TACL 2020

Syntax-Guided Controlled Generation of Paraphrases

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Machine and Language Learning Lab
Indian Institute of Science, Bangalore

Motivation for Syntax-Guided Paraphrasing

S1 : Because it is raining today, you should carry an umbrella

S2 : You should carry an umbrella today, because it is raining

	Fifth Graders	Adults
Preference		

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DISCLAIMER	All experiments conducted on English language datasets

Syntactic Paraphrase Generation

Constraining paraphrases to conform to a given syntactic exemplar

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EXEMPLAR	what are the characteristics of the elizabethan theatre ?

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(Meaning preserving)

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Fidelity
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Syntacticality
(Adherence to exemplar syntax)

Constituency-based parse tree syntactic information

EXEMPLAR	what is the best language for web development ?

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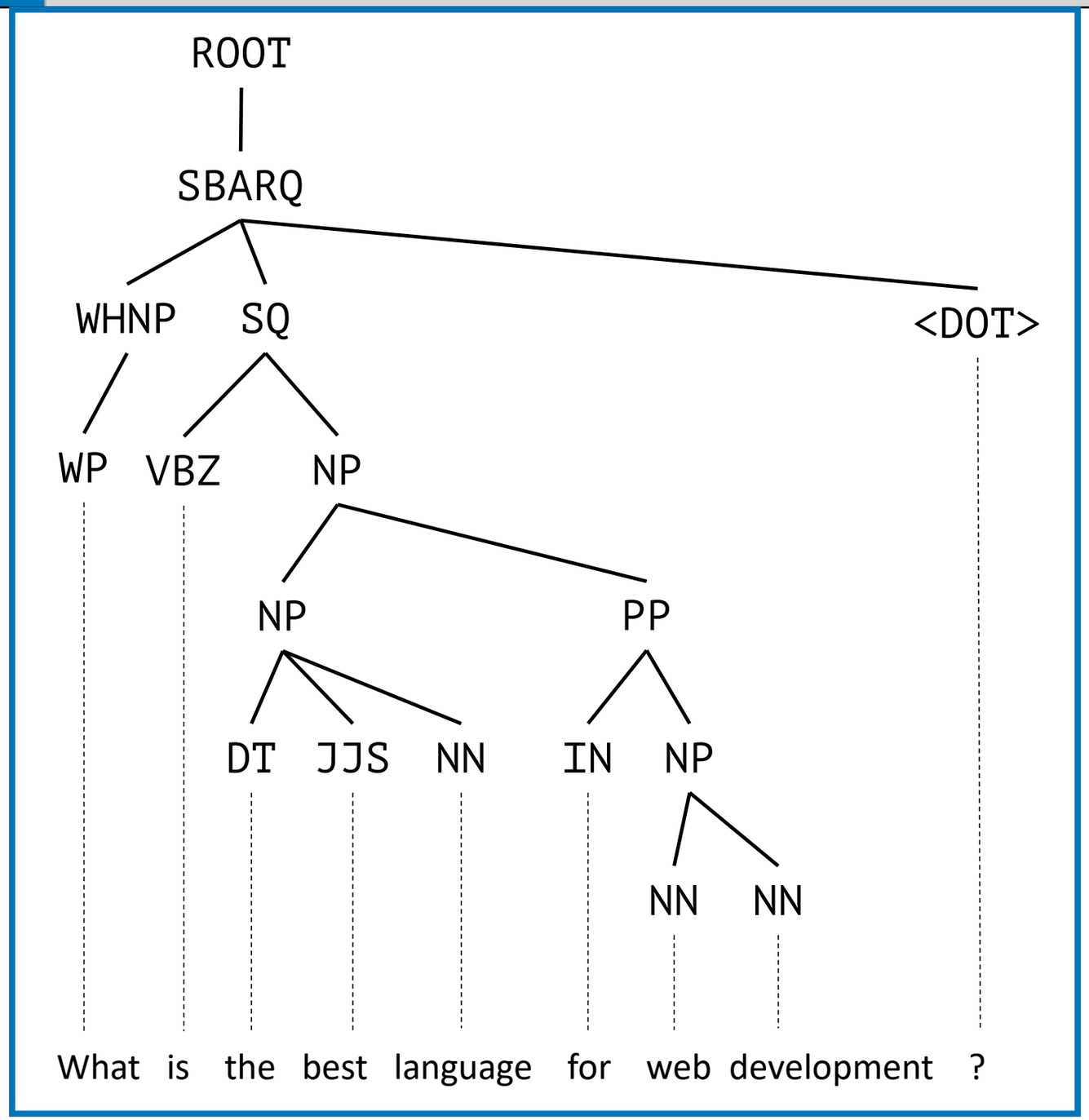

Utilisation of Syntactic Information

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Qualitative Results based on Syntactic Signals

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SGCP (Ours)	which is the best app you can’t live without and why ?

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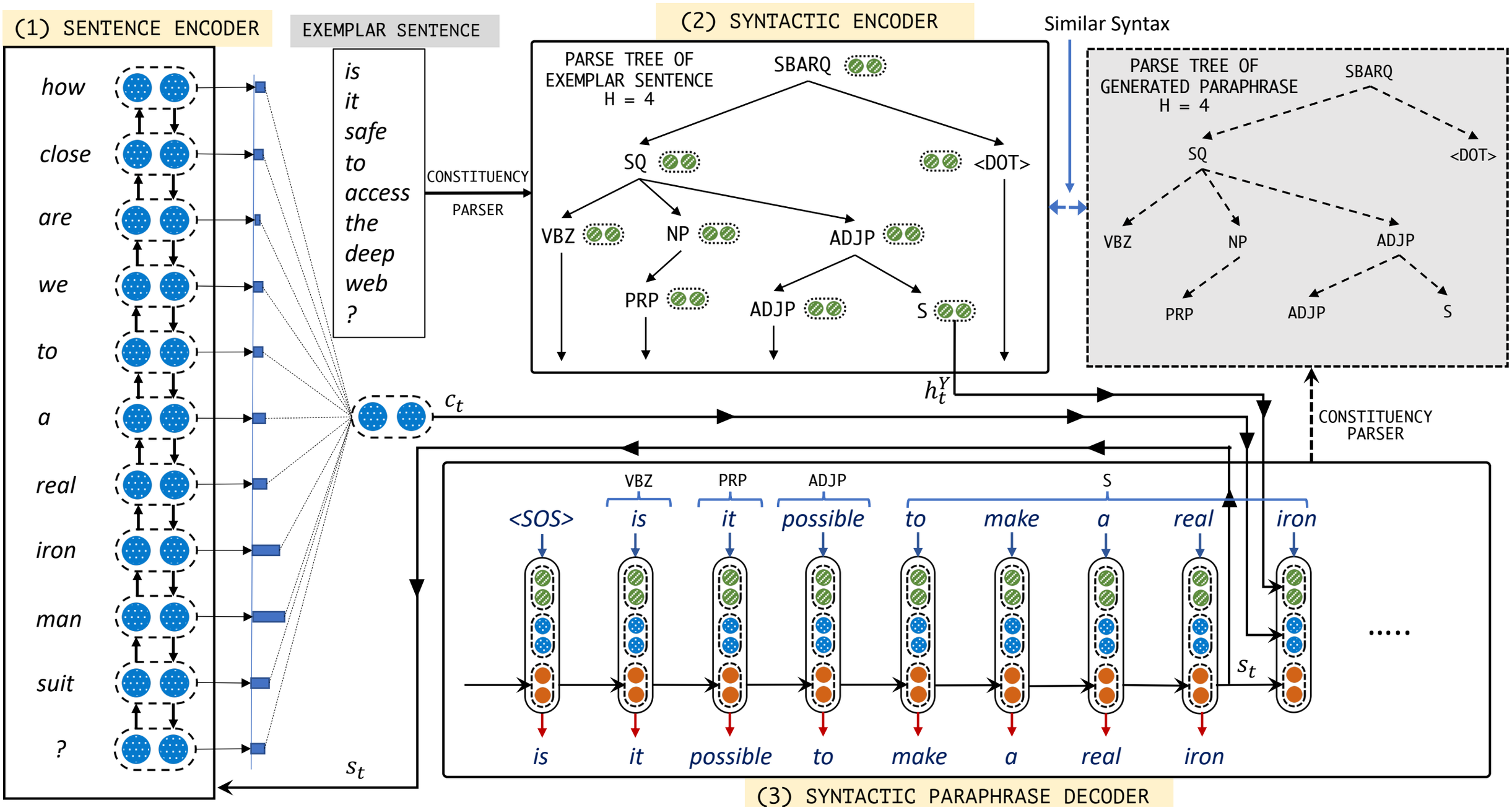
SGCP: Syntax Guided Controlled Paraphraser

Use Syntactic Tree Structure to Guide Paraphrase Generation model



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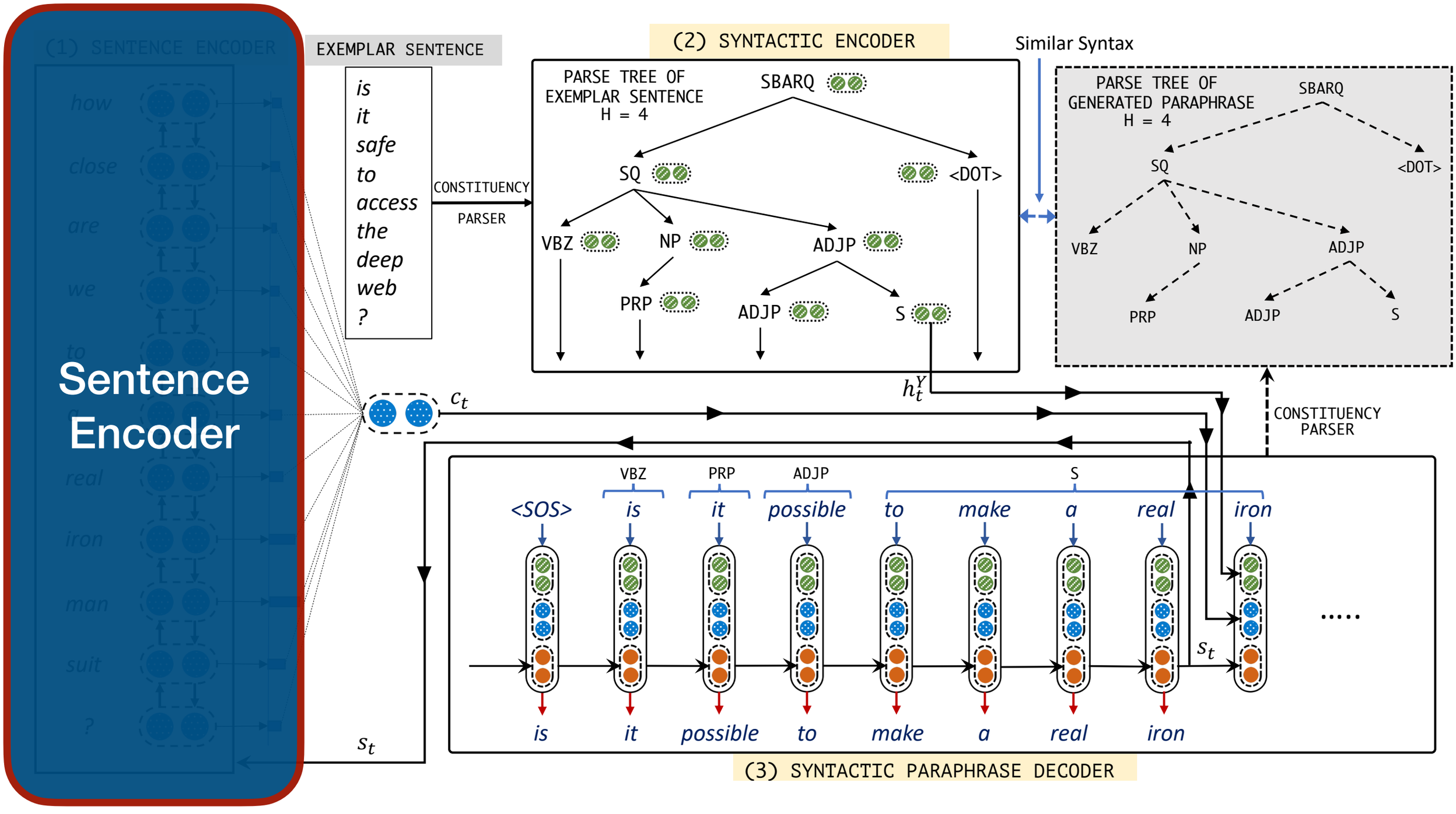

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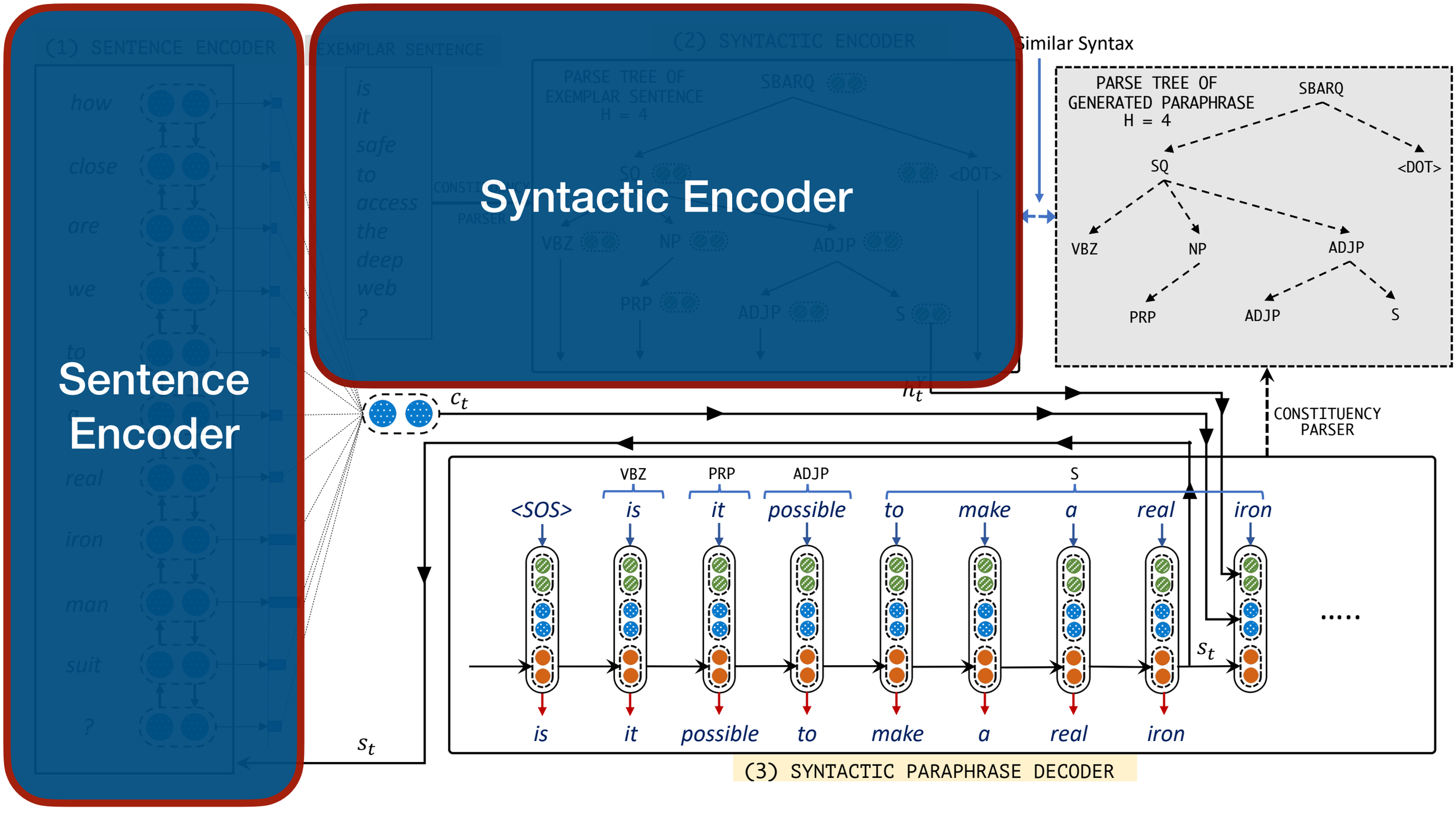

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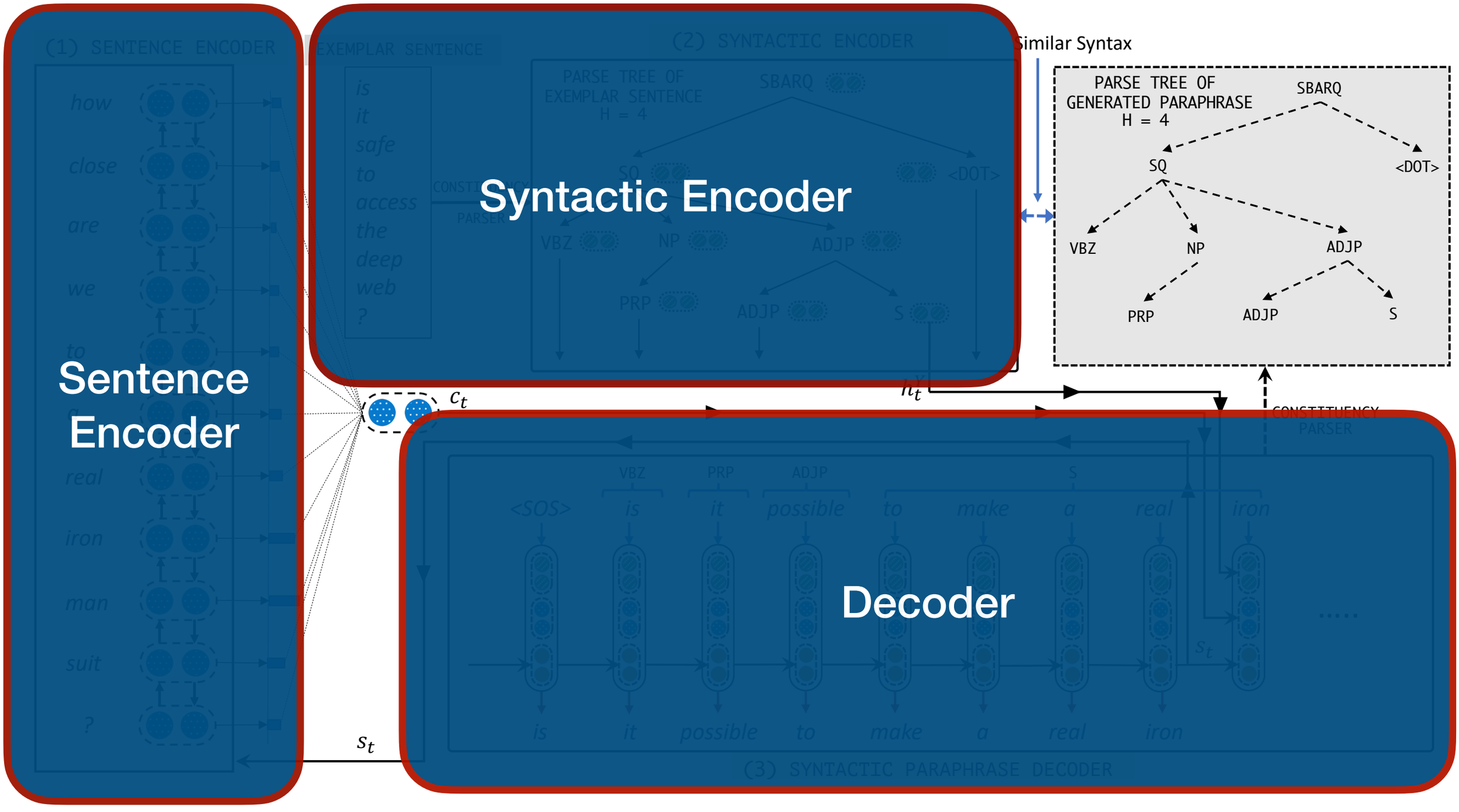

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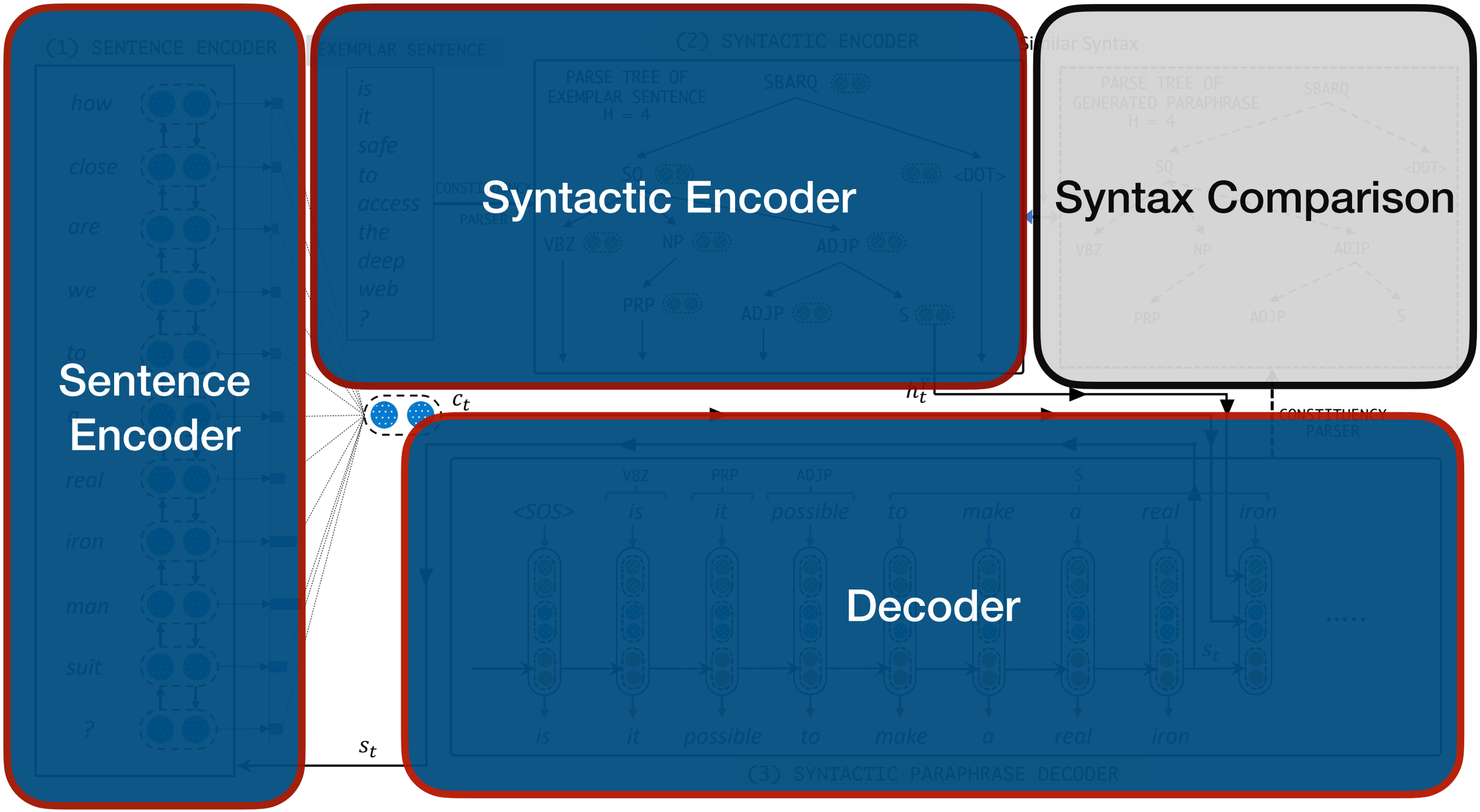

