Foundations of Deep Learning (AMMI)

Assignment 2

Due: Saturday 24 November 2018 at 18:00

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1 Shared notes contribution

1.1 Subtopic write-up

From one of eight days of class, transcribe all the notes related to the topics covered on that day (at least 2 pages expected).

We will have a total of 8 groups. You need to form your group comprising writers and reviewers for each section. Fill in your group members' names on this Google Sheet.

Try to be consistent with the notation already used.

- *E.g.* use `\vect{}` and `\matr{}` to decorate vectors and matrices respectively.
- Start a new line only and every time you end a sentence with a period '.'; the LaTeX engine will ignore this, but `git` will love you.
- Leave an empty line to start a new paragraph, and don't use the `\\` break line (see `tex.stackexchange.com/a/225925/33287`).
- Don't add dates, but meaningful section titles.
- The transposition symbol obtained with `^\top`. For example $(AB)^\top = B^\top A^\top$.

Feel free to create new sections and subsections.

1.2 Peer reviewing within groups

Check for notation consistency, correctness, grammar, figure captioning, usage of `\cref{}` instead of `\ref{}`, `\vect{}`, and `\matr{}` to decorate vectors and matrices respectively, unnecessary use of bullet points or itemisations, missing references and use of links to papers PDF instead, usage of $\mathbb{P}$, $\mathbb{E}$, and $\mathbb{V}$ for probability, expectation, and variance respectively using `\Pr`, `\E`, and `\V`, `\mid` for the conditional vertical bar, missing backslashes for log, exp, max and any badly formatted functions, $*$ for convolutions, $\odot$ for element-wise multiplication, usage of `\caption[Short caption]{Full caption}`, use of the correct transposition symbol obtained with `^\top`, just to name a few.

1.3 Taking inspiration

You can take inspiration from the work done by the students at NYU, who collectively writed up the lecture notes in this document. For example, you may reuse the following constructs:

$$\boldsymbol{X} = \begin{bmatrix} \text{—} & \boldsymbol{x}^{(1)} & \text{—} \\ \text{—} & \boldsymbol{x}^{(2)} & \text{—} \\ & \vdots & \\ \text{—} & \boldsymbol{x}^{(m)} & \text{—} \end{bmatrix}_{m \times n} \qquad \boldsymbol{Y} = \begin{bmatrix} \text{—} & \boldsymbol{y}^{(1)} & \text{—} \\ \text{—} & \boldsymbol{y}^{(2)} & \text{—} \\ & \vdots & \\ \text{—} & \boldsymbol{y}^{(m)} & \text{—} \end{bmatrix}_{m \times K}$$

$$\hat{\boldsymbol{A}}\boldsymbol{x} = \begin{bmatrix} \text{—} & \hat{\boldsymbol{a}}^{(1)} & \text{—} \\ \text{—} & \hat{\boldsymbol{a}}^{(2)} & \text{—} \\ & \vdots & \\ \text{—} & \hat{\boldsymbol{a}}^{(m)} & \text{—} \end{bmatrix} \begin{pmatrix} | \\ \boldsymbol{x} \\ | \end{pmatrix} = \begin{pmatrix} \hat{\boldsymbol{a}}^{(1)}\boldsymbol{x} \\ \hat{\boldsymbol{a}}^{(2)}\boldsymbol{x} \\ \vdots \\ \hat{\boldsymbol{a}}^{(m)}\boldsymbol{x} \end{pmatrix}_{m \times 1}$$

$$\boldsymbol{T}^{(1)}\boldsymbol{x} = \begin{bmatrix} a_{1,1} & a_{1,2} & \dots & a_{1,k} & 0 & 0 & \dots & 0 \\ 0 & a_{1,1} & a_{1,2} & \dots & a_{1,k} & 0 & \dots & 0 \\ 0 & 0 & a_{1,1} & a_{1,2} & \dots & a_{1,k} & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \ddots & \ddots & \ddots & \vdots \\ 0 & \dots & 0 & 0 & a_{1,1} & a_{1,2} & \dots & a_{1,k} \end{bmatrix}_{(n-k+1) \times n} = \begin{pmatrix} \boldsymbol{a}^{(1)}\boldsymbol{x}_{1:1+k-1} \\ \boldsymbol{a}^{(1)}\boldsymbol{x}_{2:2+k-1} \\ \vdots \\ \boldsymbol{a}^{(1)}\boldsymbol{x}_{n-k+1:n} \end{pmatrix}_{(n-k+1) \times 1}$$

Have fun!

2 Convolutional autoencoder with fashion images

In class, we used an Autoencoder (AE) with mainly affine transformations and non-linearities. However, in this exercise we will be using convolutions, pooling, affine transformations, and non-linearities. Essentially, we are moving from Fully-connected Neural Networks (FNN) to Convolutional Neural Networks (CNN) in our AE.

On top of this change in the model's architecture, we will be using a different dataset. The new dataset is called Fashion MNIST. Fashion MNIST is a data set of images consisting of a training set of 60k examples and a test set of 10k examples. Each example is a 28×28 grayscale image, associated with a label from 10 classes. The 10 classes are tee-shirt, trouser, pullover, dress, coat, sandal, shirt, sneaker, bag, and ankle boot.

2.1 Model parameters checking

You are required to print the parameters' sizes of your model based on the following architecture.

2.2 Training your model on Fashion MNIST

You are required to train your model with the following specifications.

1. Overall Architecture

Component	Number of Kernels	Kernel Size	Stride	Padding
Convolution	16	3	3	1
Leaky ReLU				
Average Pool		2	2	0
Convolution	8	3	2	1
Leaky ReLU				
Average Pool		2	1	0
Transpose Convolution	16	3	3	0
Leaky ReLU				
Transpose Convolution	8	5	3	1
Leaky ReLU				
Transpose Convolution	1	2	2	1
Tanh				

2. Epochs: 20
3. Batch size: 128
4. Optimizer: Adam
5. Learning rate: 1e-3
6. L2 regularization: 1e-5
7. Use of training dataset (60k examples)
8. At every epoch, your code needs to automatically save 1 image from the predictions for inspection with the names 1.png, 2.png, 3.png, ..., all the way to 20 in a folder.

Evaluation

Your grade for this assignment will be based on:

- 50% - Section 1 (shared notes contribution).
- 50% - Section 2 (programming assignment).

Submission

Directly edit the Overleaf document starting from the "sample day 1 topic". Feel free to add sections and sub-sections accordingly.

Send your notebook to `ritchieng@u.nus.edu` and pass your solutions to Ritchie on Saturday 24 November 2018 at 18:00. When you send your notebook, please use the following format as your email header. Any notebook without names will not be graded.

```
[Name Surname] Submission HW2
```

3 Sample day 1 topic

3.1 Sample day 1 sub-topic

Fill in your notes, equations and diagrams directly here using LaTeX .