State-of-the-art Neural Translation

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Introduction

Machine translation German to English using three different Sequence2Sequence models with encoder-decoder architectures with two different datasets. We analyze the influence of attention. For every architecture word-level embeddings were used.

Theory

$$p_{\theta_{\text{enc}},\theta_{\text{dec}}}\left(\mathbf{Y}_{1:m} \mid \mathbf{X}_{1:n}\right)$$

$$f_{\theta_{\text{enc}}} : \mathbf{X}_{1:n} \to \overline{\mathbf{X}}_{1:n}$$

$$p_{\theta_{dec}}\left(\mathbf{Y}_{1:m} \mid \overline{\mathbf{X}}_{1:n}\right) = \prod_{i=1}^{m} p_{\theta_{dec}}\left(\mathbf{y}_i \mid \mathbf{Y}_{0:i-1}, \overline{\mathbf{X}}_{1:n}\right)$$

Above it can be seen the probabilistic definition of these models, where X is the input sequence, $\bar{X}$ the context vector and Y the target sequence.

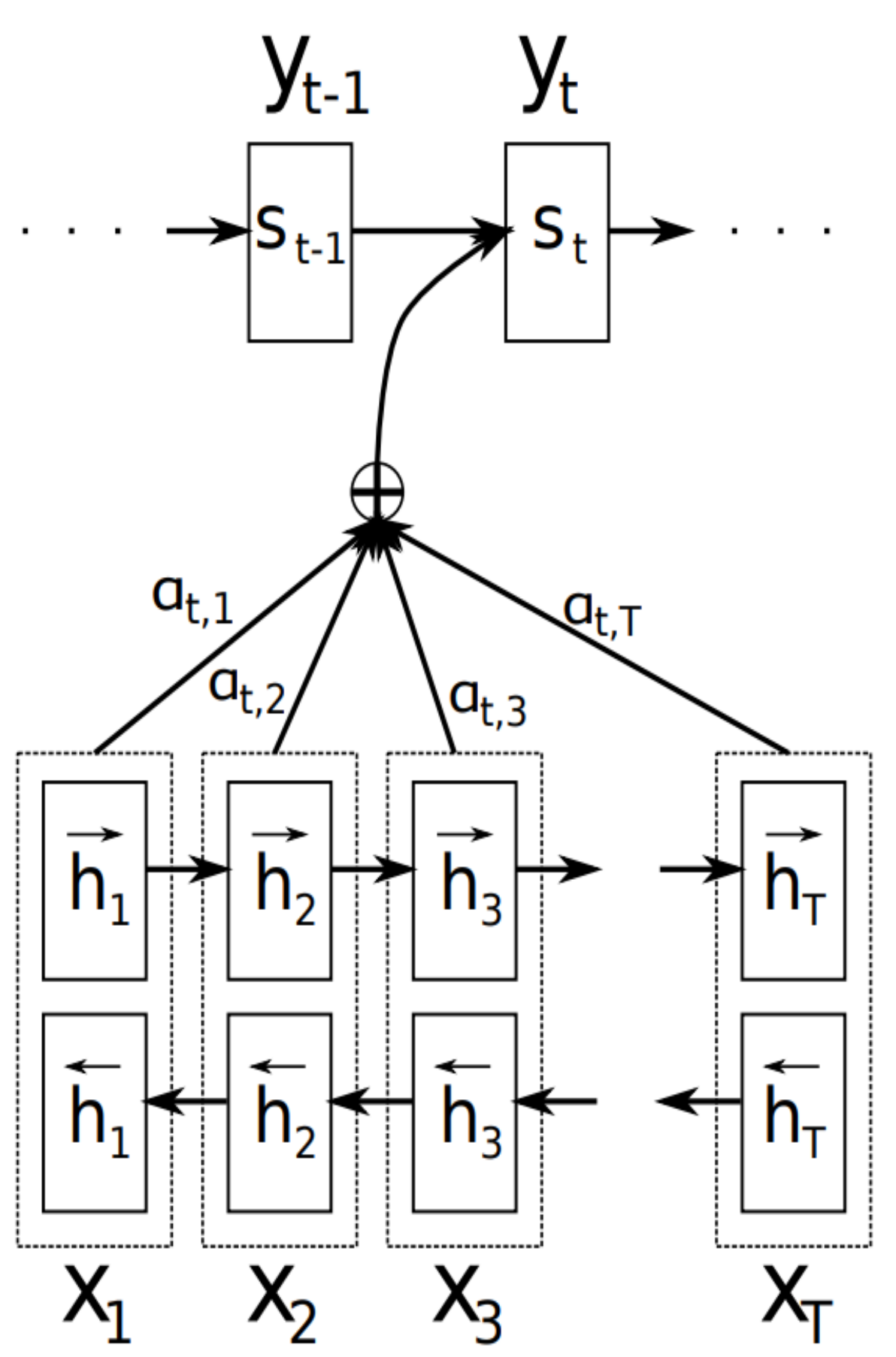
Future work

Knowledge distillation

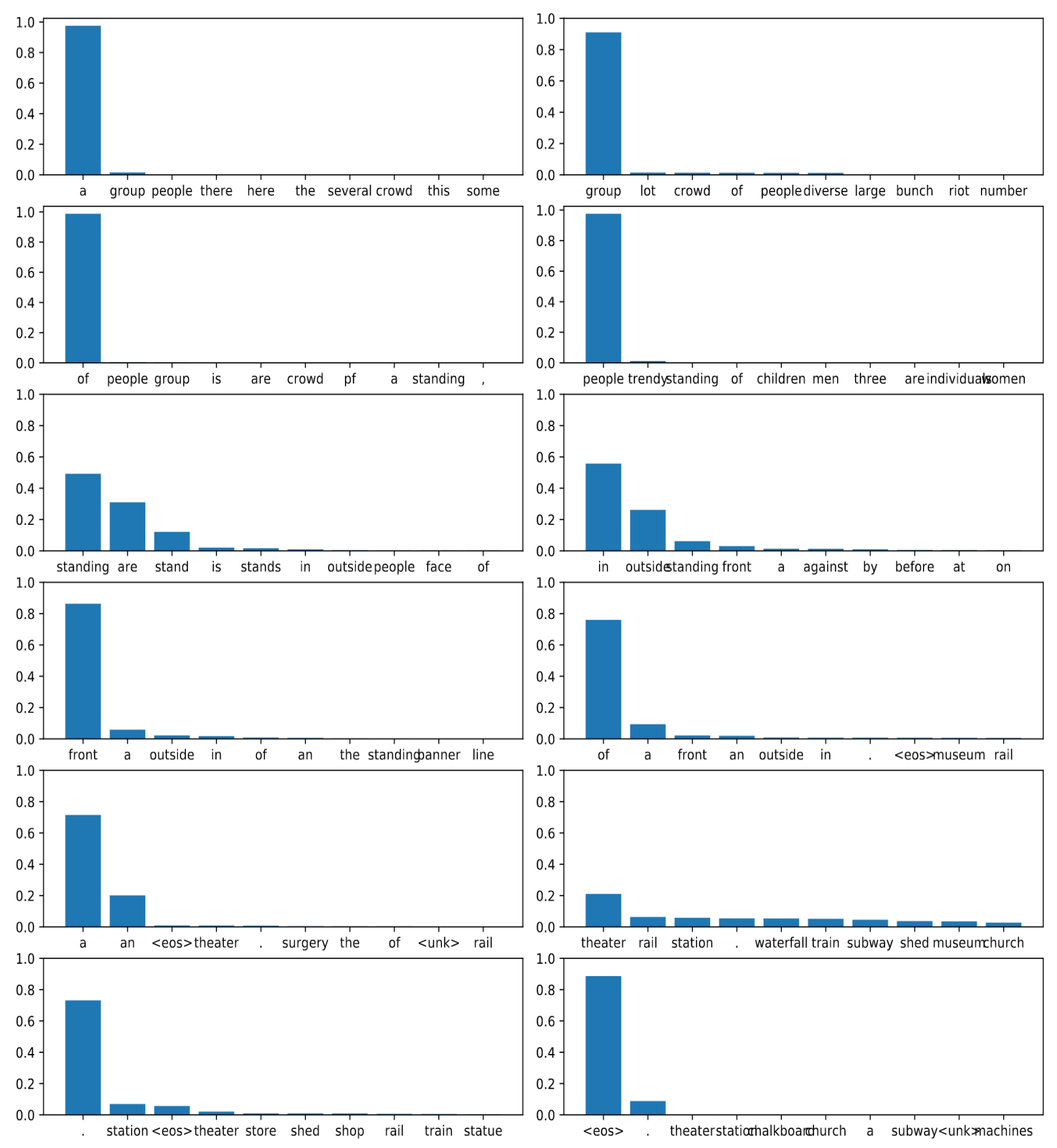
$$E(\mathbf{x}|t) = -t^2 \sum_i \hat{y}_i(\mathbf{x}|t) \log y_i(\mathbf{x}|t) - \sum_i \bar{y}_i \log y_i(\mathbf{x}|1)$$

$$y_i(\mathbf{x}|t) = \frac{e^{\frac{z_i(\mathbf{x})}{t}}}{\sum_j e^{\frac{z_j(\mathbf{x})}{t}}}$$

