ADAPTIVE HYPER-BOX GRANULATION FOR FEATURE SELECTION WITH JUSTIFIABLE GRANULARITY

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Abstract

The rapid growth of high-dimensional datasets in domains such as healthcare, finance, cybersecurity, bioinformatics, and Internet of Things (IoT) systems has intensified the need for efficient and interpretable feature selection techniques. Traditional feature selection methods—including filter, wrapper, and embedded approaches—primarily rely on statistical relevance or classifier-based optimization, often neglecting the geometric structure and spatial distribution of data in feature space. This limitation motivates the development of structurally aware dimensionality reduction techniques that preserve data representation while improving predictive performance.proposes an innovative framework titled "Adaptive Hyper-Box Granulation With Justifiable Granularity for Feature Selection." The proposed method integrates granular computing principles into the feature selection process by modeling data using adaptive hyper-rectangular regions (hyper-boxes) constructed class-wise in feature space. Each hyper-box is defined by minimum and maximum boundary vectors, representing a geometric granule that captures structural information about data distribution.A key contribution of this work is the formulation of a Justifiable Granularity Score, designed to evaluate feature subsets based on three critical criteria: (1) coverage density, ensuring adequate representation of data points; (2) inter-class overlap ratio, minimizing ambiguity between classes; and (3) structural complexity, controlling the number and volume of hyper-boxes to avoid over-fragmentation or excessive coarseness. The granularity score provides a balanced metric that reflects optimal partitioning of the feature space.