Homework I - Machine Learning for IoT 2021-2022

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I. EXERCISE 1

We selected a subset of 4 measures of the entire data-set we created. The next step was to divide the procedure in two branches: one for the normalization and one for raw data. In order to do the normalization we took the maximum and minimum values the sensor is able to register.

$$temperature \in [0, 50],$$

$$humidity \in [20, 90]$$

The input values are integers and they become float after normalization. Since the FloatList and Int64List formats store a number of bytes greater than the bytes needed to store the records, we decided to use ByteList. We took for each variable the minimum number of bytes, for both normalized and non values, not to lose information when converting to bytes. This allowed us to reach the minimum size of the output file. More specifically:

- Not normalized: 300B
- Normalized: 325B

We can notice that the normalized data need more bytes to be represented.This is a direct consequence of the normalization, since floating numbers have more characters.

II. EXERCISE 2

The parameters that influenced the execution time the most are:

- The frequency of the original audio
- The number of filters used in the MFCC
- Code's efficiency

The other parameters such as the Lower and the Upper Frequency of the MFCC are responsible for the quality.

In order to reduce the execution time we first tried to re-sample the audio files. We applied a down-sample of factor 2 and 4 so that the new frequency were 8kHz and 4kHz. This procedure was useful to decrease the execution time a little bit but it affected the quality of the files. We decided to focus on the other parameters and tried different procedures. The number of filters used in the MFCC is a crucial parameter to set in order to get a better value for the execution time. We tried to reduce it and it decreased the execution time. The best value we found was 16. In order to satisfy the constraint we focused on our code. We noticed that the *linear_to_mel_weight_matrix* is computed for each file even though the result is the same for every computation and for avoiding this we computed it only once.

Parameter	Slow	Fast
Number mel bins	**40**	**16**
Lower frequency	20 Hz	20 Hz
Upper frequency	40000 Hz	40000 Hz
Frame length	16 ms	16 ms
Frame step	8 ms	8 ms
FFT lenght	16 ms	16 ms
MFCCs coefficients	10	10
Resampling ratio	1	1
Returned shape for file	(124,10)	(124,10)
Execution time	40.97 ms	16.51 ms
SNR		10.86 dB

TABLE I

Comparison between parameters of the slow and fast performing functions that compute the MFCC.

The table shows that the parameter that mostly affect the execution time is the number of mel bins, that influences the number of different bands we consider and consequently the number of computations. That is the reason we have to keep it low, but not too much to not increase the noise level in the computation of the SNR. In conclusion, all the constraints are respected, in terms of shape, execution time and SNR.