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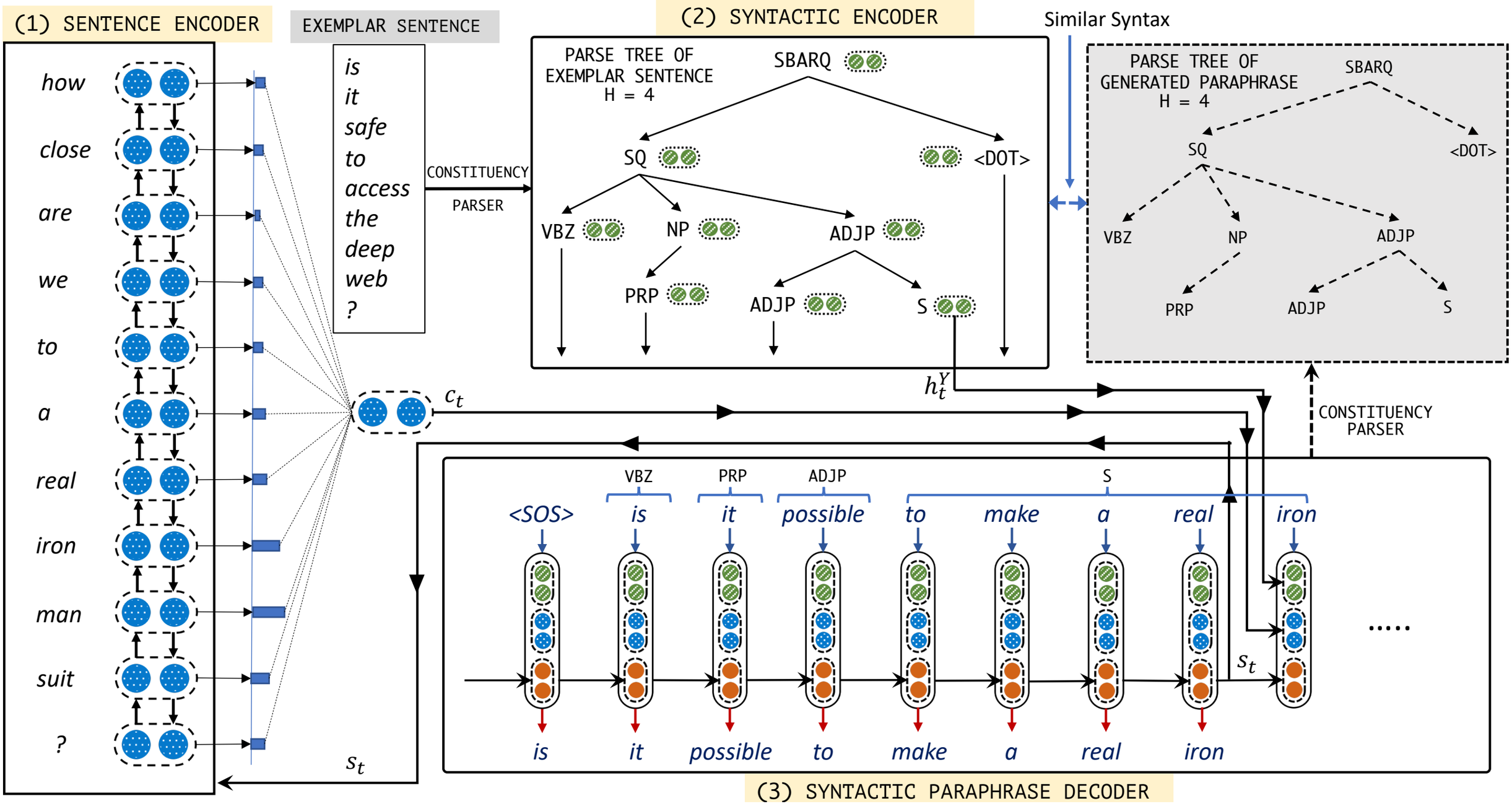

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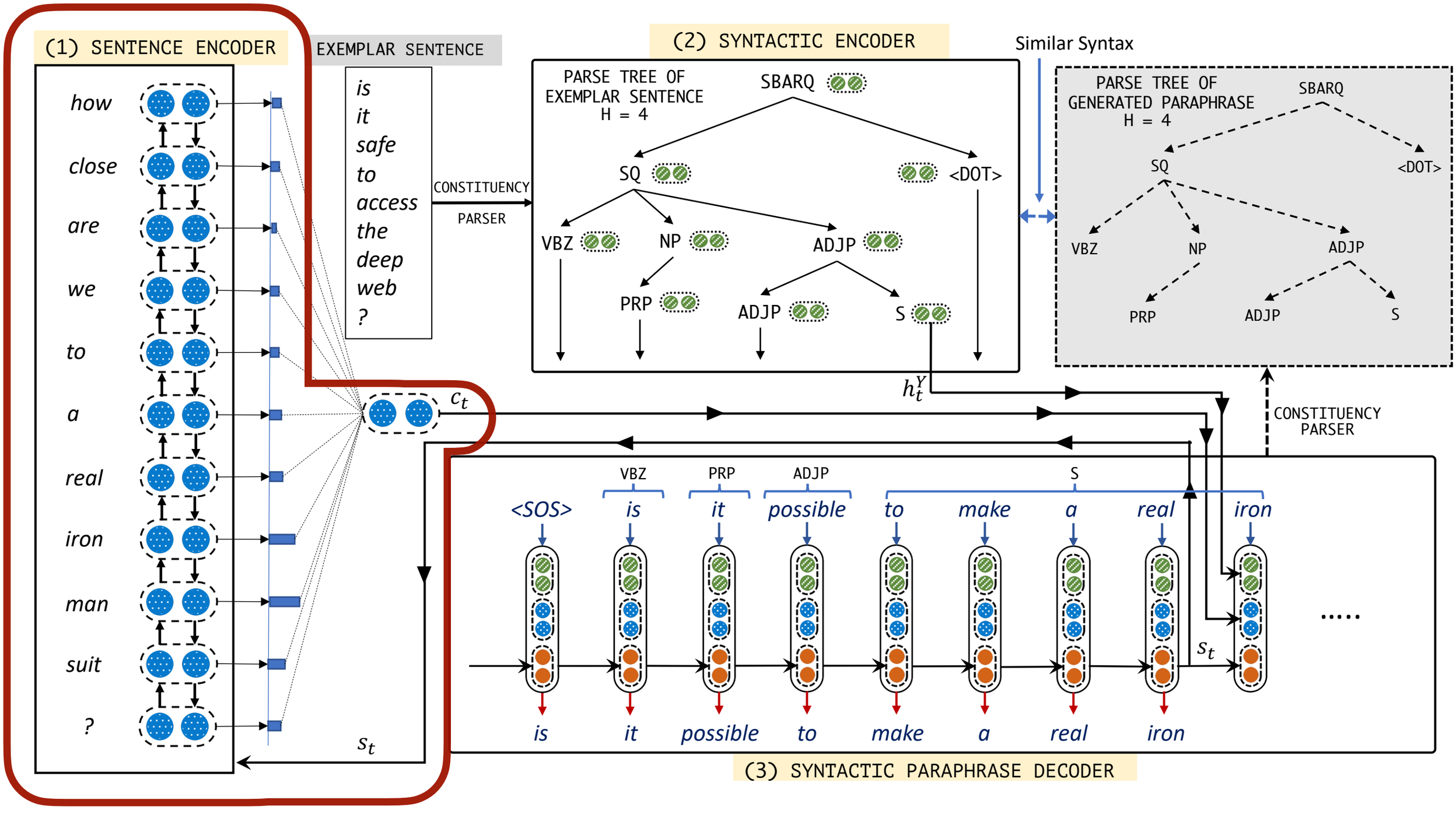

SGCP : Sentence Encoder

(1) SENTENCE ENCODER

how

close

are

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to

a

real

iron

man

suit

?

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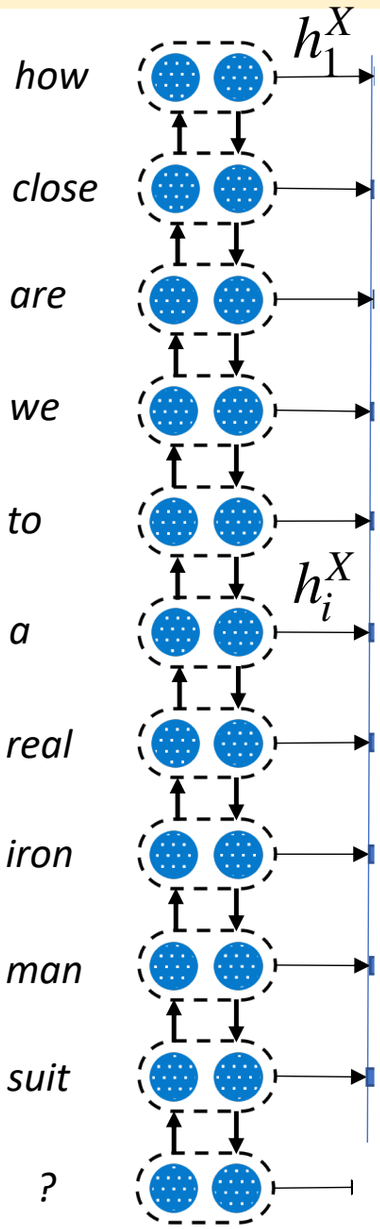

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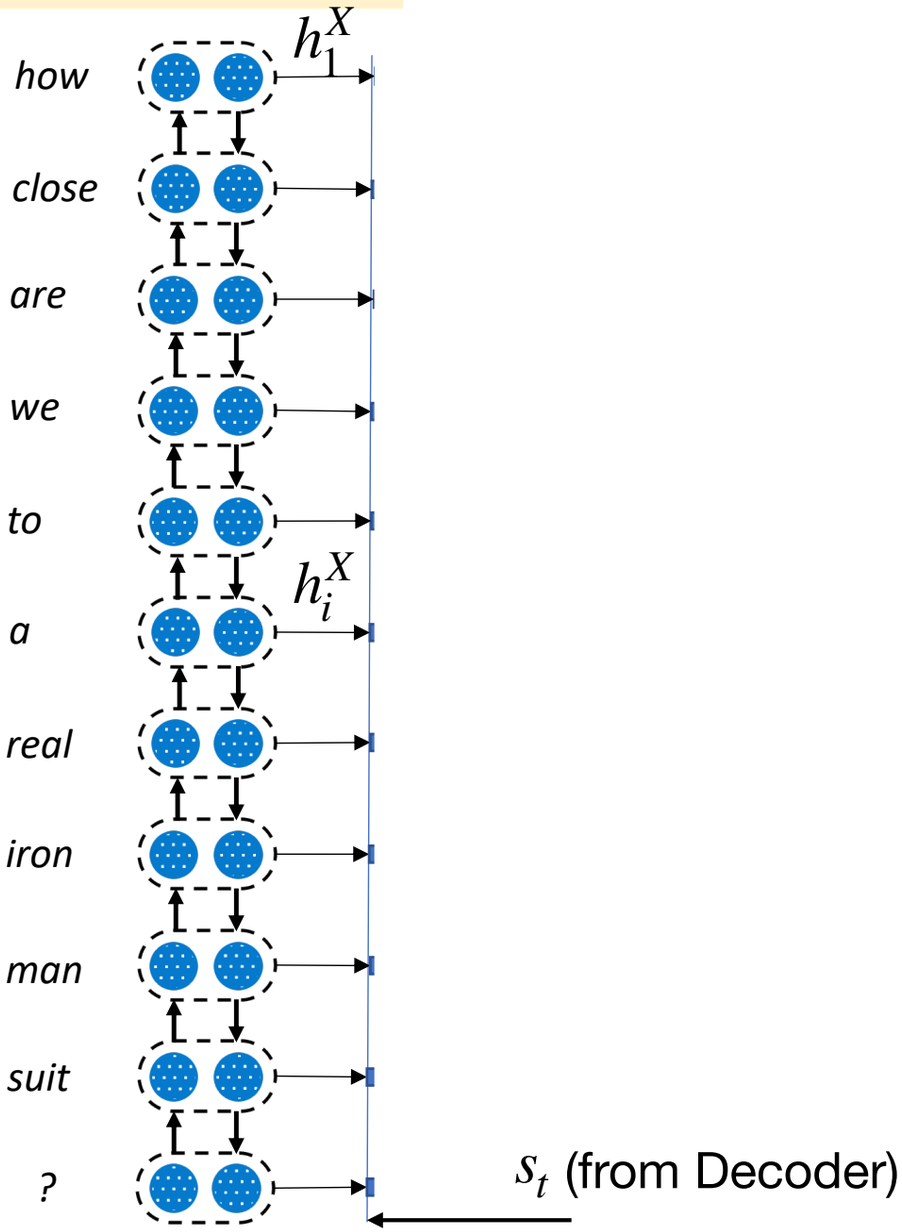

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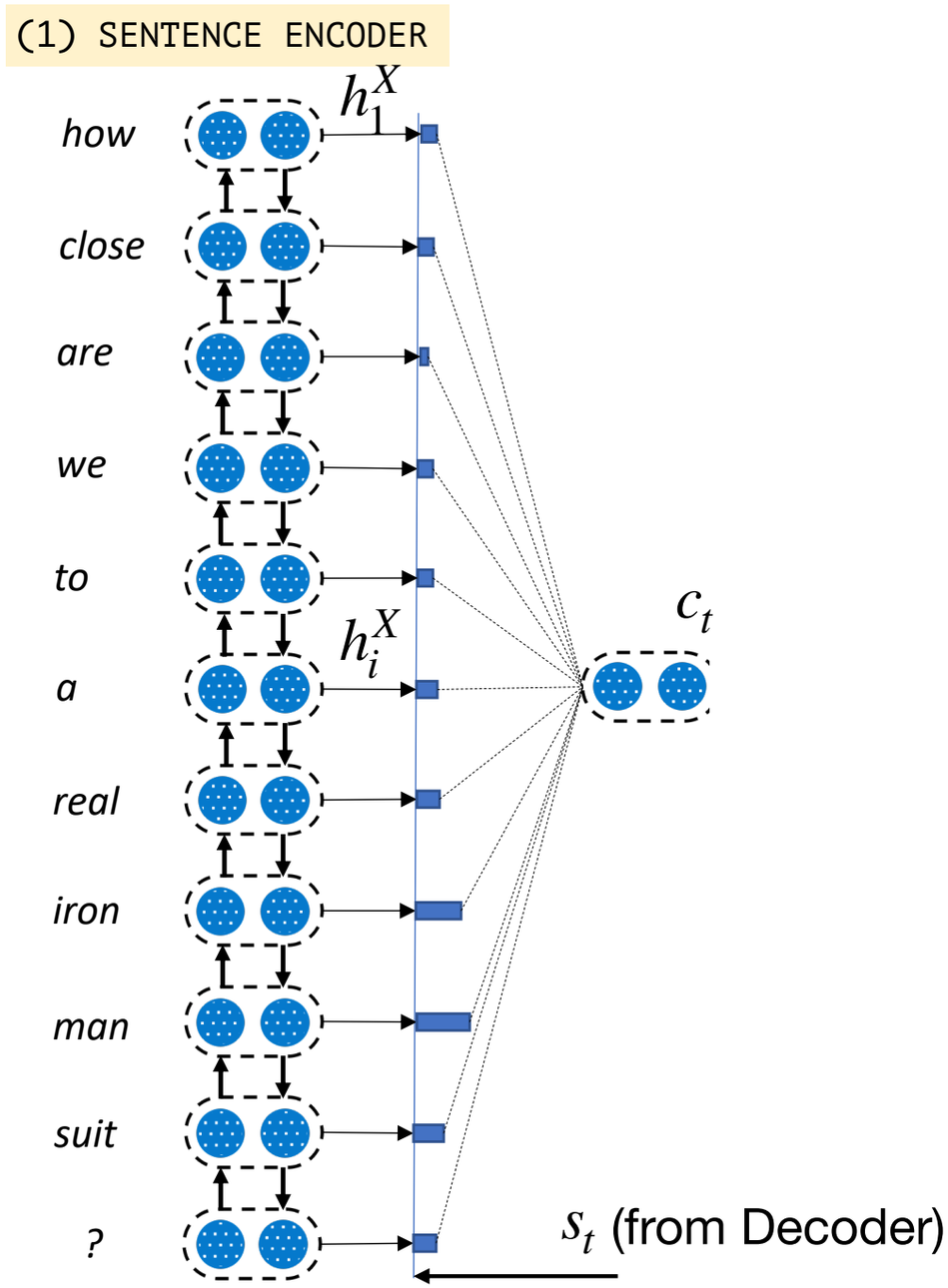

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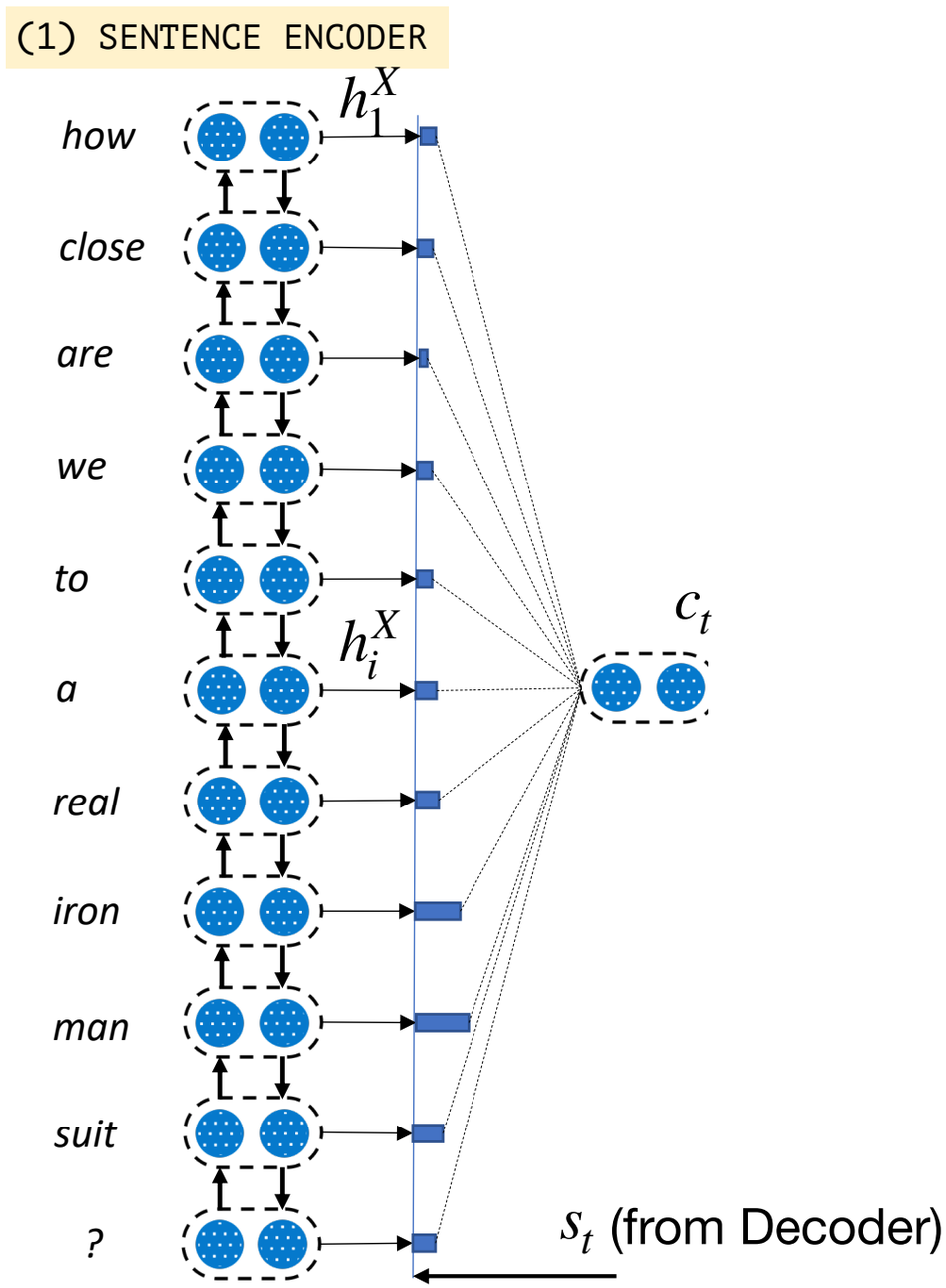

$$h_i^X = \textbf{GRU}(h_{i-1}^X, e(x_i))$$

$$e_i^t = v^\intercal \textbf{tanh}(W_h h_i^X + W_s s_t + b_{attn})$$

$$\alpha^t = \textbf{softmax}(e^t)$$

$$c_t = \sum_i \alpha_i^t h_i^X$$

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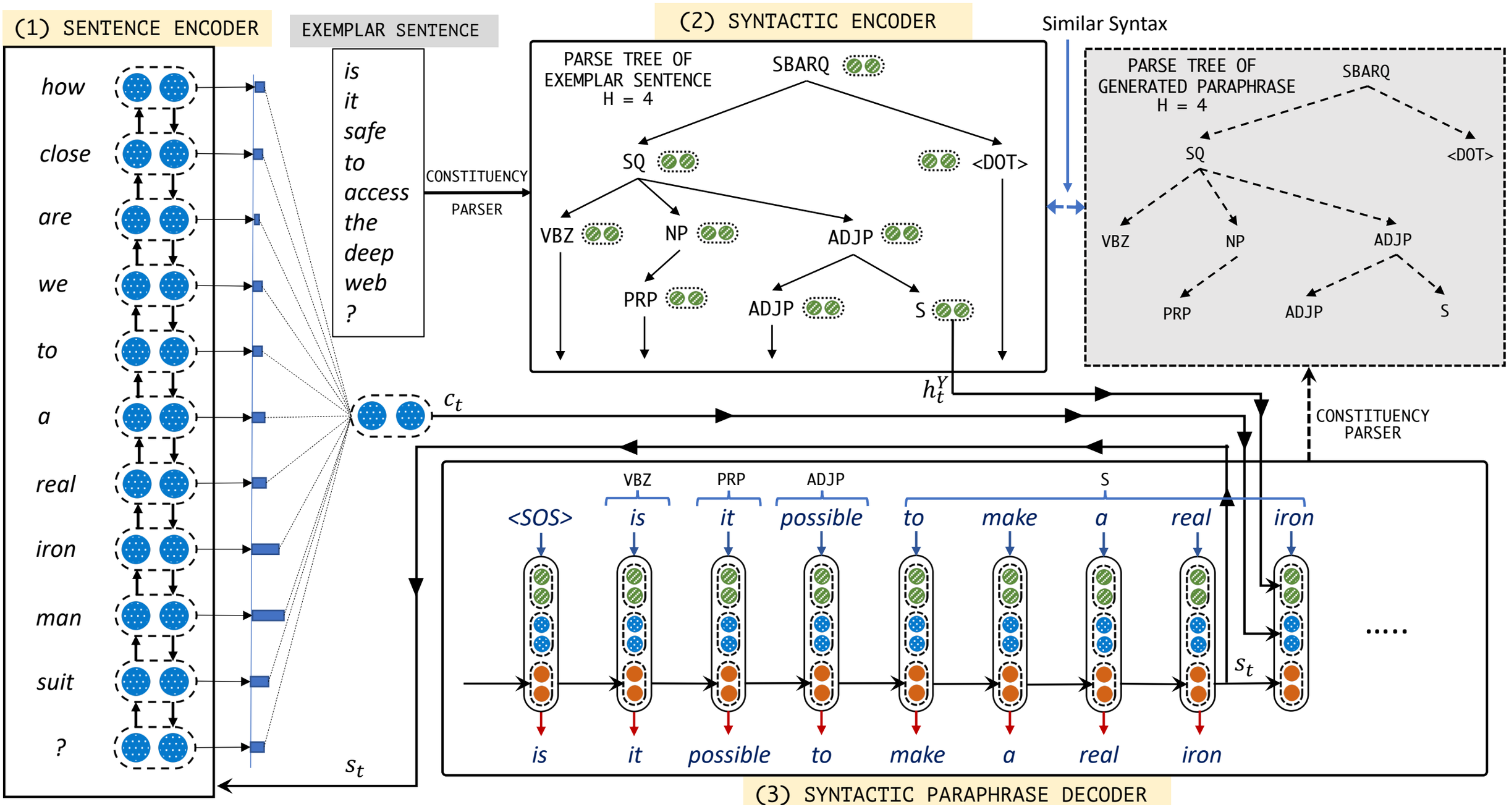

