Pareto Inspired Multi-objective Rule Fitness for Adaptive Rule-based Machine Learning

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ABSTRACT

Learning classifier systems (LCSs) are rule-based evolutionary algorithms uniquely suited to classification and data mining in complex, multi-factorial, and heterogeneous problems. LCS rule fitness is commonly based on accuracy, but this metric alone is not ideal for assessing global rule 'value' in noisy problem domains, and thus impedes effective knowledge extraction. Multi-objective fitness functions are promising but rely on knowledge of how to weigh objective importance. Prior knowledge would be unavailable in most real-world problems. The Pareto-front concept offers a strategy for multi-objective machine learning that is agnostic to objective importance. We propose a Pareto-inspired multi-objective rule fitness (PIMORF) for LCS, and combine it with a complimentary rule-compaction approach (SRC). We implemented these strategies in ExSTraCS, a successful supervised LCS and evaluated performance over an array of complex simulated noisy and clean problems (i.e. genetic and multiplexer) that each concurrently model pure interaction effects and heterogeneity. While evaluation over multiple performance metrics yielded mixed results, this work represents an important first step towards efficiently learning complex problem spaces without the advantage of prior problem knowledge. Overall the results suggest that PIMORF paired with SRC improved rule set interpretability, particularly with regard to heterogeneous patterns.

Keywords

data mining; classifier systems; fitness evaluation; multi-objective optimization; machine learning

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