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Amazon AI: Tensor and Higher-Order Generalizations of the GSVD with Applications to Personalized Cancer Medicine

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The number of high-dimensional datasets recording multiple aspects of interrelated phenomena is increasing in many areas, from medicine to finance. This drives the need for mathematical frameworks that can simultaneously identify the similar and dissimilar among multiple matrices and tensors, and thus create a single coherent model from the multiple datasets. The generalized singular value decomposition (GSVD) was formulated as such a comparative spectral decomposition of two column-matched but row-independent matrices. I will, first, define a higher-order GSVD (HO GSVD) and a tensor GSVD and prove that they extend almost all of the mathematical properties of the GSVD to multiple matrices and two tensors. Second, I will describe the development of a tensor HO GSVD for multiple tensors. Third, I will describe the use of these decompositions in the comparisons of cancer and normal genomes, where they uncover patterns that predict survival and response to treatment. The data had been publicly available for years, but the patterns remained unknown until the data were modeled by using the decompositions, illustrating their ability to find what other methods miss.

Preferred contribution length

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