



Generating Syntactically Controlled Paraphrases without Using Annotated Parallel Pairs

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Paraphrase Generation

Paraphrase model

- Input sentence → output paraphrase

Supervised approaches

- Need many **paraphrase pairs** for training

Unsupervised approaches

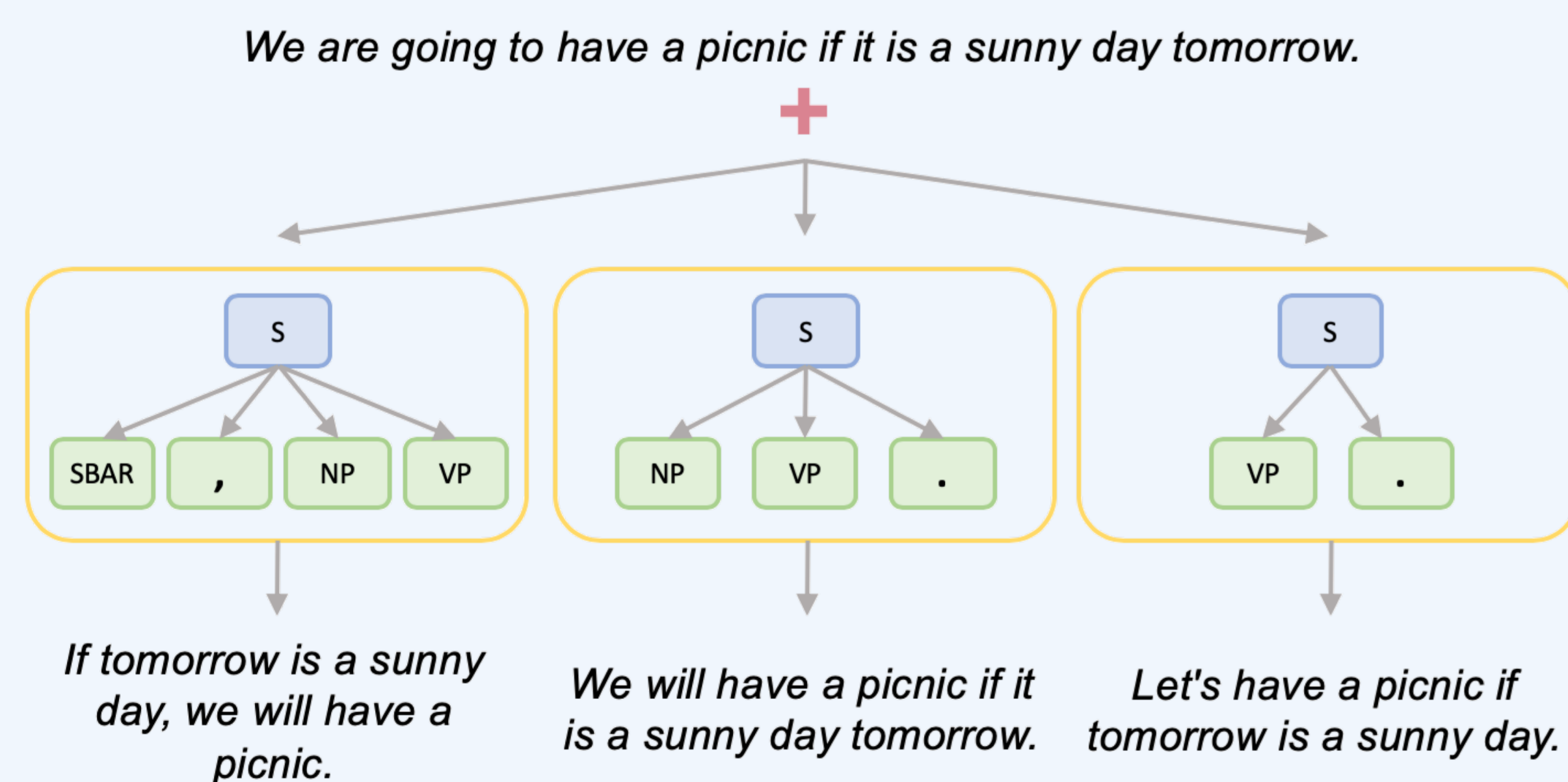
- Generated paraphrases are **not diverse** in syntax

