Why Neural Translations are the Right Length

Xing Shi, Kevin Knight and Deniz Yuret;

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Information Sciences Institute
USC Viterbi School of Engineering

What is the fundamental question as a **PhD student** ?

How to publish a lot of high-quality papers ?

How to graduate in 5 years ?

PhD Life

MT

How to publish a lot of high-quality papers ?

How to graduate in 5 years ?

PhD Life	MT
How to publish a lot of high-quality papers ?	H-index || BLEU
How to graduate in 5 years ?	5 years || right length

Language Pairs	BLEU	Length Ratio (MT output / reference)
English => Spanish	31.0	**0.97**
English => French	29.8	**0.96**

2-layer 1000 hidden units non-attentional LSTM seq2seq

English :	does he know about phone hacking ?
French reference :	a-t-il connaissance du piratage téléphonique ?
French translation:	<UNK> <UNK> <UNK> <UNK> ?

	When to stop
PBMT	[- - - -] → [- x - -] → [x x x x]
Neural MT	Word → Word → <EOF>

	When to stop	How to generate right length ?
PBMT	[- - - -] → [- x - -] → [x x x x]	● word-penalty feature
Neural MT	Word → Word → <EOF>	● no explicit penalty

	When to stop	How to generate right length ?
Statistical MT	[- - - -] → [- x - -] → [x x x x]	• word-penalty feature • MERT
Neural MT	Word → Word → <EOF>	• no explicit penalty • MLE

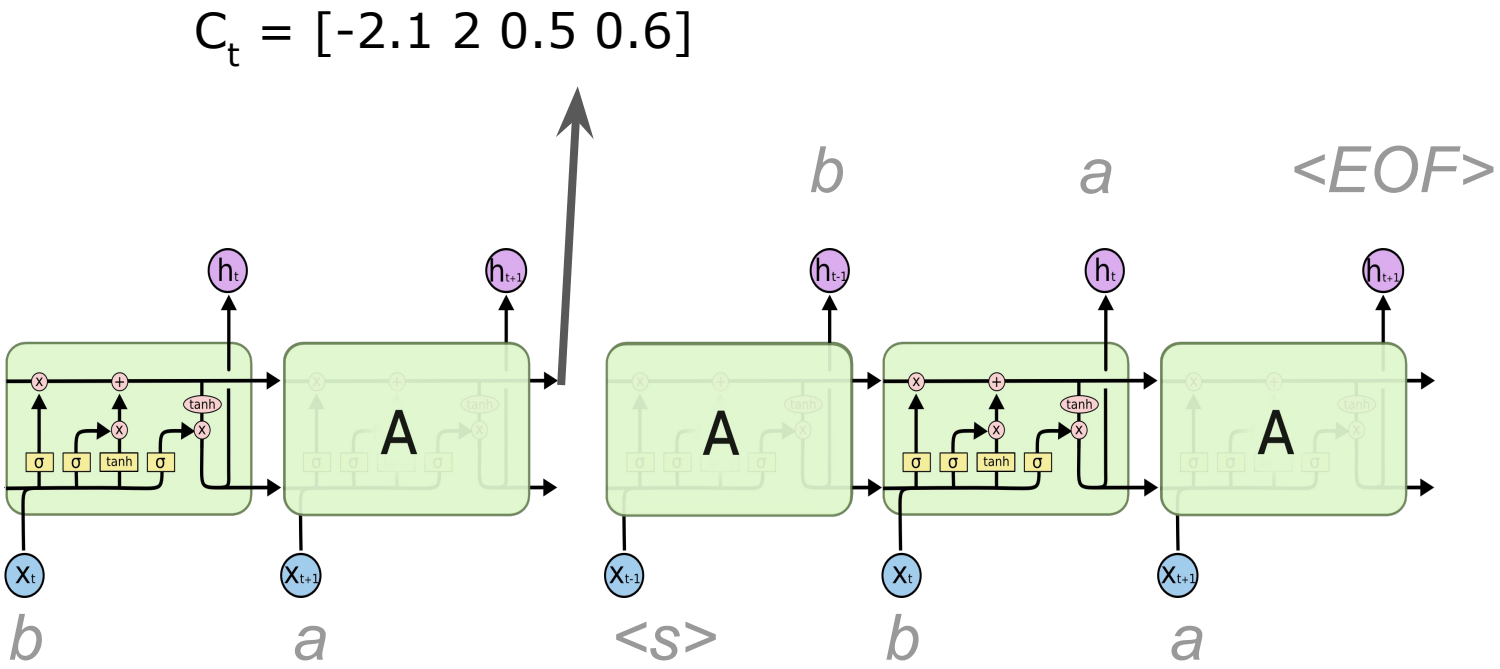
	When to stop	How to generate right length ?
Statistical MT	[- - - -] → [- x - -] → [x x x x]	● word-penalty feature ● MERT ● Heavy beam search
Neural MT	Word → Word → <EOF>	● no explicit penalty ● MLE ● light beam search (beam = 10)

