# Market Complexity State Vector: A Hybrid Regime-Aware Symbolic Framework for Probabilistic S&P 500 Forecasting

Luis Alberto Sanchez Zacateco. Universidad Anahuac Queretaro
alberto.sanchezz@anahuac.mx

## Abstract

Financial markets are complex, dynamic, and nonstationary systems whose behavior is shaped by recurrent regime shifts, limiting the predictive performance of conventional forecasting models based on stable underlying dynamics. This study proposes the Market Complexity State Vector (MCSV) as a multidimensional representation of the market's evolving complexity state, constructed from the Hurst exponent, Permutation Entropy, and Fractal Dimension. The MCSV is used as the input to a Hidden Markov Model (HMM) to infer posterior probabilities of latent market regimes. These regime probabilities, together with the underlying complexity-state information, condition an adaptive symbolic Genetic Programming framework designed to estimate regime-dependent predictive distributions for the S&P 500 Index. Rather than generating a single point forecast, the proposed framework estimates the probability that the future index level will fall within alternative price ranges over a specified forecasting horizon. The resulting regime-conditioned distributions are aggregated according to the posterior regime probabilities produced by the HMM, thereby explicitly incorporating uncertainty regarding the prevailing market state. The inferred regimes are additionally characterized through a Wolfram-inspired complexity taxonomy as an interpretive framework for distinguishing ordered, structured, disordered, and complex market dynamics, without imposing such classes on the statistical regime-identification process. The empirical analysis is conducted using daily S&P 500 data and evaluates whether complexity-aware, regime-conditioned symbolic models provide more reliable probabilistic forecasts than comparable models that do not account for latent market regimes.