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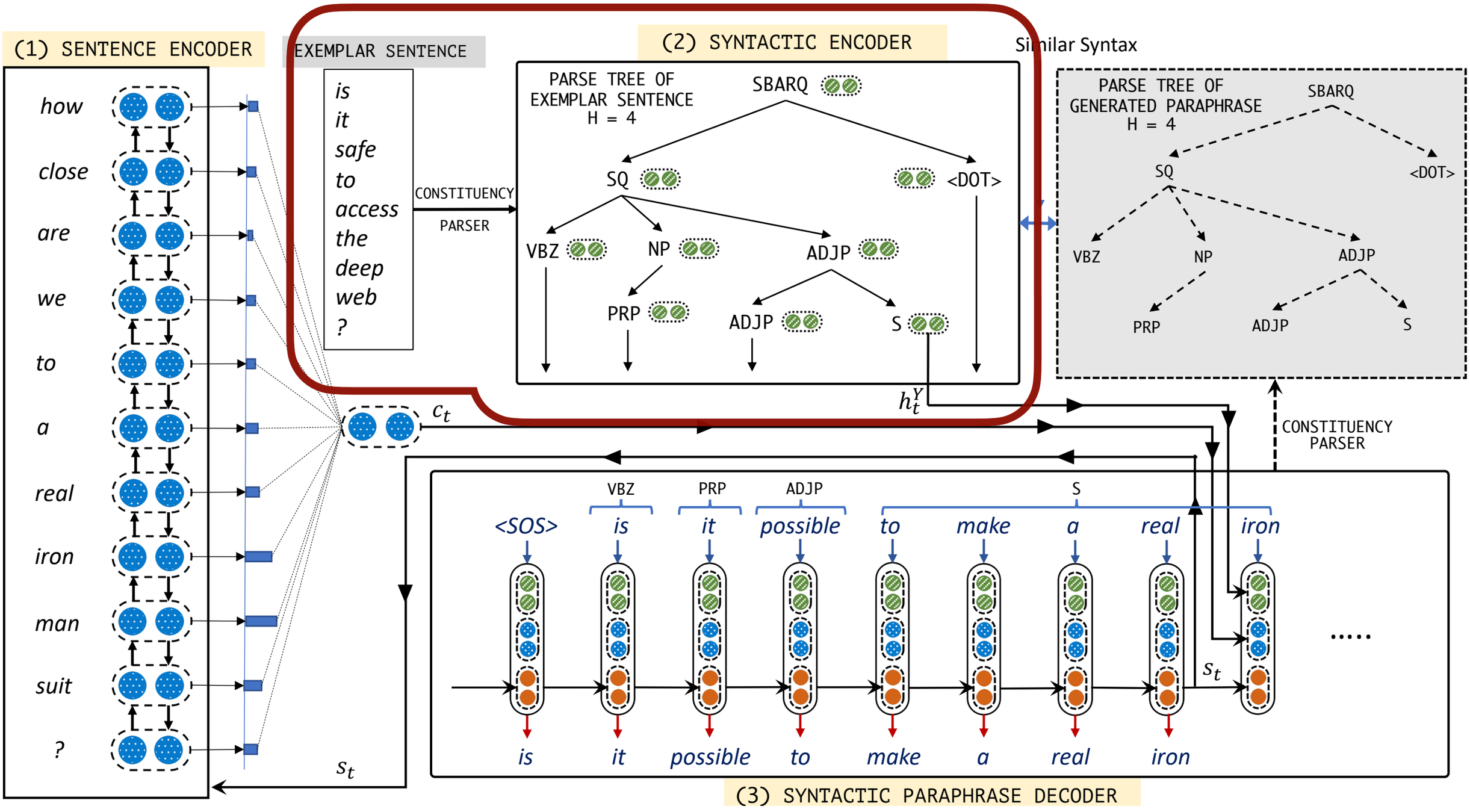

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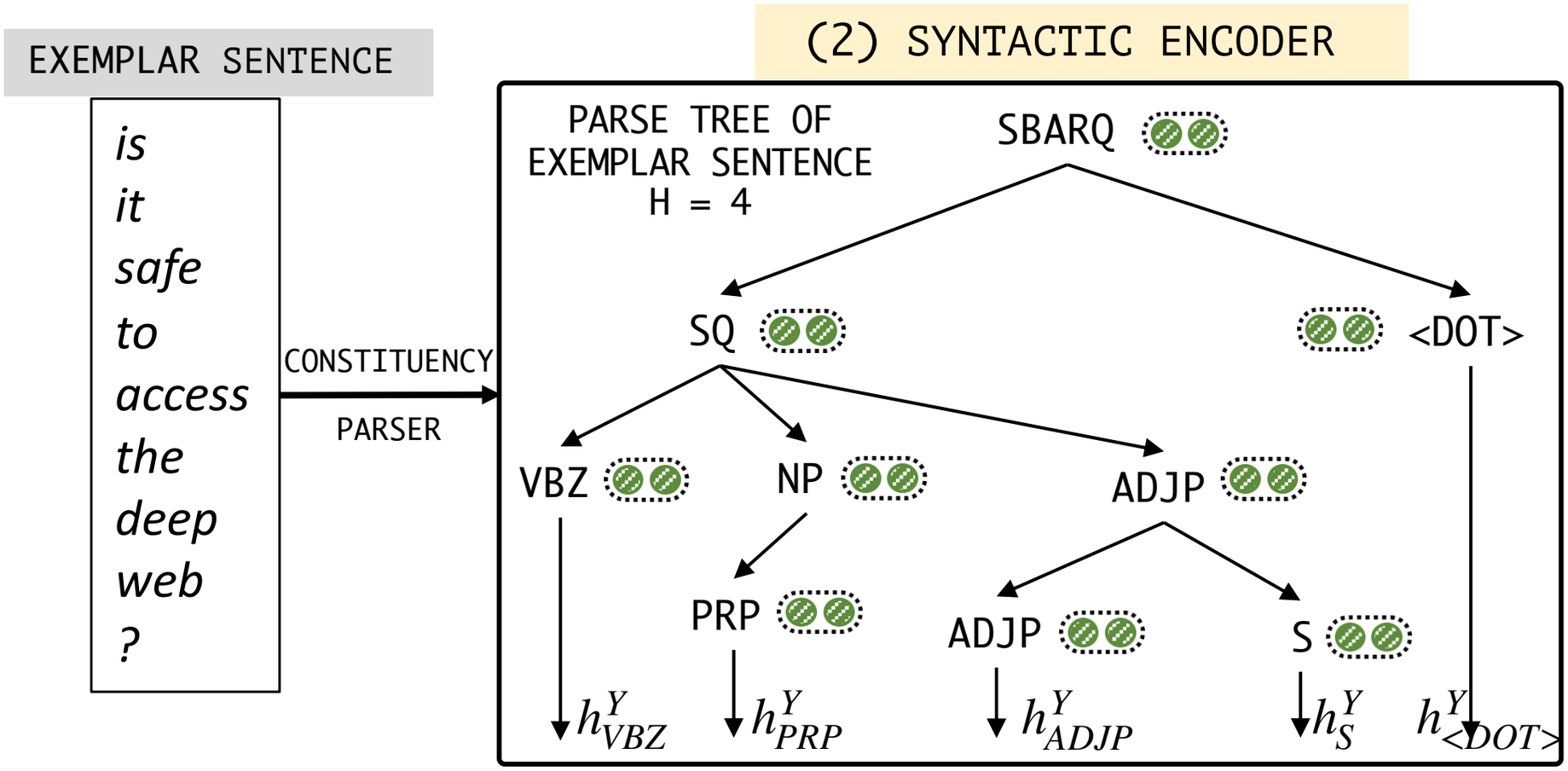

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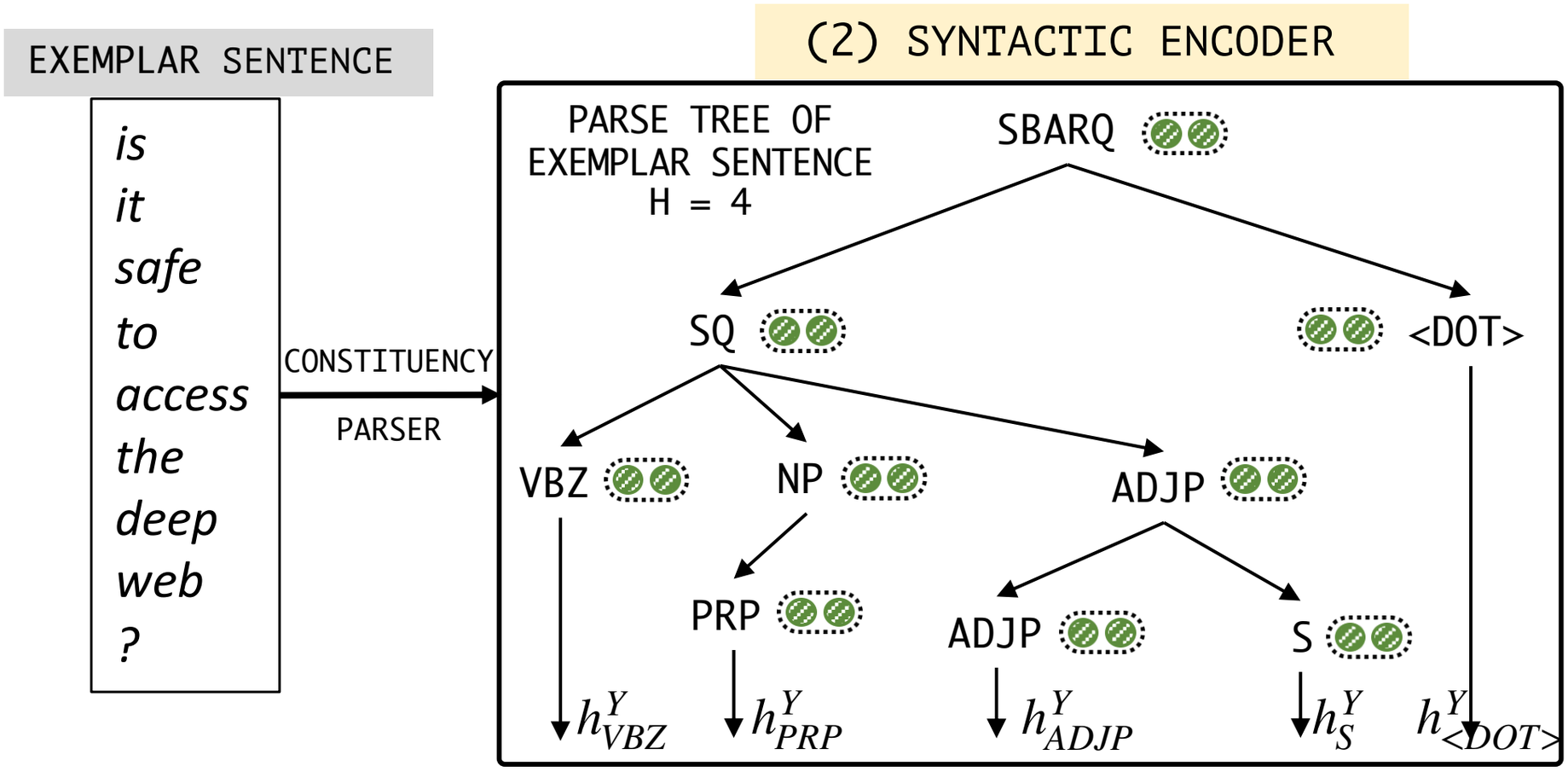

$$h_v^Y = \textbf{GeLU}(W_{pa} h_{pa(v)}^Y + W_v e(y_v) + b_v)$$

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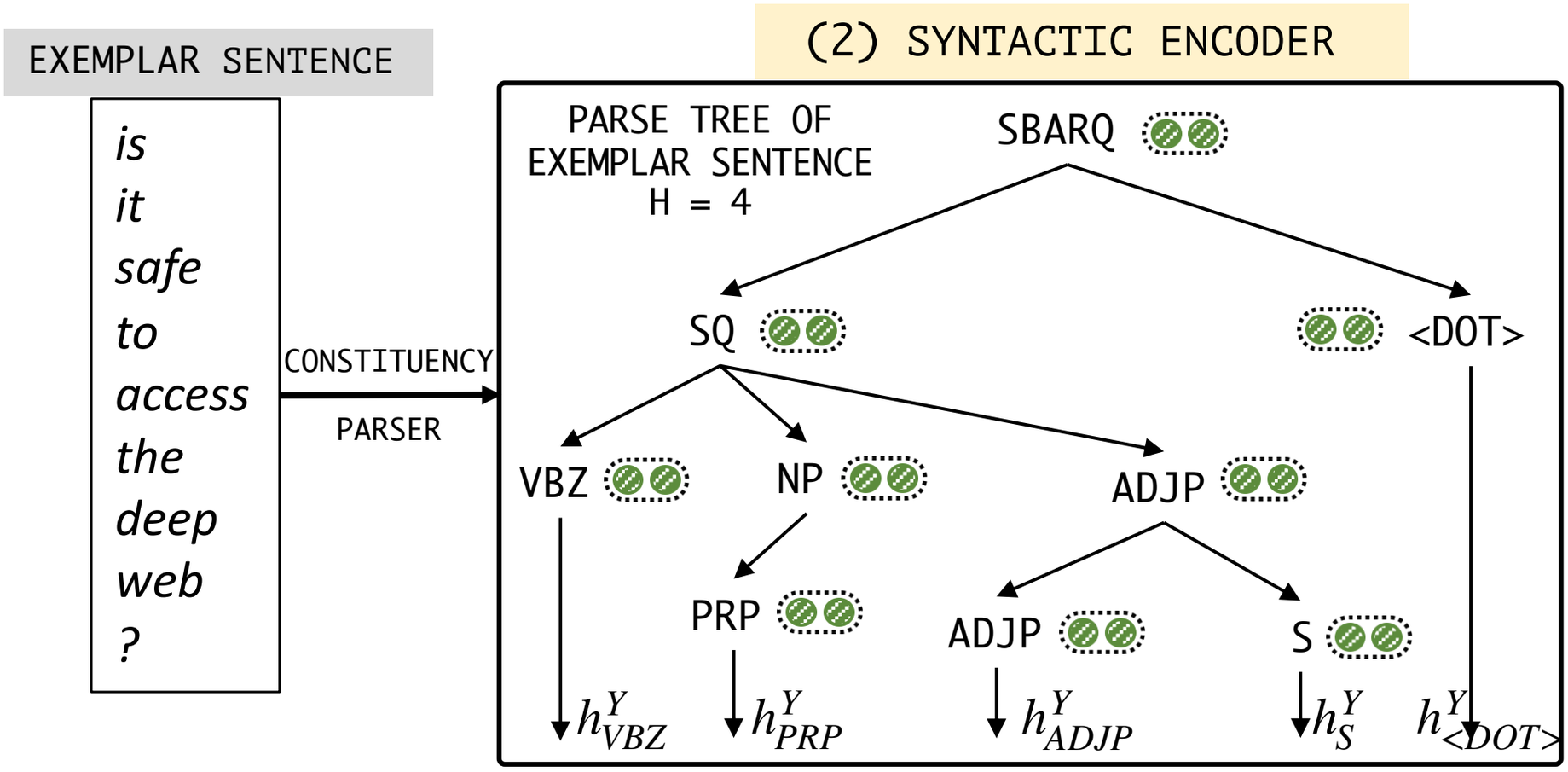

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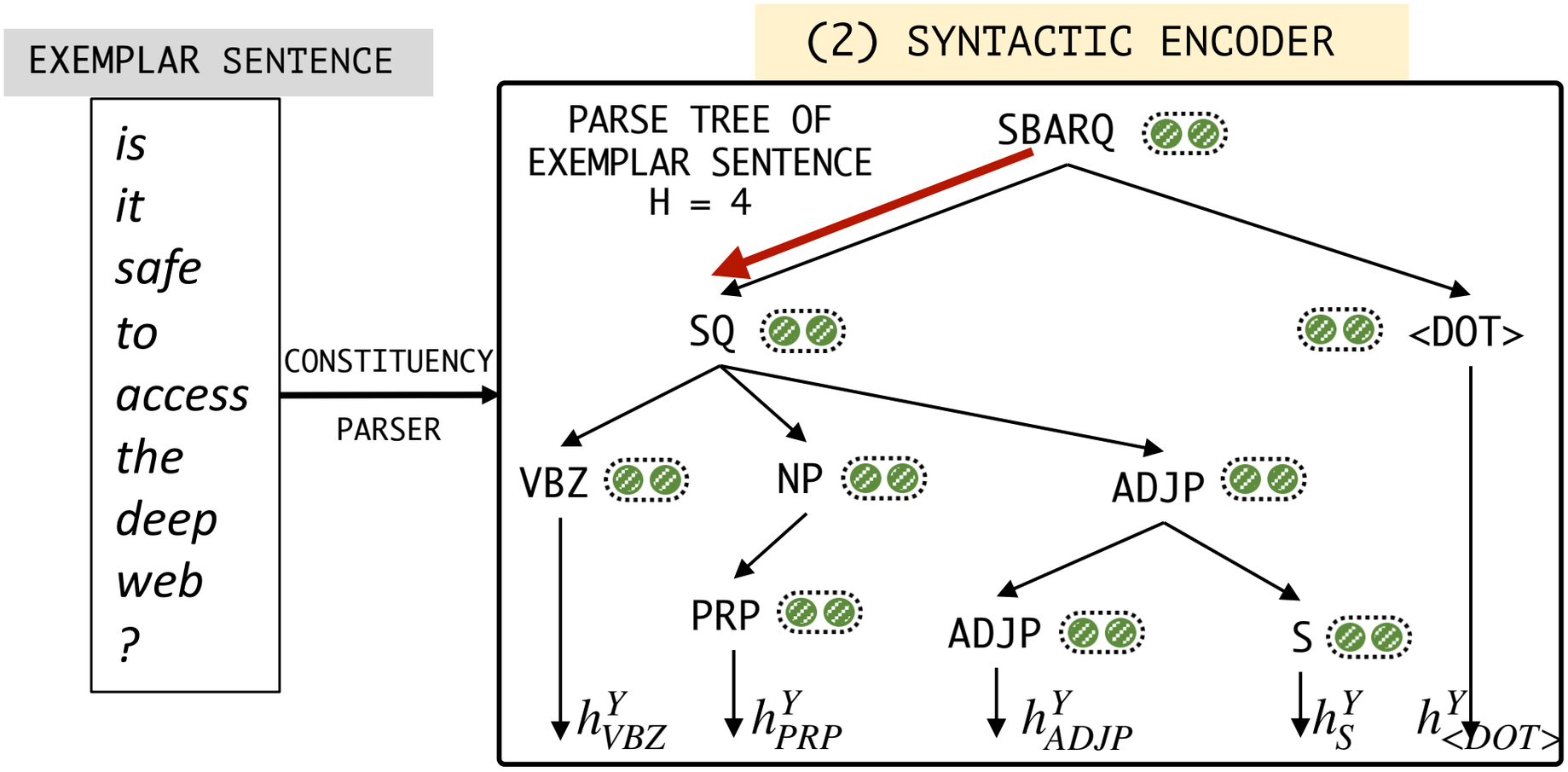

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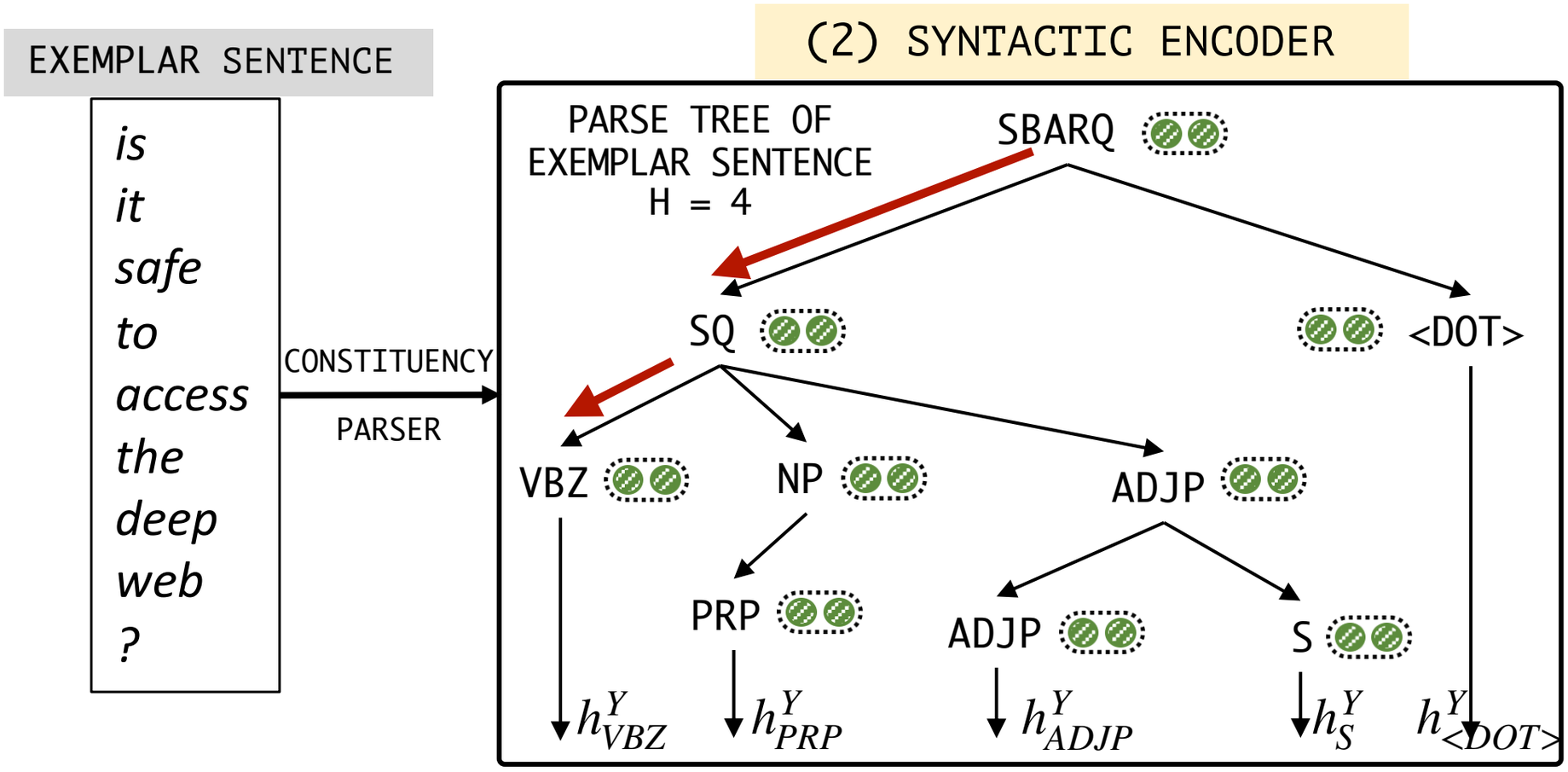

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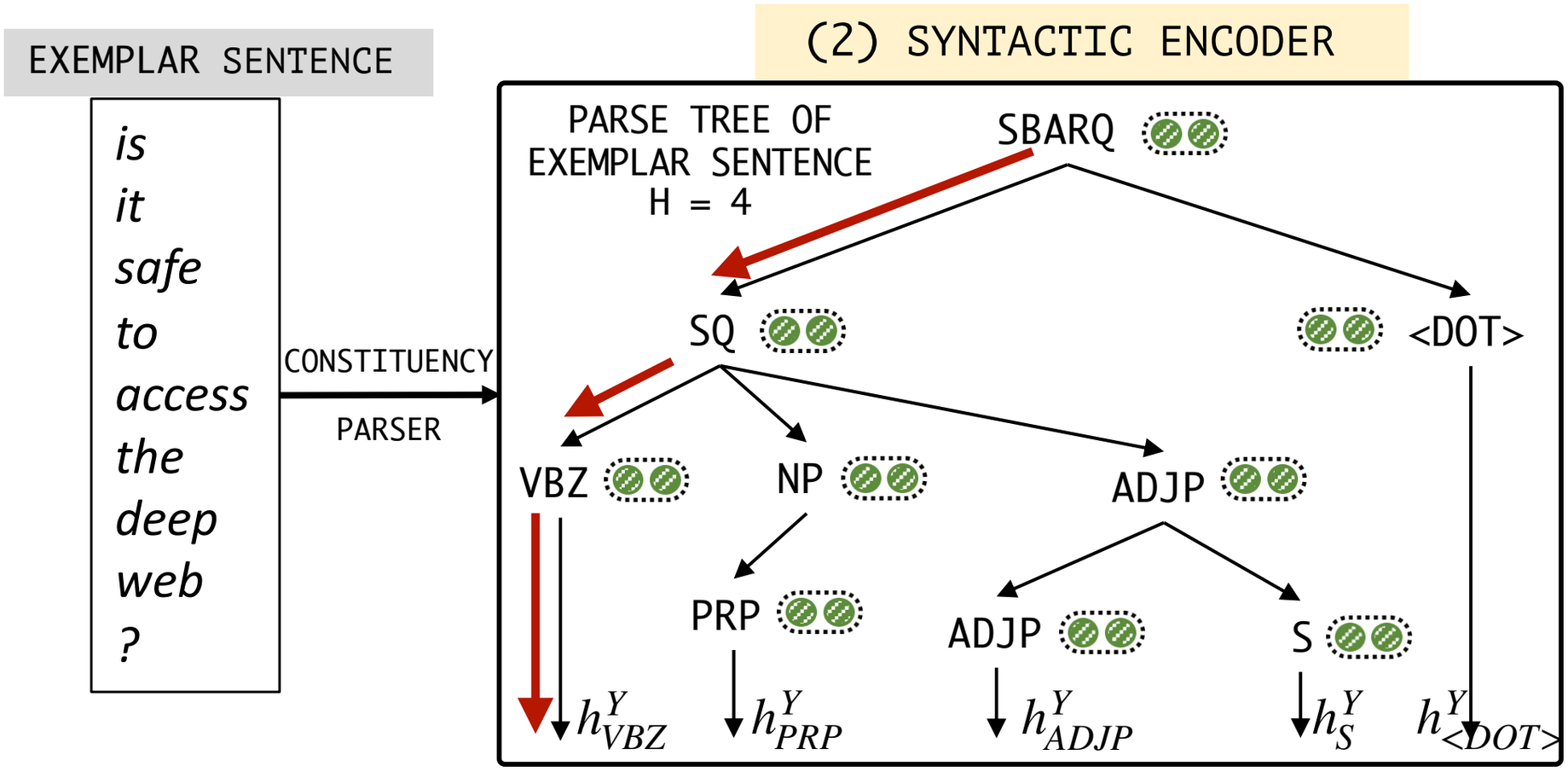