Toy Example: String Copy

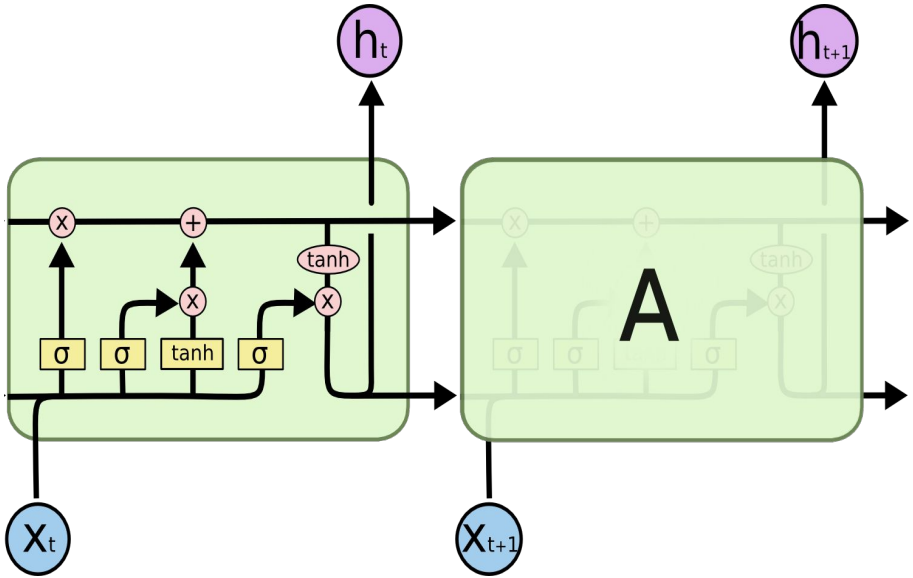
a a a b b <EOS> → *a a a b b <EOS>*
b b a <EOS> → *b b a <EOS>*

