

April 9, 2017

Rob  
Romijnders

Motivate

How it works

RNN

Seq2Seq

How to train

Word vectors

Fast training

Fast translation

Questions

# Neural machine translation

## Pydata2017 Amsterdam

Rob Romijnders

*RomijndersRob@gmail.com*

April 9, 2017

# Overview

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- Seq2Seq

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# GMail reply

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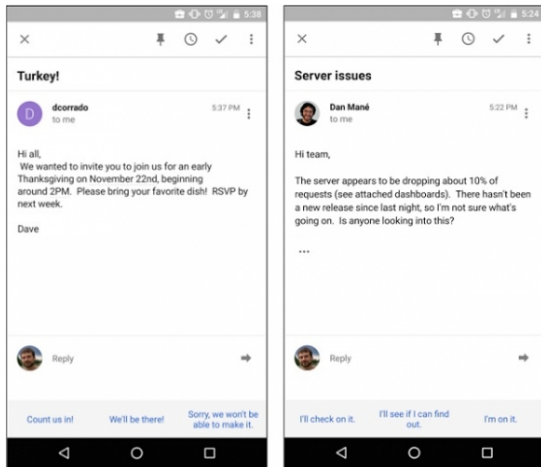


Photo: Greg Corrado, Google Research Blog

# Apple siri

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Siri



Photo: cultofmac.com

# Question Answering

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## Attention Visualization

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What is this sculpture made out of ?



Answer: **metal**



What color are the bananas ?



Answer: **green**



What is the pattern on the cat's fur on its tail ?



Answer: **stripes**



Did the player hit the ball ?



Answer: **yes**

credits: NIPS slides, Richard Socher

# Question answering

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- Info: Mary Walked to the bathroom
- Info: Sandra went to the garden
- Info: Daniel went back to the garden
- Info: Sandra took the milk there
- Question: *Where is the milk?*
- Answer: **Garden**

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<i><b>Input sentence:</b></i>	<i><b>Translation (PBMT):</b></i>	<i><b>Translation (GNMT):</b></i>	<i><b>Translation (human):</b></i>
李克強此行將啟動中加總理年度對話機制，與加拿大總理杜魯多舉行兩國總理首次年度對話。	Li Keqiang premier added this line to start the annual dialogue mechanism with the Canadian Prime Minister Trudeau two prime ministers held its first annual session.	Li Keqiang will start the annual dialogue mechanism with Prime Minister Trudeau of Canada and hold the first annual dialogue between the two premiers.	Li Keqiang will initiate the annual dialogue mechanism between premiers of China and Canada during this visit, and hold the first annual dialogue with Premier Trudeau of Canada.

credits: Google research blog

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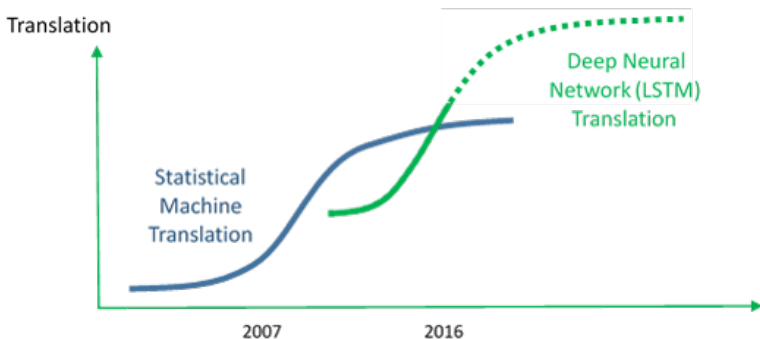
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credits: Microsoft research blog



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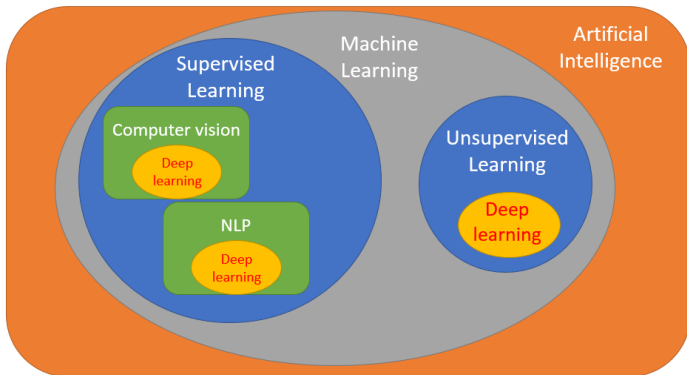
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# How do RNN's work?