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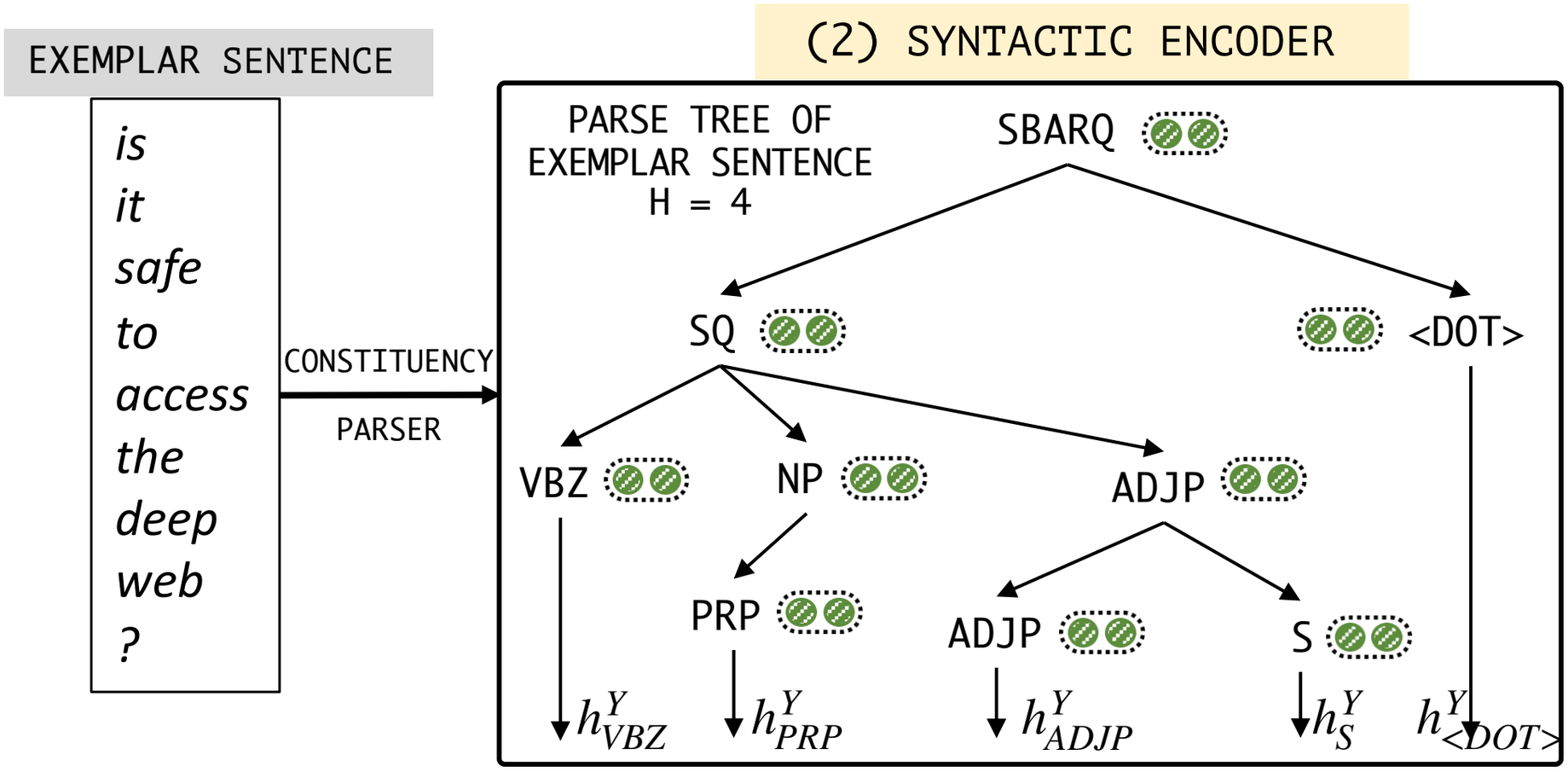

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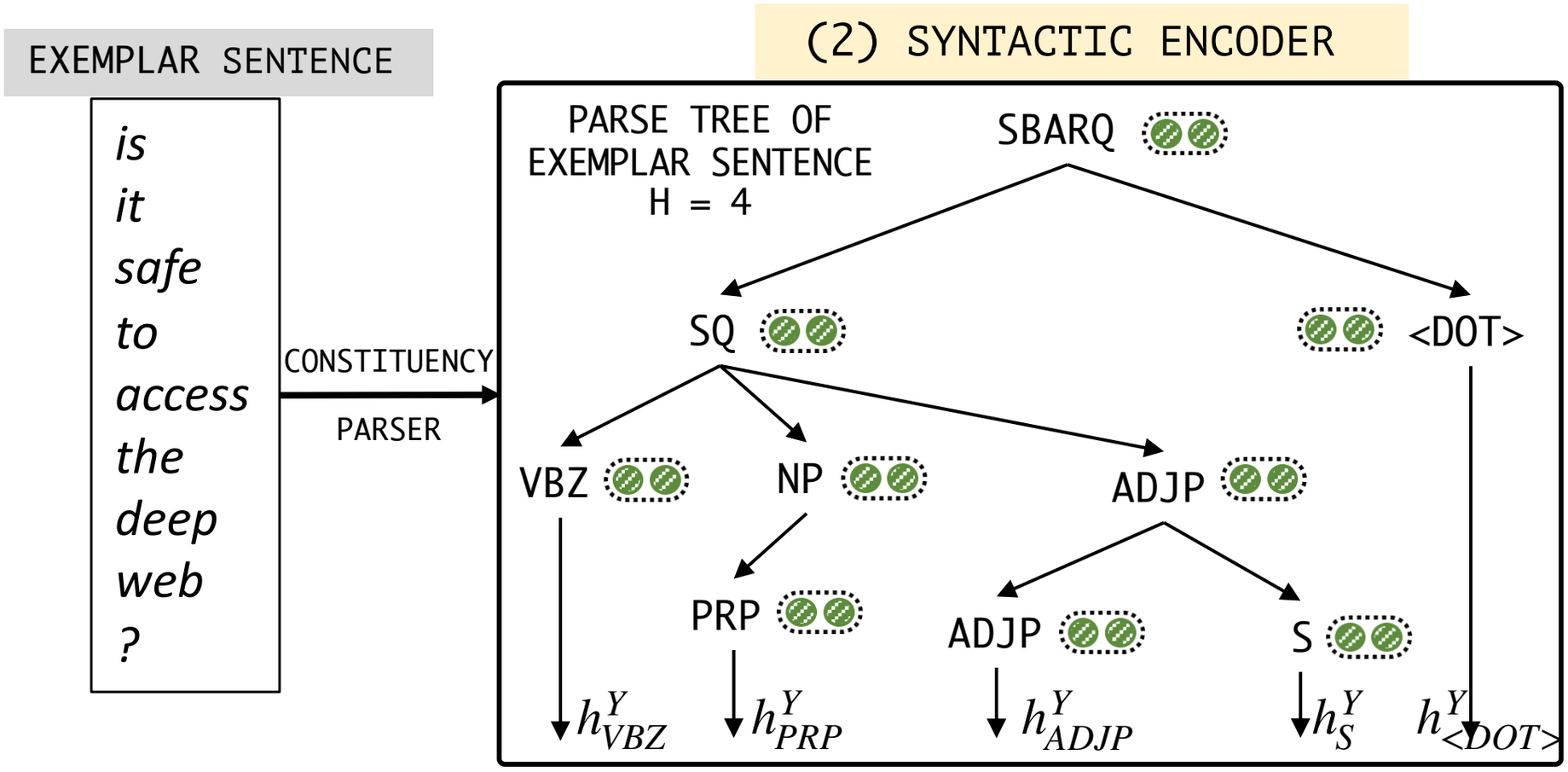

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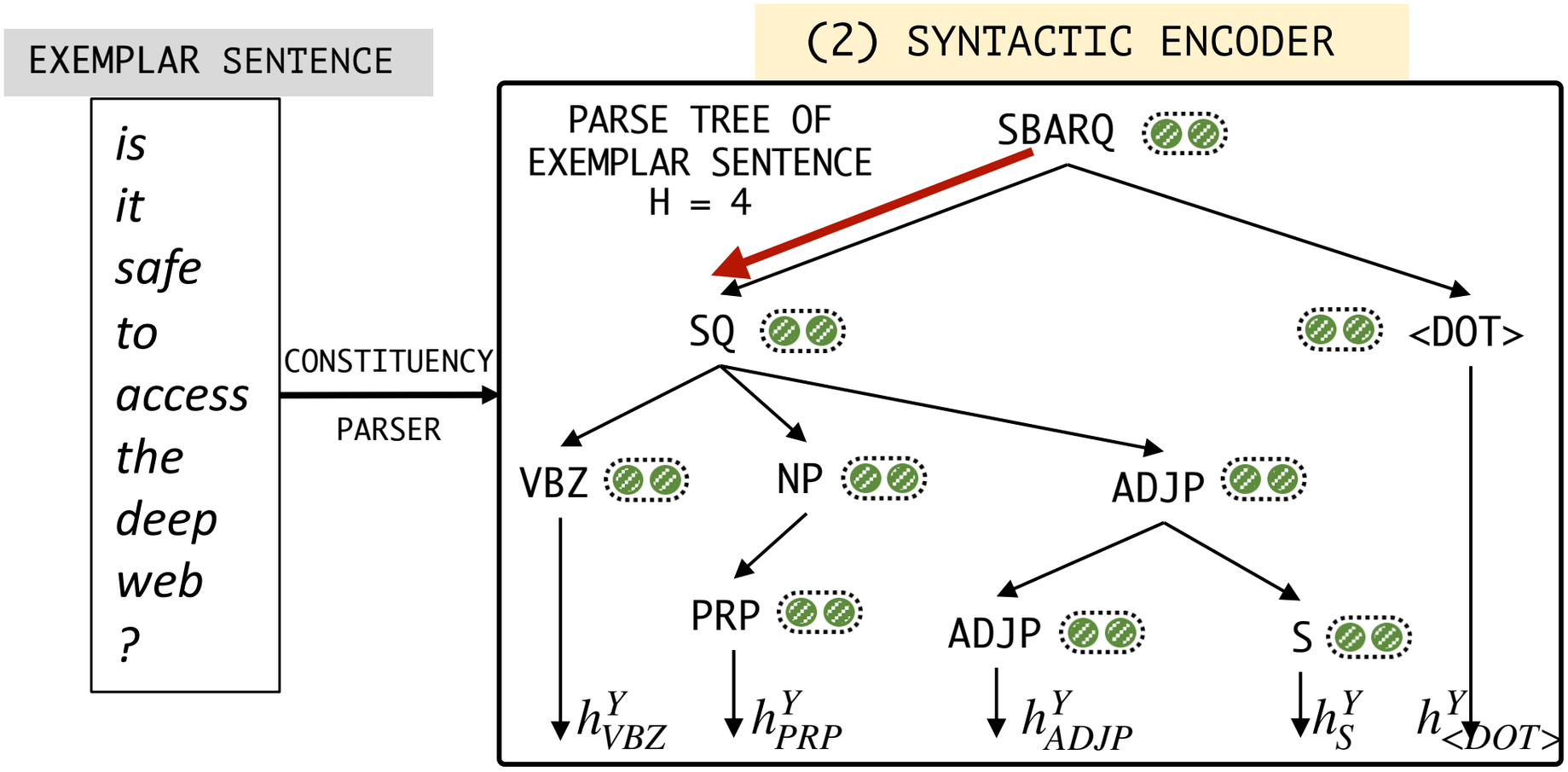

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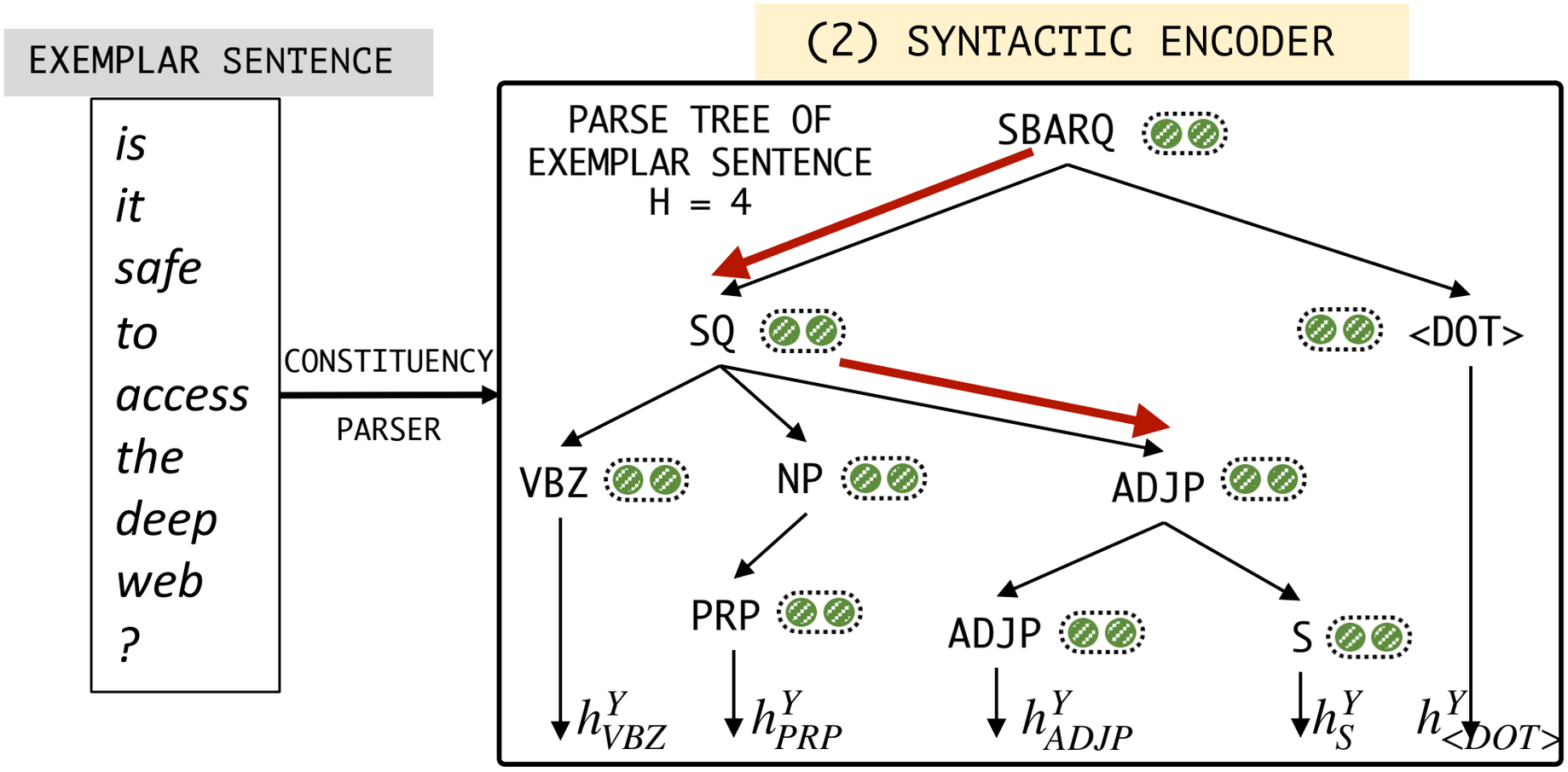

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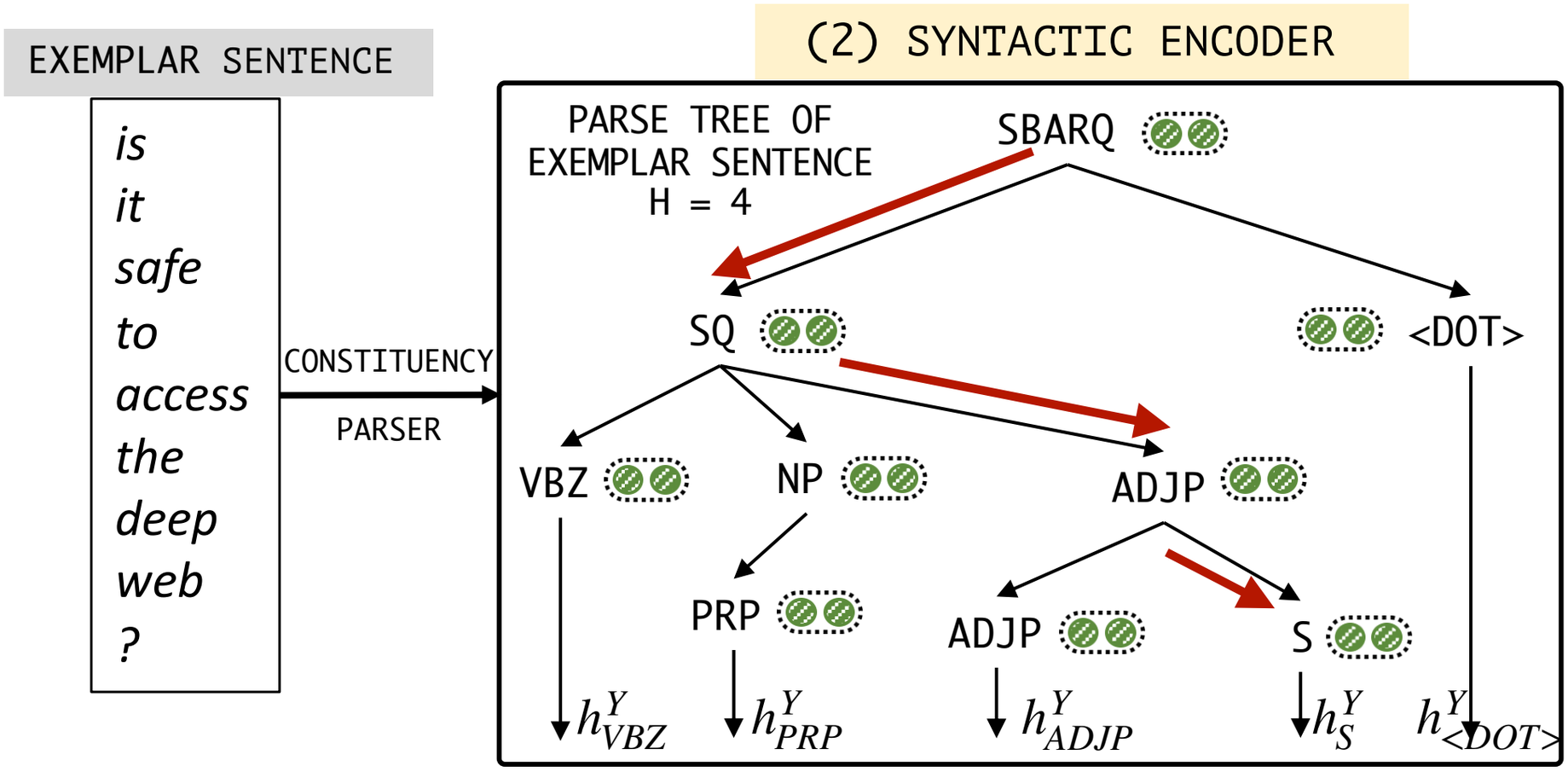

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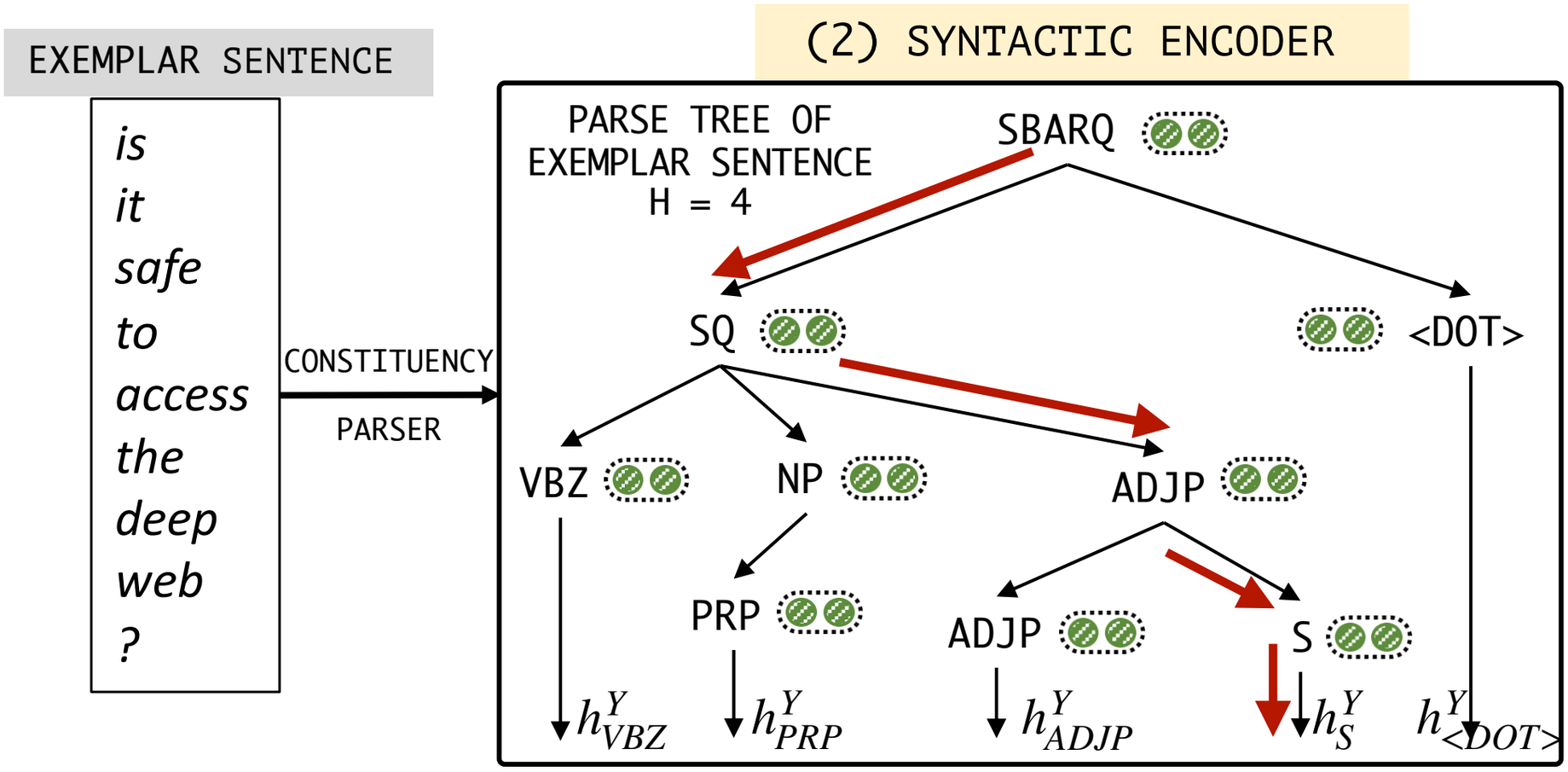

