Homework 2: Independent Component Analysis

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1 Independent Component Analysis

In this report, I applied Independent Component Analysis on Blind Source Separation problem.

2 Experiment

2.1 Experiments on Small Set

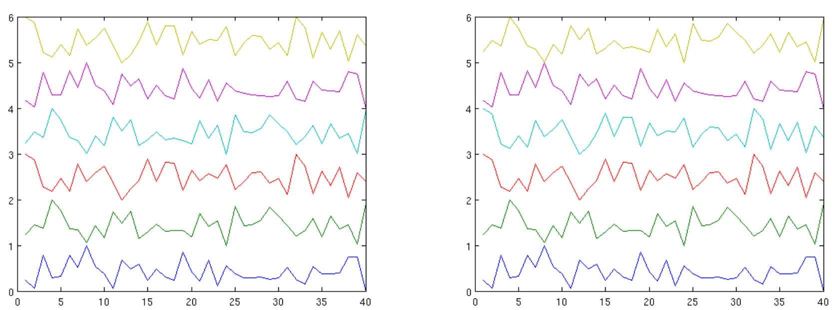

Figure 1: The bottom 3 lines are original signals from `icaTest.mat`. The top 3 lines are reconstructed signals with $\eta = 0.01$ and 1000000 iterations. Two independent experiments are shown.

	Recon. 1	Recon. 2	Recon. 3
Source 1	-0.4900	**0.9905**	-0.4248
Source 2	**0.9918**	-0.3957	-0.5454
Source 3	-0.4829	-0.5073	**0.9924**

Table 1: Linear correlation between source and reconstructed signals, for the left figure in Figure 1. The maximum correlation is highlighted.

	Recon. 1	Recon. 2	Recon. 3
Source 1	-0.4248	**0.9905**	-0.4900
Source 2	-0.5454	-0.3957	**0.9918**
Source 3	**0.9924**	-0.5073	-0.4829

Table 2: Linear correlation between source and reconstructed signals, for the right figure in Figure 1. The maximum correlation is highlighted.

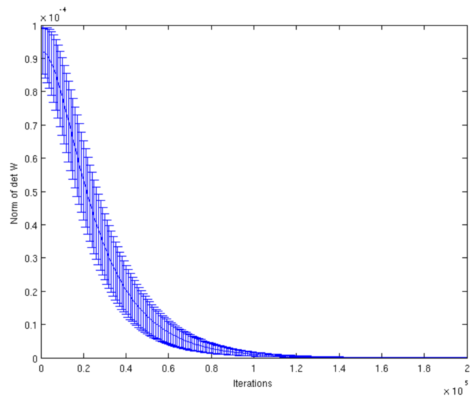

Figure 2: ΔW over number of iterations. Average of 5 runs. The length of vertical bars is σ assmuing Gaussian distribution of data points at each iteration.

The results are scaled into $[0, 1]$ interval. This experiment is repeated twice. The results are in shown in Figure 1. The result can be permutation of the original sources. Scaling is also possible (as the results are scaled into $[0, 1]$, the signal could be flipped in this case). The correlation between source and reconstructed signals are shown in Table 1 and 2. They are highly correlated if the correlavance is close to 1 or -1. We can tell in the left figure, the mapping is 0-4, 1-5, 2-3. While in the right one, the mapping is 0-5, 1-3, 2-4. This result can be verified visually. We can also observe that the algorithm overall generate highly close signal, with has more than 0.99 correlavance with its source signal.

I also examine how progress is made in each iteration in the learning process. As the algorithm uses gradient descent, the update on W each step, which is ΔW, is useful. For the convenience of visualization, I need the magtitude of this matrix. I use the largest singular value here, which can be got using `norm` function when applied to a matrix in Matlab.

The result is shown in Figure 2. Not surprisingly, steps become smaller after more iterations. The algorithm converges after 2×10^5 iterations.

2.2 Experiments on Sound

Result on sound are shown in Figure 3. The correlation result is shown in Table 3. We can observe that the correlation is smaller compared to that of

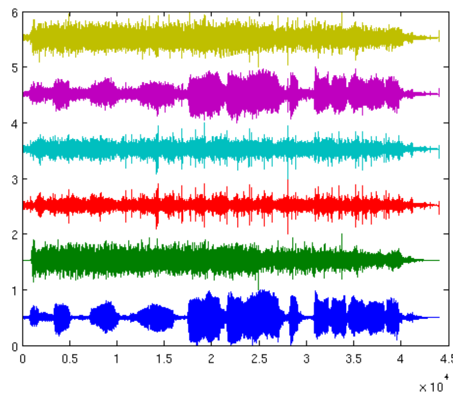

Figure 3

	Recon. 1	Recon. 2	Recon. 3
Sound 1	0.1608	**0.9306**	-0.3288
Sound 2	0.5456	0.1885	**0.8166**
Sound 3	**0.8221**	-0.3134	-0.4754

Table 3: Linear correlation between source and reconstructed signals, for the right figure in Figure 3.

experiment on small set.

3 Discussion

4 Conclusion