Credits for images to Andrej Karpathy

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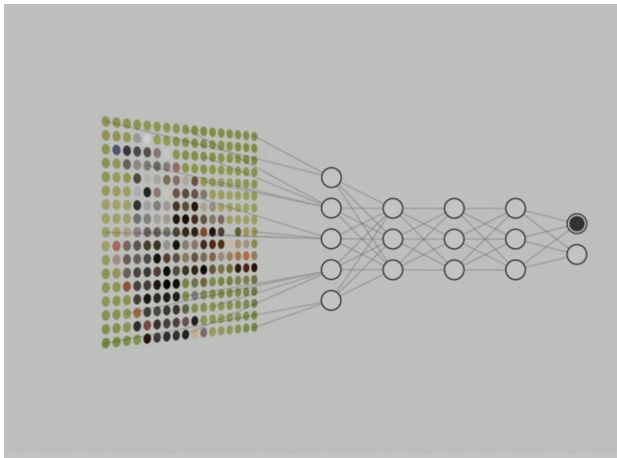
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credits: Blaise Aguera y Arcas

# Python code

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*#FF*

```
def step(x):  
    h = np.tanh(np.dot(W1, x) + b1)  
    y = np.dot(W2, h) + b2  
    return y
```

```
y = step(x)
```

# Word tagging

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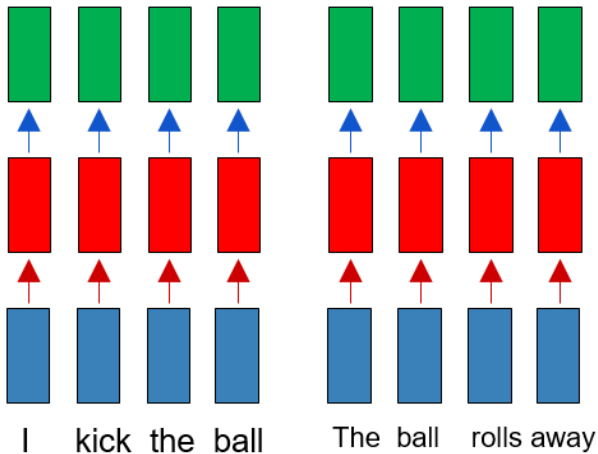
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# Connect over time

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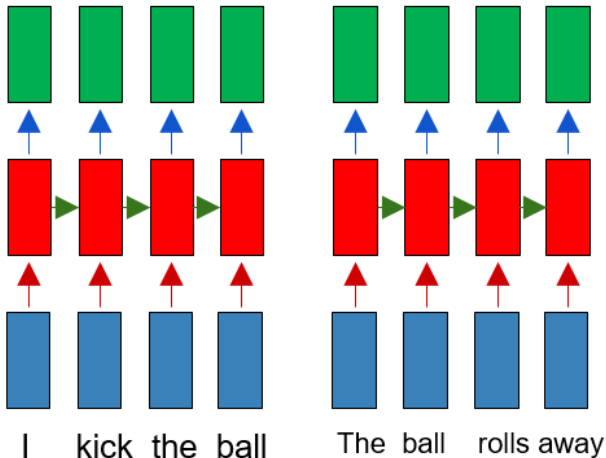
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# RNN cell

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$$h = \phi(W_{xh}x)$$

$$y = \phi(W_{hy}h)$$

$$h_t = \phi(W_{xh}x_t + W_{hh}h_{t-1})$$

$$y_t = \phi(W_{hy}h_t)$$

# Python code

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```

```
y = step(x)
```



# Python code

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```
# RNN
rnn = RNN()
y = rnn.step(x)

class RNN:
    def step(self, x):
        self.h = np.tanh(np.dot(W1, self.h)
                          + np.dot(W2, x))
        y = np.dot(W3, self.h)
        return y
```

# Python code

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*#FF*

```
def step(x):  
    h = np.tanh(np.dot(W1, x) + b1)  
    y = np.dot(W2, h) + b2  
    return y
```

*#RNN*