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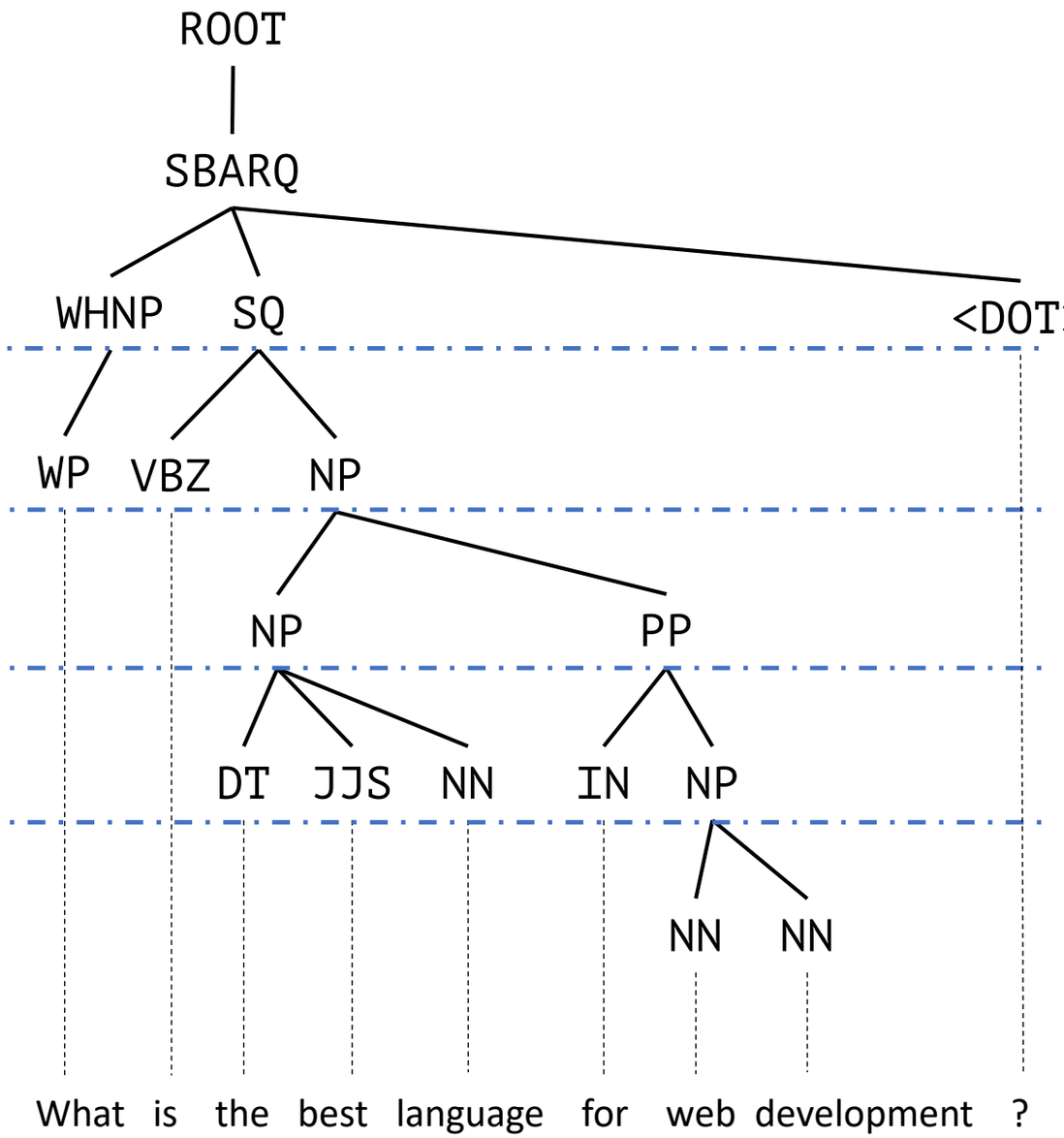
Syntactic Tree to Syntactic Signalling Vector (Only during Training)



$H = 2; a$ = (1,1,0,0,0,0,0,0,1)

$H = 3; a$ = (1,1,1,0,0,0,0,0,1)

$H = 4; a$ = (1,1,1,0,0,1,0,0,1)

$H = 5; a$ = (1,1,1,1,1,1,1,0,1)

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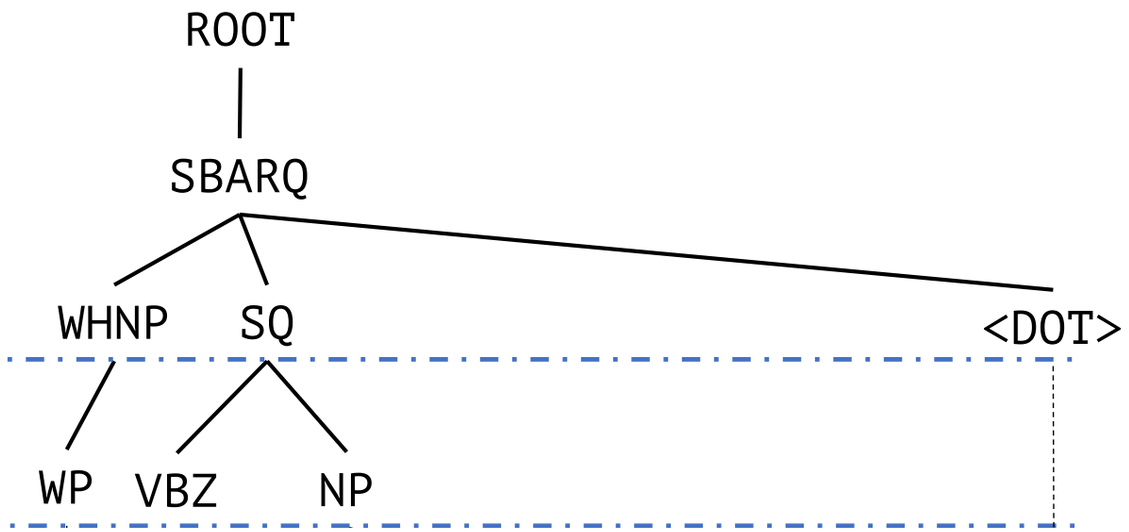
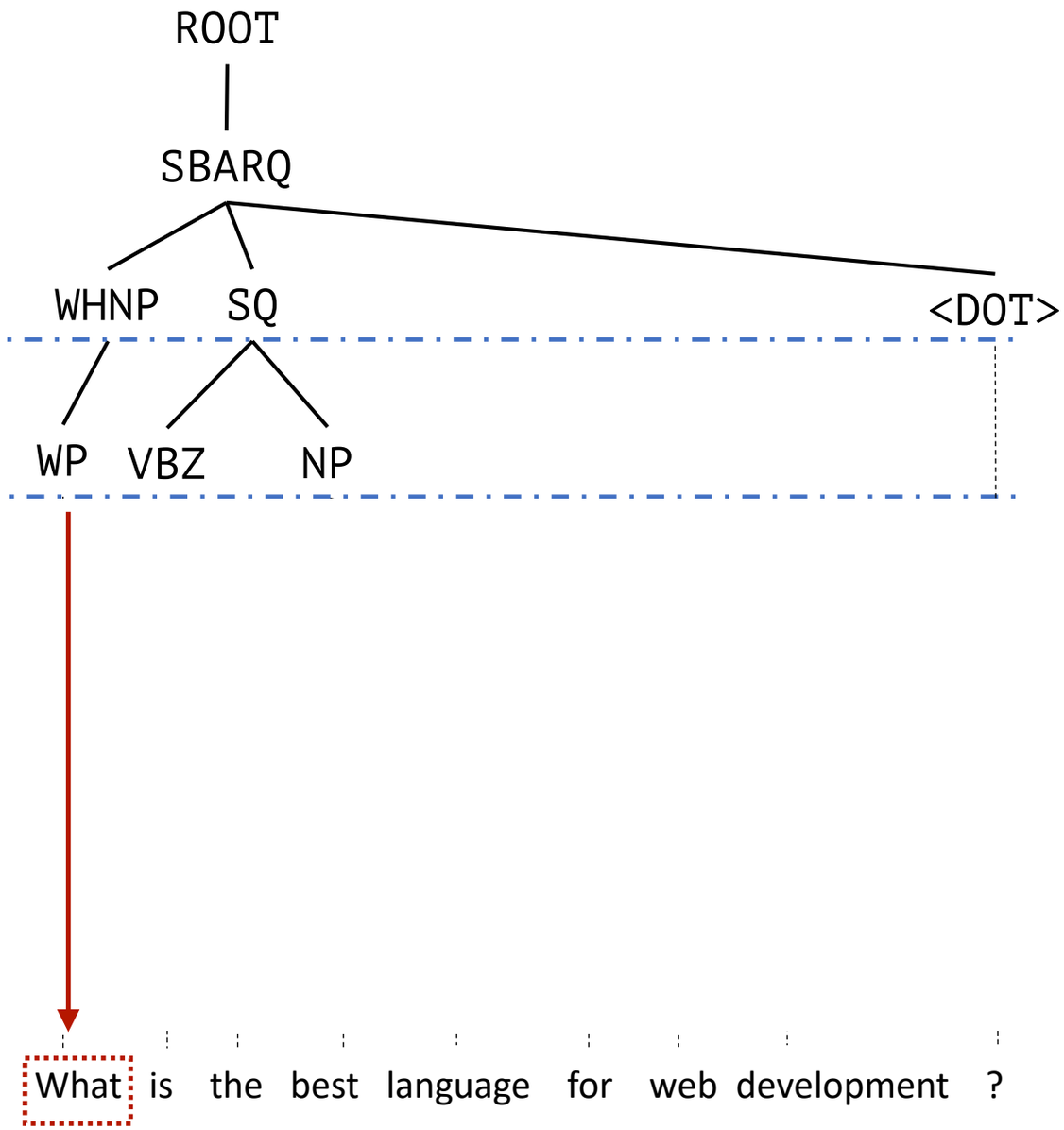


$H = 3; a = (1,1,1,0,0,0,0,0,1)$

What is the best language for web development ?

Syntactic Tree to Syntactic Signalling Vector (Only during Training)



$H = 3; a = (1,1,1,0,0,0,0,0,1)$

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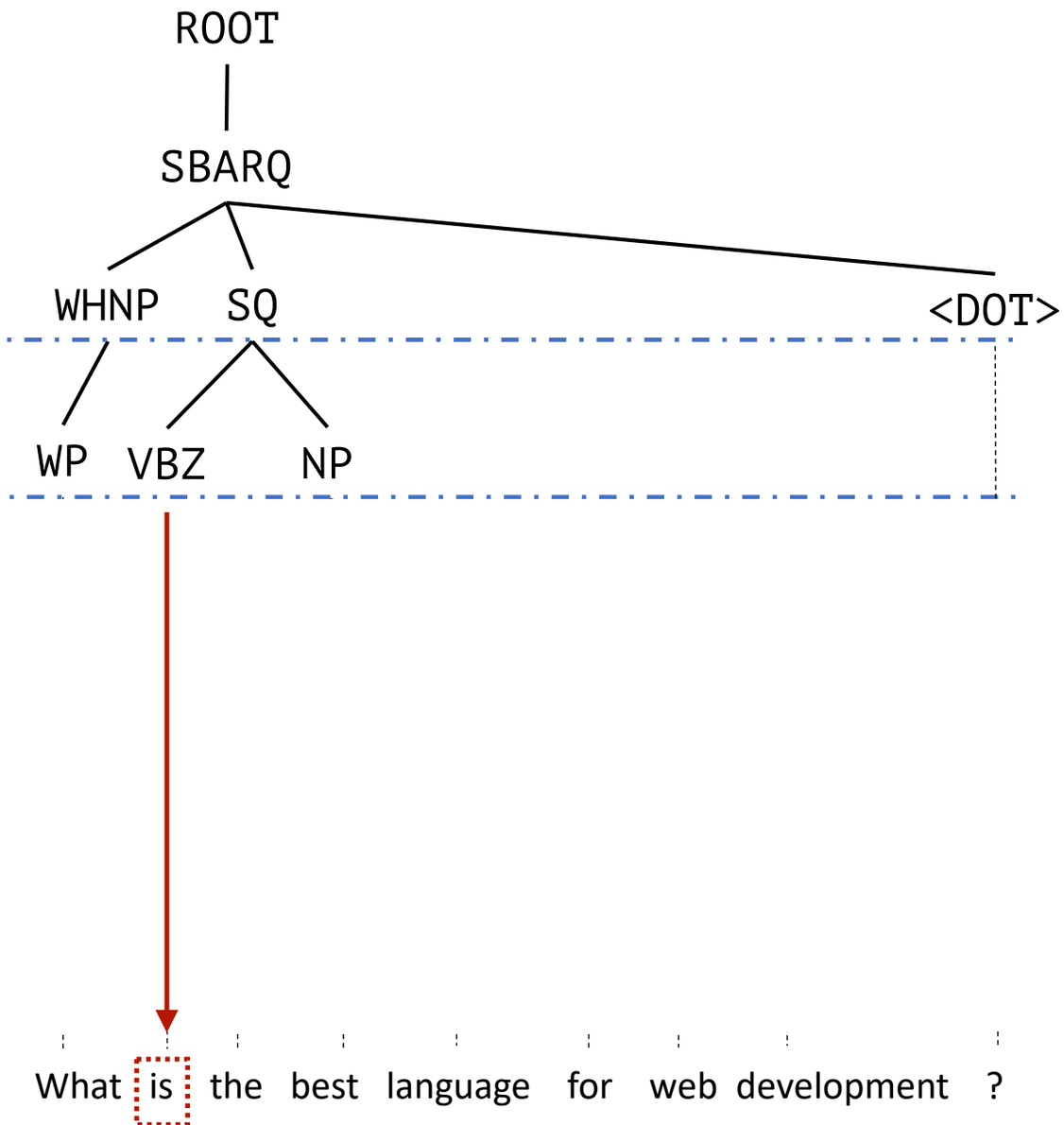

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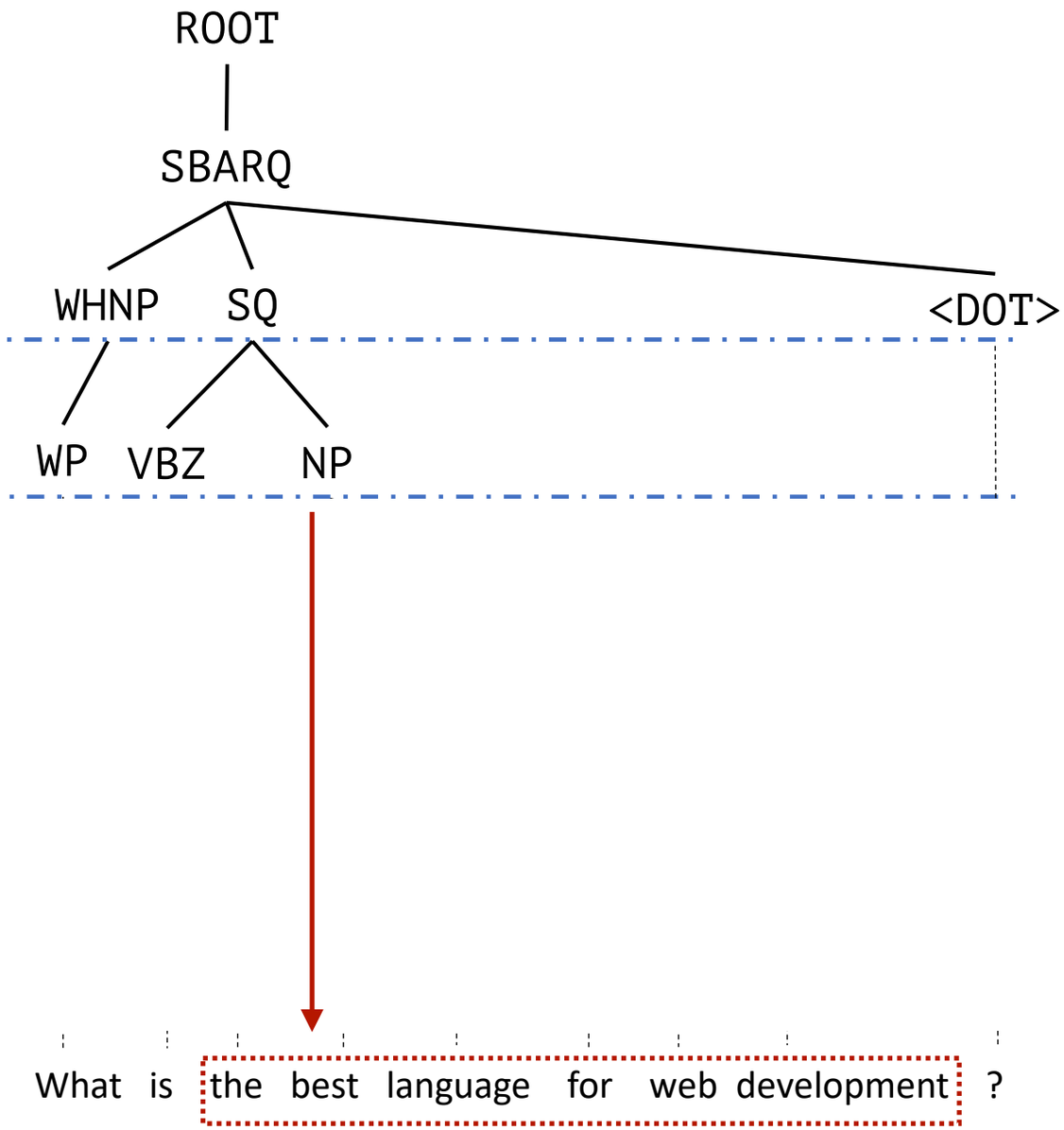

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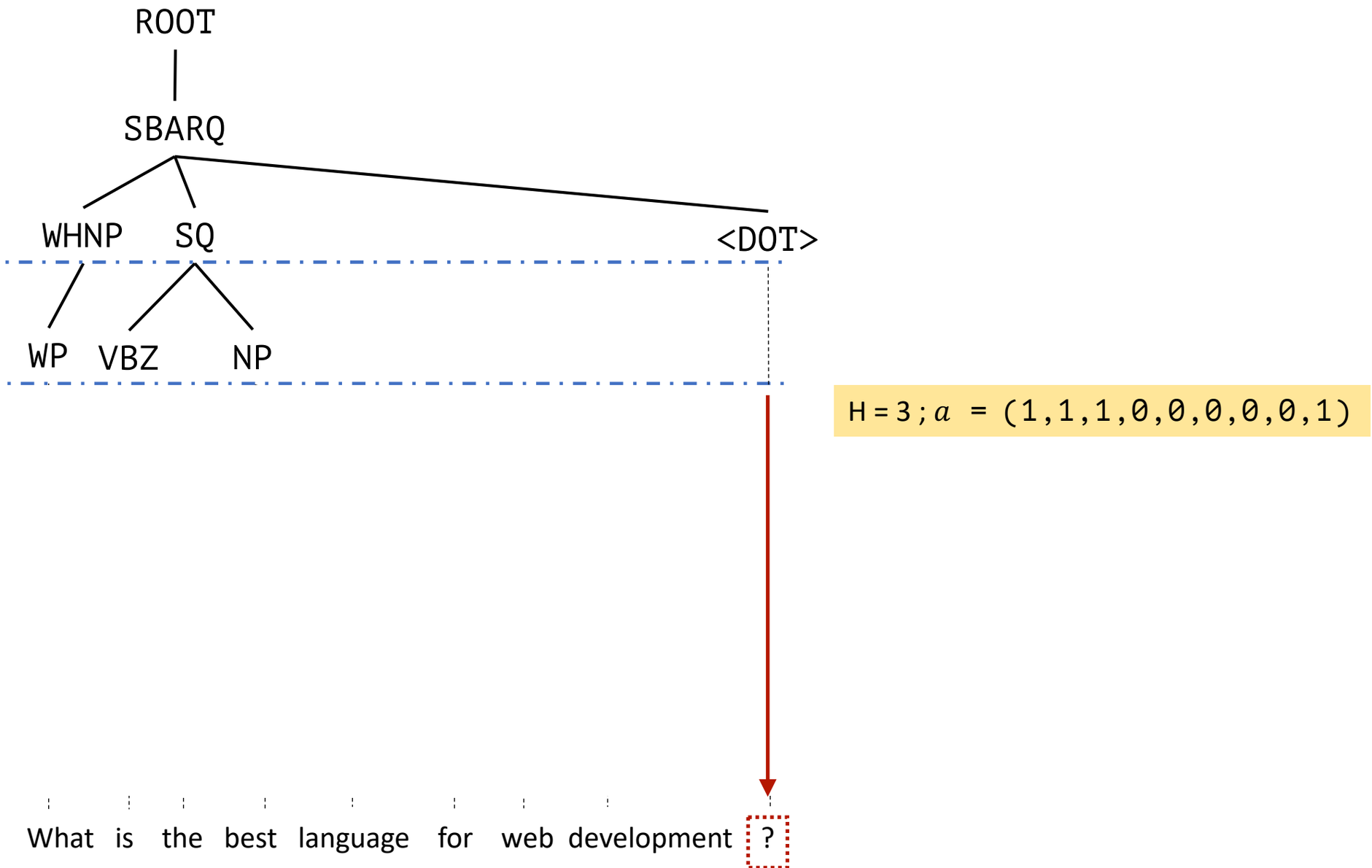

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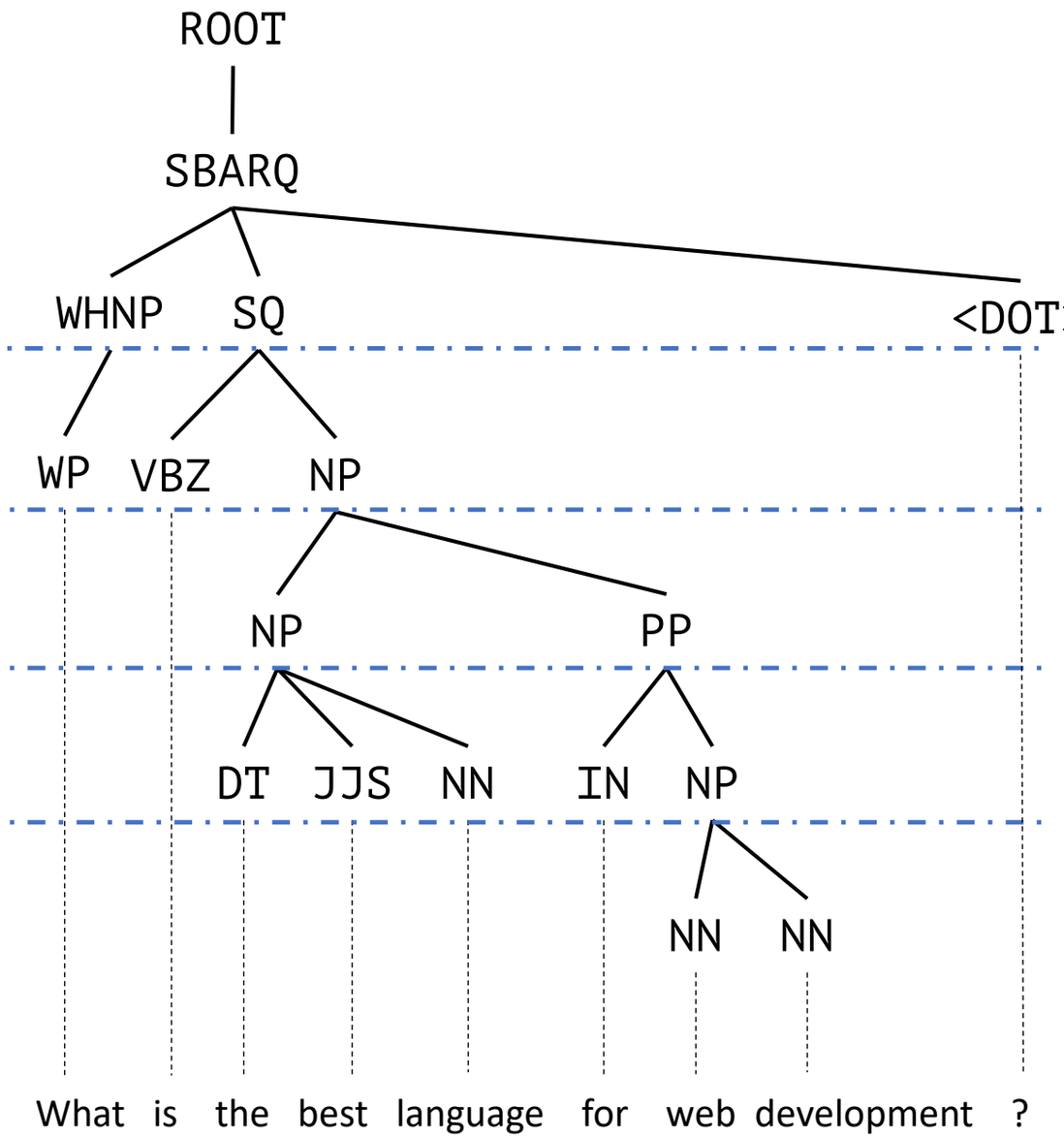
Syntactic Tree to Syntactic Signalling Vector (Only during Training)



