A Hierarchical Reinforced Sequence Operation Method for Unsupervised Text Style Transfer

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Outline

Background

Our Approach

Main Experiment

Take-Home Messages

Outline

Background

Unsupervised Text Style Transfer

☺ I will be going back and enjoying this great place !

→ ☹ I won't be going back and suffering at this terrible place !

Training data (Unsupervised)

- $\mathcal{X}_1 = \{x_1^{(1)}, \cdots, x_1^{(n)}\}$ of style s_1
- $\mathcal{X}_2 = \{x_2^{(1)}, \cdots, x_2^{(m)}\}$ of style s_2
- Non-aligned!

Goal

- $p(x_{1\to2}|x_1)$ that transfers style s_1 into style s_2
- $p(x_{2\to1}|x_2)$ that transfers style s_2 into style s_1

Prior Work

Disentanglement Approach
Disentangling latent style and content[1,2,3]

Two-step Approach
Neutralization (deletion) + stylization (reconstruction)[4,5]

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[1]Hu et al. "Toward Controlled Generation of Text". *ICML-17*.

[2]Fu et al. "Style Transfer in Text: Exploration and Evaluation". *AAAI-18*.

[3]John et al. "Disentangled Representation Learning for Non-Parallel Text Style Transfer". *ACL-19*.

[4]Li et al. "Delete, Retrieve, Generate: A Simple Approach to Sentiment and Style Transfer". *NAACL-HLT-18*.

[5]Xu et al. "Unpaired Sentiment-to-Sentiment Translation: A Cycled Reinforcement Learning Approach". *ACL-18*.

Challenges

Poor Content Preservation

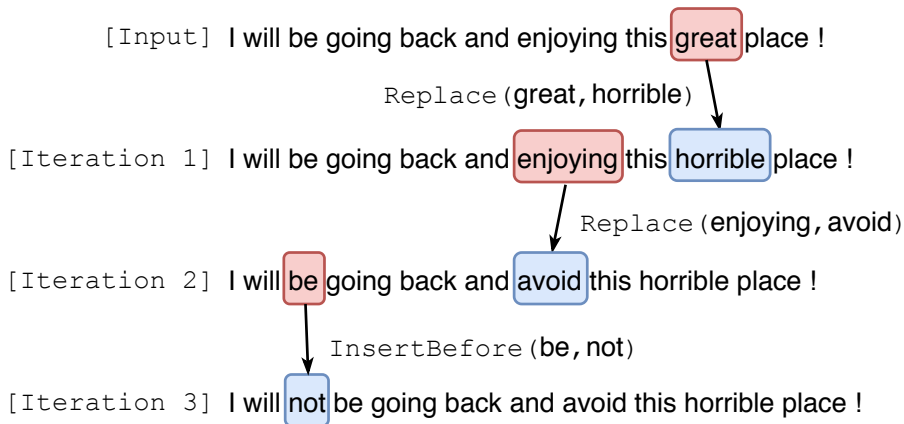| Original	staffed primarily by teenagers that do n't understand customer service .
Li et al. (2018)	staffed , the best and sterile by flies , how fantastic customer service .
Xu et al. (2018)	staffed established each tech feel when great customer service professional .
Zhang et al. (2019)	staffed distance that love customer service .

Lack of Interpretability

Outline

An Example Case

[Input] I will be going back and enjoying this great place !

Replace(great, horrible)

[Iteration 1] I will be going back and enjoying this horrible place !

Replace(enjoying, avoid)

[Iteration 2] I will be going back and avoid this horrible place !

InsertBefore(be, not)

[Iteration 3] I will not be going back and avoid this horrible place !

A Hierarchy of Agents

The Options Framework
An HRL framework proposed by
Sutton et al. (1999)

High-Level Agent
Propose a position to be operated
around

Low-Level Agent
Select an operator from the table
and generate a word $\hat{w}$ (*optional*)

| Operator	Operation
IF_{ϕ_1}	**I**nsert a word $\hat{w}$ in the **F**ront
IB_{ϕ_2}	**I**nsert a word $\hat{w}$ **B**ehind
Rep_{ϕ_3}	**Rep**lace the word with $\hat{w}$
DC	**D**elete the **C**urrent word
DF	**D**elete the word in the **F**ront
DB	**D**elete the word **B**ehind
Skip	Do not change anything