```
class RNN:  
    def step(self, x):  
        self.h = np.tanh(np.dot(W1, self.h)  
                        + np.dot(W2, x))  
        y = np.dot(W3, self.h)  
        return y
```

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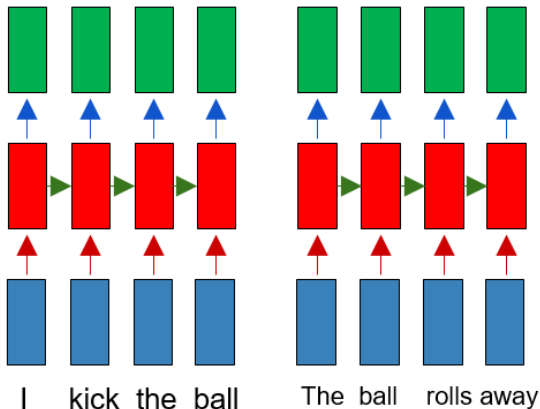
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RNN in 112 lines

# Examples

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Questions

- Weather forecasting
- Detection of walk/run/stairs in smartphones
- Analyse stock markets and other financial markers
- Speech transcription

# Tagging of clinical events

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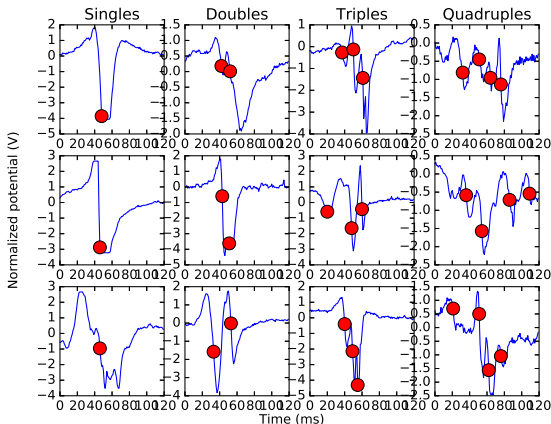
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Classification of fractionated electrograms in epicardial mappings using a recurrent neural network, R Romijnders et al.

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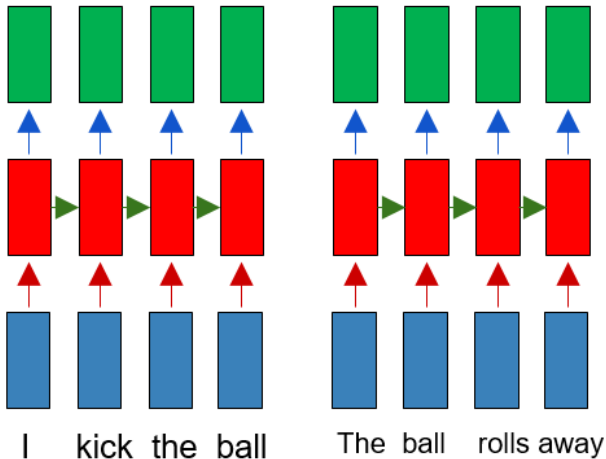
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# Seq2Seq

# Sequence 2 sequence

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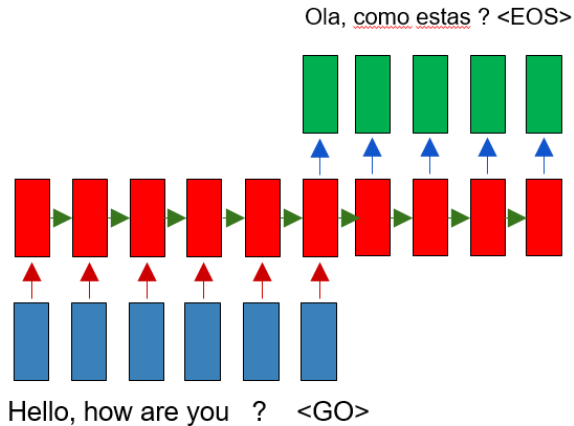
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# Long sequence 2 long sequence

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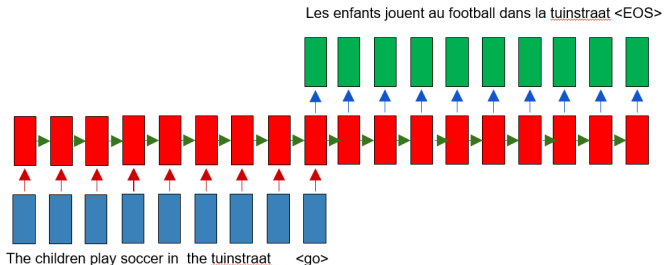
