

# Rule-Based Evolutionary Online Learning Systems: A Principled Approach to LCS Analysis and Design (Studies in Fuzziness and Soft Computing)

Martin V. Butz

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Rule-basedevolutionaryonlinelearningsystems, oftenreferredtoas Michig-style learning classi?er systems (LCSs), were proposed nearly thirty years ago (Holland, 1976; Holland, 1977) originally calling them cognitive systems. LCSs combine the strength of reinforcement learning with the generalition capabilities of genetic algorithms promising a ?exible, online generaling, solely reinforcement dependent learning system. However, despite several initial successful applications of LCSs and their interesting relations with a-mal learning and cognition, understanding of the systems remained somewhat obscured. Questions concerning learning complexity or convergence remained unanswered. Performance in di?erent problem types, problem structures, c-ceptspaces, and hypothesis spaces stayed nearly unpredictable. This book has the following three major objectives: (1) to establish a facetwise theory -

proachforLCSsthatpromotessystemanalysis,understanding,anddesign;(2) to analyze, evaluate, and enhance the XCS classi?er system (Wilson, 1995) by the means of the facetwise approach establishing a fundamental XCS learning theory; (3) to identify both the major advantages of an LCS-based learning approach as well as the most promising potential application areas. Achieving these three objectives leads to a rigorous understanding of LCS functioning that enables the successful application of LCSs to diverse problem types and problem domains. The quantitative analysis of XCS shows that the inter- tive, evolutionary-based online learning mechanism works machine learning competitively yielding a low-order polynomial learning complexity. Moreover, the facetwise analysis approach facilitates the successful design of more - vanced LCSs including Holland's originally envisioned cognitive systems. Martin V.

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