Machine Intelligence 2 - Exercise 6
Principle component analysis and whitening

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5.2 Random number generation

The inverse of the cumulative distribution function of a Laplace distribution is given by:

$$F^{-1}(y) = \text{sgn}(1/2 - y) \cdot b \cdot \log(1 - 2 \cdot |y - 1/2|) + \mu$$

Applying those on a uniformly distributed variable gives a Laplace distributed variable. The probability density of the 500 uniform samples can be seen in Fig. 1.
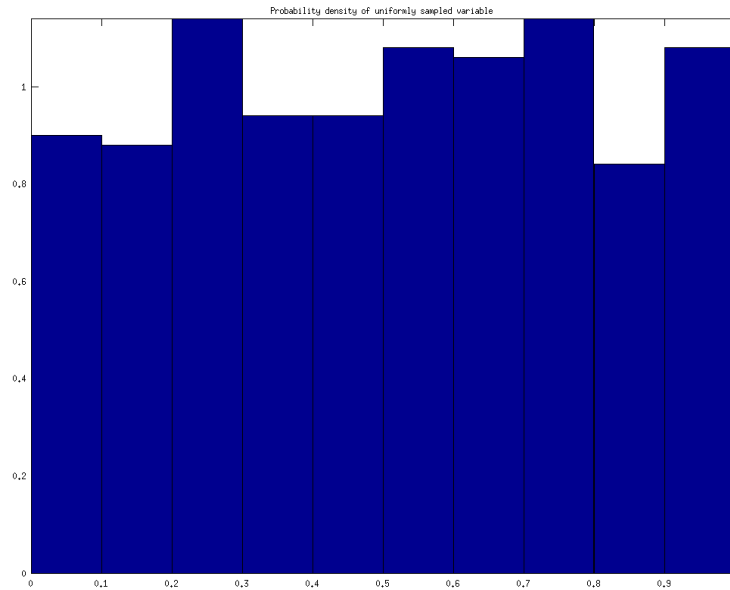

Figure 1: PDF of 500 samples
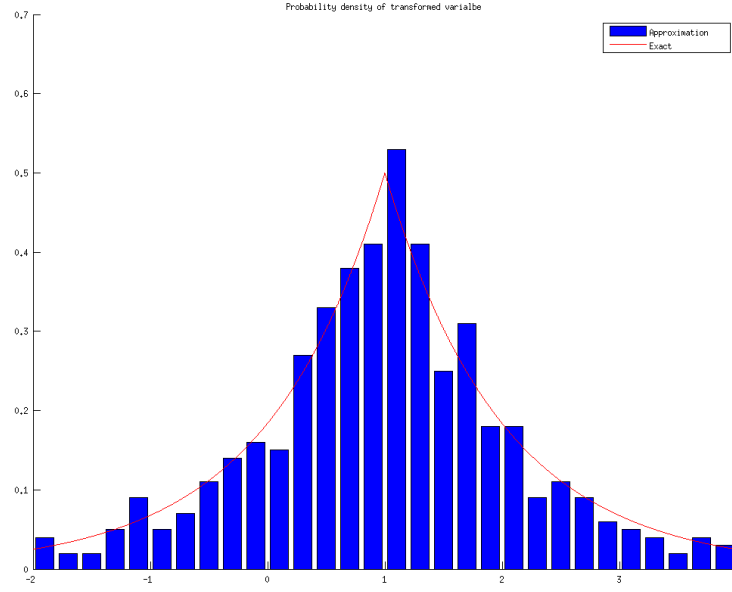
The transformed result is shown in Fig. 2.

Figure 2: PDF of transformed samples and exact Laplace distribution.

5.3 ICA

We used the constant learning rate $\eta = 0.0075$ for the online natural gradient learning of the unmixing matrix.

