a little MORE much MORE than Continu	itself Iation A
Question 2: Contra	diction				itself a little MORE much MORE than Continu	itself Iation A
Question 2: Contra	adiction				itself a little MORE much MORE than Continu	itself ation A
Question 2: Contra	adiction	much they contradict the	mselves or the	beainning of the	itself a little MORE much MORE than Continu	itself
Question 2: Contra Compare the contri beginning of the re	adiction inuations based on how view.	much they contradict the	mselves or the	beginning of the	review. A good continuation should NOT contradict itself of	itself
Question 2: Contra Compare the conti beginning of the re	idiction inuations based on how view.	much they contradict the	mselves or the	beginning of the	review. A good continuation should NOT contradict itself of	itself
Question 2: Contra Compare the contri beginning of the re Contradiction (adiction inuations based on how :view. 300d/Bad Examples	much they contradict the	mselves or the	beginning of the	review. A good continuation should NOT contradict itself of	itself ation A
Question 2: Contra Compare the conti beginning of the re Contradiction (inuations based on how view. 300d/Bad Examples	much they contradict the (Expand/Collapse)	mselves or the	beginning of the	review. A good continuation should NOT contradict itself of	or the
Question 2: Contra Compare the conti beginning of the re Contradiction (Beginning	inuations based on how view. 300d/Bad Examples	much they contradict the (Expand/Collapse)	mselves or the	beginning of the	review. A good continuation should NOT contradict itself of	br the
Question 2: Contra Compare the conti beginning of the re Contradiction (Beginning "I did find the g	inuations based on how view. Good/Bad Examples gentleman at the conciens	much they contradict the (Expand/Collapse) ye desk a bit cold."	mselves or the	beginning of the	review. A good continuation should NOT contradict itself of	or the
Question 2: Contra Compare the contr beginning of the re Contradiction (Beginning "I did find the g The following c	adiction inuations based on how wiew. Good/Bad Examples gentleman at the concieng ontinuation is GOOD as	much they contradict the (Expand/Collapse) 7e desk a bit cold."	mselves or the	beginning of the	review.	or the
Question 2: Contra Compare the contr beginning of the re Contradiction (Beginning "I did find the g The following c • "He told m	adiction inuations based on how wiew. Good/Bad Examples gentleman at the conciens ontinuation is GOOD as e to wait in line to print b	much they contradict the (Expand/Collapse) ge desk a bit cold." 5 it does not contradict i voarding passes but when a	mselves or the tself or the be	beginning of the ginning of the	review. review. hom being held there at the hotel came up he printed hers so	or the
Question 2: Contra Compare the contr beginning of the re Contradiction (Beginning "I did find the g The following c I did mathematical and the set The following c	adiction inuations based on how view. Good/Bad Examples gentleman at the concierg ontinuation is GOOD as e to wait in line to print b to wait in line"	much they contradict the (Expand/Collapse) ge desk a bit cold." s it does not contradict i voarding passes but when a	mselves or the tself or the be	beginning of the ginning of the he AAA conventio	review. n being held there at the hotel came up he printed hers so	or the
Question 2: Contra beginning of the re Contradiction (Beginning "I did find the g The following c • "He told m didn't have The following c	adiction inuations based on how view. Good/Bad Examples gentleman at the conciency ontinuation is GOOD as e to wait in line to print b t to wait in line"	much they contradict the (Expand/Collapse) ge desk a bit cold." s it does not contradict i voarding passes but when a t contradicts the beginn	mselves or the tself or the be woman from the ing of the revi	beginning of the ginning of the he AAA convention ew.	review. A good continuation should NOT contradict itself of review. methods by the set of the	or the
Question 2: Contra Compare the conti beginning of the re Contradiction (Beginning "I did find the g The following c • "He told m didn't have The following c • "However,	adiction inuations based on how view. Good/Bad Examples gentleman at the concient ontinuation is GOOD as e to wait in line" ontinuation is BAD as i he was very friendly"	much they contradict the (Expand/Collapse) ge desk a bit cold." s it does not contradict i noarding passes but when a t <u>contradicts</u> the beginn	mselves or the tself or the be a woman from the ing of the revi	beginning of the ginning of the he AAA convention ew.	review. A good continuation should NOT contradict itself of review. Preview. In being held there at the hotel came up he printed hers so	or the
Question 2: Contra beginning of the re Contradiction (Beginning "I did find the g The following c • "He told m didn't have The following c • "However,	adiction inuations based on how view. Good/Bad Examples gentleman at the conciency ontinuation is GOOD as e to wait in line to print b t to wait in line to print b t to wait in line" ontinuation is BAD as i he was very friendly"	much they contradict the (Expand/Collapse) ge desk a bit cold." s it does not contradict i noarding passes but when a t contradicts the beginn	mselves or the tself or the be a woman from the ing of the revi	beginning of the ginning of the he AAA convention ew.	review. n being held there at the hotel came up he printed hers so	or the
Question 2: Contra beginning of the re Contradiction O Beginning "I did find the g The following c The following c The following c The following c The following c The following c	adiction inuations based on how view. Good/Bad Examples gentleman at the concient ontinuation is GOOD as e to wait in line" ontinuation is BAD as i he was very friendly" nuation A contradicts	much they contradict the (Expand/Collapse) ge desk a bit cold." s it does not contradict i noarding passes but when a it contradicts the beginn tself MORE than Continu	mselves or the tself or the be a woman from the ing of the revi ation B.	beginning of the ginning of the he AAA convention ew.	review. n being held there at the hotel came up he printed hers so	or the
Question 2: Contra beginning of the re Contradiction of Beginning "I did find the g The following c The following c The following c The following c The following c	adiction inuations based on how view. Good/Bad Examples gentleman at the concient ontinuation is GODD as e to wait in line" ontinuation is BAD as i he was very friendly" nuation A contradicts i here	much they contradict the (Expand/Collapse) ge desk a bit cold." s it does not contradict i noarding passes but when a it contradicts the beginn itself MORE than Continu	mselves or the tself or the be a woman from the ing of the revi ation B.	ginning of the ginning of the he AAA convention ww.	review. A good continuation should NOT contradict itself of review. In being held there at the hotel came up he printed hers so	or the
Question 2: Contra beginning of the re Contradiction of Beginning "I did find the g The following c I the told m didn't have The following c	adiction inuations based on how view. Good/Bad Examples gentleman at the concient ontinuation is GOOD as e to wait in line" ontinuation is BAD as i he was very friendly" nuation A contradicts i Agree	much they contradict the (Expand/Collapse) ge desk a bit cold." s it does not contradict i hoarding passes but when a it contradicts the beginn itself MORE than Continu Agree	mselves or the tself or the be a woman from the ing of the revi ation B.	ginning of the ginning of the he AAA convention ww.	review. A good continuation should NOT contradict itself of review. In being held there at the hotel came up he printed hers su Actually, Continuation B Continuation B contradict und MORE than Continuation	or the o she

