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Learning to Anticipate Flexible Trade-off Choices

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Resumo

The presence of uncertainty in future outcomes can lead to indecision in choice processes, especially when eliciting the relative importances of multiple decision criteria and of long-term vs. near-term performance. Some decisions, however, must be taken under incomplete information, what may result in precipitated actions with unforeseen consequences. When a solution must be selected under multiple conflicting views for operating in time-varying and noisy environments, implementing flexible provisional alternatives can be critical to circumvent the lack of complete information by keeping future options open. Anticipatory engineering can be then regarded as the strategy of designing flexible solutions that enable decision makers to respond robustly to unpredictable scenarios. This strategy can thus mitigate the risks of strong unintended commitments to uncertain alternatives, while increasing adaptability to future changes. In this thesis, the roles of anticipation and of flexibility on automating sequential multiple criteria decision-making processes under uncertainty are investigated. The dilemma of assigning relative importances to decision criteria and to immediate rewards under incomplete information is then handled by autonomously anticipating flexible decisions predicted to maximally preserve diversity of future choices. An online anticipatory learning methodology (see Figure 1) is then proposed for improving the range and quality of future trade-off solution sets. This goal is achieved by predicting maximal expected hypervolume sets, for which the anticipation capabilities of multi-objective metaheuristics are augmented with Bayesian tracking in both the objective and search spaces. The methodology has been applied for obtaining investment decisions that are shown to significantly improve the future hypervolume of trade-off financial portfolios for out-of-sample stock data, when

compared to a myopic strategy. Moreover, implementing flexible portfolio rebalancing decisions was confirmed as a significantly better strategy than to randomly choosing an investment decision from the evolved stochastic efficient frontier in all tested artificial and real-world markets. Finally, the results suggest that anticipating flexible choices has lead to portfolio compositions that are significantly correlated with the observed improvements in out-of-sample future expected hypervolume.

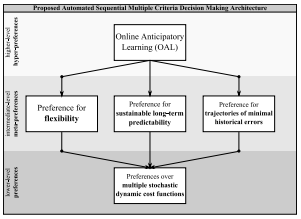

Figura 1: Diagram with the layered architecture proposed in this thesis.