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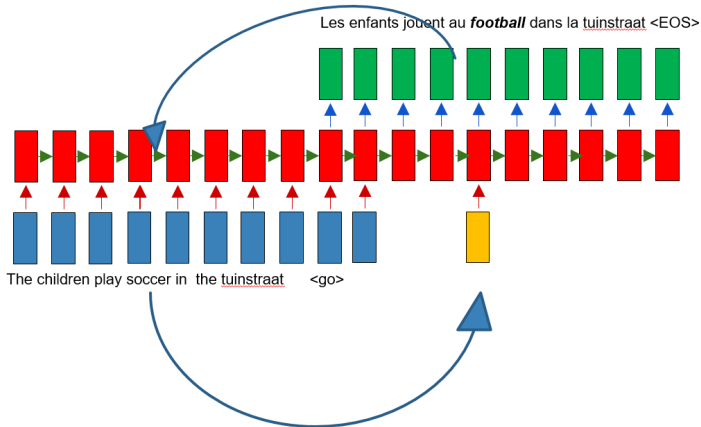
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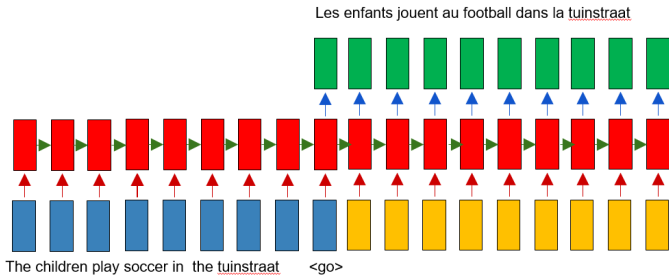
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# Visualize attention

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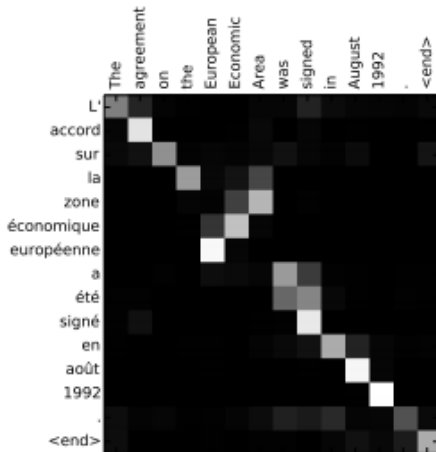
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# How to train

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Questions

- Word vectors
- Training
  - Data parallelism
  - Model parallelism
- Fast translation

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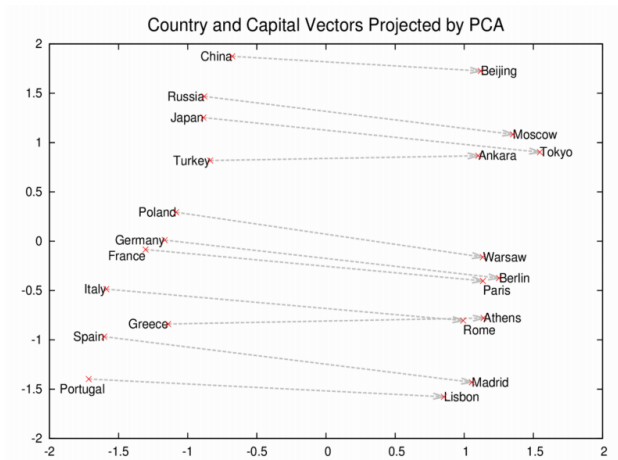
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credits: [deeplearning4j.org/word2vec](http://deeplearning4j.org/word2vec)



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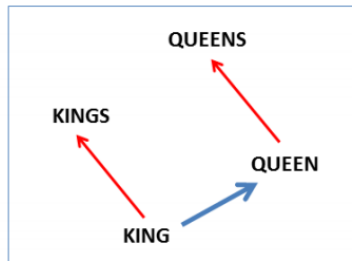
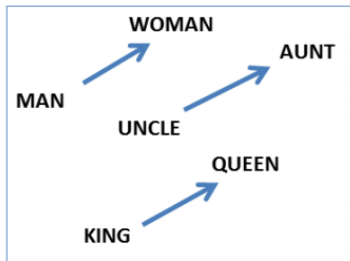
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(Mikolov et al., NAACL HLT, 2013)

# Gradient Descent

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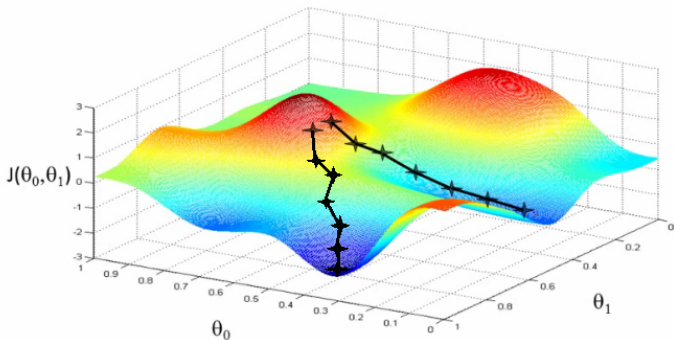
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Credits: ML blog Vasilis Vryniotis

# Data parallelism

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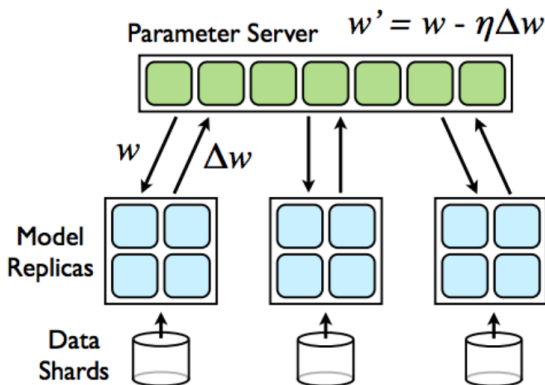
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Credits: [arimo.com/machine-learning/deep-learning/2016/arimo-distributed-tensorflow-on-spark/](http://arimo.com/machine-learning/deep-learning/2016/arimo-distributed-tensorflow-on-spark/)

# Model parallelism

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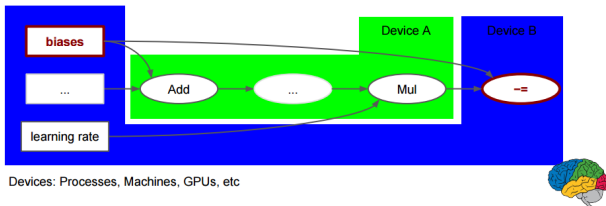
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Credits: slideshare Jeff Dean

# Quantization

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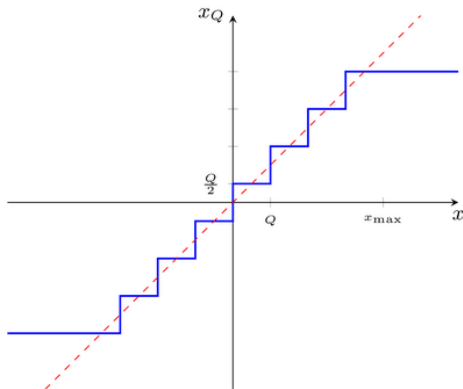
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Credits: Sascha Spors

# Speed up

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	BLEU	Log Perplexity	Decoding time (s)
CPU	31.20	1.4553	1322
GPU	31.20	1.4553	3028
TPU	31.21	1.4626	384

Credits: Arxiv GNMT paper

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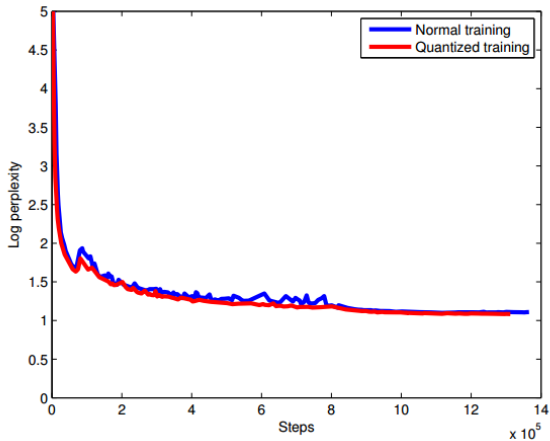
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Credits: Arxiv GNMT paper

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# Conclusion



# Further reading

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Questions

- 1 GNMT paper
- 2 The Unreasonable Effectiveness of Recurrent Neural Networks, Andrej Karpathy
- 3 Supervised sequence labelling with RNN, Alex Graves
- 4 Generating Sequences with RNN, Alex Graves
- 5 [robromijnders.github.io](https://github.com/robromijnders)