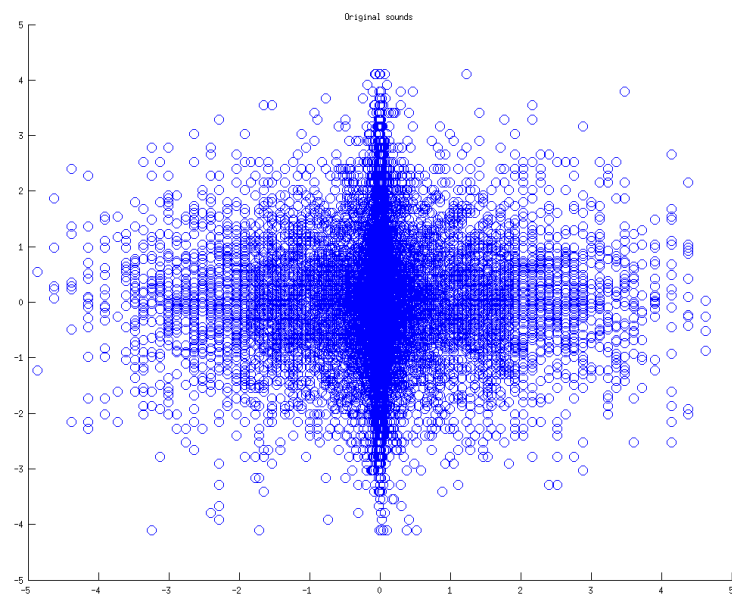The scatter plot of the original data is given in Fig. 3.

Figure 3: Scatter plot of original sound

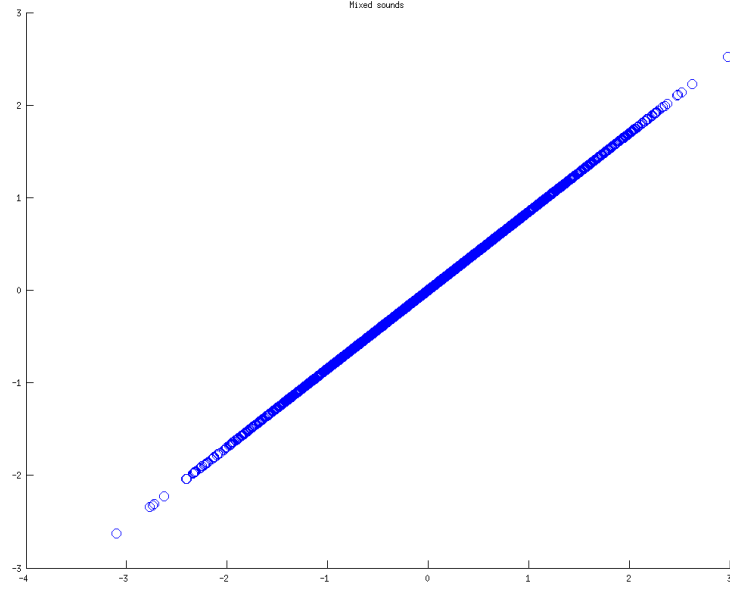After the mixing the data looked like in Fig. 4.

Figure 4: Scatter plot of mixed sound

The natural gradient learning could approximate the unmixing matrix quite well and the results are shown in Table 1.

$$
\begin{aligned}
A^{-1} &= 10^3 \cdot \left[\begin{array}{cc} -1.5178 & 1.7922 \\ 0.6322 & -0.7444 \end{array} \right] \\
W &= 10^3 \cdot \left[\begin{array}{cc} 1.0756 & -1.2661 \\ -2.7963 & 3.3018 \end{array} \right]
\end{aligned}
$$