Table 3: The first half of the form for the TripAdvisor human evaluation.

If a saw, NO, LOUILERIOW, I	RE confusing than Contin Agree	nuation B.	Actually, Continuation B is a little	Continuation B is much MC confusing
 "He then told us that they as online booking" The following continuation is B "He sold "No. I dock for the sold" 	re completly booked and the	nere was nothing he could do. He we ng and <u>hard to understand</u> .	ent on to blame the problem in the o	corporate office who runs the
Beginning "I showed them the email that I the hotel to confirm it, I said no is. The following continuation is G	had printed out with the co n't that the point of the hot OOD because it is clear :	onfirmation number and the desk pe tel sending me the email with a conl and understandable.	erson said that it didn't help him at a firmation number?"	all. He then asked me if I cal
ompare the continuations based Confusion Good/Bad Example:	on how confusing they are (<u>Expand/Collapse</u>)	e. A good continuation is clear and u	understandable.	
estion 4: Confusion				
Strongly Agree	Agree	They're roughly the same	Actually, Continuation B is a little MORE generic or unrelated	Continuation B is much MO generic or unrelated than Continuation A
" <u>If you want to feel like yo</u> Statement: Continuation A is LE	u are on vacation, this is no SS relevant (more generic	<u>ot for you</u> " c or unrelated) than Continuation B	L.	
The following continuation is	BAD as it is <u>generic</u> , as w	vell as being <u>unrelated</u> to the beg	jinning of the review.	
The following continuation is	GOOD as it continues the	e beginning in a detailed and sen	sical way.	
Beginning	a huga lobby guilded in ligh	t marble with a fountain "		
Relevance Good/Bad Exampl	es (Expand/Collapse)			

Thanks! If you have any feedback or comments for us, feel free to leave	ave them here:	
		1.
	Submit	

Table 4: The second half of the form for the TripAdvisor human evaluation.