

Acceleration and re-start of the alternating least squares algorithm for non-linear principal components analysis

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In principal components analysis of mixture of quantitative and qualitative data (non-linear PCA), the alternating least squares (ALS) algorithm can be used as the quantification method for obtaining optimal scaling data and applying ordinary PCA. However, the drawback of the ALS algorithm is that its convergence is linear and very slow in the application of non-linear PCA to very large data set and variable selection problem. In order to circumvent the problem of slow convergence of the ALS algorithm, we provide an acceleration method using the vector epsilon (ve) algorithm. The ve algorithm transforms the vector sequence of the ALS iterations into another vector sequence that converges faster than the original sequence of ALS iterations. We refer to the ve acceleration for the ALS algorithm to the ve-ALS algorithm. The ve-ALS algorithm for non-linear PCA consists of two steps: The first step is the ALS computation for obtaining the ALS sequence of optimal scaling data and the ve acceleration in the second step generates the sequence using the ALS sequence in the first step. The ve-ALS algorithm uses the ALS sequence to generate the ve accelerated sequence for the ALS sequence but does not change the original ALS sequence. We find that the ve accelerated sequence enters rapidly in the neighborhood of a stationary point of the ALS sequence. We try to re-start the ALS iterations using the ve accelerated sequence and then generate a new ALS sequence that increases its speed of convergence. We determine the frequency of the re-starting and perform it by checking the convergence behavior of the ve accelerated sequence. The re-starting rule is a very simple and its computational cost is almost negligible. The re-starting procedure embedding in the ve acceleration finds an initial value for re-starting the ALS computation such that a newly generated ALS sequence from the value moves more quickly into a neighborhood of the stationary point. Therefore the use of the re-starting procedure makes the ve-ALS algorithm converge faster.

Key Words: acceleration of convergence, vector epsilon algorithm, re-starting procedure