Train: 2500 random string
Single-layer, 4 hidden states LSTM

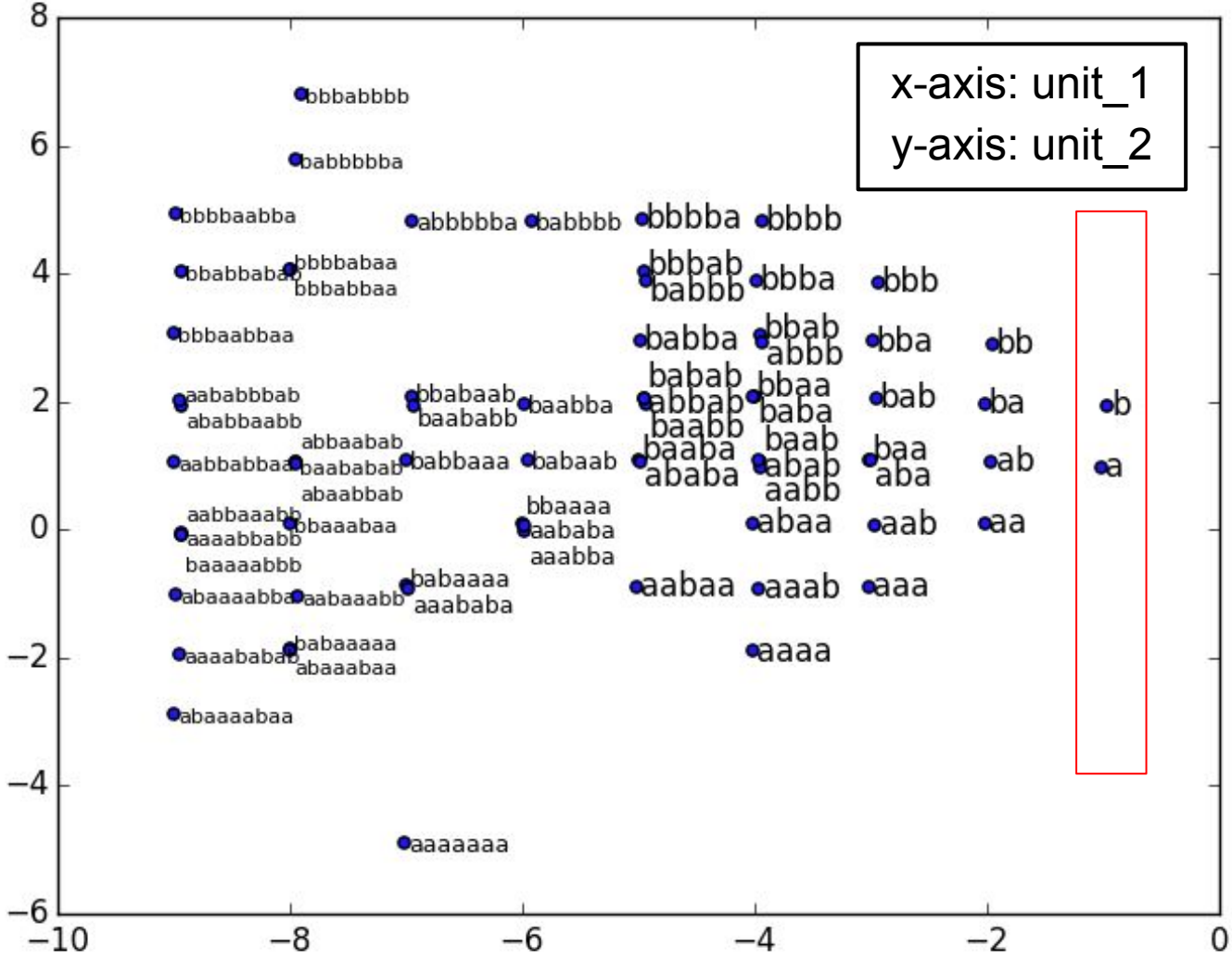
Toy Example: String Copy



Toy Example: String Copy



C_t involves only **elementwise** + and x.


