Elements of Machine Learning

Assignment 3

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Preprocessing, designing network and experiments

I will measure the generalization error or test loss

$$Err_\tau = \mathbb{E}\{L(Y, \hat{f}(X)) \mid \tau\}$$

where τ represents the training set, and X and Y are the test set data and labels, drawn randomly from their joint distribution. If the model is overfitting, then I would expect $Err_\tau > e\bar{r}r$, where $e\bar{r}r$ is the average loss of the training sampling

$$e\bar{r}r = \frac{1}{N}\sum_{i=1}^{N} L(y_i, \hat{f}(x_i))$$

The following tables show the number of channels, original min and max values, normalized min and max values of all the data.

	No. of Channels	Original Min	Original Max	Norm Min	Norm Max
1	3	0	255	-1	1
2	3	0	255	-1	1
3	3	0	241	-1	1
4	3	0	255	-1	1
5	3	0	226	-1	1

Table 1: Images test

	No. of Channels	Original Min	Original Max	Norm Min	Norm Max
1	3	0	255	-1	1
2	3	0	255	-1	1
3	3	0	255	-1	1
4	3	0	255	-1	1
5	3	0	255	-1	1
6	3	0	255	-1	1
7	3	0	255	-1	1
8	3	0	255	-1	1
9	3	0	255	-1	1
10	3	0	255	-1	1
11	3	0	255	-1	1
12	3	0	255	-1	1
13	3	0	255	-1	1
14	3	0	255	-1	1
15	3	0	255	-1	1

Table 2: Images train

	No. of Channels	Original Min	Original Max	Norm Min	Norm Max
1	1	0	255	-1	1
2	1	0	255	-1	1
3	1	0	255	-1	1
4	1	0	255	-1	1
5	1	0	255	-1	1
6	1	0	255	-1	1
7	1	0	255	-1	1
8	1	0	255	-1	1
9	1	0	255	-1	1
10	1	0	255	-1	1
11	1	0	255	-1	1
12	1	0	255	-1	1
13	1	0	255	-1	1
14	1	0	255	-1	1
15	1	0	255	-1	1

Table 3: Labels train

I will use Convolutional Neural Networks (CNNs) to solve this task. Convolutional Neural Networks is a type of Feed-Forward Neural Networks used in tasks like image analysis, natural language processing, and other complex image classification problems. Features in the image data like edges, borders, shapes, textures, objects, circles, etc. At a higher level, convolutional layers detect these patterns in the image data with the help of filters. The higher-level details are taken care of by the first few convolutional layers. The deeper the network goes, the more sophisticated the pattern searching becomes.
CNN is a way of reducing the number of weights. The integral of the multiplication of a function and another function which is reserved and shifted:

$$s(t) = \int x(a)w(t-a)da$$

And in fact, using cross-correlation which has no reversing:

$$\begin{aligned} S(i,j) &= (I \cdot K)(i,j) \\ &= \sum_m \sum_n I(i+m, j+n)K(m,n) \end{aligned}$$

Implementation, training and analysis

Download the data from
https://www.dropbox.com/sh/jhvugjvowcnuovb/AADHwtqWk7p2y7KkO8OUg$_l ha?dl =$
0

Load image by using PIL python library and convert to numpy array first to find the number of channels of each file. Normalize the data and print out the min and max values of data before and after normalization, which gives the values of the tables in the previous section. Then, using ToTenser() to convert file into tensor.

Results evaluation and possible improvements

A common performance metric for segmentation is the Dice Similarity Coefficient, defined as twice the volume of the intersection of the resulting segmentation with the ground truth divided by the sum of the two segmentation volumes: $\frac{2|A \cap B|}{|A|+|B|}$, where A is the binary segmentation output image and B is the ground truth segmentation (label) image.

It took me quite long time to understand this field, but it is really interesting to learn a programming language and computer algorithm. Through this assignment, I got more understanding about different algorithms, however, the more I got into the more unclear questions I got, which took a lot of time from the plan. I will spend more time into understanding the algorithm and coding theory during the spare time to see if it can help with understanding it better.