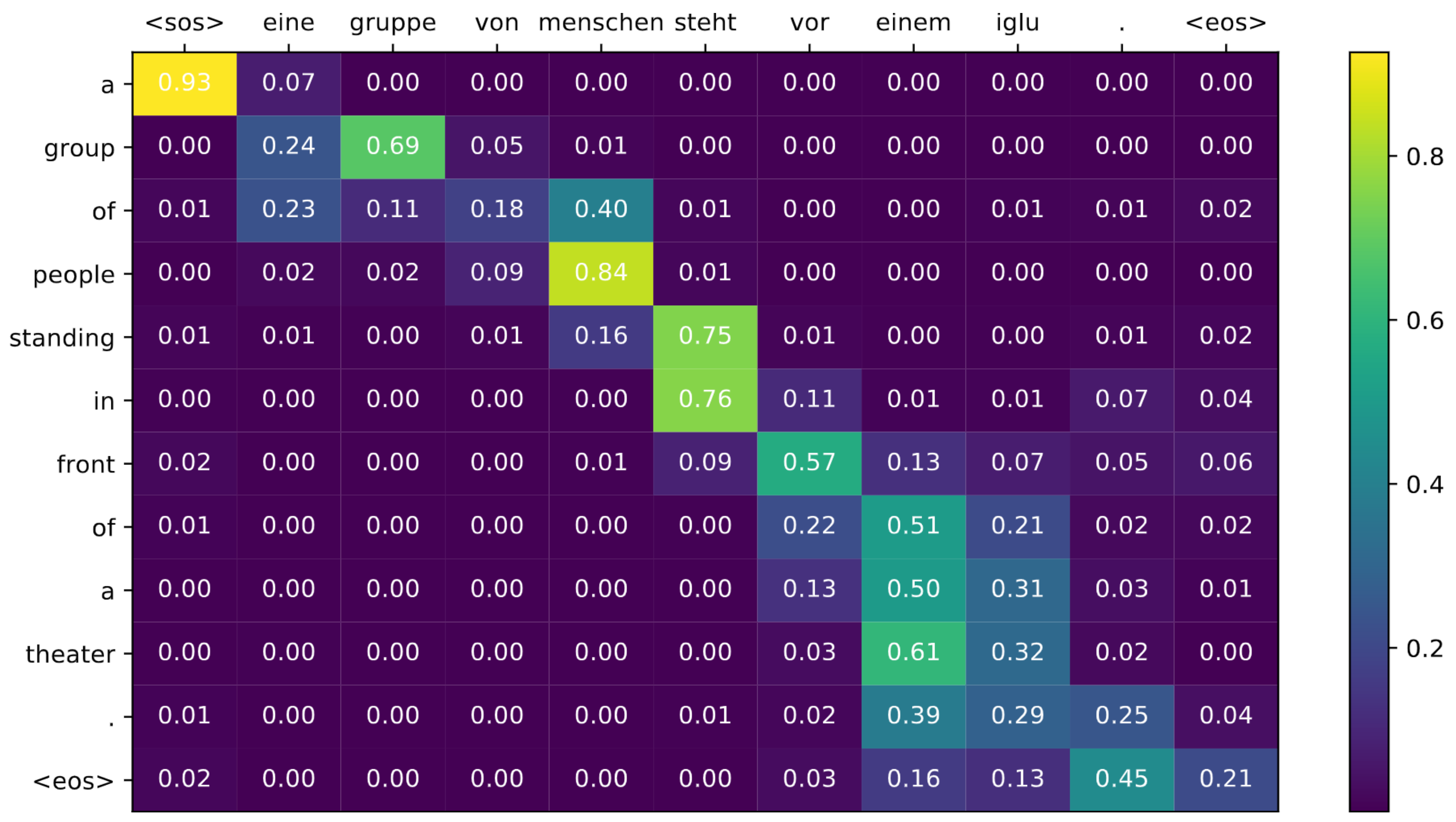
Seq2seq GRU w attn [3]