$H = 2; a$ = (1,1,0,0,0,0,0,0,1)

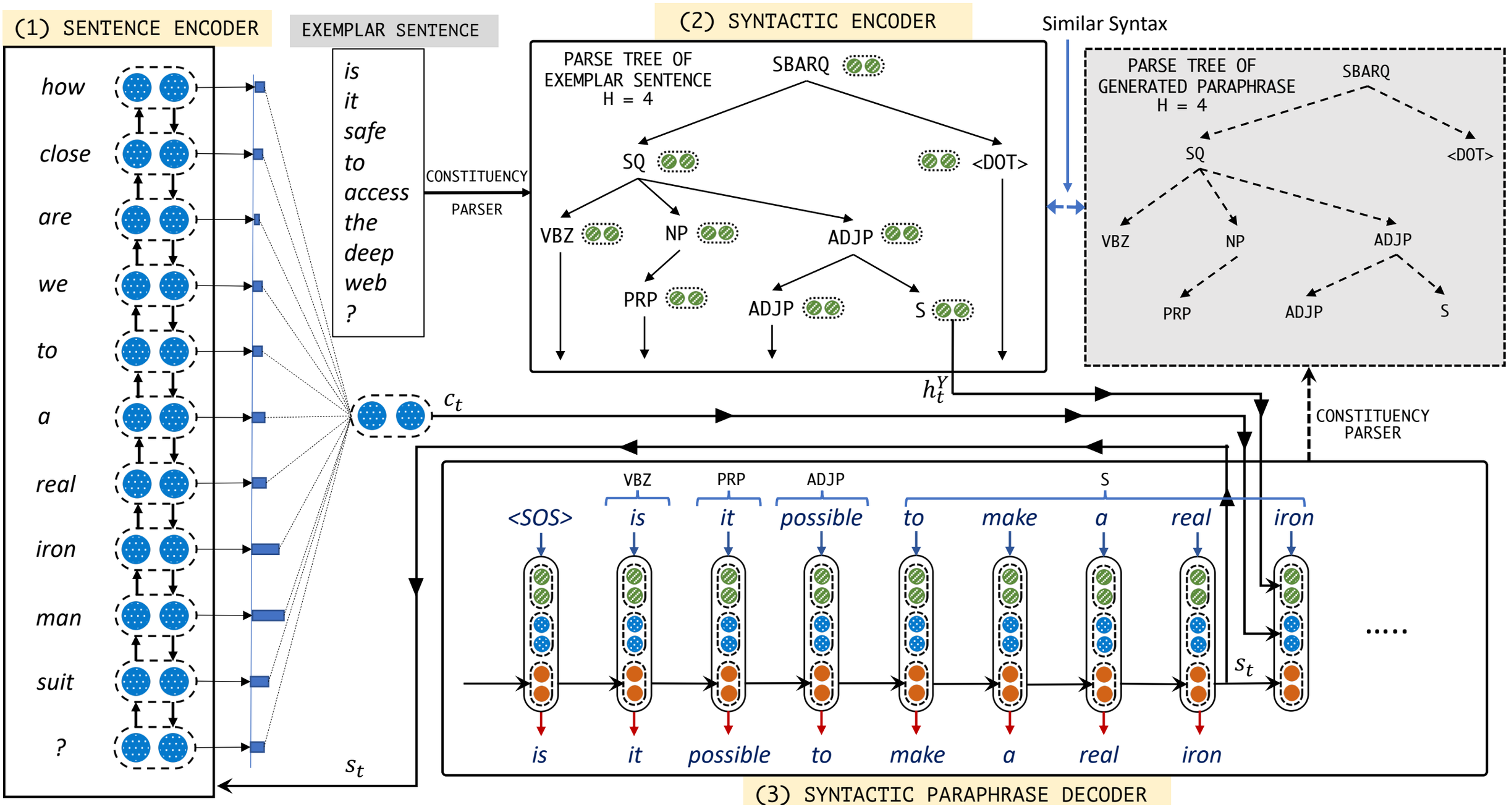
$H = 3; a$ = (1,1,1,0,0,0,0,0,1)

$H = 4; a$ = (1,1,1,0,0,1,0,0,1)

$H = 5; a$ = (1,1,1,1,1,1,1,0,1)

SGCP: Syntax Guided Controlled Paraphraser

Use Syntactic Tree Structure to Guide Paraphrase Generation model



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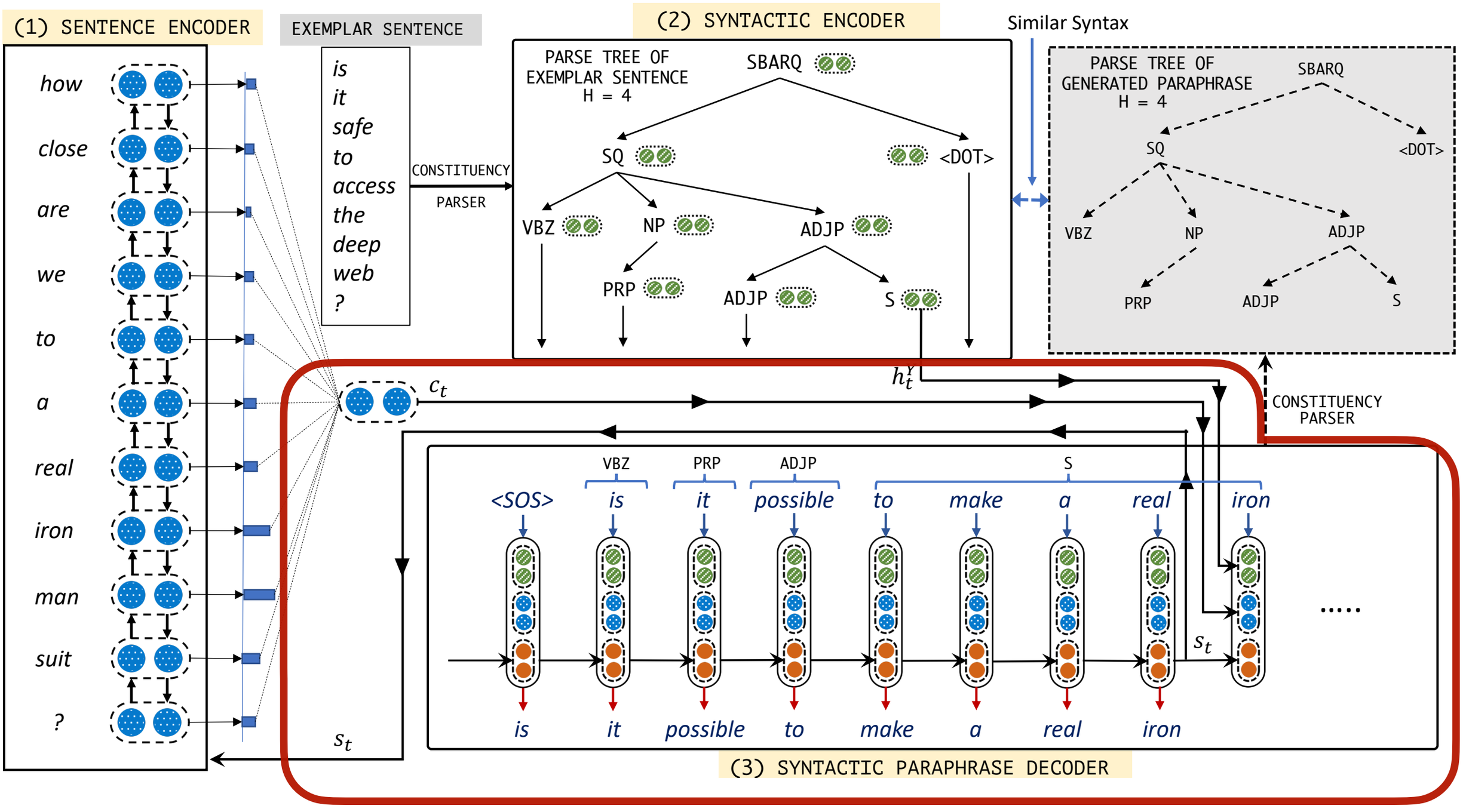
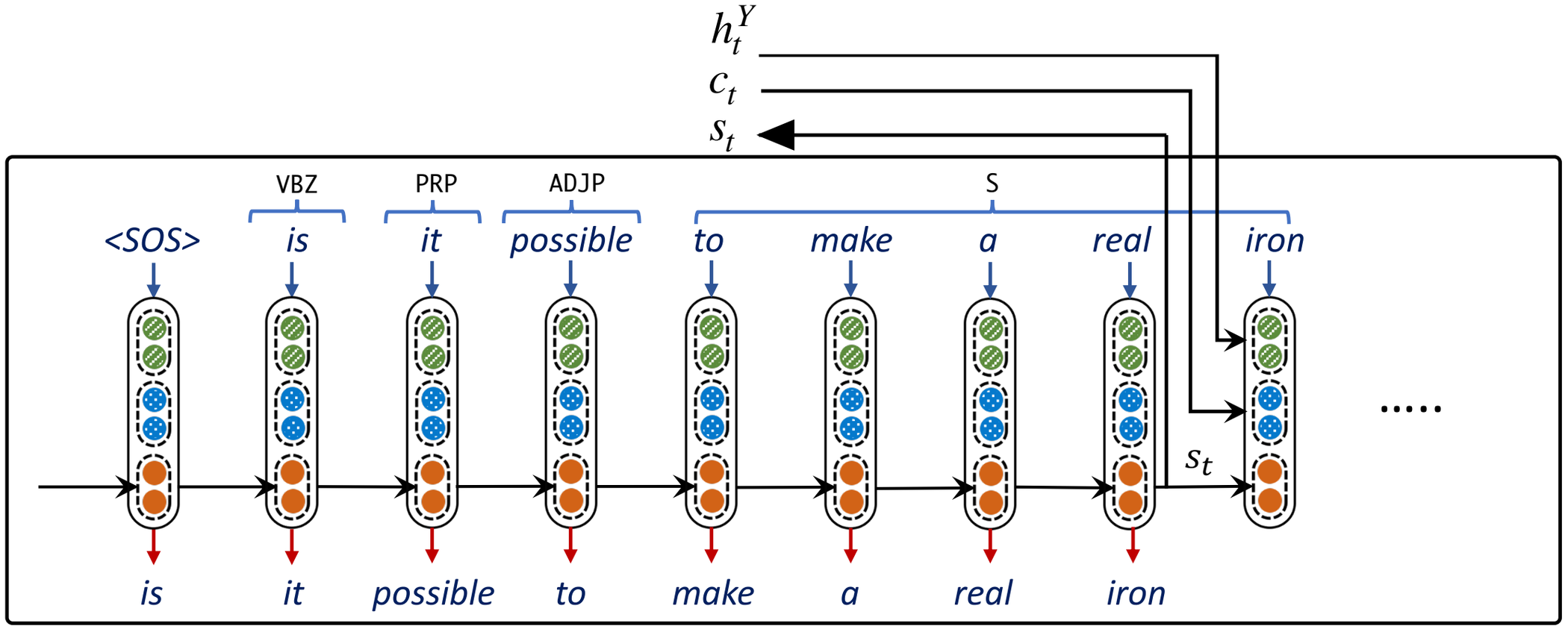
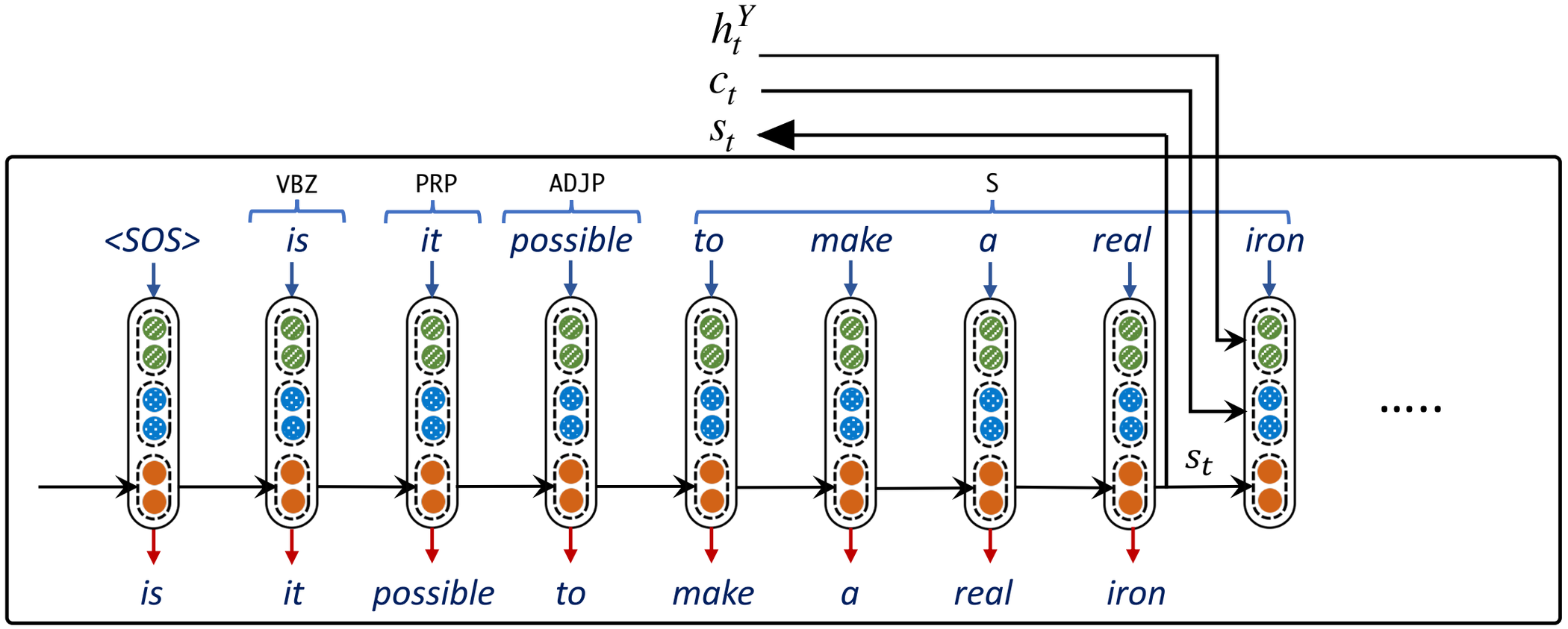


SGCP: Decoder



(3) SYNTACTIC PARAPHRASE DECODER

SGCP: Decoder



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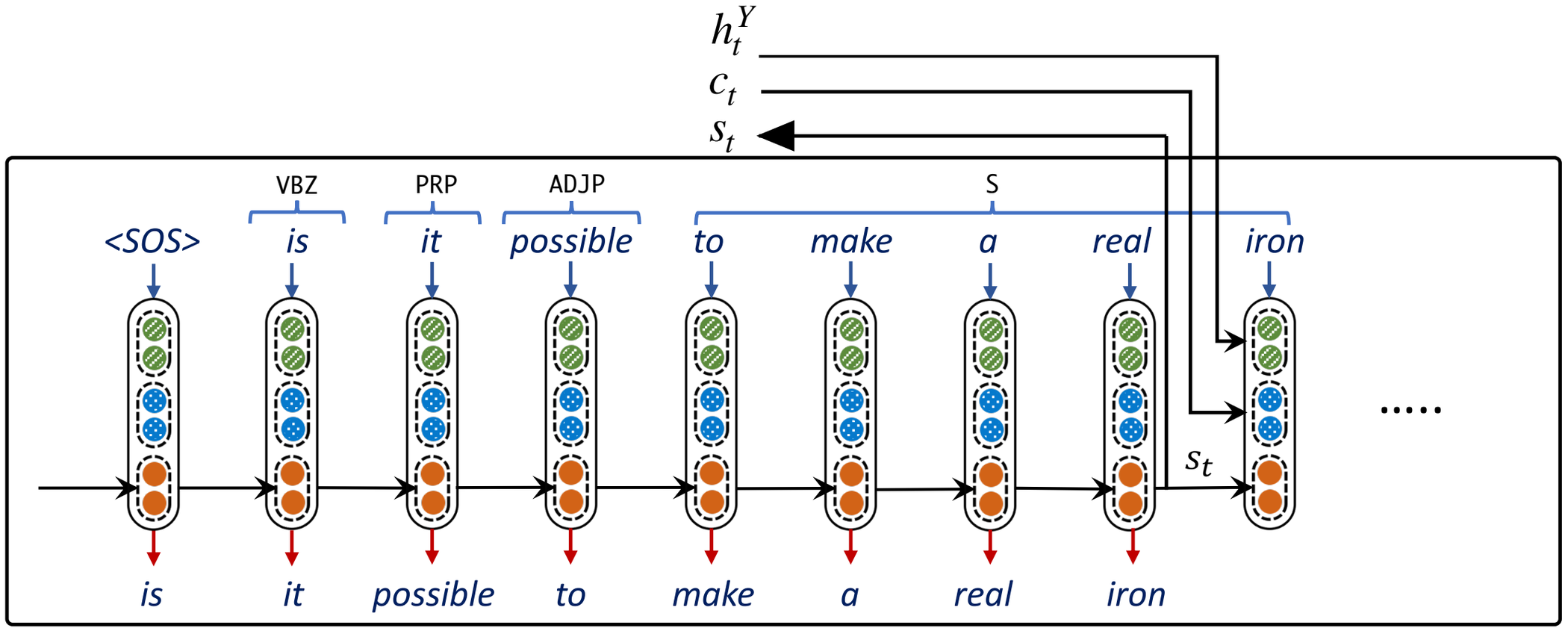
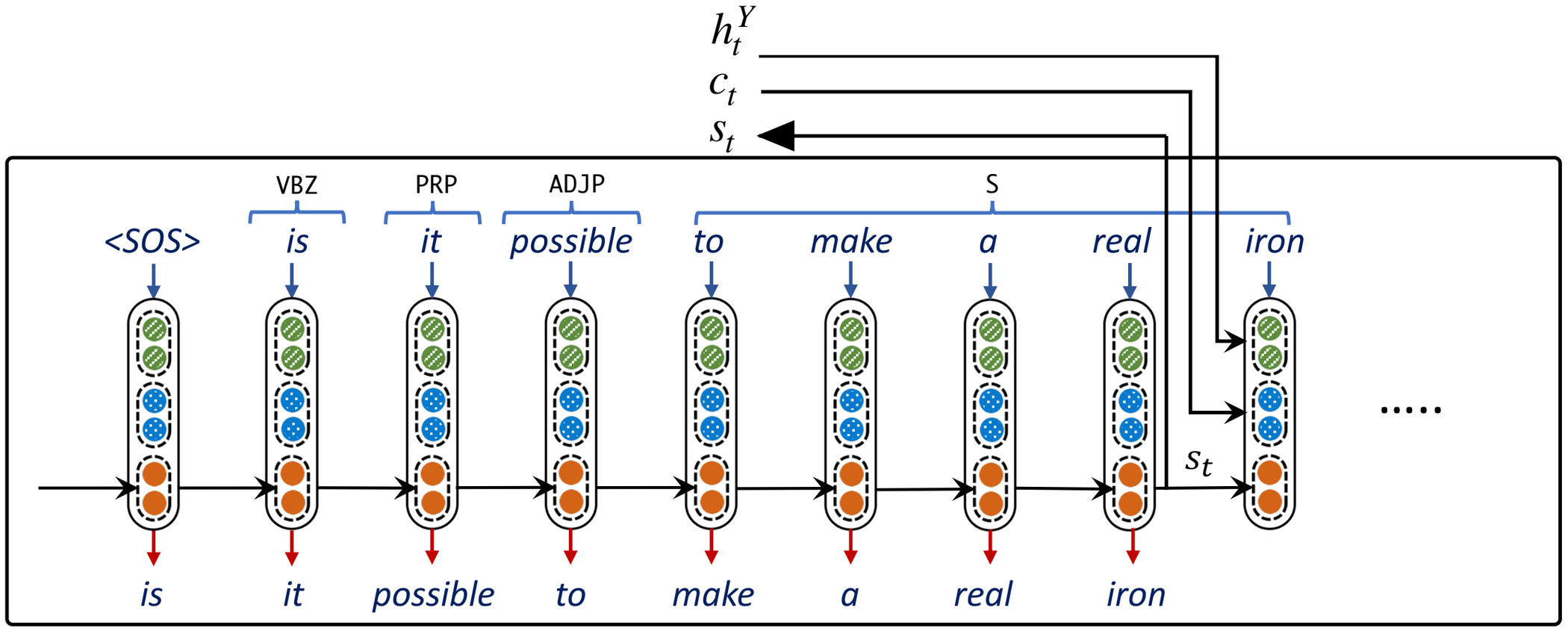


(3) SYNTACTIC PARAPHRASE DECODER

$$p_t = \sigma(W_{bop}([c_t; h_t^Y; s_t; e(z_t')]) + b_{bop})$$

$$h_{t+1}^Y = \begin{cases} h_t^Y & p_t < 0.5 \\ \textbf{pop}(\mathbb{L}_H^Y) & otherwise \end{cases}$$

SGCP: Decoder



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$$\mathbb{P}(z) = \textbf{softmax}(W([c_t; h_t^Y; s_t; e(z_t')]) + b)$$

SGCP Objective

SGCP Objective

$$\mathscr{L} = -\frac{1}{T}\sum_{t=0}^{T}[\log \mathbb{P}(z_t^*) + a_t \log(p_t) + (1 - a_t)\log(1 - p_t)]$$

a_t : Signalling vector, p_t: Transition probability,

T : Generation Time-step, z_t^*: Ground Truth token

Dataset Statistics

Dataset Statistics

	Triples (Sentence, Exemplar, Reference)		
	Train*	Dev.	Test
ParaNMT-small	4,92,878	500	800
QQP-Pos	1,37,185	3000	3000

* During Training: Exemplar = Reference Paraphrase

Syntactic Granularity & SGCP-Variations

GRANULARITY	
SOURCE	what are pure substances ? what are some examples ?
EXEMPLAR	what are the characteristics of the elizabethan theatre ?

Syntactic Granularity & SGCP-Variations

GRANULARITY	
SOURCE	**what are pure substances ? what are some examples ?**
EXEMPLAR	**what are the characteristics of the elizabethan theatre ?**
H = 4	what are pure substances ?
H = 5	what are some of pure substances ?
H = 6	what are some examples of pure substances ?
H = 7	what are some examples of a pure substance ?

Syntactic Granularity & SGCP-Variations

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SGCP VARIATIONS	
SGCP-F (Full Tree)	what are some examples of a pure substance ?

Syntactic Granularity & SGCP-Variations

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SGCP VARIATIONS	
SGCP-F (Full Tree)	what are some examples of a pure substance ?
SGCP-R (ROUGE)	what are some examples of pure substances ?

