Automatic portfolio management using a Linear Quadratic Gaussian control law

1. Background

Managing a portfolio of financial assets is a challenge with many issues and few good solutions that many investors around the world must solve. This management is often affected by numerous cognitive, behavioural and emotional biases that can cause the initially defined final objective to be imperfectly achieved. By introducing an automated decision system for the purchase and sale of these financial assets, we are proposing a renewed portfolio management framework which, whilst taking into account the latest performance observed on the financial markets, optimises the investment and divestment decisions according to the known past performance, the estimated future trading costs, the average level of volatility of the portfolio over the entire remaining investment period and, finally, the expected final performance.
This problem has been solved by implementing a multivariable Linear Quadratic Gaussian control law. This approach appears to be more powerful than a Model Predictive Control as amply described by S. Boyd[1] or W. Syaifudin[2].
First developments have been conducted in Excel and yielded promising results. They may be the base of a future publication in an academic journal, in cooperation with the Lund Department of Automatic Control. Based on these results, we have decided to propose a related master thesis subject, which would be taken up by two students in order to investigate the full potential of this approach. Simultaneously, we shall be having further contacts with VC investors and different French portfolios managers to validate the commercial interest of this endeavour. This project is part of the worldwide fintech stream devoted to robot advising.

2. Objective

This master thesis work is about investigating how an adaptive LQG control law should be designed and evaluated. To do this, we suggest an approach where the work includes:
• Implementing the current control law in python within an Anaconda framework, including all the financial and graphical toolboxes available,
• Investigating an automatic feed of the stocks database based on the public information published by the stock markets and on Natural Language Programming tools,
• Investigating the interest of an adaptive control law in order to take into account the latest (but not too volatile) performances of the managed stocks,
• Evaluating, based on back testing, the performances (including robustness) of the robot advisor,
• Validating the usefulness of the approach with some portfolio managers who would be interested in using such a robot advisor for some of their most wealthy clients / investors,
• Producing a case that may be used for future teaching by the LTH. Indeed, the students will work with a multi variable, asynchronous state control law with real life noisy data. The state is made of

[1] : Boyd Stephen, Mueller Mark, O'Donoghue Brendan, Wang Yang (2014). "Performance Bounds and Suboptimal Policies for Multi-Period Investment", Foundations and Trends in Optimization", Vol. 1, N°. 1 (2014) pp 1-72.

[2] : Syaifudin H. Wawan, Putri R.M. Endah, 2019. "The application of model predictive control on stock portfolio optimization without loan", AIP Conference Proceedings 2192, https://doi.org/10.1063/1.5139166

several dozens of stocks and the signal to noise ratio is in the order of 1 to 30 (average weekly return of 0.3 % while the daily change may be up to 6%)!

The project is due to start at the earliest in January 2022.

3. Qualifications

If you are interested in applying the knowledge you acquired in automatic control at the LTH and have a genuine curiosity about the financial markets, this thesis is for you! The different specifics of portfolio management will be acquired during the project.
We are searching for two students that are focused and creative, as well as knowledgeable in control theory, signal processing, and programming. Preferably the students should have some experience in python, Scikit Learn, matplotlib or Seaborn. An interest for a career in quantitative finance would be a plus, although by no means a prerequisite.
The project will be jointly supervised by a team based in Paris and the Lund Department of Automatic Control. For more information please contact, Stéphane Sallé (int+33688608112, stephane.salle65@gmail.com) or Anders Rantzer from the Department of Automatic Control. Stéphane Sallé has taught Management Control at several French business schools and continues to do so in the Executive MBA programs of Paris Dauphine University. He obtained a PhD in automatic control from the University of Grenoble on supervised control and robust Kalman filtering and, as part of his research, spent a year and a half in Lund in the early 90s.

4. Keywords

LQG, Portfolio Management, Programming, Signal Processing, Applied Finance,

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Stéphane is working on an organisation to promote and further implement the concepts to be tested within this Master Thesis project: API AM - Advanced Programs for an Intelligent Asset Management.

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