Seq2seq GRU w attn Model

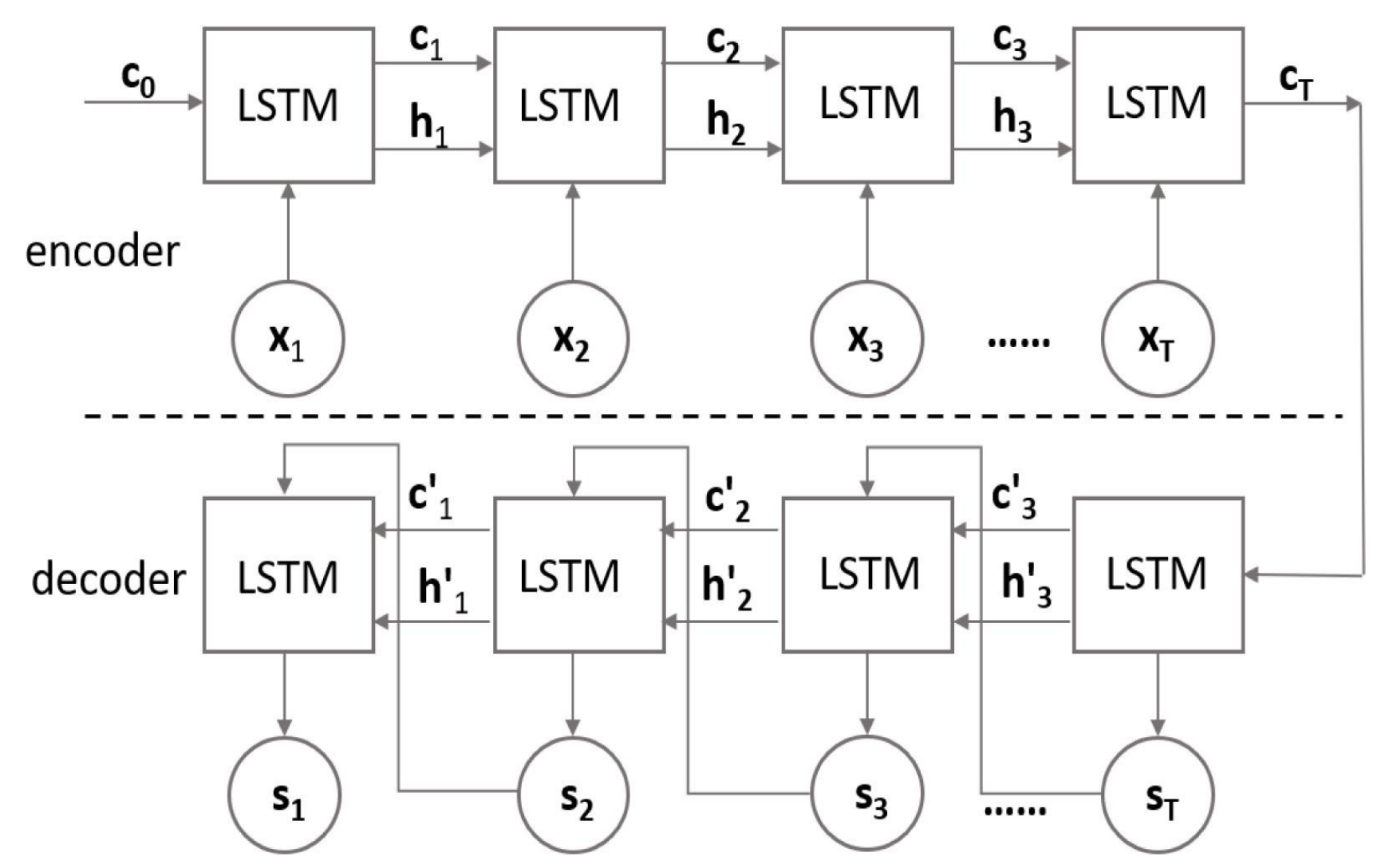


Conditional probability distribution



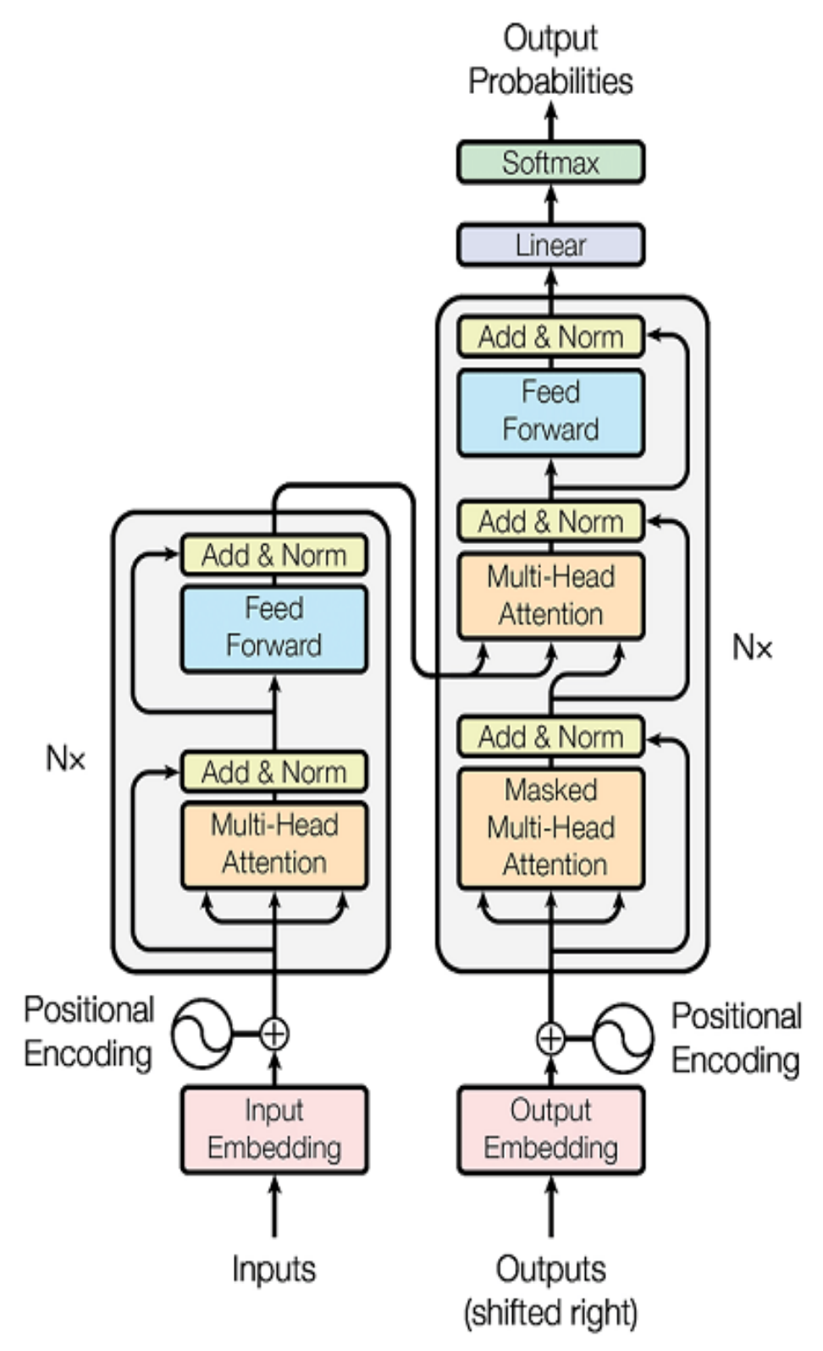
