Homework 6
(due Monday, December 5, 2005)

November 23, 2005

1. **Testing the fastICA algorithm (and its variants)**

a) Run the fastICA (fastICA `http://www.cis.hut.fi/projects/ica/fastica/`) algorithm on the two mixed data (macgtr1 `http://www.cise.ufl.edu/~anand/fa05/macgtr1.wav` and macgtr2 `http://www.cise.ufl.edu/~anand/fa05/macgtr2.wav`) to get two estimated sources $\hat{s}_1$ and $\hat{s}_2$. Document the parameter settings of the ICA algorithm used and also report the mixing matrix W. Make sure to re-record the two estimated sources as .wav files and report the qualitative (experiential-subjective and not quantitative) performance of the algorithm that you used. When re-recording the sources, make sure to correct for clipping by rescaling the signals to a $[-1, 1]$ range. Compare your results with PCA. [If you don't know much about audio files, read the help on wavread and wavwrite in Matlab.]

b) Beginning from a stereo source of your own choosing, attempt to recover the mixing matrix using an ICA algorithm when using the left and the right channel as sources. Document the parameter settings of the ICA algorithm used and also report the mixing matrix W. Make sure to re-record the two estimated sources as .wav files and report the qualitative (experiential-subjective and not quantitative) performance of the algorithm that you used. When re-recording the sources, make sure to correct for clipping by rescaling the signals to a $[-1, 1]$ range. Compare your results with PCA.

2. Derive the first step of the LLE process, namely, the transition from a vector space representation of the data ($\mathbf{x}$) to a relational representation (W) by explaining all the steps involved in minimizing the objective function

$$E(W) = \sum_{i=1}^{N} \| \mathbf{x}_i - \sum_{j=1}^{N_i} W_{ij} \mathbf{x}_j \|^2 \tag{1}$$

subject to $\sum_{j=1}^{N_i} W_{ij} = 1$. The number of nearest neighbors $N_i = K$ is the same for all $\mathbf{x}_i$.

3. Derive the second step of the LLE process, namely, the transition from a relational representation of the data (W) to a lower dimensional vector space represention ($\mathbf{y}$) by explaining all the steps

involved in minimizing the objective function

$$E(\mathbf{y}) = \sum_{i=1}^{N} \| \mathbf{y}_i - \sum_{j=1}^{N_i} W_{ij}\mathbf{y}_j \|^2 \tag{2}$$

subject to $\sum_{i=1}^{N} \mathbf{y}_i = 0$ and $\sum_{i=1}^{N} \mathbf{y}_i \mathbf{y}_i^T = I$. The number of nearest neighbors $N_i = K$ is the same for all $\mathbf{x}_i$. Note that nearest neighbors are defined w.r.t. $\mathbf{x}$ and not $\mathbf{y}$.