

Application of Deep Reinforcement Learning in Asset Liability Management

Abstract

Asset Liability Management (ALM) is an essential risk management technique in Quantitative Finance and Actuarial Science. It aims to maximize a risk-taker's ability to fulfil future liabilities. ALM is especially critical in environments of elevated interest rate changes, as has been experienced globally between 2021 and 2023. Traditional ALM implementation is still heavily dependent on the judgement of professionals such as Quants, Actuaries or Investment Managers. This over-reliance on human input critically limits ALM performance due to restricted automation, human irrationality and restricted scope for multi-objective optimization. This paper addressed these limitations by applying Deep Reinforcement Learning (DRL), which optimizes through trial, and error and continuous feedback from the environment. We defined the Reinforcement Learning (RL) components for the ALM application: the RL decision-making Agent, Environment, Actions, States and Reward Functions. The results demonstrated that DRL ALM can achieve duration-matching outcomes within 1% of the theoretical ALM at a 95% confidence level. Furthermore, compared to a benchmark weekly rebalancing traditional ALM regime, DRL ALM achieved superior outcomes of net portfolios which are, on average, 3 times less sensitive to interest rate changes. DRL also allows for increased automation, flexibility, and multi-objective optimization in ALM, reducing the negative impact of human limitations and improving risk management outcomes. The findings and principles presented in this study apply to various institutional risk-takers, including insurers, banks, pension funds, and asset managers. Overall, DRL ALM provides a promising Artificial Intelligence (AI) avenue for improving risk management outcomes compared to the traditional approaches.