Attention heat map, GRU

Seq2seq LSTM

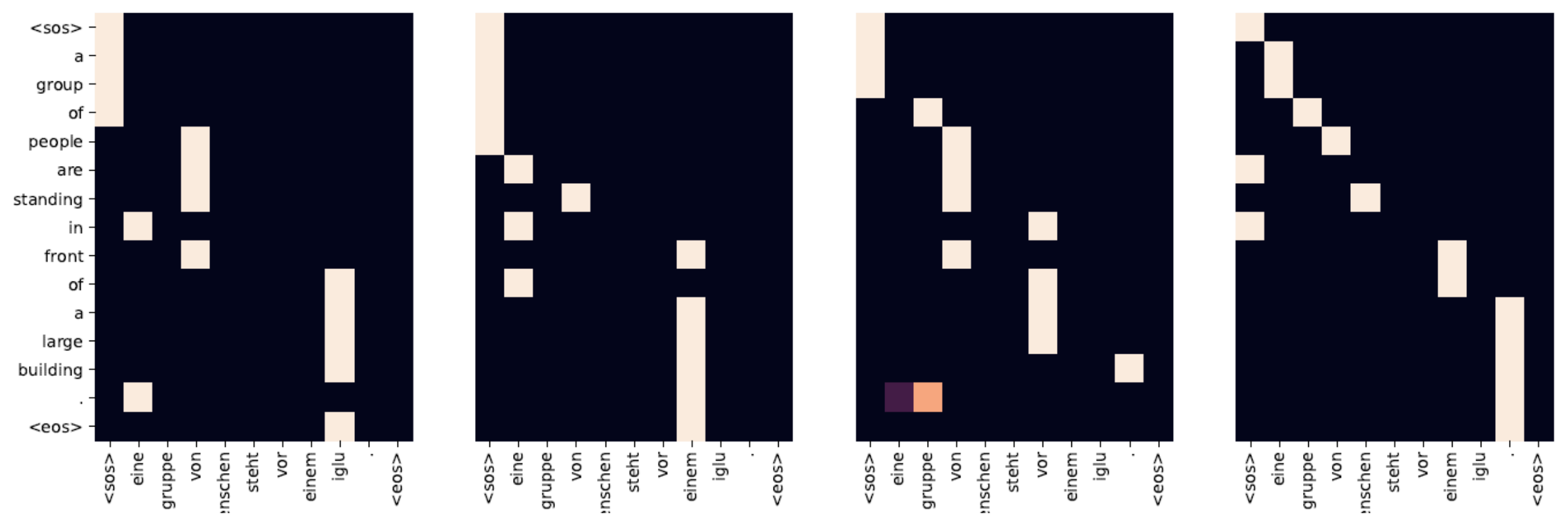


LSTM Model

Transformer [1][2]