Graphical Overview for Training
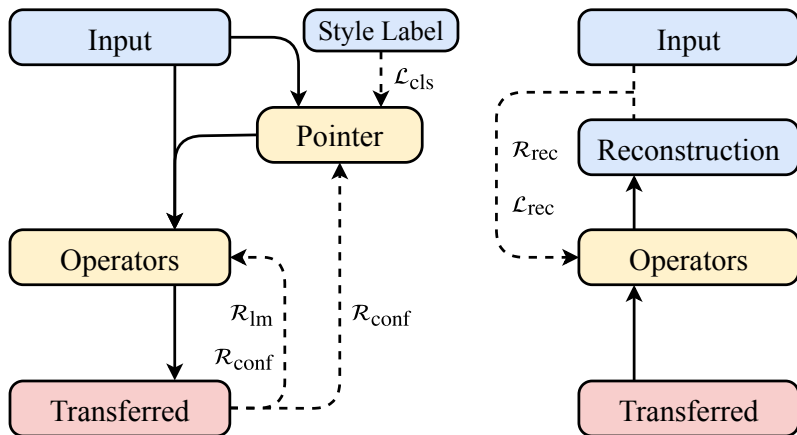
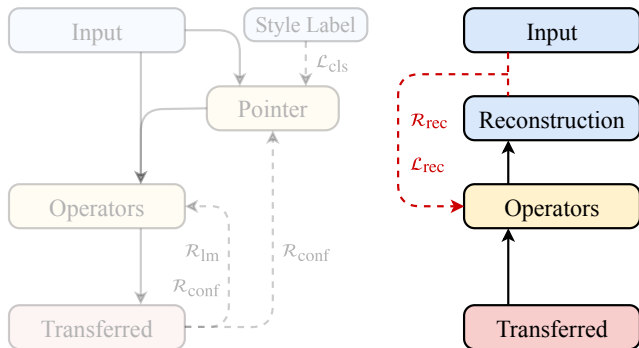# Hierarchical Policy Learning

- Language model reward
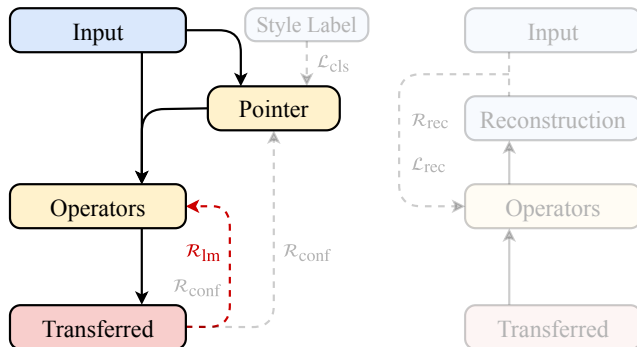
Hierarchical Policy Learning

- Classification confidence reward
- Auxiliary task: style classification
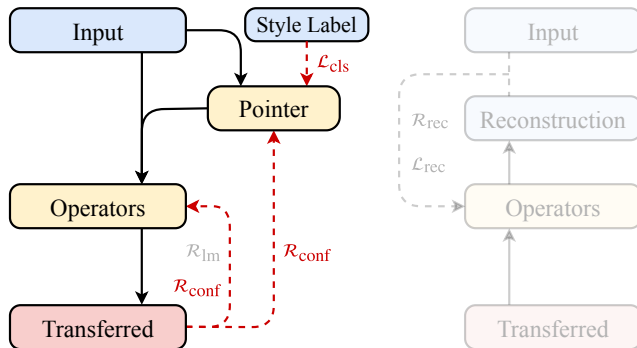
Hierarchical Policy Learning

- Self-supervised reconstruction loss
- Reconstruction reward

Single-Step Training + Multi-Step Inference

Single-Step Training

- Only *one* modification in each episode

Iterative and Dynamic Inference

- Enumerate the operators and select the *best* one in each iteration
- Greedy modifications
- Mask-mechanisms
- Until the sentence does not show the original style anymore
  (or beyond maximum iterations)

Outline

Automatic Evaluation

	Yelp		Amazon	
	Acc	BLEU	Acc	BLEU
CrossAligned	74.7	9.06	75.1	1.90
MultiDecoder	50.6	14.54	69.9	9.07
StyleEmbedding	8.4	21.06	38.2	15.07
TemplateBased	81.2	22.57	64.3	34.79
DeleteOnly	86.0	14.64	47.0	33.00
Del-Ret-Gen	88.6	15.96	51.0	30.09
BackTranslate	94.6	2.46	**76.7**	1.04
UnpairedRL	57.5	18.81	56.3	15.93
UnsuperMT	**97.8**	22.75	72.4	33.95
Human	74.7	-	43.2	-
Point-Then-Operate	91.5	**29.86**	40.2	**41.86**

- Classification accuracy is low for human references
- BLEU of our method outperforms baselines by a large margin

Human Evaluation[6]

	Yelp				Amazon			
	Flu.	Cont.	Sty.	Suc	Flu.	Cont.	Sty.	Suc
TemplateBased	3.47	3.76	3.25	68.0 %	3.46	4.08	2.15	9.0 %
Del-Ret-Gen	3.82	3.73	3.52	70.3 %	4.02	4.31	2.69	21.0 %
UnpairedRL	3.54	3.59	2.90	53.8 %	2.58	2.55	2.44	4.5 %
UnsuperMT	4.26	4.24	**4.03**	**82.5 %**	4.24	4.13	3.05	35.5 %
Point-Then-Operate	**4.39**	**4.56**	3.78	81.5 %	**4.28**	**4.47**	**3.31**	**47.0 %**

- Better overall performance
- Sacrificed style polarity on Yelp

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[6]Baselines for human evaluation are selected based on automatic evaluation

Outline

Take-Home Messages

1. A sequence operation method with hierarchical reinforcement learning (HRL) for unsupervised text style transfer
2. Address two challenges
   - Content preservation
   - Interpretability
3. Provide an iterative and dynamic mask-based inference algorithm that allows for single-option trajectory training

We make our code public.