CS429

Logistic Regression Music Classifier

The University of New Mexico

Team:
Eros Espínola González
Mauricio David Zaragoza Ibarra

I. Code description

We implemented our code in Python 2.7 using SciPy/NumPy, the dataset is converted into a matrix format and all its operations are fully-vectorized, which decreases the run time of this algorithm to a matter of seconds.

The FFT/MFCC dataset matrices were precomputed and pickled into files, so they are just loaded according to the given input command line arguments, peak performance was reached when every feature was scaled to a [-1.0, 1.0] range.

II. Results with FFT components and cross validation

For this part of the validation we used the FFTs components and a 10-fold cross validation, the best performance we reached with this configuration is an expected ~38% of accuracy. The results are represented in the following confusion matrices:

```
First iteration:
[ 10.   0.   0.   0.   0.   0.]
[  4.   3.   0.   0.   3.   0.]
[  2.   0.   0.   2.   5.   1.]
[  1.   0.   4.   3.   0.   2.]
[  1.   0.   3.   4.   2.   0.]
[  3.   1.   1.   3.   0.   2.]
Current cross validation accuracy: 33.3333333333

Second iteration:
[ 9.  0.  1.  0.  0.  0.]
[ 7.  1.  2.  0.  0.  0.]
[ 1.  3.  0.  0.  6.  0.]
[ 1.  1.  0.  2.  3.  3.]
[ 0.  0.  1.  5.  4.  0.]
[ 0.  1.  1.  1.  7.  0.]
Current cross validation accuracy: 26.6666666667

Third iteration:
[ 10.   0.   0.   0.   0.   0.]
[  9.   1.   0.   0.   0.   0.]
[  2.   4.   4.   0.   0.   0.]
[  0.   0.   4.   3.   0.   3.]
[  0.   1.   7.   1.   1.   0.]
[  0.   2.   1.   2.   3.   2.]
Current cross validation accuracy: 35.0

Fourth iteration:
[ 5.  5.  0.  0.  0.  0.]
[ 1.  8.  1.  0.  0.  0.]
[ 2.  1.  4.  0.  1.  2.]
[ 2.  0.  3.  4.  0.  1.]
[ 1.  1.  4.  3.  1.  0.]
[ 0.  2.  0.  3.  3.  2.]
Current cross validation accuracy: 40.0
```

```
Fifth iteration:
[ 2.  3.  0.  0.  5.  0.]
[ 0.  9.  0.  0.  1.  0.]
[ 1.  1.  8.  0.  0.  0.]
[ 1.  1.  1.  5.  0.  2.]
[ 1.  3.  4.  0.  1.  1.]
[ 4.  1.  0.  0.  1.  4.]
Current cross validation accuracy: 48.3333333333

Sixth iteration:
[ 5.  2.  0.  0.  3.  0.]
[ 0.  5.  0.  1.  2.  2.]
[ 0.  0.  4.  2.  0.  4.]
[ 1.  1.  0.  7.  0.  1.]
[ 0.  1.  2.  3.  2.  2.]
[ 0.  0.  2.  6.  0.  2.]
Current cross validation accuracy: 41.6666666667

Seventh iteration:
[ 7.  3.  0.  0.  0.  0.]
[ 1.  5.  0.  1.  2.  1.]
[ 1.  0.  8.  1.  0.  0.]
[ 2.  0.  1.  6.  1.  0.]
[ 0.  2.  6.  0.  0.  2.]
[ 0.  8.  1.  0.  0.  1.]
Current cross validation accuracy: 45.0

Eighth iteration:
[ 10.   0.   0.   0.   0.   0.]
[  1.   3.   0.   0.   6.   0.]
[  4.   0.   2.   0.   4.   0.]
[  0.   2.   2.   5.   0.   1.]
[  1.   0.   2.   1.   3.   3.]
[  1.   2.   1.   3.   1.   2.]
Current cross validation accuracy: 41.6666666667

Nineth iteration:
[ 10.   0.   0.   0.   0.   0.]
[  1.   0.   5.   0.   4.   0.]
[  0.   0.   8.   2.   0.   0.]
[  1.   0.   1.   4.   1.   3.]
[  0.   1.   9.   0.   0.   0.]
[  0.   0.   2.   2.   3.   3.]
Current cross validation accuracy: 41.6666666667

Tenth iteration:
[  0.  10.   0.   0.   0.   0.]
[  0.   9.   0.   0.   1.   0.]
[  0.   2.   0.   6.   0.   2.]
[  0.   2.   0.   5.   2.   1.]
[  0.   9.   0.   0.   0.   1.]
[  0.   4.   0.   0.   1.   5.]
Current cross validation accuracy: 31.6666666667

Total accuracy: 38.5
```

Given the FFT components as features, we can notice that classical genre classification was more accurate than the rest of the classes, that is because the FFT components of the classical music contrast significantly from other genres. That is the reason why the classifier got better results on the classical music dataset.