x-axis: unit_1
y-axis: unit_2
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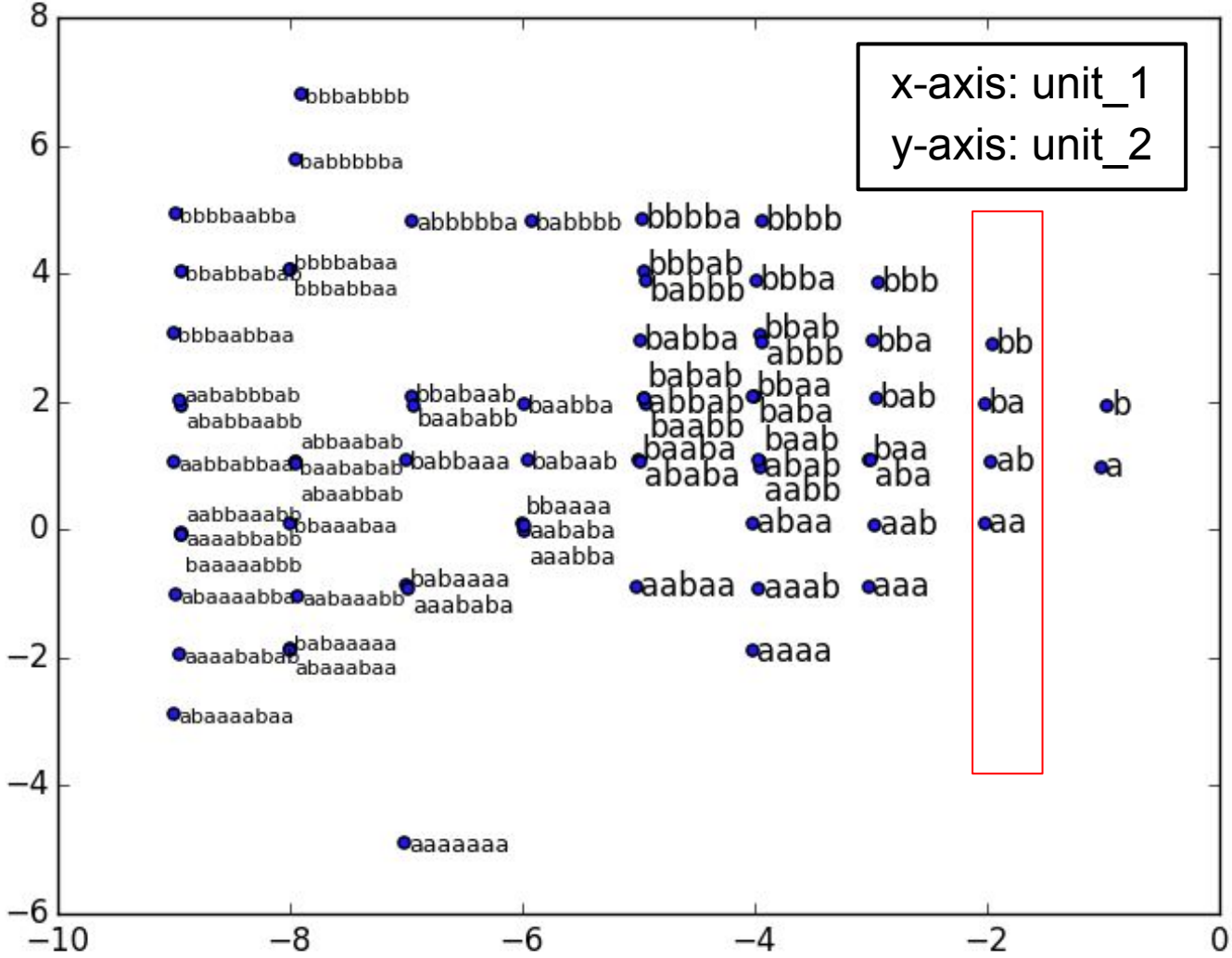
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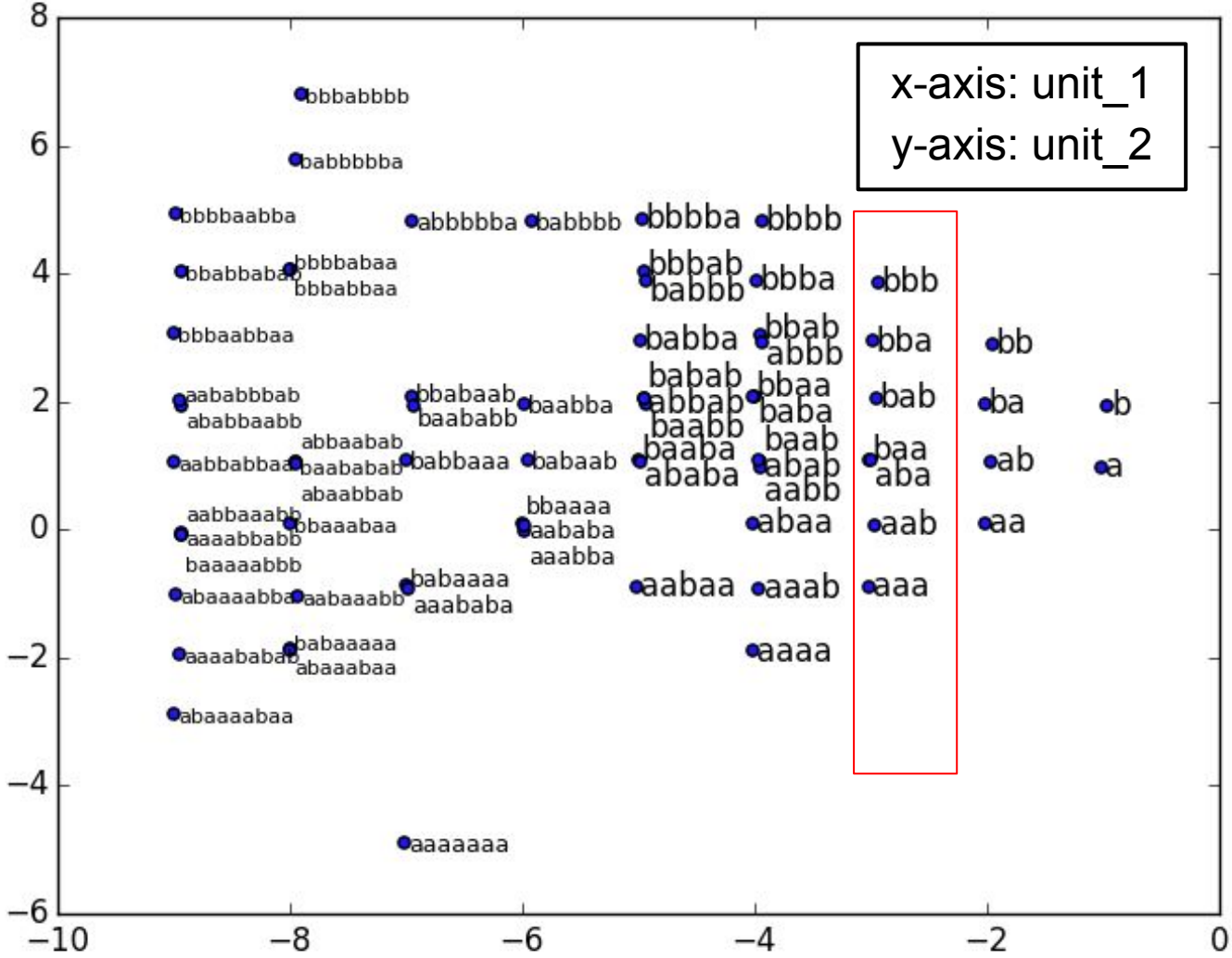