Transformer Model



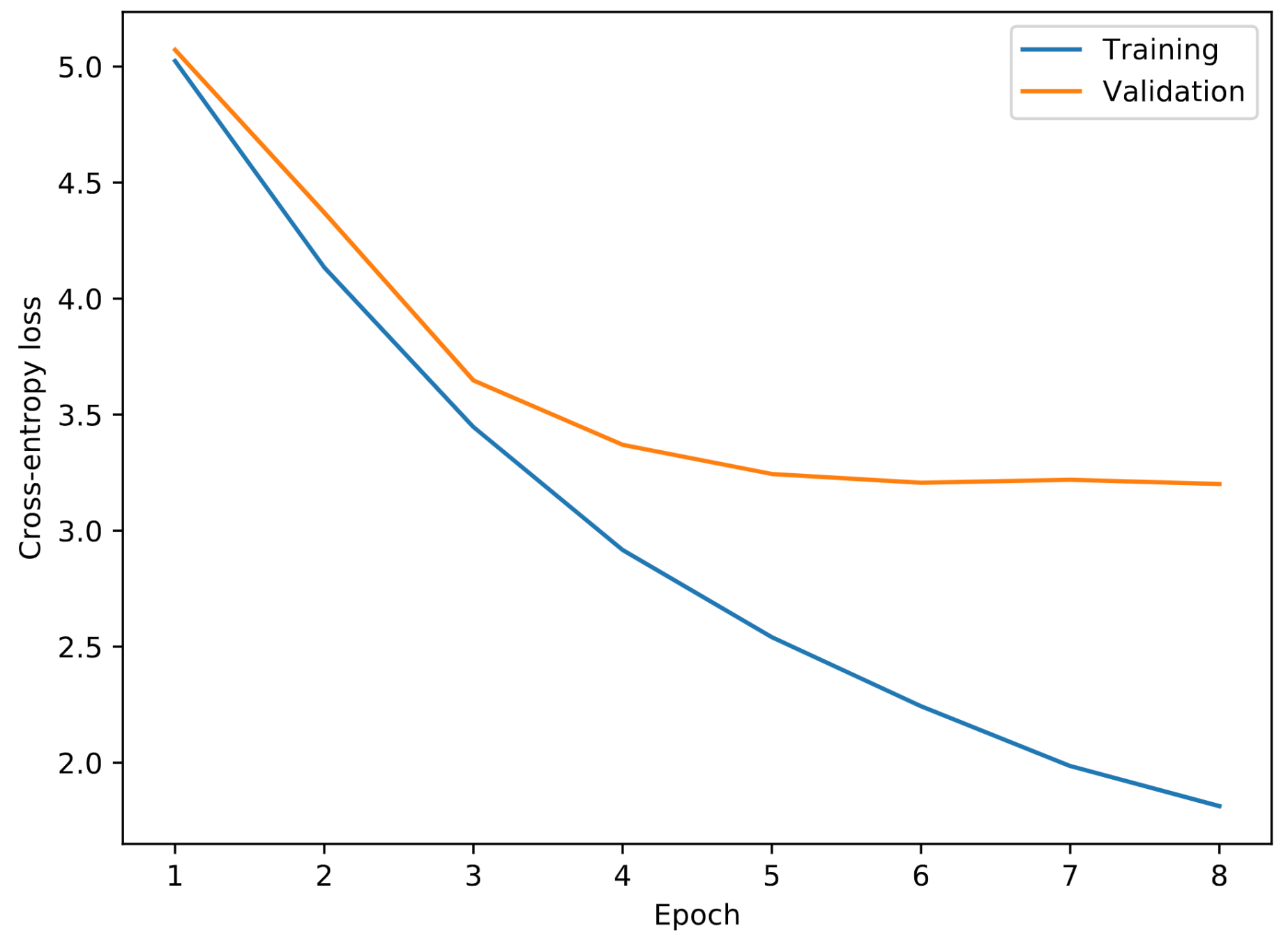
Attention heat map, Transformer decoder layer 6 (source)