Table 1: Original and approximated unmixing matrix

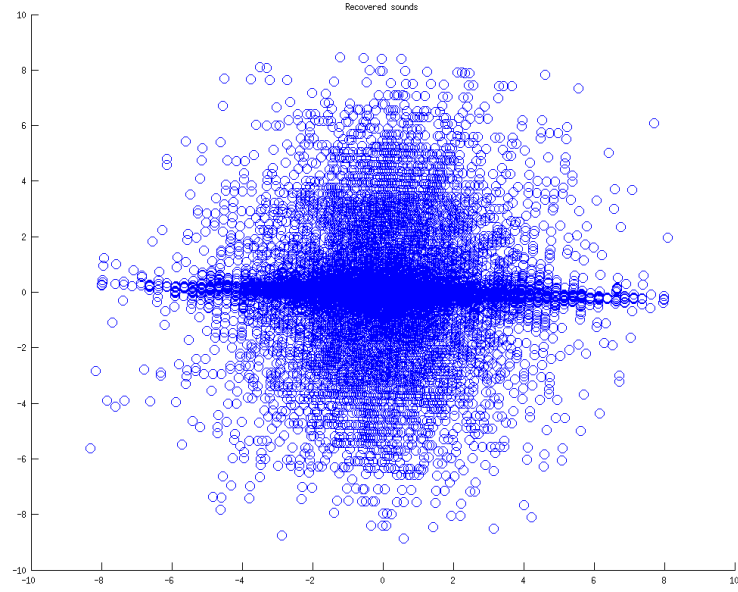The scatter plot of the recovered data is given in Fig. 5

Figure 5: Scatter plot of recovered sound

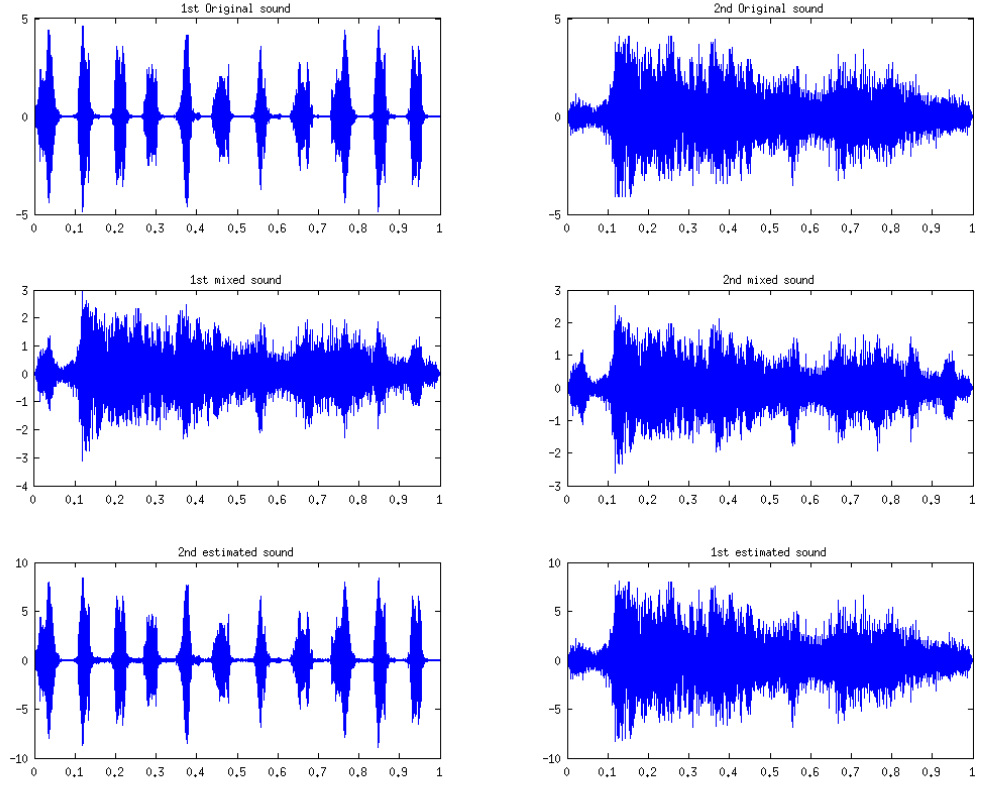The signals plotted over the time can be found in Fig. 6.

