**Deep Learning Project**

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# Subject: Speaker Identification by Voice.

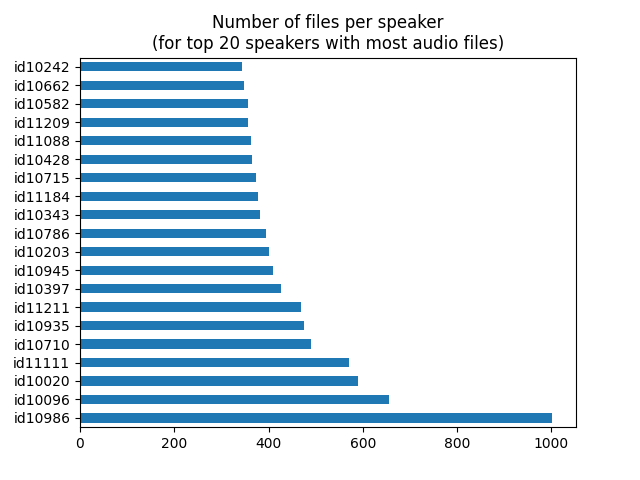
# The Original Dataset

[VoxCeleb](https://www.robots.ox.ac.uk/~vgg/data/voxceleb/) is an audio-visual dataset consisting of short clips of human speech, extracted from interview videos uploaded to YouTube. The dataset consists of two versions, VoxCeleb1 and VoxCeleb2. For this project **VoxCeleb1** dataset was selected. **VoxCeleb1** contains 2 sets of files, **Dev files** and **Test files**. **Test files** contains speakers’ ids that are not included in the **Dev files**, so they could not be used as a test set for our classification task. For this reason, only **DEV files** were used.

|  |  |
| --- | --- |
|  | **DEV files** |
| **# Speakers** | 1,211 |
| **# Files** | 148,642 |

# The Identification Dataset

From the1,251 speakers of the **DEV files**, only 10 were selected for identification. To select a balanced subset of **VoxCeleb1**, the speaker ids were sorted by their total number of audio files. Then, 10 speakers were chosen out of the speakers with the most audio files. The speakers were selected so that the resulting dataset would be balanced with respect to the number of audio files per speaker. The resulting dataset consists of **10** speakers and **4,195** audio files in total.



**VoxCeleb1 ID VGGFace1 ID**

id10203 David Attenborough

id10343 Gloria Steinem

id10397 J.J. Abrams

id10710 Louis C.K.

id10715 Lucie Arnaz

id10786 Meat Loaf

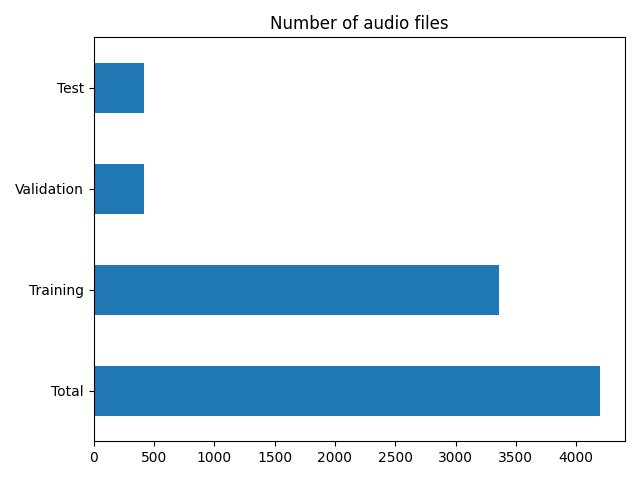
id10935 Peter Jackson

id10945 Quentin Tarantino

id11184 Tom Hooper

id11211 Vince Gilligan

After the generation of the dataset, we then split it into a training, validation, and a test set. The training set consists of the 80% of the total audio files, while the test and the validation sets consist of the 10% of the files each. The number of files per dataset is presented in the plot below:

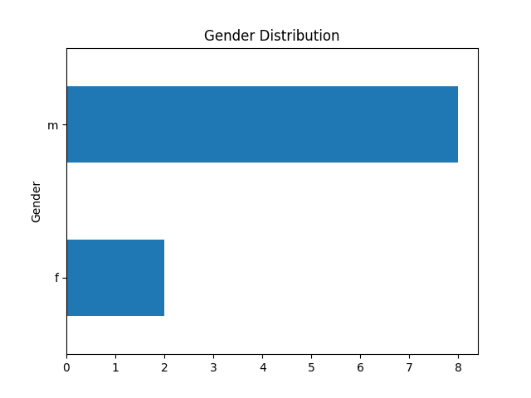
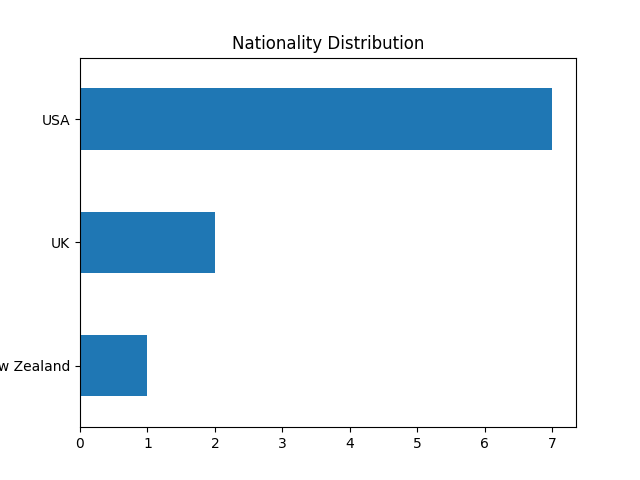


# Data Exploration

In the file **explore\_data.py** we can visualize information about the dataset. Specifically, as we can see from the plots below, we can observe that:

* 80% of the speakers are males and 20% are females
* 10 % are from New Zealand, 30% from UK and 70% from USA

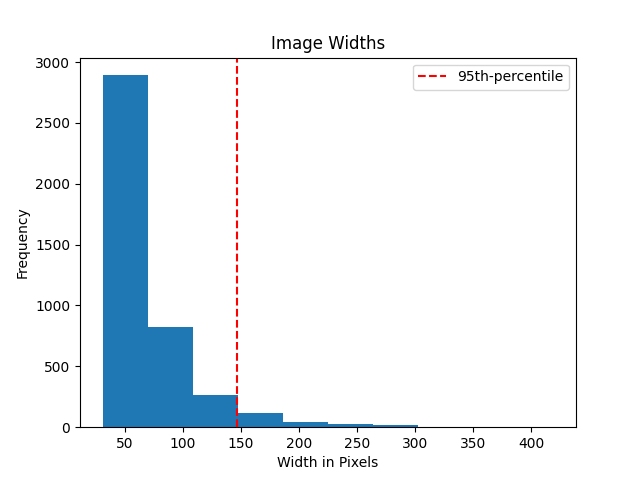
We conclude that our dataset is balanced in terms of the number of audio files per user, but it is unbalanced in terms of the gender and nationality of the speakers.



# Audio Preprocessing

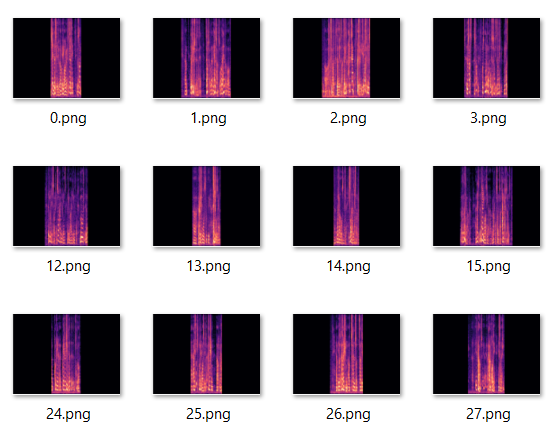
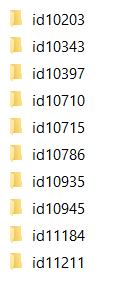
The file **audio\_analysis.py** includes functions for the analysis and preprocessing of the audio files. After observing that all audio signals have the same sample rate (16,000 kHz), which means that they do not need to be resampled, then we define the necessary functions that are required for the preparation of the audios for the training of our model. Audio preprocessing consists of the following steps:

1. The audio signals get converted to mono, so they have the same number of channels.
2. The processed signals get converted to a Mel spectrogram.
3. The spectrograms get resized to have the same height, width to be fed to the model. The audio clips have different duration, so they get cropped or padded to have equal width. The metric that was used for selecting the best image width in pixels is the 95th-Percentile of all spectrograms’ widths since it keeps a large amount of the total audio information. In the plot below we can see the distribution of image widths and the 95-percentile (147 pixels).