III. Results with top 120 FFT components and cross validation

For this part of the validation we used the top 120 FFTs components and a 10-fold cross validation, the best performance we reached with this configuration is an expected ~35% of accuracy. The results are represented in the following confusion matrices:

```
First iteration:
[ 8.  1.  0.  0.  0.  1.]
[ 9.  0.  0.  0.  1.  0.]
[ 3.  0.  0.  2.  3.  2.]
[ 0.  1.  2.  2.  1.  4.]
[ 0.  1.  2.  2.  5.  0.]
[ 3.  1.  1.  2.  0.  3.]
Current cross validation accuracy: 30.0

Second iteration:
[ 9.  0.  1.  0.  0.  0.]
[ 7.  1.  2.  0.  0.  0.]
[ 1.  4.  1.  0.  4.  0.]
[ 1.  1.  1.  2.  2.  3.]
[ 0.  0.  3.  2.  5.  0.]
[ 1.  0.  0.  0.  8.  1.]
Current cross validation accuracy: 31.6666666667

Third iteration:
[  8.   1.   1.   0.   0.   0.]
[ 10.   0.   0.   0.   0.   0.]
[  3.   1.   4.   0.   2.   0.]
[  1.   0.   2.   4.   0.   3.]
[  1.   0.   8.   0.   1.   0.]
[  1.   1.   1.   3.   4.   0.]
Current cross validation accuracy: 28.3333333333

Fourth iteration:
[ 6.  4.  0.  0.  0.  0.]
[ 3.  6.  1.  0.  0.  0.]
[ 5.  0.  2.  0.  0.  3.]
[ 2.  0.  2.  5.  1.  0.]
[ 3.  0.  4.  2.  0.  1.]
[ 2.  0.  0.  4.  3.  1.]
Current cross validation accuracy: 33.3333333333

Fifth iteration:
[ 4.  1.  0.  0.  4.  1.]
[ 1.  7.  1.  0.  1.  0.]
[ 1.  4.  5.  0.  0.  0.]
[ 2.  0.  0.  5.  0.  3.]
[ 1.  3.  2.  0.  3.  1.]
[ 4.  2.  1.  0.  0.  3.]
Current cross validation accuracy: 45.0
```

```
Sixth iteration:
[ 7.  0.  0.  0.  3.  0.]
[ 0.  5.  0.  1.  1.  3.]
[ 0.  0.  4.  3.  0.  3.]
[ 1.  2.  1.  6.  0.  0.]
[ 0.  1.  3.  1.  5.  0.]
[ 0.  0.  1.  8.  1.  0.]
Current cross validation accuracy: 45.0

Seventh iteration:
[ 7.  3.  0.  0.  0.  0.]
[ 2.  3.  1.  1.  2.  1.]
[ 1.  1.  5.  1.  1.  1.]
[ 2.  0.  1.  6.  1.  0.]
[ 2.  1.  6.  0.  0.  1.]
[ 4.  4.  2.  0.  0.  0.]
Current cross validation accuracy: 35.0

Eighth iteration:
[ 8.  2.  0.  0.  0.  0.]
[ 1.  5.  0.  0.  4.  0.]
[ 5.  0.  2.  0.  3.  0.]
[ 1.  0.  1.  3.  0.  5.]
[ 2.  0.  1.  1.  3.  3.]
[ 3.  0.  0.  3.  2.  2.]
Current cross validation accuracy: 38.3333333333

Nineth iteration:
[ 9.  1.  0.  0.  0.  0.]
[ 1.  1.  3.  0.  5.  0.]
[ 0.  0.  7.  3.  0.  0.]
[ 2.  1.  1.  1.  0.  5.]
[ 1.  1.  7.  1.  0.  0.]
[ 0.  2.  0.  3.  5.  0.]
Current cross validation accuracy: 30.0

Tenth iteration:
[ 8.  0.  2.  0.  0.  0.]
[ 5.  2.  1.  0.  2.  0.]
[ 1.  1.  4.  2.  1.  1.]
[ 2.  0.  1.  4.  2.  1.]
[ 9.  0.  1.  0.  0.  0.]
[ 2.  0.  1.  0.  3.  4.]
Current cross validation accuracy: 36.6666666667

Total accuracy: 35.3333333333
```

In this setting we can see that the results are not as good as the previous one, this is because some relevant features could be eliminated while ranking all the features, but in general the accuracy is very similar between the FFT components and the top 120 FFT components.

