How to Use This Code

1 Introduction

This is the accompanying code for our paper titled *Harmonic Structure-Based Neural Network Model for Music Pitch Detection*, which has been submitted to IEEE ICMLA 2020 for review. Here we go through the steps to prepare the environment for running this code. The relative paths mentioned hereafter are relative to your Python environment.

2 Environment Preparation

- Install Dependent Libraries

tensorflow	1.13.1
librosa	0.6.2
soundfile	0.10.2
mido	1.2.9
magenta	0.4.0

- There is a defect with the function *apply_sustain_control_changes* provided by magenta for translating sustain pedal into extended note durations. This function is contained in script *sequences_lib.py*. We have fixed this defect and uploaded the updated script. Please update the corresponding script after installing magenta. The relative path of this script is *lib/python2.7/site-packages/magenta/music/*.

- Sparse convolution is not a standard operation coming with Tensorflow so we implemented it ourselves. The code for this operation is contained in script *harmonic_dense.py*. Add this operation to Tensorflow as per the following steps.

  - Append all the stuff in *harmonic_dense.py* to script *layers.py* whose relative path is *lib/python2.7/site-packages/tensorflow/contrib/layers/python/layers/*.
  - At the beginning of *layers.py*, there is a list variable named *__all__*. Append '*harmonic_dense*' to this variable.
  - There is a script *__init__.py* controlling the visibility of the operations defined in *layers.py*. We need to make the newly added operation

visible. The relative path of this script is *lib/python2.7/site-packages/tensorflow/contrib/layers/python/*. This is done by adding *@@harmonic_dense* to the long list of similar terms at the beginning of this script.

3 Download Datasets

- MAPS
  Download the MAPS dataset as per the instruction given in the paper below.

  V. Emiya, R. Badeau, and B. David, "Multipitch estimation of piano sounds using a new probabilistic spectral smoothness principle," *IEEE Transactions on Audio, Speech, and Language Processing*, 18(6), pp. 1643—1654, 2010.

  You may need to unzip the downloaded file. Then create an environment variable named *maps* pointing to the top folder of this dataset. Make sure the following 9 folders are under this folder.
  ENSTDkCl_2/MUS
  ENSTDkAm_2/MUS
  AkPnBcht_2/MUS
  AkPnBsdf_2/MUS
  AkPnCGdD_2/MUS
  AkPnStgb_2/MUS
  SptkBGAm_2/MUS
  SptkBGCl_2/MUS
  StbgTGd2_2/MUS

- MAESTRO
  Download the MAESTRO dataset from the link given in the paper below.

  C. Hawthorne, A. Stasyuk, A. Roberts, I. Simon, C. A. Huang, S. Dieleman, E. Elsen, J. H. Engel, and D. Eck, "Enabling factorized piano music modeling and generation with the MAESTRO dataset," in *7th International Conference on Learning Representations*, ICLR 2019, New Orleans, LA, USA, May 6–9, 2019.

  Note that this dataset has multiple versions. The version we used is v1.0.0. You may need to untar the downloaded file. Then create an environment variable named *maestro* pointing to the top folder of this dataset.

4 Generate VQT Spectrograms

We implemented functions for computing VQT in Matlab and will call them from Python to generate VQT spectrograms. Please follow the steps below to generate VQT spectrograms.

1. Install Matlab.
2. Follow the instruction at this link to install necessary libraries so that we can call Matlab functions from Python.
3. The Matlab code for VQT is put in folder *vqt_with_pitch_shift*. Please add this folder to Matlab's search path.
4. Run Python script *gen_vqt_for_maps.py* to generate spectrograms for the MAPS dataset. By default, they will be stored in a folder named *maps_vqt* under the folder of the MAPS dataset. You can change it by changing variable *FOLDER* at the beginning of the Python script. Create an environment variable named *maps_vqt* to point to this folder before or after running the script.
5. Run Python script *gen_vqt_for_maestro.py* to generate spectrograms for the MAESTRO dataset. By default, they will be stored in a folder named *maestro_vqt* under the folder of the MAESTRO dataset. You can change it by changing variable *FOLDER* at the beginning of the Python script. Create an environment variable named *maestro_vqt* to point to this folder before or after running the script

5 Python Scripts for Running the Experiments

In the first experiment, the dataset for training and test is the MAPS dataset. An LSTM is put over the harmonic acoustic model. Data augmentation is used. The script for this experiment is *maps_lstm_data_aug.py*.

In the second experiment, the dataset for training is the MAESTRO dataset. LSTM is used but there is no data augmentation. The test is done on the MAESTRO and the MAPS dataset. The script for this experiment is *maestro_w_lstm_wo_data_aug.py*.

6 View Results

All the statistics have been saved as tensorboard (tb) summaries. Please use tb to view the results.