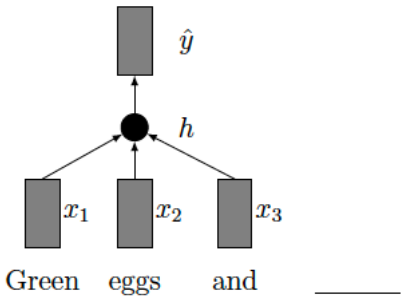
CLASS Exercises: WORD2VEC

Exercise 1

A feed-forward neural network language model (LM) is an alternative architecture for training word vectors. This architecture focuses on predicting a word given the N previous words. This is done by concatenating the word vectors of N previous words and use them as input of a single hidden layer of size H with a non-linearity (e.g. tanh). Finally, a softmax layer is used to make a prediction of the current word. The size of the vocabulary is V. The model is trained using a cross entropy loss for the current word.

Let the word vectors of the N previous words be $x_1; x_2; \ldots x_N$, each a column vector of dimension D, and let y be the one-hot vector for the current word. The network is specified by the equations that follow these lines:



$$x = \begin{bmatrix} x_1 \\ x_2 \\ \ldots \\ x_N \end{bmatrix}$$

$$h = \tanh(Wx + b)$$

$$\hat{y} = softmax(Uh + d)$$

$$J = CE(y, \hat{y})$$

$$CE = -\sum_i y_i \log(\hat{y}_i)$$

The dimensions of our parameters and variables are $x \in \mathbb{R}^{(N \cdot D)}, W \in \mathbb{R}^{Hx(N \cdot D)}, b \in \mathbb{R}^H, h \in \mathbb{R}^H, U \in \mathbb{R}^{V\,x\,H}, d \in \mathbb{R}^V, \hat{y} \in \mathbb{R}^V$

1a. Mention 2 important differences between this feed-forward neural network LM and the CBOW model. Explain how these differences might affect the word vectors obtained.

1b. Compute the complexity of forward propagation in a feed-forward LM for a single training example. Propose at least one way to change the model that would reduce this complexity.

Exercise 2.

2a. We know that dense word vectors like the ones obtained with word2vec or GloVe have many advantages over using sparse one-hot word vectors. Name a few.

2b. Also name at least 2 disadvantages of sparse vectors that it are not solved in dense vectors. Which of the following is NOT an advantage dense vectors have over sparse vectors?

Exercise 3

Two developers have used the Word2Vec algorithm to obtain word embeddings for the same vocabulary of words V.

In particular, developer A has got `context' vectors $u_w^A$ and `center' vectors v_w^A for every w in V, and developer B has got `context' vectors $u_w^B$ and `center' vectors v_w^B for every w in V .

For every pair of words w, w' in V, the inner product is the same in both models: $(u_w^A)^T v_{w'}^A = (u_w^B)^T v_{w'}^B$. Does it mean that, for every word w in V, $v_w^A = v_w^B$? Discuss your response.