Translation samples

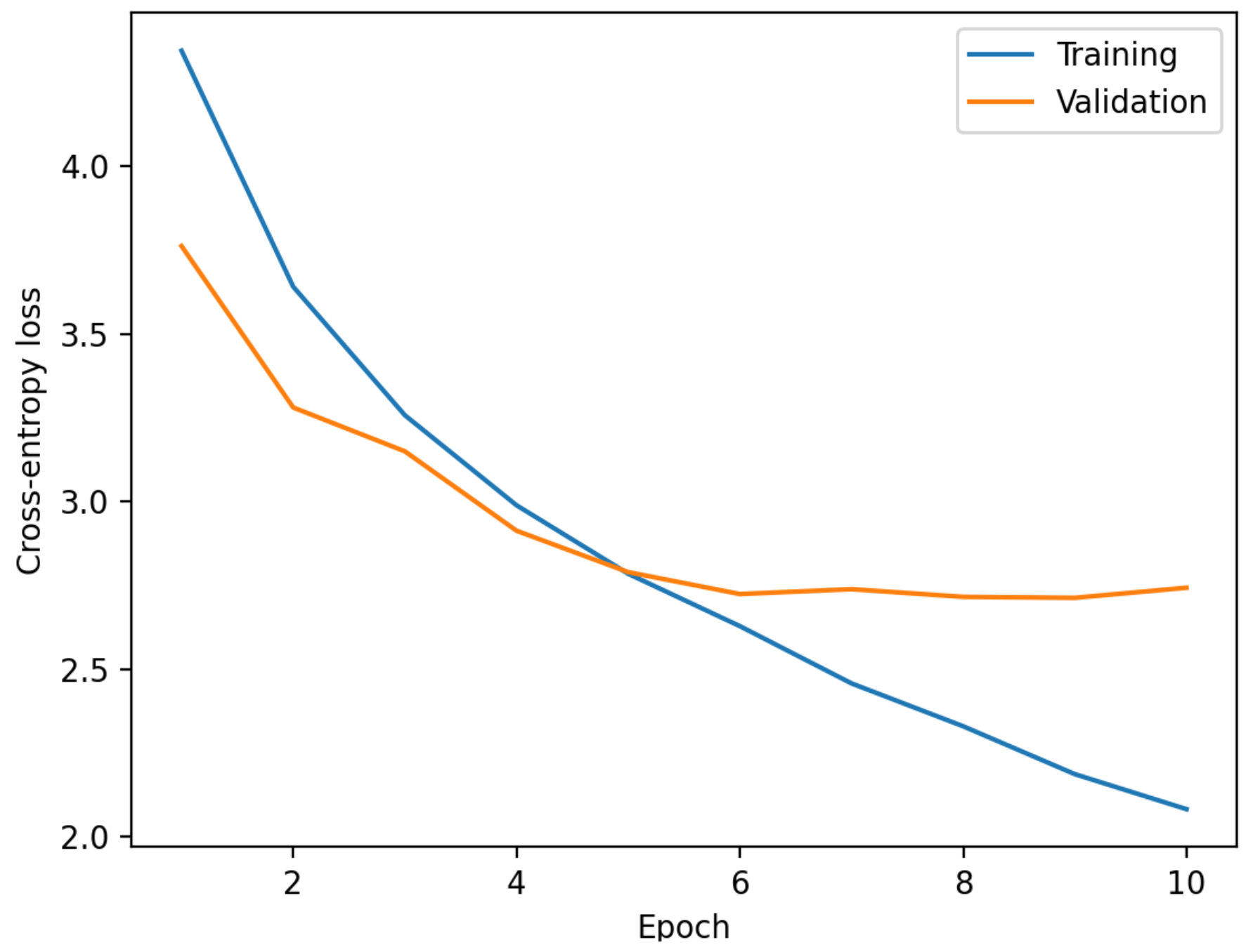
Original: eine gruppe von menschen steht vor einem iglu .
Translation: a group of people stands in front of an igloo .
Seq2Seq LSTM: a group of people standing in front of a <unk> booth .
Seq2Seq GRU w/ Attn: a group of people standing in front of a theater .
Transformer: a group of people are standing in front of a large building .
Bert2Bert: a group of people standing in front of an igloo.

Original: ein mann mit kariertem hut in einer schwarzen jacke und einer schwarz-weiß gestreiften hose spielt auf einer bühne mit einem sänger und einem weiteren gitarristen im hintergrund auf einer e-gitarre.
Translation: a man in a black jacket and checkered hat wearing black and white striped pants plays an electric guitar on a stage with a singer and another guitar player in the background .
Seq2Seq LSTM: a man in a black hat and black shirt plays a a with a a a a a a a a in a a in a background .
Seq2Seq GRU w/ Attn: a man in a plaid hat , jacket and black striped striped striped striped striped shirt , playing a guitar with a guitar with a guitar with a guitar in a treadmill.
Transformer: a man in a white shirt and jeans is playing a guitar on a stage .
Bert2Bert: a man with a checkered hat in a black jacket and a black-and-white striped pants plays on a balcony with a singer and another guitarist behind on an e-guitar

