

Internship at Sorbonne Université

Laboratoire de Probabilités Statistique et Modélisation

Subject: Enhancing Hedging Robustness through Post-Control under Model Uncertainty

Lokmane ABBAS TURKI (lokmane.abbas_turki@sorbonne-universite.fr)

Keywords: Deep Hedging, Linear Quadratic Regulator, Kalman filtering

Starting period: February-April 2026

Internship duration: 6 months

Context of the work: This internship is a part of the “Capital Markets Tomorrow: Modeling and Computational Issues” chair under the aegis of the Institut Europlace de Finance, a joint initiative of Laboratoire de Probabilités, Statistique et Modélisation (LPSM), Université Paris Cité and Crédit Agricole CIB.

The proposed internship is motivated by the growing role of machine learning in quantitative finance, not only as a means of functional approximation but, more importantly, as a powerful tool for process automation. In addition to the theoretical groundwork required to master the underlying concepts, the internship will place substantial emphasis on numerical implementation and critical reflection on their practical applicability. Engagement with industry practitioners will be facilitated to gain insight into the challenges associated with scaling and deploying the developed methodologies in real-world financial contexts.

Upon successful completion of the internship, the student may be offered the opportunity to pursue a thesis, with supervision and/or funding provided, on a topic that constitutes a natural continuation of the work undertaken during the internship.

Description and key developments: Selecting an appropriate pricing model for a given financial product requires a careful analysis of the profit and loss (PnL) generated by its hedged portfolio. In an idealized framework with perfect hedging, risk-neutral pricing models are designed so that the PnL remains zero under any market scenario consistent with the model’s stochastic dynamics. However, in practice, market behavior deviates from model assumptions, these discrepancies primarily arise from two sources:

1. The divergence between the realized and model-implied variances.
2. The sensitivity of the global portfolio to second-order derivatives (the so-called gamma exposure).

While the first factor is relatively intuitive, the second plays an equally critical role in determining the adequacy and robustness of a pricing model. Recent advances such as the “Deep Hedging” approach (cf. [1]) employ neural networks to directly learn optimal hedging ratios for given products. This method offers significant flexibility in capturing complex market dynamics but also lacks robustness guarantees across different market regimes.

The goal of this internship is to build upon an existing hedging strategy, either derived from a specific analytical model or obtained via a deep hedging framework on interest rate contract, and enhance its robustness with respect to alternative models that may govern the underlying stochastic processes. The proposed approach will leverage concepts from Linear Quadratic Regulator control theory (cf. [2]) to stabilize and optimize the hedging strategy. Assuming a known state-space model, Kalman filtering techniques (cf. [3]) will be employed for state estimation, thereby improving the strategy's adaptability to real-time market conditions.

Required Qualifications: As the subject lies at the intersection of advanced mathematical methodologies such as closed-loop control theory and the use of machine learning to establish hedging strategies for derivative contracts, applications from candidates with a strong background in applied mathematics or computer science are particularly encouraged. The selected student will receive dedicated mentorship and guidance to develop any additional skills required to successfully carry out the project.

Application Process: Please send your resume and a short cover letter explaining your interest in this internship to `lokmane.abbas_turki@sorbonne-universite.fr` before December 12th, 2025.

References

- [1] Buehler, H., Gonon, L., Teichmann, J., and Wood, B. (2019). *Deep hedging*. Quantitative Finance, 19(8), 1271–1291.
- [2] Anderson, B. D., and Moore, J. B. (2007). *Optimal control: linear quadratic methods*. Dover Publications.
- [3] Simon, D. (2006). *Optimal state estimation: Kalman, H infinity, and nonlinear approaches*. John Wiley & Sons.