

Domaine : Mathématiques et applications - **Thématique(s) :** Modélisation
DIPLÔMES D'UNIVERSITÉ (DU, DIU), EMBA, CQP

FINANCIAL ENGINEERING, MODELING, SIMULATION AND DATA ANALYTICS

Dates : Voir le calendrier
Lieu : Campus Pierre et Marie Curie – Paris (Jussieu)
Tarif : 22000 €

Modalité : Distanciel Présentiel

GOALS

Executive version of the famous Parisian degree in financial mathematics. Taught by an educational team from the leading French universities : Ecole polytechnique and Sorbonne Université. Focus on acquiring, completing and updating your knowledge in Mathematical, statistical and numerical methods for Financial markets, accounting the recent developments of data science and artificial intelligence contributions.

COMPÉTENCES VISÉES

Understanding the emerging issues of Quantitative Finance in connection with the regulation and economic upheavals (XVA : high-frequency trading, blockchains, cryptocurrencies , negative rates, multivalued rate curves, etc.). Numerical methods for simulation/optimization as well as their parallel implementation (GPU). Statistical tools for calibration, high-frequency trading and automatic investment strategies. Financial Engineering for Investment and Fintech. Data Science for Finance. Quantitative Risk Management. Quantitative Portfolio Management

PUBLIC ET PREREQUISITE

- Graduates in science with various backgrounds and training in applied mathematics (including Probability and Statistics)
- Market practitioners: IT quants, front office, middle office, risks, software editor, asset manager
- Engineers in repositioning on the equity markets, rates, foreign exchange, hybrids, energy markets, commodities, precious metals, and cryptocurrencies

PROGRAMME

2 units of skills :

- > Unit of skills 1 : Financial Engineering : Fundamental tools and methods.
- > Unit of skills 2 : Financial Engineering : Advanced applications.

Unit 1 of skills

Stochastic modeling and derivatives

Course and small classes

Emmanuel Gobet, PR. Ecole Polytechnique

Aim : master the up-to-date tools for stochastic modeling used in

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✉ Sciences-

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pricing/hedging derivatives, calibrating models, managing and modeling risks.

Content :

- Financial derivatives, future and forward contracts, spot markets, no-arbitrage arguments, static hedging of vanilla options with call/puts
- Dynamics hedging portfolio, change of numeraire, PDE valuation, Black-Scholes formula and ramifications
- Local and stochastic volatility, Dupire model, Heston model, Gyongy projection
- Implied volatility, dynamics of IV, links with spot volatility, hedging and sticky rules, robustness formulas
- Asymptotics for prices and implied volatility (small maturity, small vol of vol, large strikes, wing's formula...)
- Interest rates modeling, HJM framework, Gaussian model, market models
- FX markets, cross-currency derivatives

Evaluation : written final exam + pricing/calibration project joint with "Numerical methods".

Acquired skills : In-depth understanding of stochastic models dynamics of traded assets, interest rates, etc, and their use for the pricing of derivative products and risk management.

Numerical methods : efficient Monte Carlo
Course and small classes

Gilles Pages, PR. Sorbonne Université

Aim : Provide fast efficient simulation methods for pricing and hedging derivatives on various asset classes, risk management, model validation.

Content :

- Random variate simulation: yield and complexity
- Variance réduction
- Numerical schemes for stochastic dynamics : which scheme for which problem ?
- Quasi-Monte Carlo versus Monte Carlo
- Erasing the bias: multilevel methods
- Efficient implementation on modern device (GPU)

Evaluation : written final exam + computing project joint with « Stochastic Calculus & Control ou Derivatives.

Acquired skills :

Optimize the implementation of a Monte Carlo simulation method under operational constraints.

Statistical Methods and Data Science for Finance

Course and small classes

Mathieu Rosenbaum, PR. Ecole Polytechnique

Aim : Introduction to standard statistical methods for risk management.

Content :

- Markowitz theory and capital asset pricing model
- Principal component analysis
- Random matrices
- High dimensional regression methods
- Copulas
- GARCH models

Evaluation : Take home QCM + computing project joint with « Derivatives".