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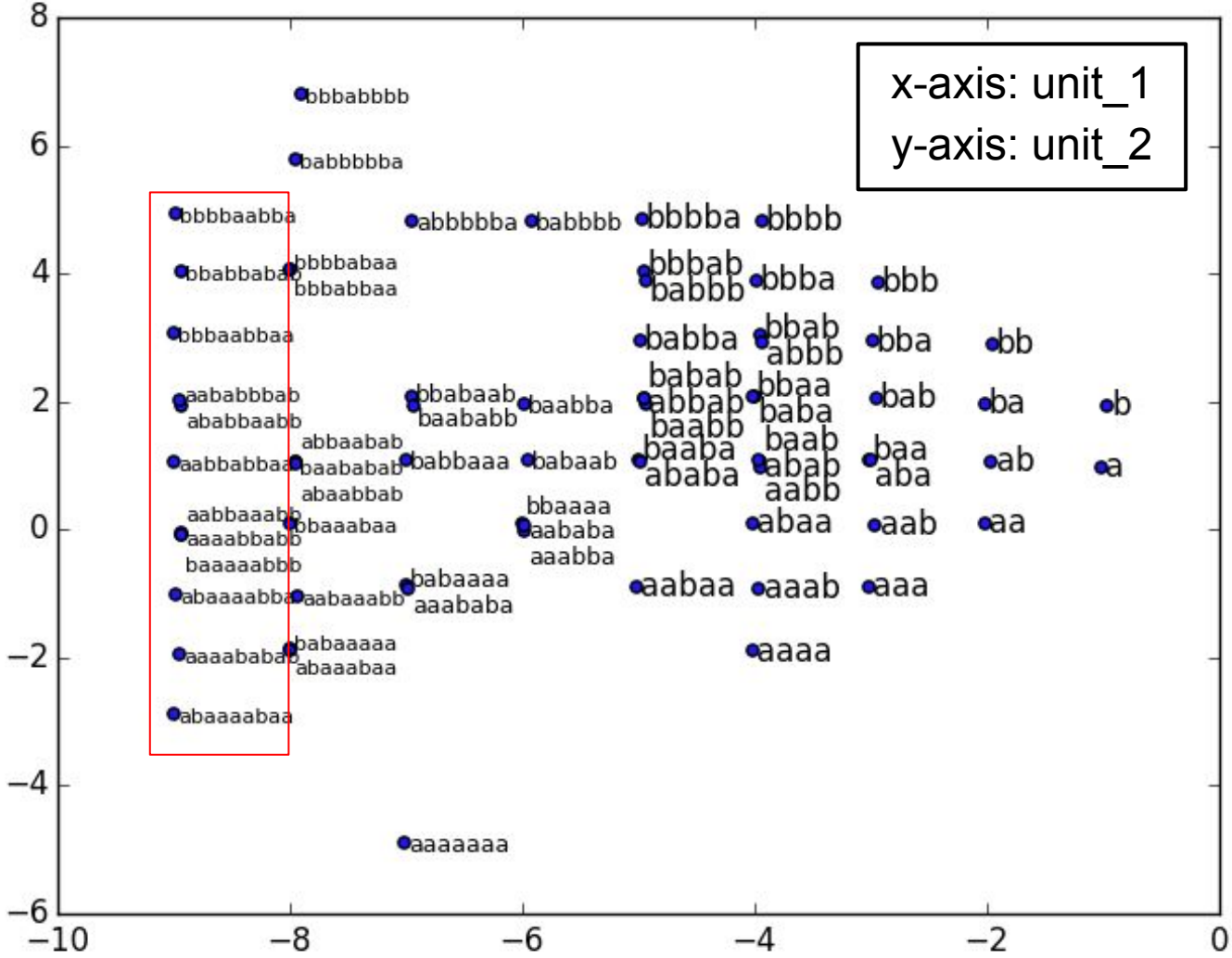
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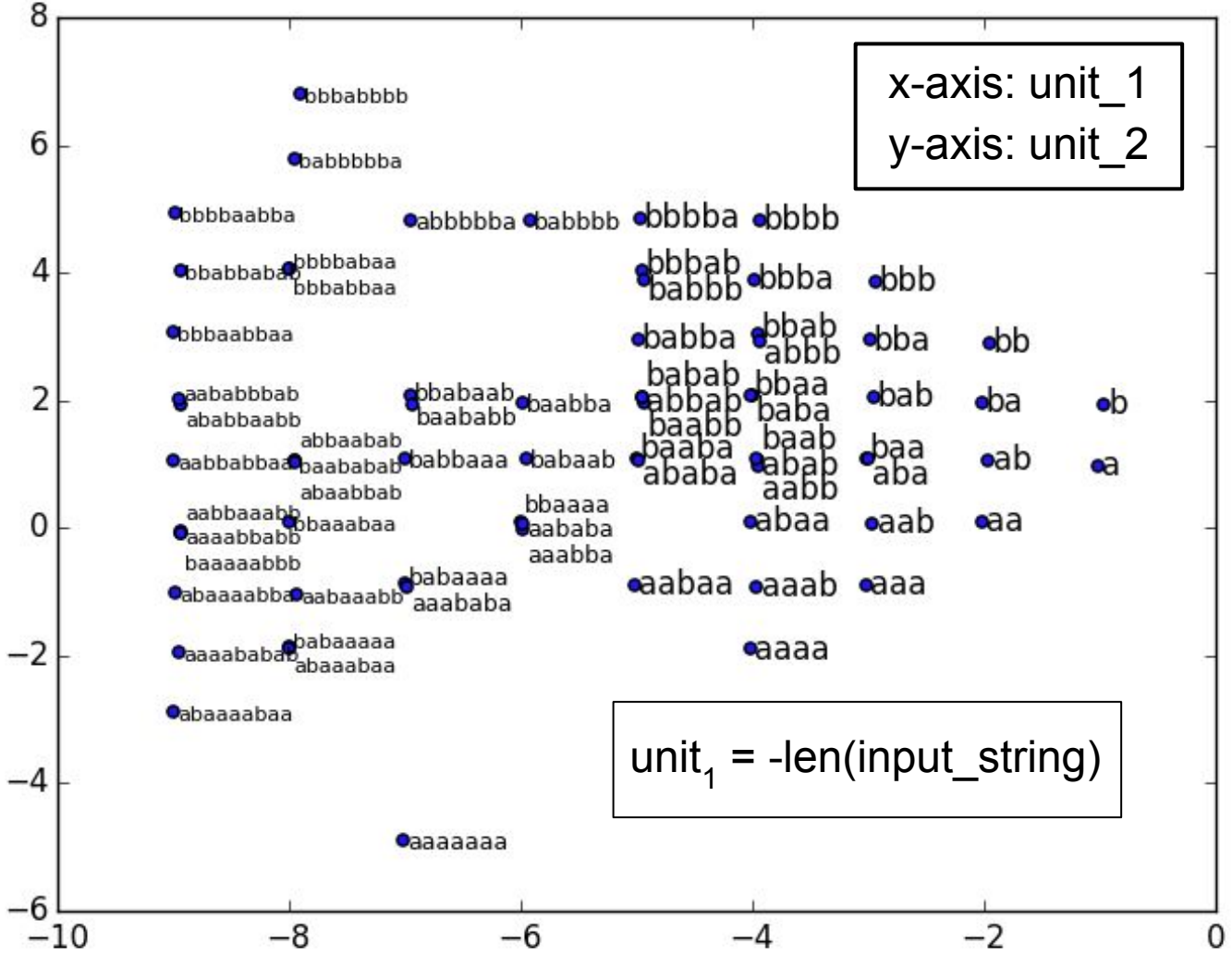
x-axis: unit_1
y-axis: unit_2
unit1 = -len(input_string)
bbbabbbb
babbbbba
bbbbaabba
abbbbba
babbbb