Fidelity
QQP-Pos Dataset

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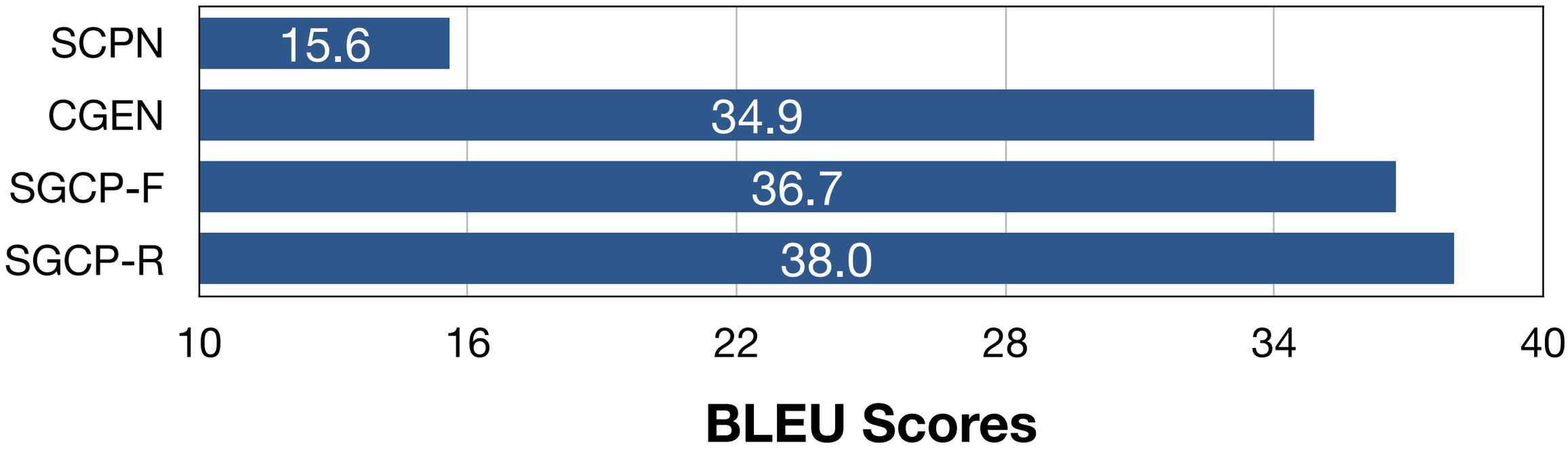
QQP-Pos Dataset



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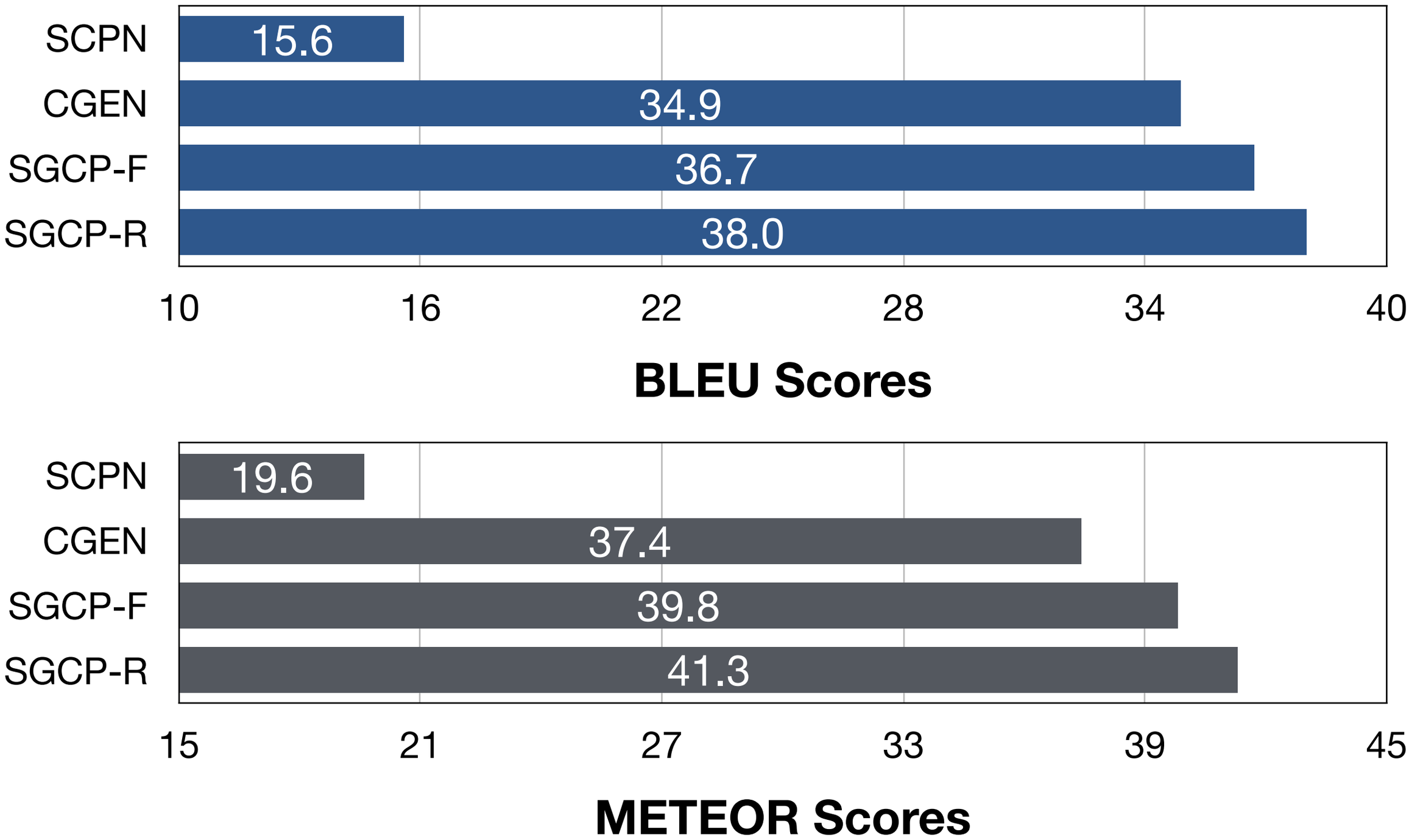

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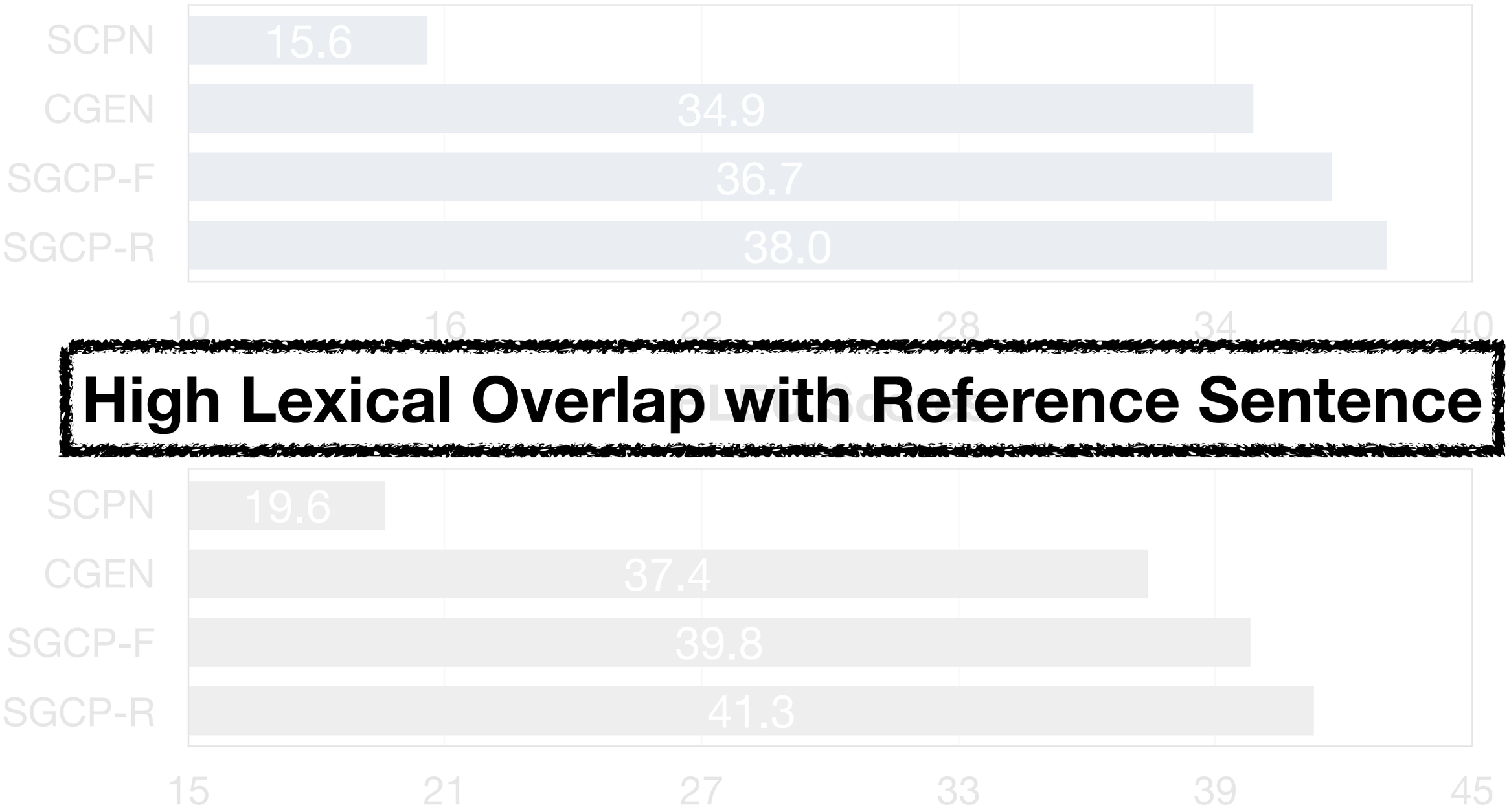

High Lexical Overlap with Reference Sentence

Fidelity
ParaNMT-small Dataset

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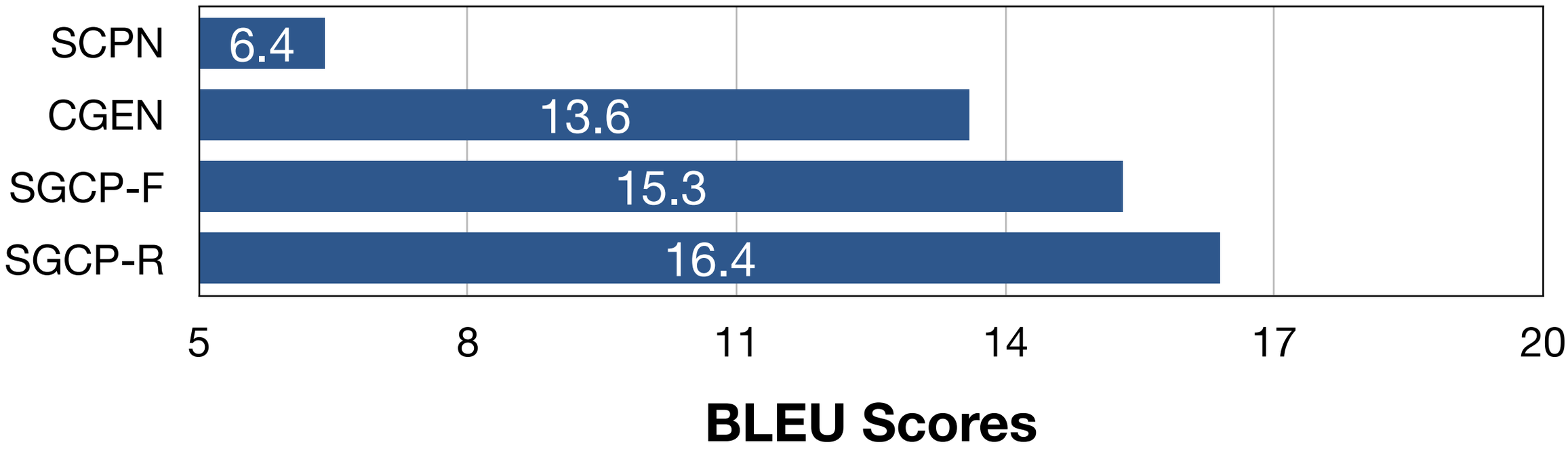

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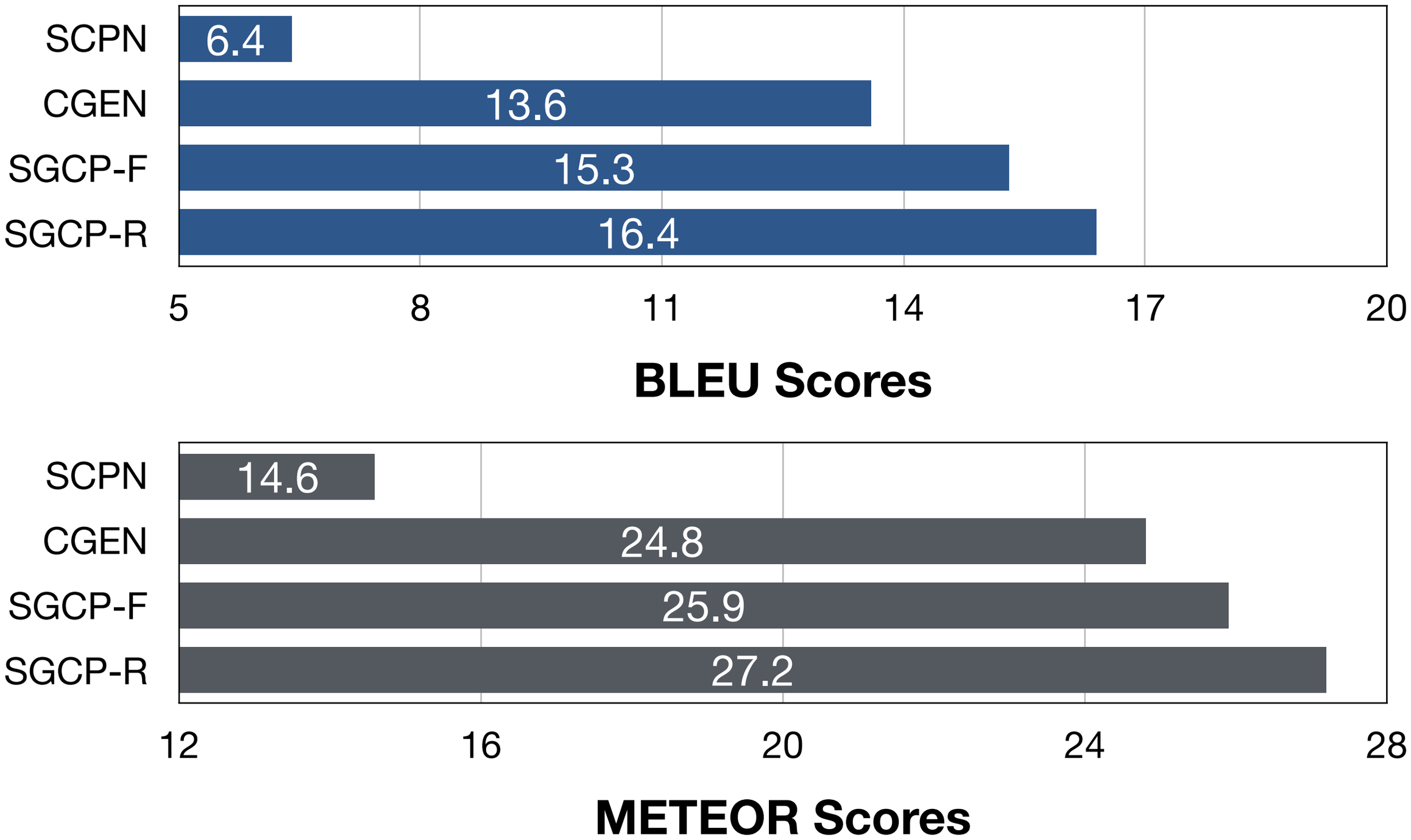

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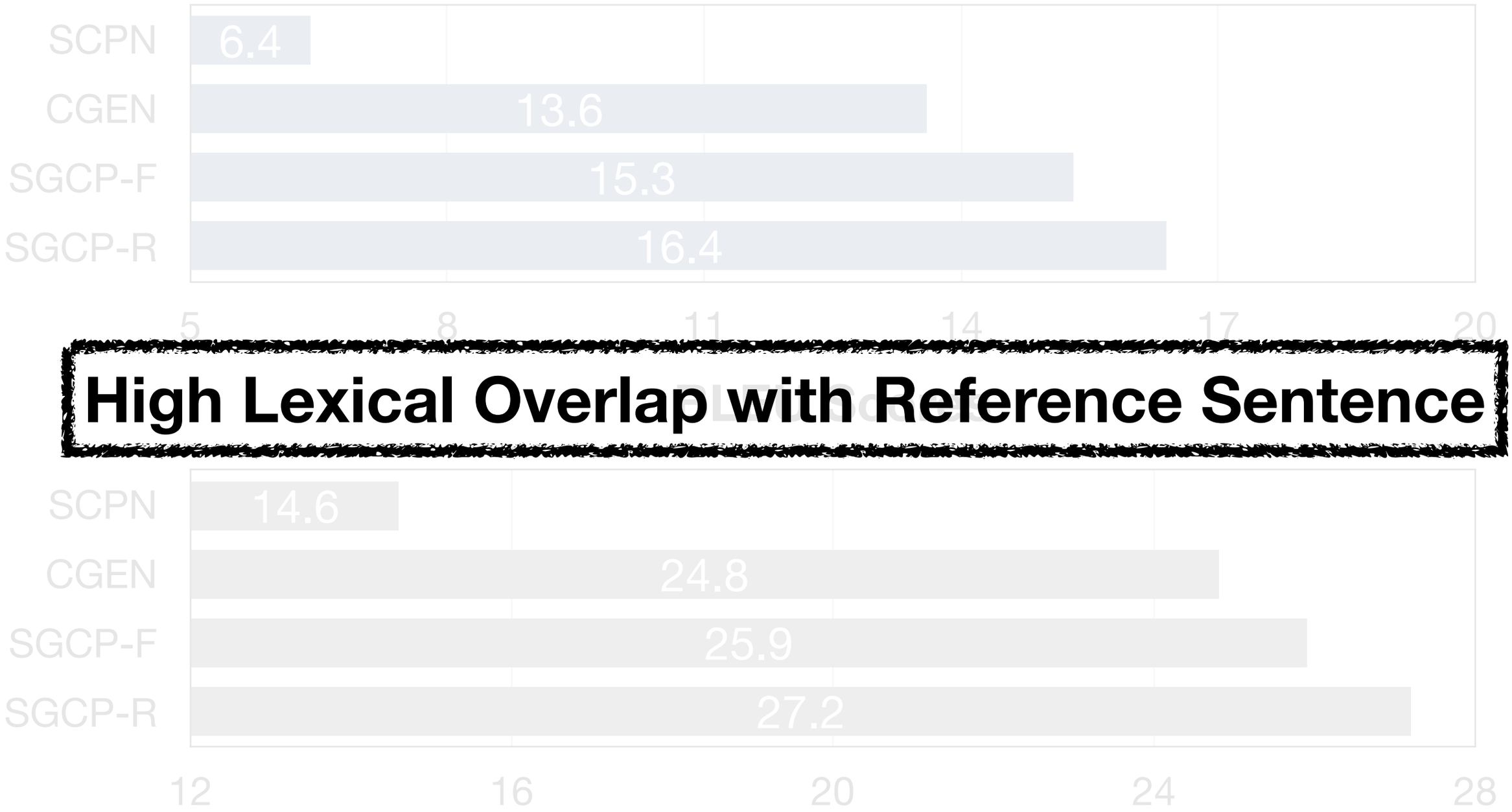

High Lexical Overlap with Reference Sentence

Fidelity : Paraphrase Detection Score (PDS)

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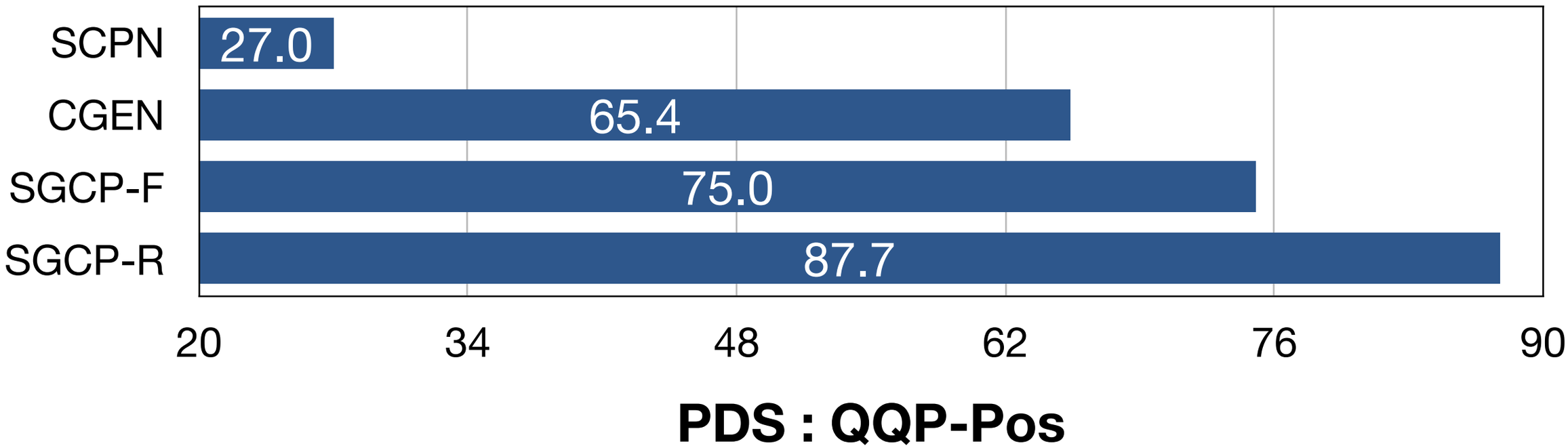

PDS : QQP-Pos

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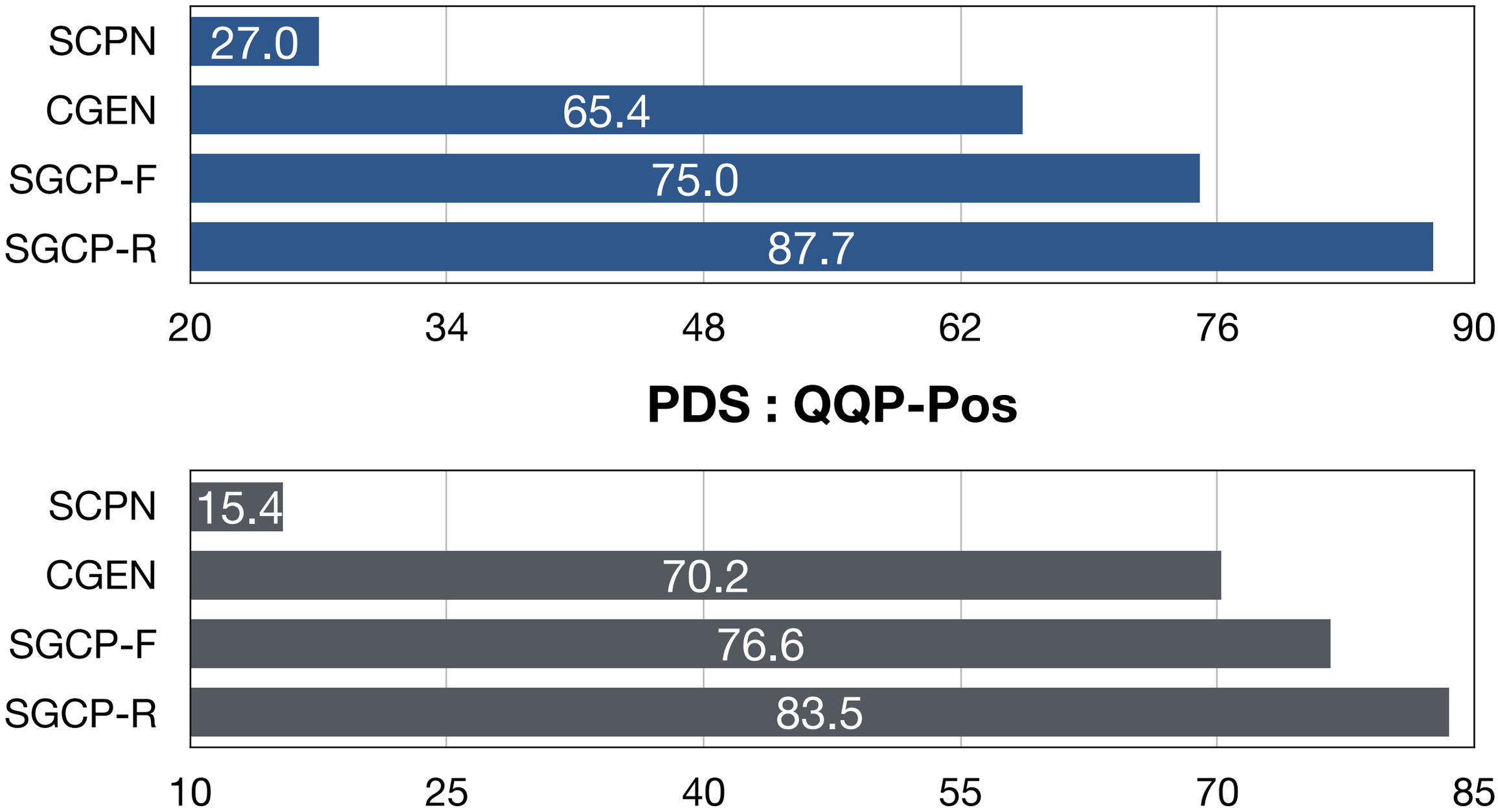

