Maximum Entropy Guide for BSS

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Abstract

This paper proposes a novel method for Blindly Separating unobservable independent component (IC) Signals (BSS) based on the use of a maximum entropy guide (MEG). The paper also includes a formal proof on the convergence of the proposed algorithm using the guiding operator, a new concept in the genetic algorithm (GA) scenario. The Guiding GA (GGA) presented in this work, is able to extract IC with faster rate than the previous ICA algorithms, based on maximum entropy contrast functions, as input space dimension increases. It shows significant accuracy and robustness than the previous approaches in any case [1].

The statistical independence of a set of random variables can be described in terms of their joint and individual probability distribution. This is equivalent to the maximization (or minimization) of the mutual entropy (information) of the later variables. The proposed algorithm is based on the estimation of mutual information, value which cancels out when the signals involved are independent. Mutual information I between the elements of a multidimensional variable y is defined as:

$$\Psi \equiv I(y_1,\ y_2, ..., y_n) = \sum_{i=1}^{n} H(y_i)\ - H(y_1,\ y_2, ..., y_n)\ .$$

where *H(x)* is the entropy measure of the random variable or variable set x. Using this contrast function we derive MEG defining its associated transition probability function by column stochastic matrices $\mathbf{M}_{\mathbf{G}}^{\mathbf{n}}$, $n \in \mathcal{N}$ acting on populations as: "the value of the probability to go from individual p_i to q_i depends on contrast functions as: $P(\xi_{n+1} = p_i|\xi_n = q_i) = \frac{1}{\aleph(T_n)} \exp\left(-\frac{\Psi(p_i)+\Psi(q_i)}{T_n}\right)$; $p_i, q_i \in \mathbf{C}$ where $\aleph(T_n)$ is the normalization constant depending on iteration n; temperature follows a variation decreasing schedule, that is $T_{n+1} < T_n$ converging to zero, and $\Psi(q_i)$ is the value of the selected contrast function over the individual (an encoded separation matrix)". We prove weak and strong ergodicity and the convergence to the optimum under very little restrictions on T_n and Ψ.

Key Words: Maximum Entropy, Blind Source Separation, Markov Chains, Genetic Algorithms References:

[1] J.M. Górriz et al.: Genetic Algorithms for solving SVM-ICA. MAXENT 2004. AIP Conference Proceedings – November 16, 2004 – Volume 735, Issue 1, pp. 371-378