bbbba
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bbbbabaa
bbbabbaa
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aaaaaaa
8
6
4
2
0
−2
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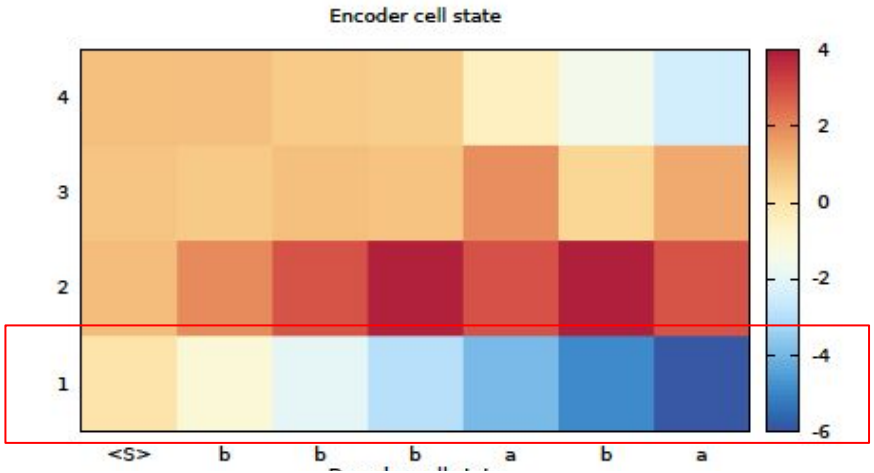
−4
−2
0