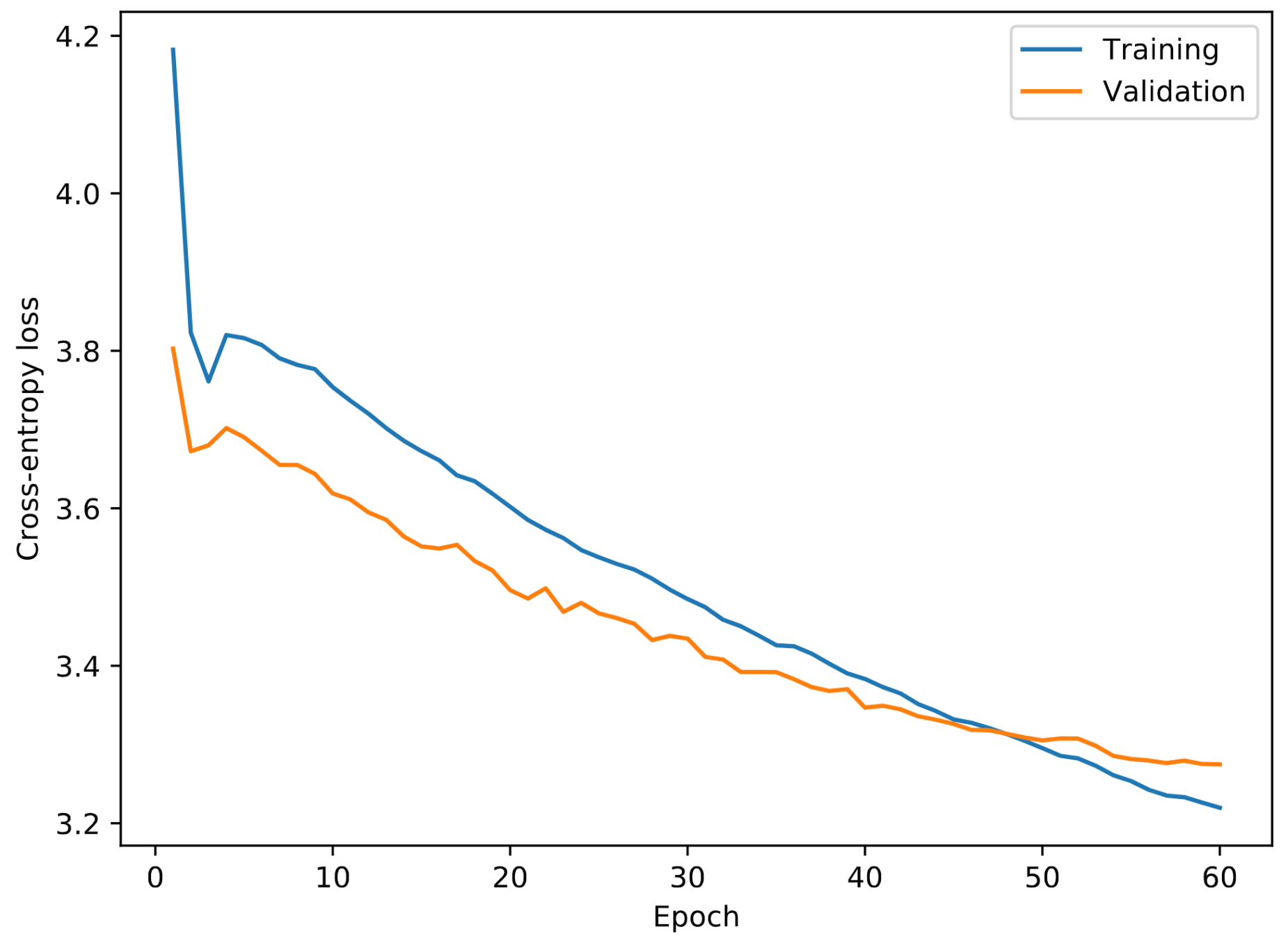
Seq2seq GRU w/ attn



Seq2seq LSTM



Transformer



Comparisons

	Seq2seq LSTM	Seq2seq GRU	Transformer	Bert2Bert
CE Train*	2.19	1.81	3.28	---
CE Val*	2.71	3.20	3.31	---
CE Test*	2.84	3.25	3.287	---
Perplexity*	17.116	25.774	26.751	---
BLEU*	21.7	29.3	10.5	27.7
Params	~35M	~20M	~50M	~770M
BLEU WMT14	0.13	0.21	2.8	17

*evaluated on Multi30k unless stated otherwise

References

[1] Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Lukasz Kaiser, and Illia Polosukhin, "Attention is all you need," CoRR, vol. abs/1706.03762, 2017.
[2] Guillaume Klein, Yoon Kim, Yuntian Deng, Jean Senellart, and Alexander M. Rush, "Opennmt: Open-source toolkit for neural machine translation," in Proc. ACL, 2017.
[3] Dzmitry Bahdanau, Kyunghyun Cho, and Yoshua Bengio, "Neural machine translation by jointly learning to align and translate," 2016.