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Figure 6: Plot of original, mixed and recovered sounds

As one would expect, the plot of the permutated mixed signals looks like white noise and is shown in Fig. 7 and Fig. 8.
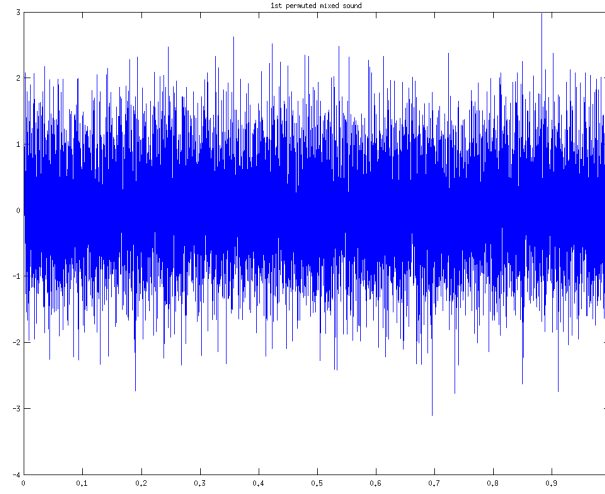
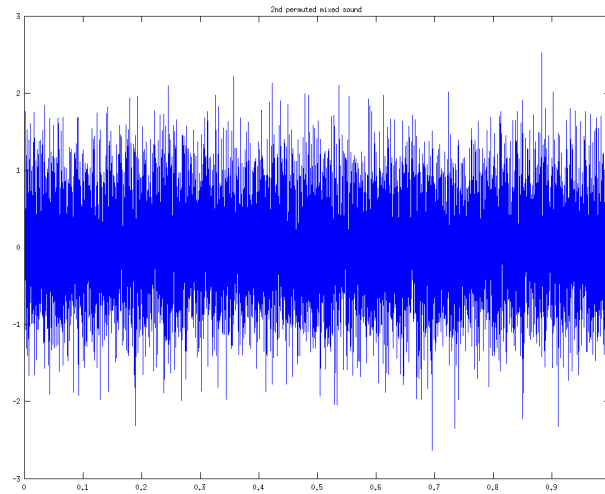Figure 7: Plot of 1st mixed and permutated data

Figure 8: Plot of 2nd mixed and permutated data

Finally, the correlation coefficients scaled to the range $[-1, 1]$ are shown in Fig. 9.
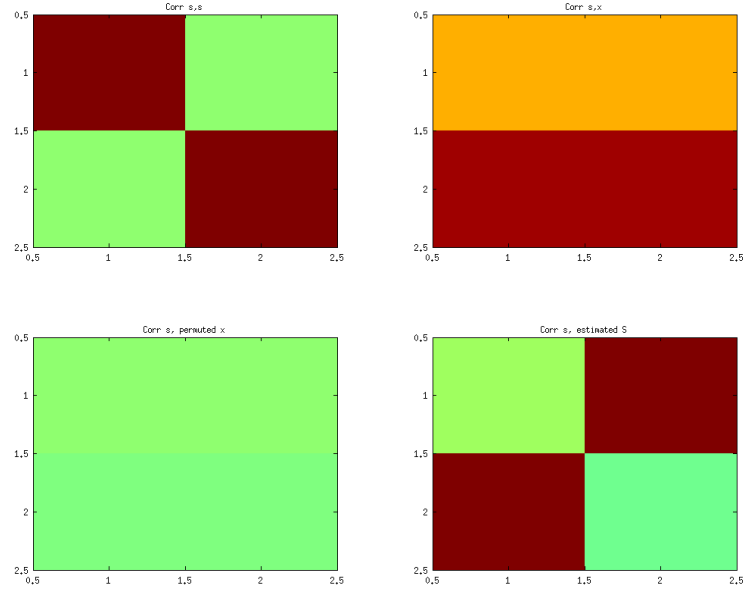
Figure 9: Top left: Correlation of original data and original data. Top right: Correlation of original data and mixed data. Bottom left: Correlation of original data and mixed and permutated data. Bottom right: Correlation of original data and recovered data.