Toy Example: String Copy

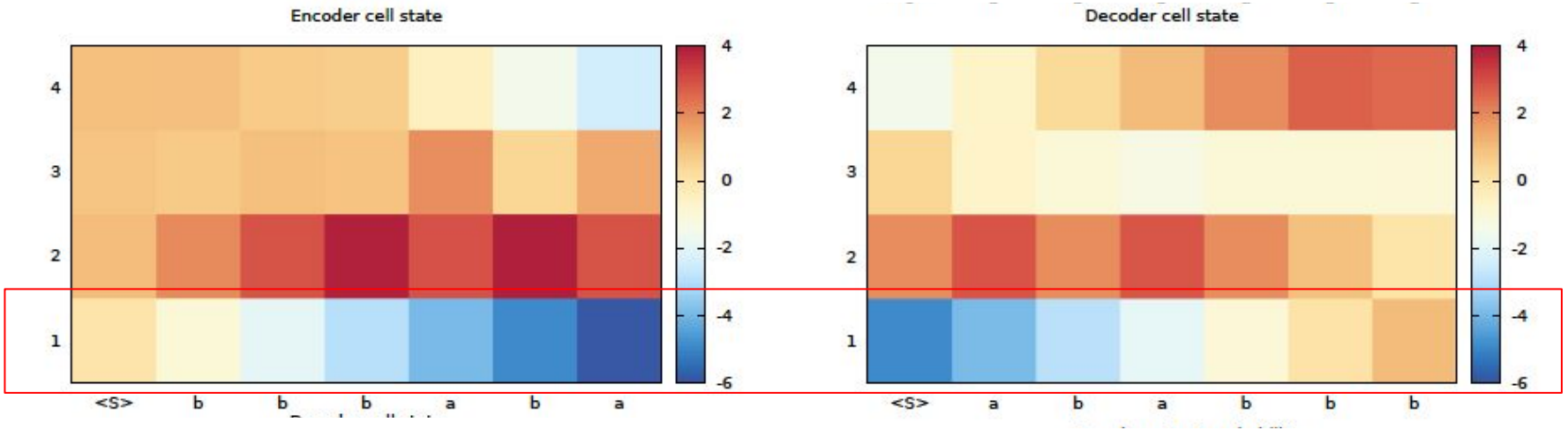
<s> *b b b a b a* → <s> *b b b a b a <EOF>*



Encoding Cell State
unit_1 decrease by 1.0

Toy Example: String Copy

<s> b b b a b a → <s> b b b a b a <EOF>



Encoding Cell State
unit_1 decrease by 1.0

Decoding Cell State
unit_1 increase by 1.0

Full Scale NMT

English => French

1000 hidden units LSTM

2 layers

Non-attention

BLEU = 29.8

Full Scale NMT

$$Y = w_1 * X_1 + w_2 * X_2 + \ldots + w_{1000} * X_{1000} + b$$

Sentence_i	It	is	raining	right	now
Y	1	2	3	4	5
X	1000 cell states	1000 cell states	1000 cell states	1000 cell states	1000 cell states

In total 143,379 (Y, X)