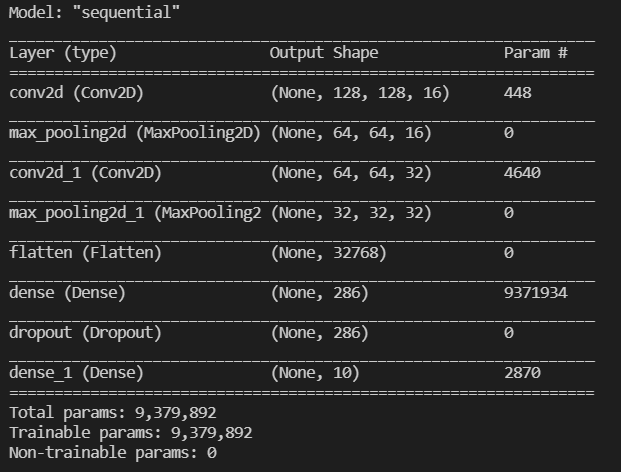
# Spectrograms Directories Creation

The file **create\_directories.py** creates 3 directories (train, val, test) with the spectrogram images of the audios for each speaker. Each directory contains 10 folders each one named after a speaker id and each folder contains the spectrogram images of the respective speaker. The folders of the directories and its containing files can be seen in the following figure:



# Training

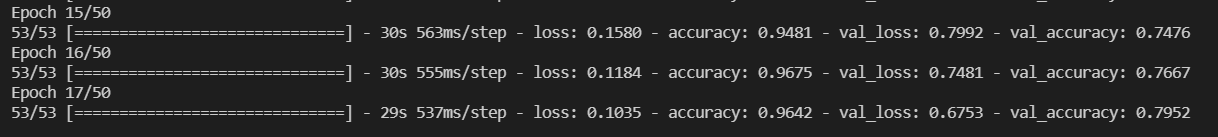
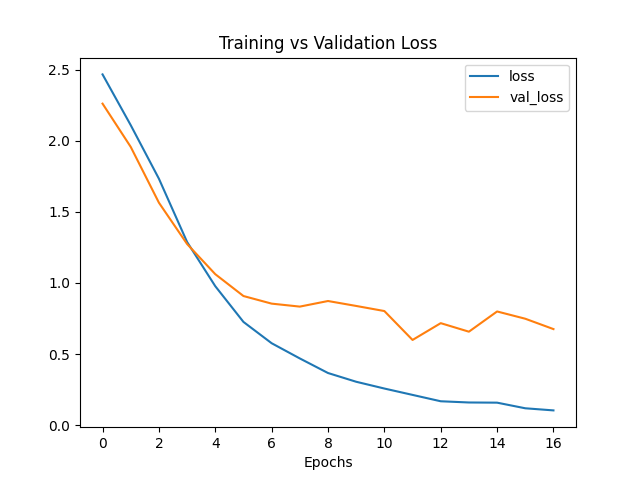
The model that was used for classification is a CNN model that consists of 2 convolutional layers, both containing a **Convolutional** and a **Maxpool** layer, followed by 2 **Fully Connected** layers and a **SoftMax** output layer. To reduce overfitting and improve generalization error, a **Dropout** layer that drops 50% of the data was added before the last **Fully Connected** layer. The architecture of the network can be viewed in the following figure:

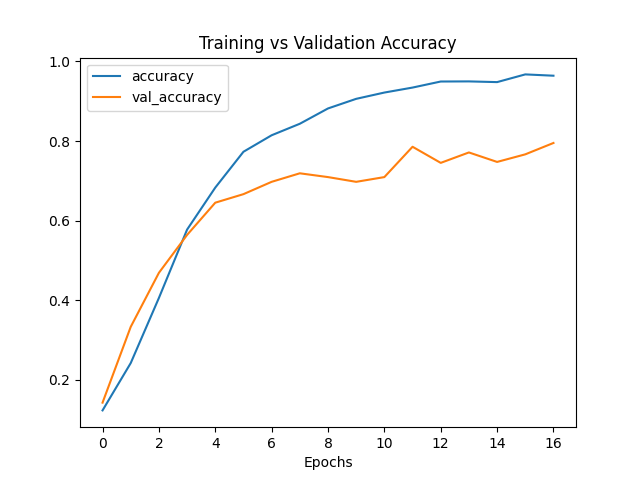


The model was trained by running the **cnn.py** file and was then saved to a .h5 file format named model.h5. For training we used:

* ‘Adam’optimizer with a learning rate of **0.001**
* categorical entropy loss and
* accuracy as metric for the model’s performance
* an early stopping with **5** epochs patience and a minimum change to qualify as an improvement of **0.001**

The results of the model’s performance for the training and the validation set are the following:





# Evaluation

The model’s performance was evaluated on the test set by running the **evaluate.py** file. The results we get are the following:



Then we performed some prediction on 3 spectrogram images of the test directory. The speakers that were selected for these predictions are of different genders and nationalities:

* Gloria Steinem (female, UK)
* Tom Hooper (male, New Zealand)
* Quentin Tarantino (male, UK)

As we can see from the figure below, the model identifies correctly all 3 speakers:

