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2. Assignment in “Machine Learning for Natural Language Processing”

Summer Term 2024

1 General Questions

1. Name three common activation functions and their derivatives!
2. Given two word embeddings E and E' for a corpus of words, how could you rate the quality of the embeddings relative to one another? Is there a possibility to give an absolute, global rating for word embeddings?

   ? Something to think about

3. Suggest a combination of GloVe and FastText!

2 Neural Networks

Bias Trick

Formally, a feed-forward layer in a neural network is defined by a number of parameters consisting of a weight matrix W and a bias vector b. The output y that is passed to the activation function is then calculated as

$$y = Wx + b.$$

In practice, we want to keep the number of vectorised operations as small as possible, to enable maximum training/prediction speed (remember that GPUs can parallelise the matrix operations). Therefore, these two parameter sets are often combined into one matrix

$$W' = W \| b = \begin{pmatrix} w_{11} & w_{12} & \cdots & w_{1m} & b_1 \\ w_{21} & w_{22} & \cdots & w_{2m} & b_2 \\ \vdots & & \ddots & & \vdots \\ w_{n1} & w_{n2} & \cdots & w_{nm} & b_n \end{pmatrix}$$

1. How does the input x need to be modified to enable computing the output y in a single operation?
2. How is the output y calculated using the modified W' and input x'?
3. Proof that this always yields the same result as $Wx + b$!

3 Python

In the lecture, some commonly used optimisers for neural networks were introduced. Implement functions for

1. `sgd_update`
2. `nesterov_momentum_update`
3. `adam_update`

in Python. Each function should

- take as input
  - the current value of *one* input parameter,
  - a function returning the gradient regarding this parameter, and
  - the necessary hyper-parameters such as the learning rate, and
- return the new value for this parameter after the update.

You do *not* have to implement backpropagation in this assignment!