Full Scale NMT

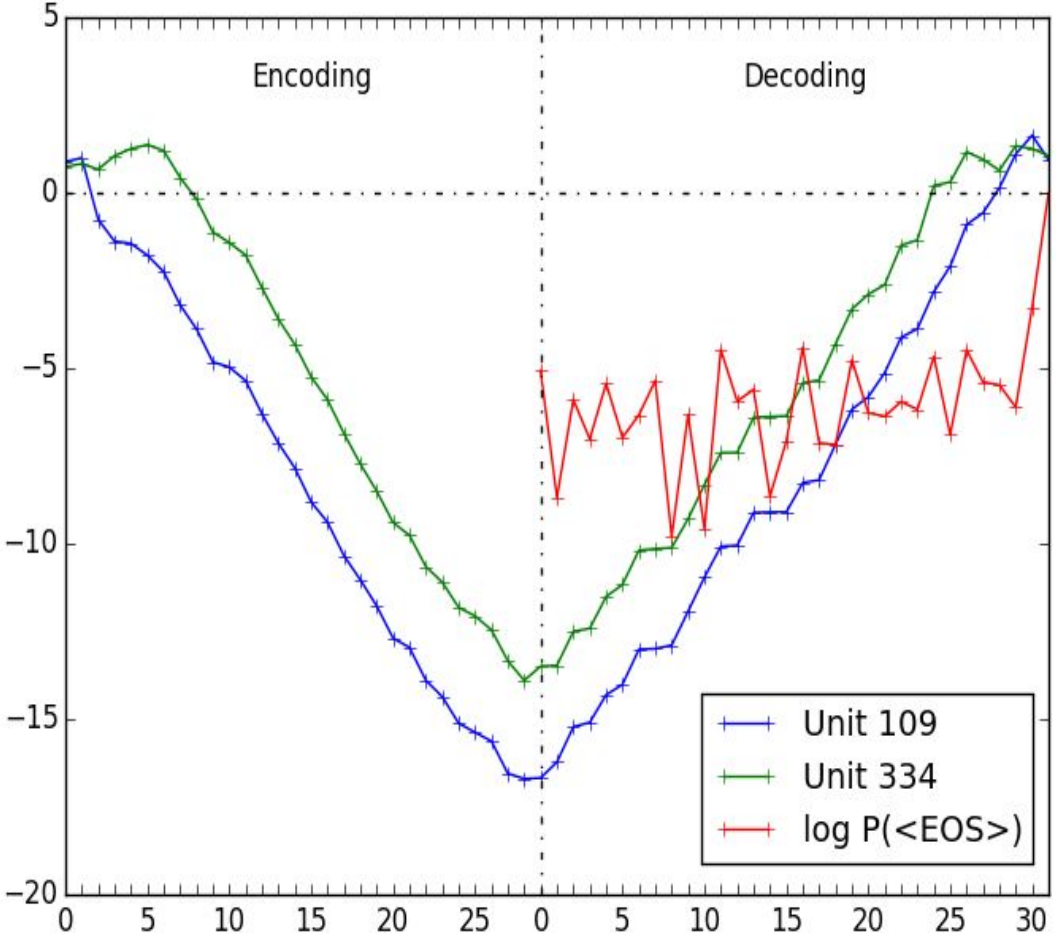
$$Y = w_1 * X_1 + w_2 * X_2 + \ldots + w_{1000} * X_{1000} + b$$

	R^2
1000 units in lower-layer	0.990
1000 units in upper-layer	0.981

Full Scale NMT

k	Best subset of LSTM's 1000 units	R^2
1	109	0.894
2	334, 109	0.936
3	334, 442, 109	0.942
4	334, 442, 109, 53	0.947
5	334, 442, 109, 53, 46	0.951
6	334, 442, 109, 53, 46, 928	0.953
7	334, 442, 109, 53, 46, 433, 663	0.955

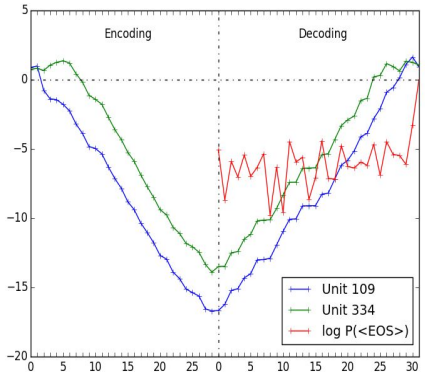
Table 2: Sets of k units chosen by beam search to optimally track length in the NMT encoder. These units are from the LSTM's second layer.



Encoding
Unit 109 and 334 decrease from above zero

Decoding
Increase during decoding, once they are above zero, the model is ready to generate <EOS>.

Conclusion

	Toy Example	**Full Scale NMT**
Who	Unit_1 controls the length	Unit_{109} and Unit_{334} contributes to the length
How		

Thanks and QA