Overview of Independent Component Analysis

Brian Nguyen, Dr. Edward Kim

Drexel University, College of Computing & Informatics, Dept. of Computer Science

Introduction

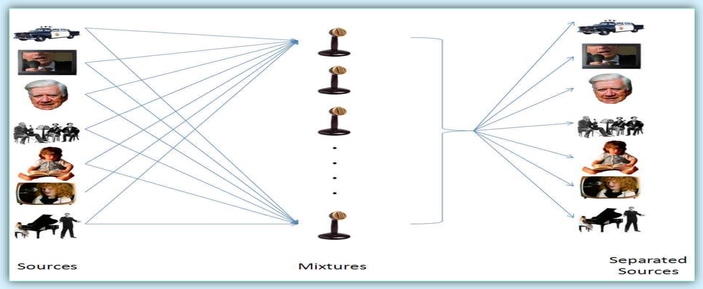
Independent component Analysis (ICA) is a computational method used to decompose mixed signals into their original components. ICA is significant because it operates despite having no information about the original signals or mixing process. Several of its applications include artifact removal in brain wave activity, image denoising, and audio separation. ICA is often mentioned in reference to the cocktail party problem (see below).

Methods

Identify and analyze the ICA algorithm, both in written text and in Python code

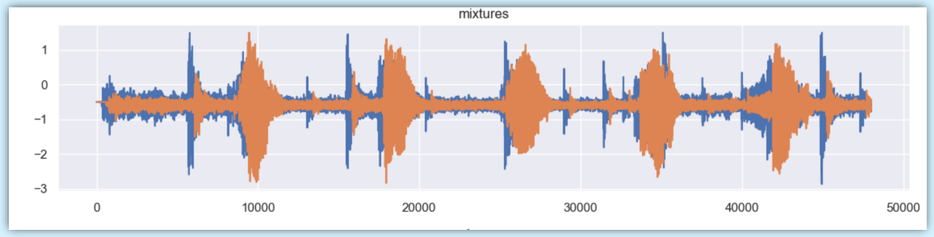
Write code that accept pairs of mixed audio signals from a peer-generated WAV file database

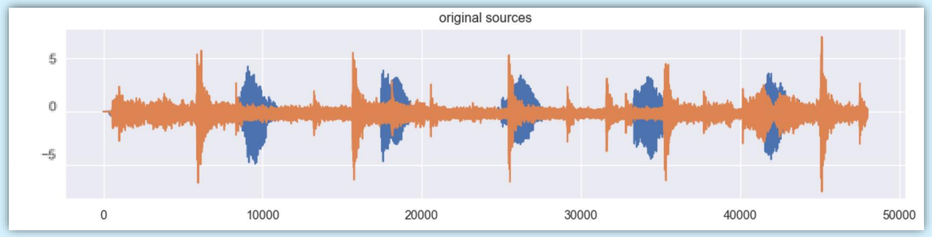
Generate graphs and output files predicting the original sounds used to synthesize each mixed signal

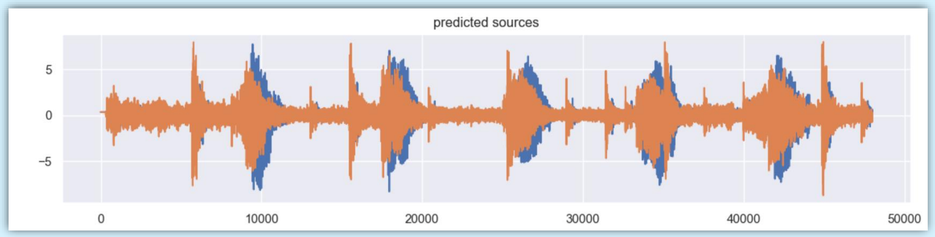


The cocktail party problem concerns the idea of separating the many audio sources one might hear at a cocktail party. While humans are comparatively good at this, the real challenge lies in getting a computer to make these distinctions.

Data/Results







The following are waveforms generated from one of the datasets my team created. Normally, we would **not** have the original sources to observe, but they were included in this example for comparison.

Using information only from the mixed signals (top), the sources that ICA predicted (bottom) were generally accurate. While the prediction signals seem to have been influenced by noise from the dataset, the overall structure and shape of the original sources were recovered. For auditory purposes, however, the program was quite successful, as it was able to distinguish the original sounds of a human talking and a bird chirping.

Conclusion

After applying ICA to various datasets, one notable flaw was its inability to consistently produce accurate prediction signals. With that being said, refinements are constantly being made to the ICA algorithm, which will hopefully reduce experimental incongruencies between true and predicted sources for future use.

Future Work

Manipulate code to achieve greater success with larger, more complex audio files

Optimize the whitening process to mitigate potential correlations between initial signals

Explore how ICA can be used given a single mixed signal as opposed to multiple

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References

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