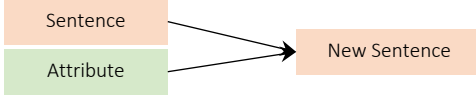


# Controllable Paraphrase Generation with a Syntactic Exemplar

Mingda Chen, Qingming Tang, Sam Wiseman, Kevin Gimpel

## Controllable Generation

Prior Work: controlled attributes with a finite set of values



Our work: control the syntax of a generated sentence with a syntactic exemplar

his teammates' eyes got an ugly, hostile expression.

+

the smell of flowers was thick and sweet.

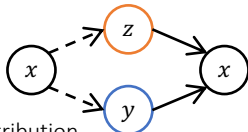
||

the eyes of his teammate had turned ugly and hostile.

## vMF-Gaussian VAE

→ Inference model

→ Generative model



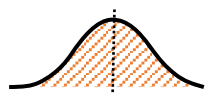
○ Semantic variable, vMF distribution

○ Syntactic variable, Gaussian distribution

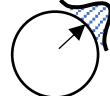
$$p_{\theta}(x, y, z) = p_{\theta}(y)p_{\theta}(z) \prod_{t=1}^T p_{\theta}(x_t | x_{1:t-1}, y, z)$$

Background

Gaussian distribution



vMF distribution



Neural Architecture

$q_{\phi}(y|x)$

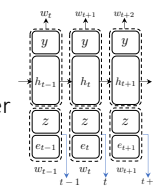
Word averaging encoder

$q_{\phi}(z|x)$

Bidirectional LSTM encoder

$p_{\theta}(x_t | x_{1:t-1}, y, z)$

LSTM decoder



## Multi-Task Training

Training uses paraphrase  $x_1, x_2$

ParaNMT-50M: 50 million paraphrases

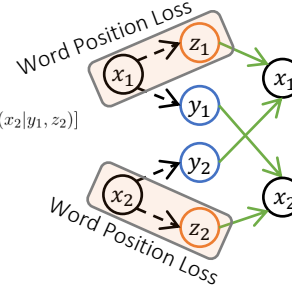
Paraphrase reconstruction loss (PRL)

$$\mathbb{E}_{y_2 \sim q_{\theta}(y|x_2)} [\log p_{\theta}(x_1|y_2, z_1)] + \mathbb{E}_{y_1 \sim q_{\theta}(y|x_1)} [\log p_{\theta}(x_2|y_1, z_2)]$$

Shown in green lines (→)

Word position loss (WPL)

$$\mathbb{E}_{z \sim q_{\theta}(z|x)} \left[ \sum_t \log \text{softmax}(f([e_t; z]))_t \right]$$



## Better Learning of Syntax

### Latent Codes (LC) for Syntactic Encoder

$$e_w = \sum_{c_w} p(c_w) v_{c_w}$$

$c_w$  is the latent code for word  $w$ ,  $v_{c_w}$  is the vector for  $c_w$  and  $e_w$  is the resulting word embedding for word  $w$ .

### Word Noising (WN) via Part-of-Speech Tags

A. Tag training set

B. Group the word types by tag

C. Randomly replace word tokens from the same group (syntactic input)

Word tokens	something	funny	happened	this	...
POS tags	NN	JJ	VBD	DT	
eyebrow	snotty	locked	an		
loss	muddy	cackled	another		
concern	green	rebuked	those		
smoke	spiteful	nodded	all		
...	...	...	...		

## Learned Word Clusters

12	does must could shall do wo 's did ai 'd 'll should
451	watching wearing carrying thrown refuse drew
11	? : * > > ! , , " , ' ,
18	maybe they because if where but we when how
41279	elvish festive freeway anteroom jennifer terrors
10	well (unk) anyone okay now everybody someone
165	supposedly basically essentially rarely officially
59	using on by into as the with within under quite

## Experiment Results

Data: 1300 human-annotated instances. (500 for Dev, 800 for Test)

Evaluation metrics:

- Semantic similarity: BLEU, ROUGE, METEOR.
- Syntactic similarity: Syntactic tree edit distance (ST). Tree edit distance between constituency parse trees of two sentences.

	BLEU (↑)	ST (↓)
Return-input baselines		
Semantic template	18.5	12.0
Syntactic template	3.3	5.9
Our work		
VGVAE	3.5	10.6
VGVAE+WPL	4.5	10.0
VGVAE+LC	3.3	9.1
VGVAE+LC+WPL	5.9	9.0
VGVAE+WN	13.0	6.8
VGVAE+WN+WPL	13.2	6.7
VGVAE+LC+WN+WPL	13.6	6.7
Prior work using supervised parsers		
SCPN+template	17.8	9.9
SCPN+full parse	19.2	5.9

SCPN: Adversarial Example Generation with Syntactically Controlled Paraphrase Networks. (NAACL 2018)

## Generated Sentences

Semantic input	if i was there, i would kick that bastard in the ass.
Syntactic input	they would've delivered a verdict in your favor.
reference	i would've kicked that bastard out on his ass.
generation	she would've kicked the bastard on my ass.
Semantic input	don't you think that's a quite aggressive message?
Syntactic input	that's worth something, ain't it?
reference	that's a pretty aggressive message, don't you think?
generation	that's impossible message, aren't you?
Semantic input	her yelling sounds sad.
Syntactic input	she looks beautiful. shining like a star.
reference	she sounds sad. yelling like that.
generation	she sounds sad. screaming like a scream.