Independent Component Analysis

writeLaTeX

January 18, 2017

1 FastICA

Algorithm 1 FastICA: Using computationally efficient and light ICA method.

```
Input: $C \in \mathbb{R}$ Number of components
Input: $X \in \mathbb{R}^{N \times M}$, $N$ = the number of input signals (in our case, number of electrodes), $M$ = number of measurements/samples (in our case, time). Assumed centered (zero mean) and whitened (uncorrelated, variance = 1)
Output: $W \in \mathbb{R}^{N \times C}$ Unmixing matrix
Output: $S \in \mathbb{R}^{C \times M}$ Independent signals
procedure FASTICA($C, X$)
    for $p$ in $(1, C)$ do    ▷ for each component we're supposed to find
        $w_p$ = vector($N$)    ▷ initialize $w_p$ as a random n-length vector
        while $w_p$ hasn't converged do    ▷ while $w_p$ is still pointing in the same direction
            $w_p \in \mathbb{R}^N$    ▷ initialize $w_p$ as a random n-length vector
            $w_p = \frac{1}{M} X g(w_p^T X)^T - \frac{1}{M} g'(w_p^T X)\mathbf{1} w_p$    ▷ Run estimation of $E\left\{Xg(w_p^T X)^T\right\} - E\left\{Xg'(w_p^T X)\right\} w_p$. Also
            $w_p = w_p - \sum_{j=1}^{p-1} w_p^T w_j w_j$    ▷ using Grahm-Schmidt method, decorrelate $w_p$ from the other weight vectors found
            $w_p = \frac{w_p}{\|w_p\|}$    ▷ normalize weight vector
```

For the equations g and g' in the algorithm: $f(u)$ is a nonquadratic nonlinearity function, $g(u)$ is its first derivative and $g'(u)$ is its second derivative.
For general cases:

$$f(u) = log(cosh(u)), g(u) = tanh(u), g'(u) = 1 - tanh^2(u)$$

For robust scenarios:

$$f(u) = -e^{-\frac{u^2}{2}}, g(u) = ue^{-\frac{u^2}{2}}, g'(u) = (1 - u^2)e^{-\frac{u^2}{2}}$$