Synopsis for 02456 Project "Various Deep Learning Architectures for Urban Sound Classification"

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Background and Motivation:

Sound classification is a task commonly solved by RNNs rather than CNNs, which in turn are rather suitable for image data. However, since a spectrogram of an audio sequence can be interpreted as an image, CNNs too can be used for sound data, as was done e.g. in [1]. Therefore, sound data is a good opportunity to work with two of the architectures we learned in 02456, namely CNNs and RNNs. The dataset chosen for the project was the *UrbanSound8K*[2], which is a collection of over 8000, up to 4 seconds long, audios from urban environments with labels such as dog barking or jackhammer.

Milestones:

1. (also safe plan B) Reproduce the CNN architecture proposed in [1], with each audioclip processed into several 60×41 pixel spectrograms. Try to interpret "the abstract features" learned by the model. Choose a randomly selected subset of the misclassified observations and try to interpret why they are hard to classify.

2. Same architecture and same data as in Milestone 1, but now train easier observations first and more difficult observations afterwards (see *curriculum learning* [3]). See if the performance improves.

3. Implement an architecture combined of CNN and RNN (maybe realizing some of the ideas in [4]).

4. Experiment with mixed data: (i) Artificially overlap two audios of classes a and b and make it one observation. The network should give a softmax output where the highest values are in a and b. (ii) Concatenate audios, e.g. dog – jackhammer – silence – jackhammer. Use CTC[5, 6] to automatically segment the new audio and give a label for each segment.

References

[1] K. J. Piczak: "ENVIRONMENTAL SOUND CLASSIFICATION WITH CONVOLUTIONAL NEURAL NETWORKS", in *2015 IEEE INTERNATIONAL WORKSHOP ON MACHINE LEARNING FOR SIGNAL PROCESSING*, Sept. 17–20, 2015, Boston, USA

[2] J. Salamon, C. Jacoby, and J. P. Bello, "A dataset and taxonomy for urban sound research", in *Proceedings of the ACM International Conference on Multimedia*. ACM, 2014, pp. 1041–1044.

[3] Y. Bengio, J. Louradour, R. Collobert, J. Weston: "Curriculum Learning"

[4] Baidu Research – Silicon Valley AI Lab: "Deep Speech 2: End-to-End Speech Recognition in English and Mandarin"

[5] A. Graves, S. Fernández, F. Gomez, and J. Schmidhuber: "Connectionist temporal classification: Labelling unsegmented sequence data with recurrent neural networks." In *ICML*, pages 369–376. ACM, 2006.

[6] TensorFlow implementation of [5]: `https://www.tensorflow.org/versions/r0.12/api_docs/python/nn/connectionist_temporal_classification__ctc_`