Document Analysis

Exercise : Handwritten Digits Recognition with Artificial Neural Networks

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Objective

- Experiment with Neural Networks (NNs) on a real problem to understand how NNs work. Study the following aspects:
  - Impact of topology of NNs
  - Impact of parameters, i.e., learning rate, number of epochs
  - Impact of training set size
  - Overfitting

Problem statement

- Using NNs to recognize handwritten digits (0-9)

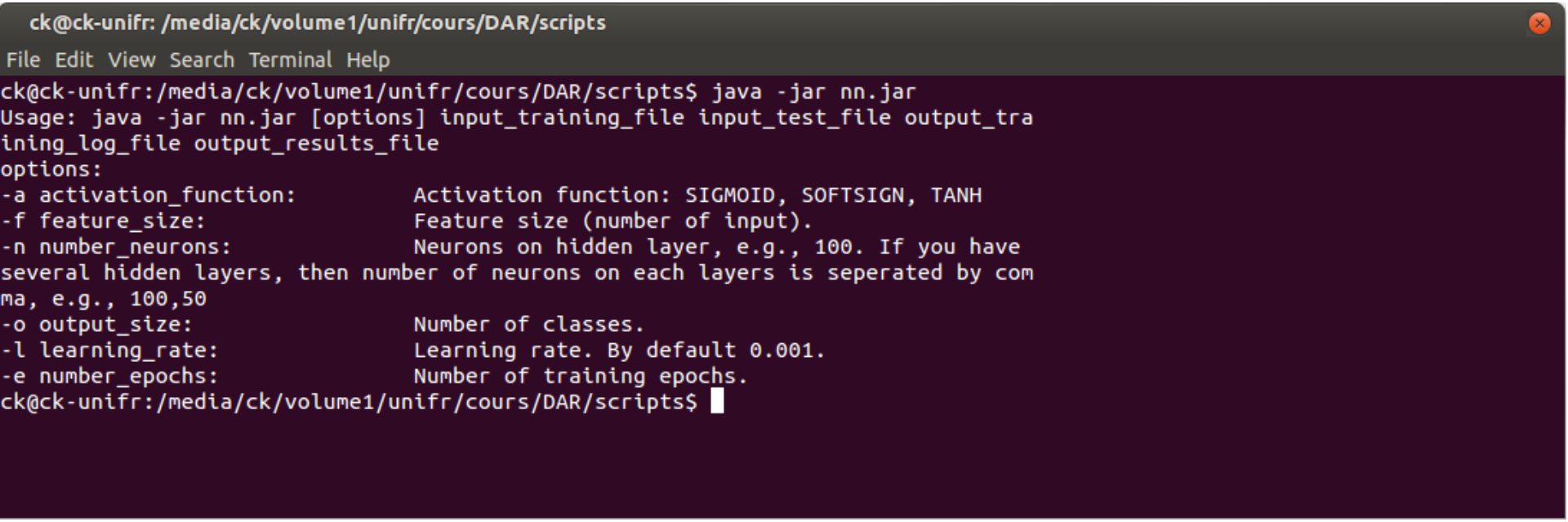
Data

- MNIST dataset
  - Gray scale PNG images
    - Img-lbl*digit*-number-num.png, e.g., img-lbl**0**-1-num.png
    - Size : 28x28 pixels
    - Pixel intensity value : 0-255
  - Number of images per datasets
    - Training : 31920
    - Test: 10000
    - Validation : 1000

http://yann.lecun.com/exdb/mnist/

Tool

- Java application



Example:
java -jar -Xmx512m nn.jar -a SIGMOID -f 784 -n 100 -o 10 -l 0.001 -e 10 mnist.train.txt mnist.test.txt mnist.train.output.txt mnist.test.output.txt

Tool

- Input file format
  - class_label,feature$_1$,feature$_2$, …
  - Features are float values

Class

Features (here: raw pixel values)

Tool

- Output file format
  - Train

```
0.17970781
0.17752841
0.16313086
0.14881098
0.13672492
0.12724894
0.120099396
0.112911336
0.10735046
0.10313332
```

Training error rate per epoch

  - Test

```
result: 8,8
result: 5,2
result: 3,3
result: 4,4
result: 9,9
result: 6,6
result: 2,2
result: 4,4
result: 6,6
result: 5,2
result: 1,1
result: 3,3
result: 0,0
accuracy: 0.8186
```

Results: class label, predict label

Average accuracy

Suggested parameters

- Number of neurons for one layer NNs
  - 5, 10, 50, 100, 200, 500, 784, 1000, …
- Number of epochs
  - 5, 10, 50, 100, …
- Learning rate
  - …, 0.0001, 0.001, 0.01, 0.1, …
- Training samples
  - 20, 100, 1000, 2000, 5000, 10000, ...

Tasks and Schedule

- Task 1 (14th May)
  - Generate feature files containing class label with pixel values
  - Evaluate one layer NNs
  - Use different parameter values and observe the performance
    - #neurons, learning rate, #epochs
  - Optional : Evaluate NNs with more than one layer
- Task 2 (28th May)
  - Replace pixel values by high-level set of features
    - e.g., scale down images and extract pixel intensity values
  - Use different number of training samples

Hints

- Normalize the features from -1 to 1
- Before doing a test with many epochs, try it with only 3-4 to see if it runs correctly
- Write scripts to run bunch of test
- The initial weights are random
  - Run twice the same test, you will get two different results
  - Very samll differences of accuracy might not be relevant
  - In such cases, take the average of several runs
- Keep track of the experiments you did
  - So that you don't lose time doing them twice

Deadline

- May 28, 15:00
- Hand in a ZIP file “HansMuster_JaneDoe_JohnDoe.zip” via ILIAS that contains:
  - Your source code
  - Report with descriptions and figures (PDF)