Our goal

- Generate **syntactically diverse** paraphrases
- Training **without using paraphrase pairs**

Syntactically Controlled Paraphrase Generation

- Control the syntax of output paraphrases
- Use **target parse templates** as control signals
- Generate paraphrases that follow templates
- Provide many templates → diverse paraphrases



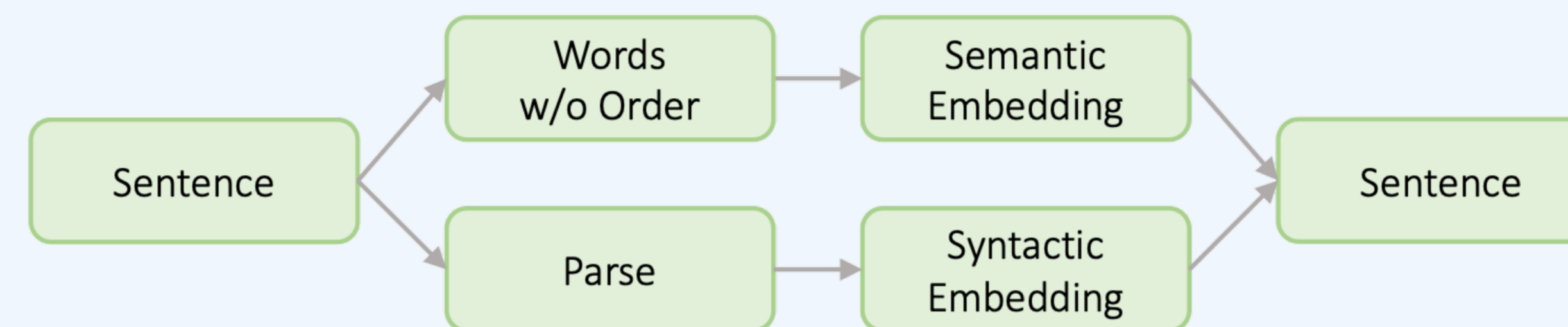
Challenges

- **No ground truths**: given a sentence and an arbitrary template, what is the ground truth?
- **Syntactic control**: how to ensure that the output can follow the given template?

Disentangled Semantic and Syntactic Embedding

Training time

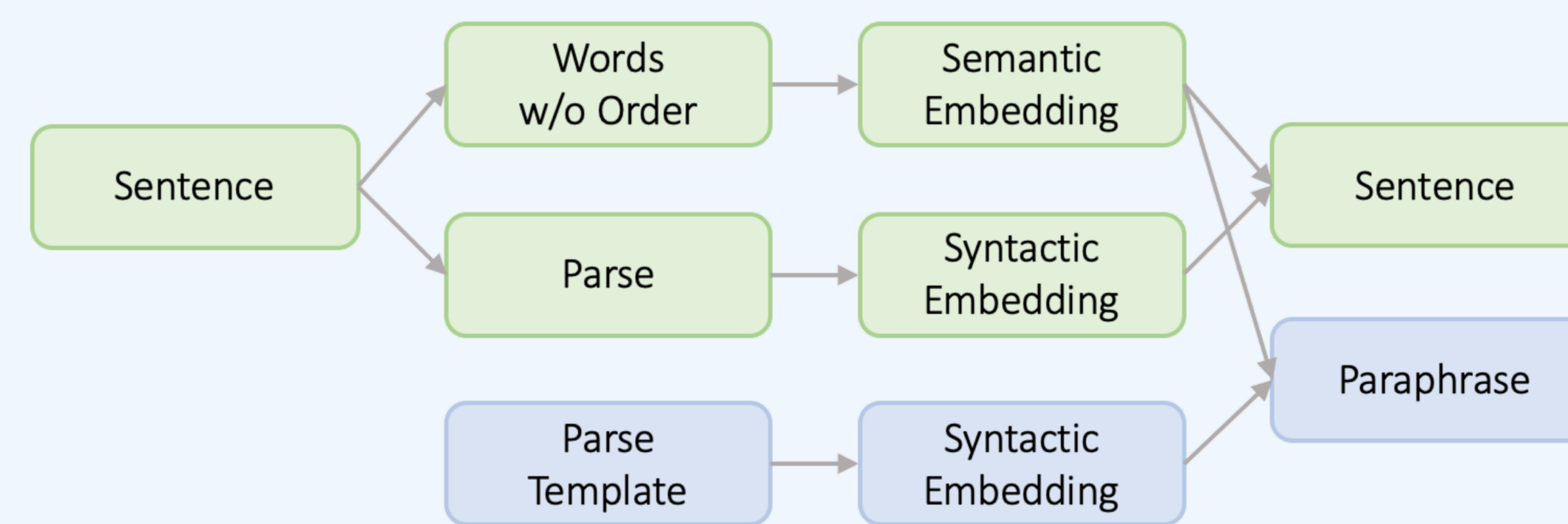
- Disentangle a sentence into semantic and syntactic embedding