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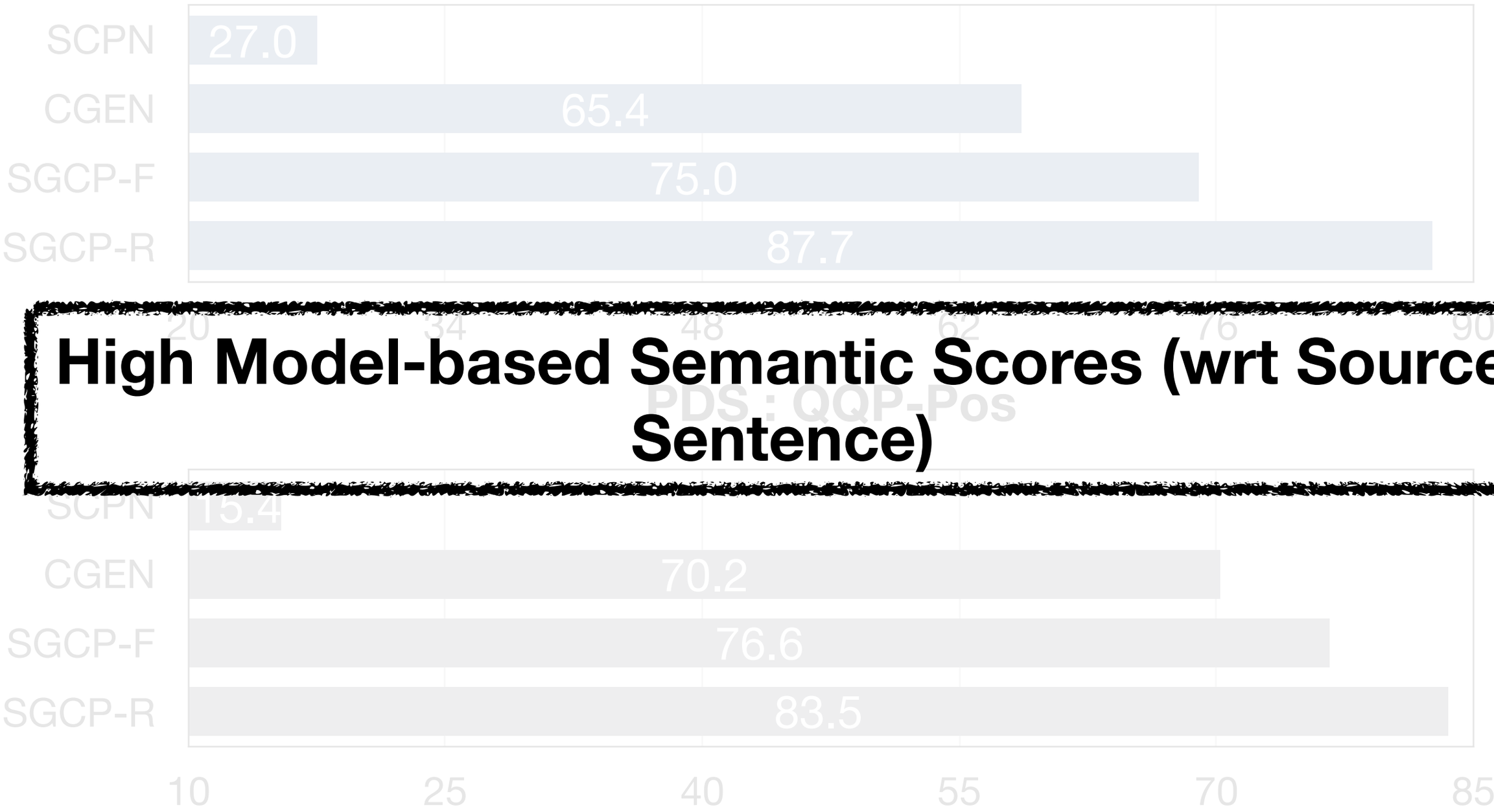
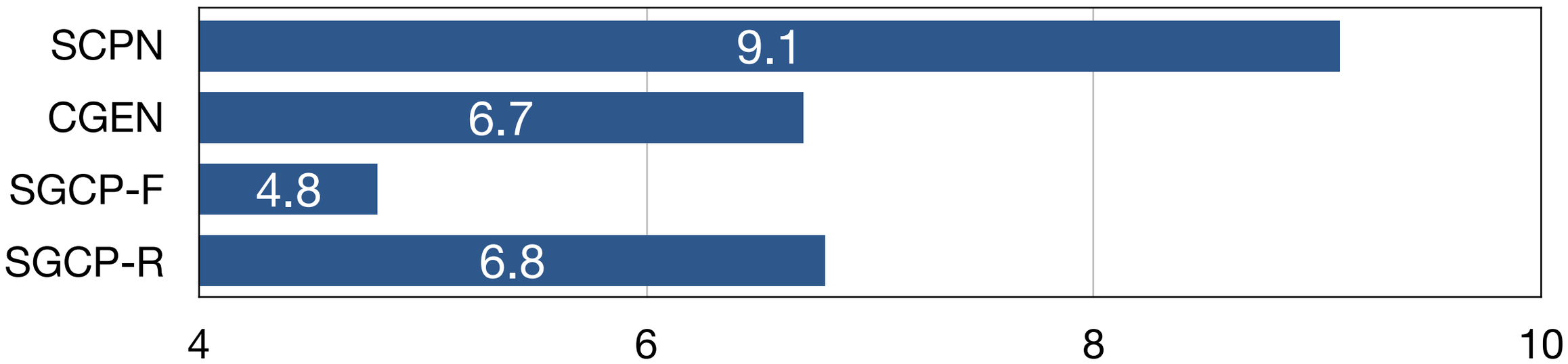


High Model-based Semantic Scores (wrt Source Sentence)

Syntax Conformation QQP-Pos Dataset

Syntax Conformation
QQP-Pos Dataset



Tree Edit Distance with Reference (Lower is better)

Syntax Conformation
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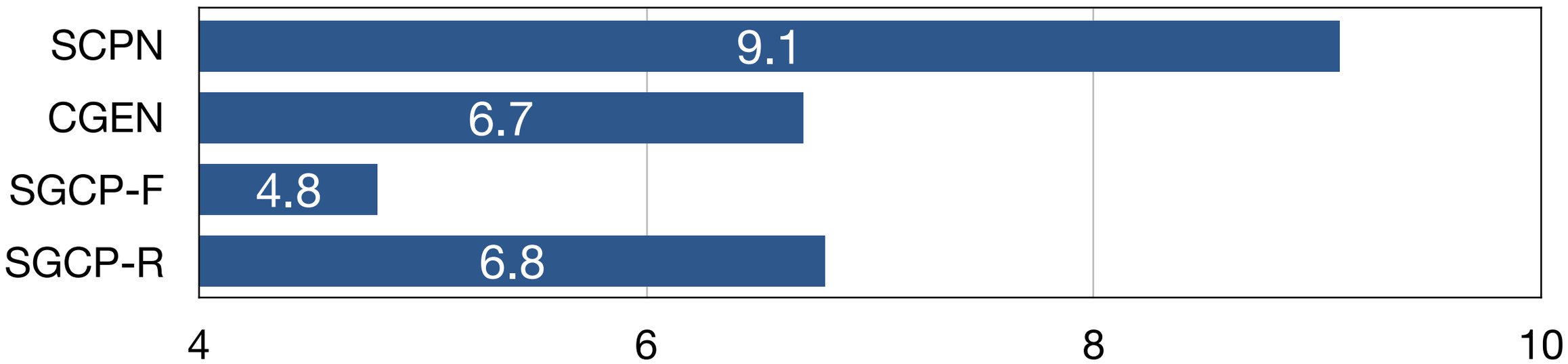

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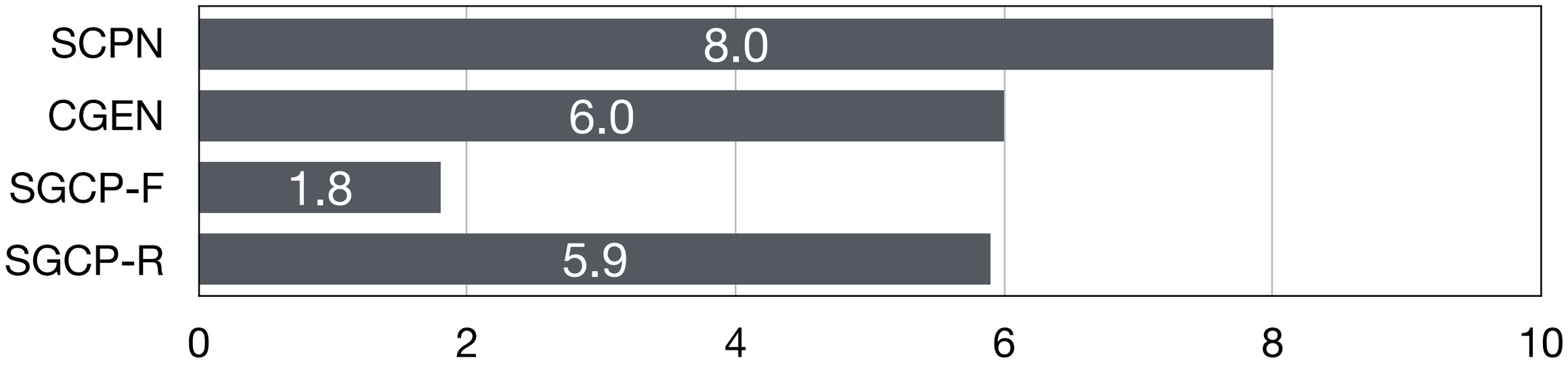

Tree Edit Distance with Exemplar (Lower is better)

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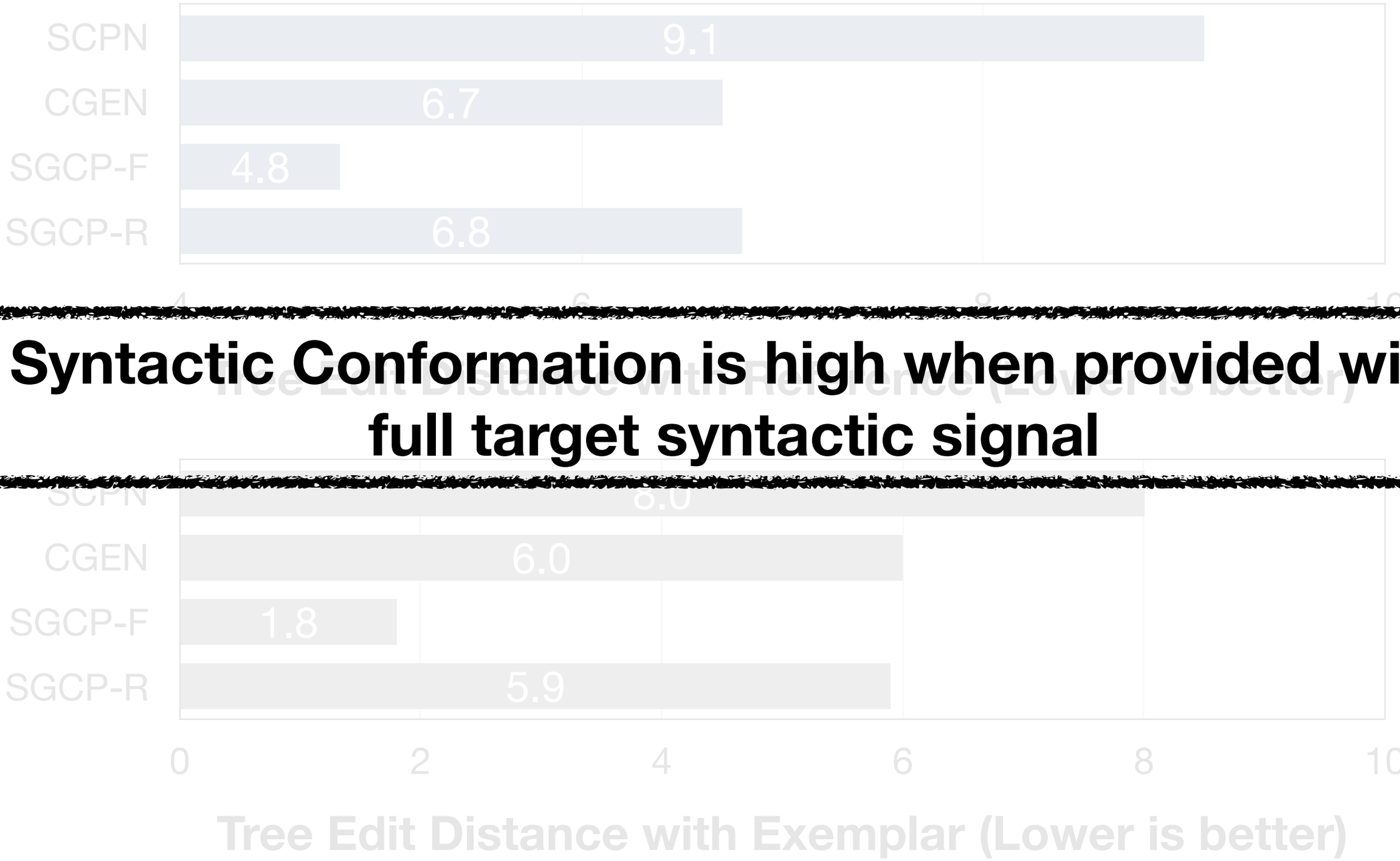

Syntactic Conformation is high when provided with full target syntactic signal

Syntax Conformation ParaNMT-small Dataset

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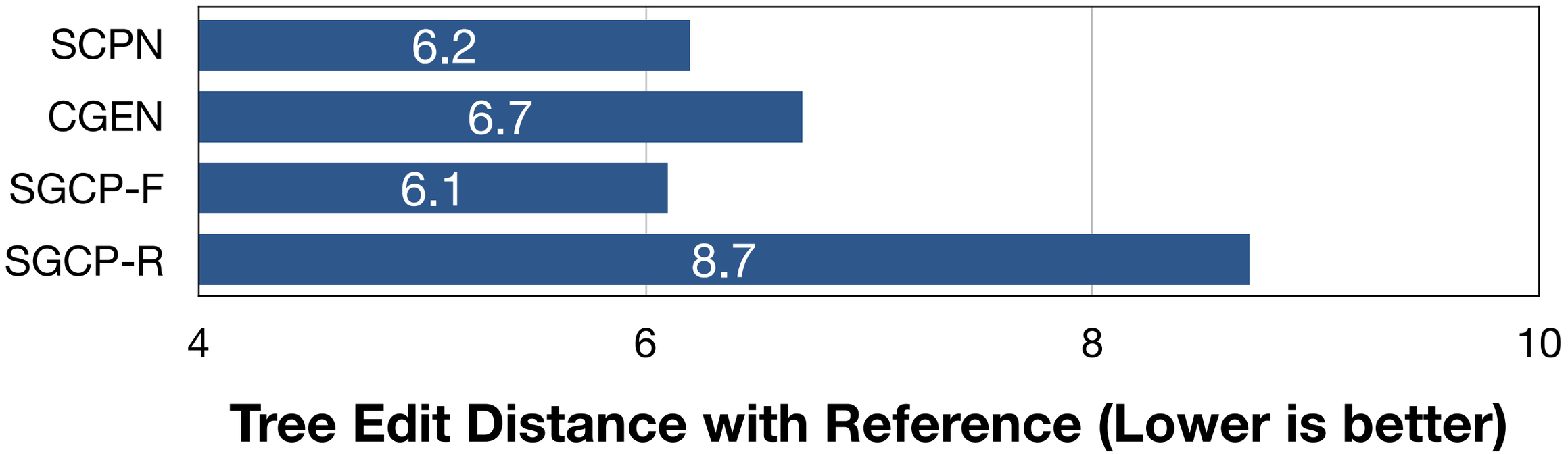

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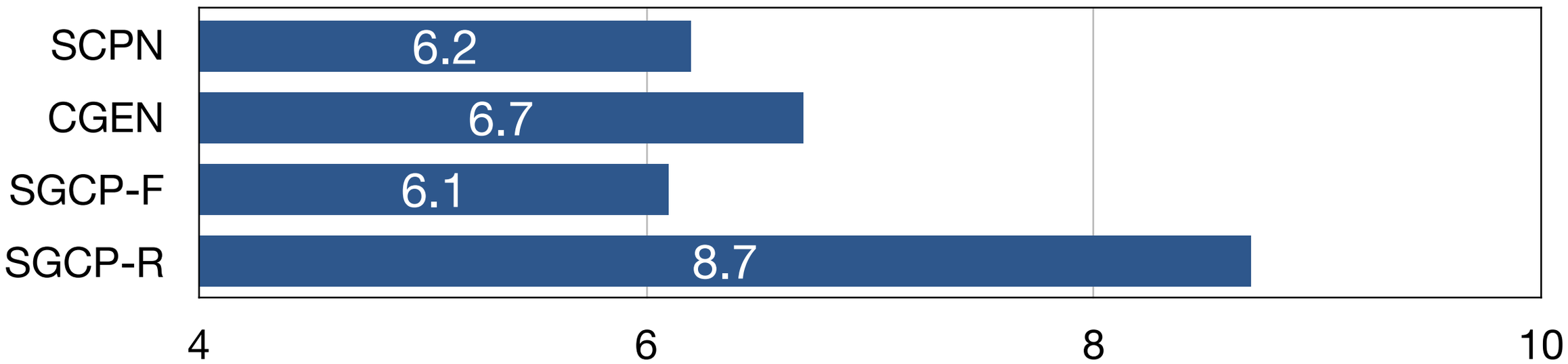

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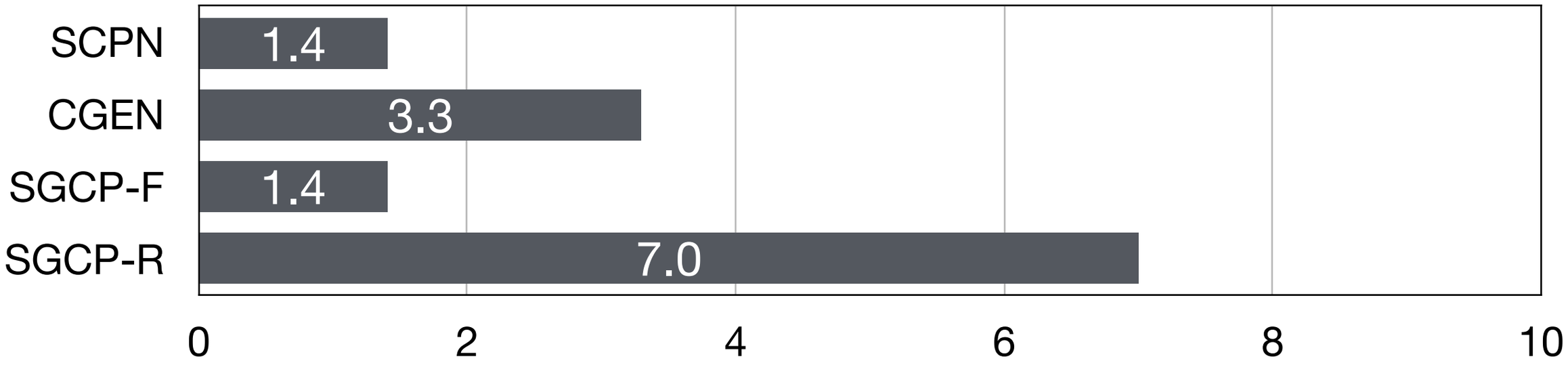

Tree Edit Distance with Exemplar (Lower is better)

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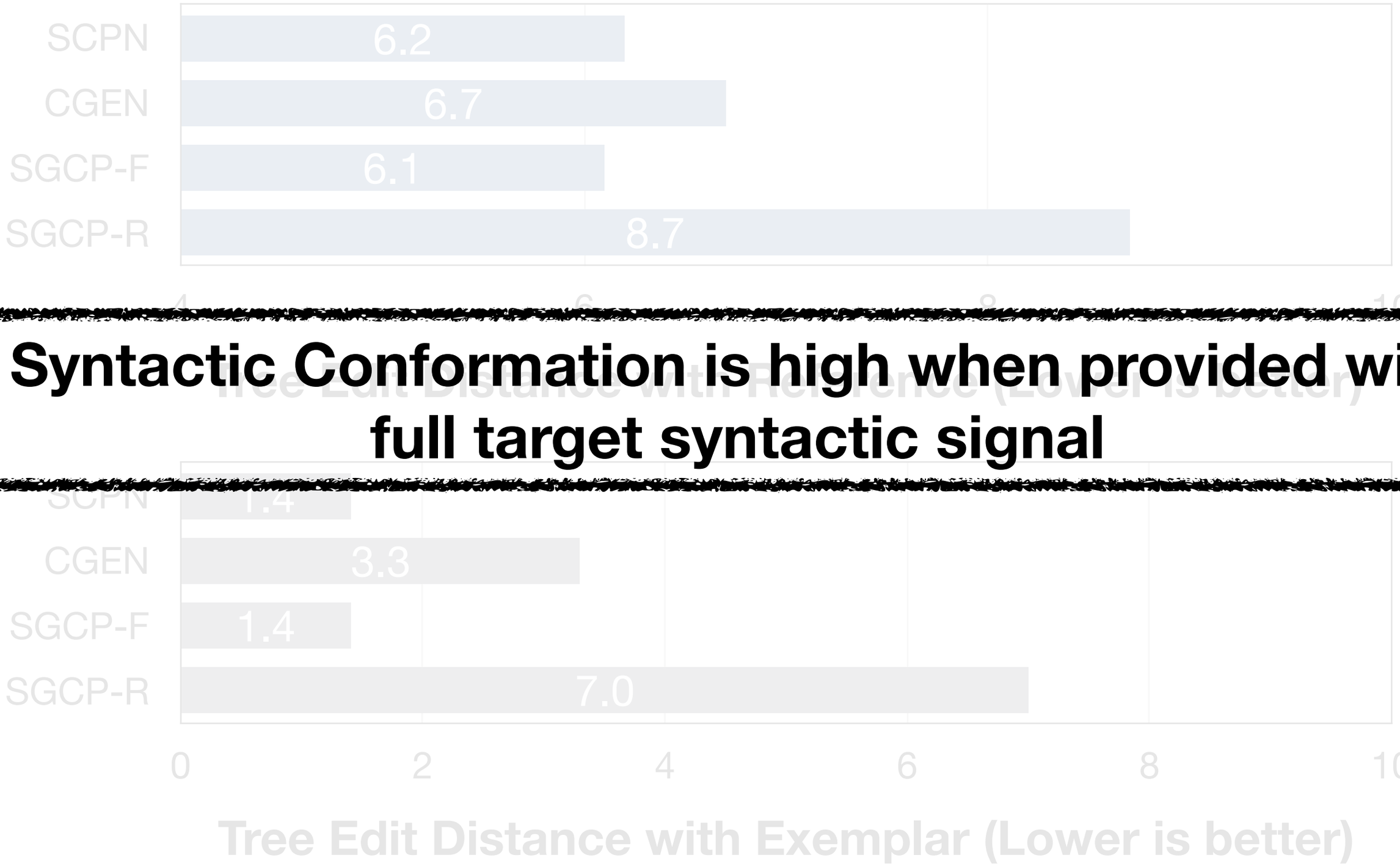

Syntactic Conformation is high when provided with full target syntactic signal

Syntactically Diverse Exemplar Inputs

SOURCE : how do i develop my career in software ?	
SYNTACTIC EXEMPLAR	**SGCP-R GENERATIONS**
how can i get a domain for free ?	how can i develop a career in software ?
what is the best way to register a company ?	what is the best way to develop career in software ?
what is chromosomal mutation ? what are some examples ?	what is a good career ? what are some of the ways to develop my career in software ?

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Conclusion

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Problem

Syntactically Controlled Generation

While preserving semantics

Conclusion

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Syntactically Controlled Generation

While preserving semantics

Method

SGCP

Guiding Decoder Using Syntactic Signals

Conclusion

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Syntactically Controlled Generation

While preserving semantics

Method

SGCP

Guiding Decoder Using Syntactic Signals

Future Work

Target Syntax Compatibility

Data Augmentation Using Syntactic Paraphrasing

Code

https://github.com/malllabiisc/SGCP

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Acknowledgement

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Government of India
Ministry of Human Resource
Development

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Thank you