IV. Results with MFCC components and cross validation

For this part of the validation we used the MFCCs components and a 10-fold cross validation, the best performance we reached with this configuration is an expected ~66% of accuracy. The results are represented in the following confusion matrices:

```
First iteration:
[ 8.  1.  0.  0.  1.  0.]
[ 5.  2.  3.  0.  0.  0.]
[ 0.  0.  2.  7.  1.  0.]
[ 0.  0.  1.  8.  1.  0.]
[ 0.  0.  2.  0.  8.  0.]
[ 0.  0.  0.  0.  1.  9.]
Current cross validation accuracy: 61.6666666667

Second iteration:
[ 10.   0.   0.   0.   0.   0.]
[  4.   3.   1.   0.   2.   0.]
[  1.   2.   5.   2.   0.   0.]
[  0.   0.   0.   8.   2.   0.]
[  0.   2.   2.   1.   2.   3.]
[  0.   0.   0.   0.   0.  10.]
Current cross validation accuracy: 63.3333333333

Third iteration:
[  9.   1.   0.   0.   0.   0.]
[  2.   5.   1.   0.   1.   1.]
[  0.   3.   5.   0.   2.   0.]
[  0.   0.   0.  10.   0.   0.]
[  0.   0.   5.   0.   4.   1.]
[  0.   0.   0.   0.   0.  10.]
Current cross validation accuracy: 71.6666666667

Fourth iteration:
[ 10.   0.   0.   0.   0.   0.]
[  1.   6.   2.   0.   1.   0.]
[  1.   4.   4.   0.   0.   1.]
[  0.   0.   0.  10.  0.    0.]
[  0.   2.   2.   3.   3.   0.]
[  0.   0.   0.   0.   3.   7.]
Current cross validation accuracy: 66.6666666667

Fifth iteration:
[  5.   0.   3.   0.   2.   0.]
[  2.   4.   3.   0.   0.   1.]
[  0.   1.   6.   2.   1.   0.]
[  0.   0.   0.   8.   2.   0.]
[  0.   3.   0.   4.   0.   3.]
[  0.   0.   0.   0.   0.  10.]
Current cross validation accuracy: 55.0

Sixth iteration:
[  6.   1.   2.   0.   1.   0.]
[  0.   5.   4.   1.   0.   0.]
[  0.   4.   3.   0.   3.   0.]
[  0.   0.   0.  10.   0.   0.]
[  0.   2.   2.   2.   3.   1.]
[  0.   0.   0.   0.   1.   9.]
Current cross validation accuracy: 60.0
```

```
Seventh iteration:
[  5.   5.   0.   0.   0.   0.]
[  1.   4.   3.   1.   1.   0.]
[  2.   3.   3.   0.   2.   0.]
[  0.   0.   1.   9.   0.   0.]
[  0.   4.   0.   1.   3.   2.]
[  0.   0.   0.   0.   0.  10.]
Current cross accuracy: 56.6666666667

Eighth iteration:
[ 10.  0.   0.   0.   0.   0.]
[  1.  6.   3.   0.   0.   0.]
[  2.  4.   2.   0.   2.   0.]
[  0.  0.   1.   9.   0.   0.]
[  0.  0.   0.   0.   9.   1.]
[  0.  1.   1.   0.   0.   8.]
Current cross validation accuracy: 73.3333333333

Nineth iteration:
[ 10.   0.   0.   0.   0.   0.]
[  0.   3.   0.   4.   1.   2.]
[  0.   0.   9.   0.   1.   0.]
[  0.   0.   1.   9.   0.   0.]
[  0.   0.   0.   0.   7.   3.]
[  0.   0.   1.   0.   1.   8.]
Current cross validation accuracy: 76.6666666667

Tenth iteration:
[ 10.   0.   0.   0.   0.   0.]
[  0.   5.   0.   1.   4.   0.]
[  0.   1.   8.   0.   0.   1.]
[  0.   0.   0.  10.   0.   0.]
[  0.   1.   5.   0.   1.   3.]
[  0.   1.   0.   0.   0.   9.]
Current cross validation accuracy: 71.6666666667
```

Total accuracy: 65.6666666667

In this setting, the accuracy was almost duplicated, this is because the MFCC components contrast more among the different genres, so the classifier is able to generate more reliable results. And this make sense since is already proved that MFCC is better than FFC and often is used in speech recognition and genre classification.

V. Improvement

Accuracy could probably increase if certain FFT components were introduced into the MFCC dataset, this because maybe some FFT are very relevant to the classifier, and can give us some information that MFCC components don’t have. Another improvement could be to train the algorithm with a bigger dataset, since Logistic

Regression is not good good classifying with few samples like Naive Bayes, some more data would be better for the algorithm.