- Words w/o order → semantic embedding
- Constituency parse → syntactic embedding
- Reconstruction → no need for parallel pairs

Inference time

- Replace the syntactic embedding with the target parse information



Parse Generator

- Provide **full parses** is not friendly
 - Provide **parse templates** is simple
 - parse template: top 2 layers of full parse tree
 - Generator: (sentence, template) → full parse
- Inference steps:
- (sentence, template) → (sentence, full parse) → output

Paraphrase Examples

Template	Generated Paraphrase
Original (S (NP) (VP) (.))	can you adjust the cameras? you can adjust the cameras.
(SBARQ (ADVP) (,) (S) (,) (SQ) (.))	well, adjust the cameras, can you?
(S (PP) (,) (NP) (VP) (.))	on the cameras, you can adjust them?
Original (SBARQ (WHADVP) (SQ) (.))	she doesn't keep pictures from her childhood. why doesn't she keep her pictures from childhood.
(S ('') (NP) (VP) ('') (NP) (VP) (.))	"she doesn't keep pictures from her childhood" she said.
(S (ADVP) (NP) (VP) (.))	perhaps she doesn't keep pictures from her childhood.

Evaluation

- Paraphrase pair (s1, s2) and their parses (p1, p2)
- Given (s1, p2) and generate output q2
- Metrics
 - BLEU score: similarity between q2 and s2
 - Template matching score: exact matching accuracy for q2 following p2

Model		ParaNMT		Quora		PAN		MRPC	
		TMA	BLEU	TMA	BLEU	TMA	BLEU	TMA	BLEU
No Paraphrasing	CopyInput	33.6	16.4	55.0	20.0	37.3	26.8	47.9	30.7
Unsupervised Models	BackTrans	29.0	16.3	53.0	16.4	27.9	16.2	47.2	21.6
	VAE	26.3	9.6	44.0	8.1	19.4	5.2	20.8	1.2
With Syntactic Specifications	SIVAE	30.0	12.8	48.3	13.1	26.6	11.8	21.5	5.1
	Seq2seq-Syn	33.5	16.3	54.9	19.8	37.1	26.5	47.7	30.4
	SynPG	71.0	32.2	82.6	33.2	66.3	26.4	74.0	26.2

Model		ParaNMT		Quora		PAN		MRPC	
		TMA	BLEU	TMA	BLEU	TMA	BLEU	TMA	BLEU
Ours	SynPG	71.0	32.2	82.6	33.2	66.3	26.4	74.0	26.2
	SynPG-Large	70.3	31.8	83.8	34.7	66.6	27.1	79.3	36.2
	SynPG-FT	-	-	86.3	44.4	66.4	34.2	80.7	44.6
Supervised Models	Seq2seq-Sup	40.2	19.6	54.0	11.3	29.2	13.1	44.3	16.3
	SCPN	83.9	58.3	87.1	41.0	72.3	37.6	80.1	41.8

Defend Syntactically Adversarial Attacks

- Generate syntactically different paraphrases
- Train models with data augmentation

Model	SST-2		MRPC		RTE	
	Acc.	Brok.	Acc.	Brok.	Acc.	Brok.
Base	91.9	46.7	84.1	52.8	63.2	58.3
SynPG	88.9	39.6	80.1	35.5	60.7	33.9