Acquired skills : Estimation techniques for portfolio management,

Econometrics of high dimensional data,

Risk modelling and forecasting.

Stochastic calculus and control theory

Course and small classes

Nizar Touzi, PR. Ecole Polytechnique

Aim : Basics of stochastic calculus tools for financial modeling, Hamilton-Jacobi-Bellman equations for control problems, applications in hedging and portfolio optimization.

Content :

- Brownian motion, stochastic integral, Itô's formula, Girsanov's change of

measure, review of basic valuation theory, Poisson process, financial modeling with jumps

- Optimal stochastic control and HJB equation, application to portfolio optimization
- Optimal stopping and obstacle partial differential equation, application to American securities
- Introduction to stochastic differential games, application to contract theory

Evaluation : Take home QCM + computing project joint with « Numerical methods ».

Acquired skills : Stochastic modeling, optimization under uncertainty, nonlinear partial differential equations.

Professional seminars/meetings

Unit 2 of skills

Regulation

Course and small classes

Michael Vincent, Sorbonne Université

AIM : Introduction to regulation starting from a historical viewpoint.

Content :

- 1929 crisis, Glass-Steagall act, deregulation (Thatcher-Reagan era), subprimes, CDO, Lehman Brothers bankruptcy, bail out plans, reinforcement of financial regulation
- Prudential regulation since the subprime crisis: what has been done, what is left to be done
- Other reforms: accounting, market structures, (CMU, IFRS, EMIR)
- From CVA to XVA : high-frequency trading, blockchains, cryptocurrencies, negative rates, multivalued rate curves,...

Evaluation : written examination (QCM).

Acquired skills : History of regulation through successive crisis, and its impact on the design, the trading and the hedging of derivative products.

High Frequency and Algorithmic Trading

Course and small classes

Charles Albert Lehalle, Senior Researcher, CFM, Mathieu Rosenbaum, PR.

Ecole Polytechnique

Aim : Introduction to cutting edge statistical and stochastic control techniques for high frequency finance under the new regulatory environment.

Content :

Market microstructure after MIFID II

Introduction to high frequency modelling

High frequency statistics

Limit order book modelling

Optimal high frequency trading

Microstructure and volatility

Regulatory issues

Evaluation : written examination + project (joint with other courses).

Acquired skills : Master the principles, models and techniques of High Frequency and Algorithmic Trading in connection with the evolution of the regulation.

Energy Markets

Small classes

Olivier Bardou ENGIE & Sorbonne Université, René Aïd, PR Dauphine

AIM : Introduction to the specificities of energy markets and to the mathematical tools.

Content :

- Modeling of energy markets (gas, oil, electricity) : specificities and mathematical tools. (stochastic convolutions, jump diffusions)
- Dynamics of the underlying: spot prices, forward price structure, correlations,
- Derivative contracts (swing option, sparks options, real options)
- More about gas (gas plants, storage, take-or-pay contracts)
- More about electricity (peaks, negative prices, etc)
- Stochastic control methods for pricing energy derivatives : theoretical and

numerical aspects.

Evaluation : written examination.

Acquired skills : Master the principle of modelling of assets and the pricing of spot/forward contracts on energy markets (especially gas and electricity).

Fintech/Retail finance

Small classes

Sébastien Choukroun, PwC

AIM : Basic notions of machine learning.

Content :

- Introduction to cryptography
- Tokenisation of asset by blockchain, bitcoin
- Blockchain by ethereum, smart contracts
- Ledger (securisation of crypto-currency)
- Examples of use case

Evaluation : analysis of a use case.

Acquired skills : Understand the basics of blockchain technology and how to use it for crypto-currencies with a focus on use case.

Machine learning

Course and small classes

Victor Reutenauer, Dirigeant Fotonower

AIM : Basic notions of machine learning.

Content :

Supervised and unsupervised learning

Regression, classification

Recommendation and e-marketing

Tools for convex optimization, online stochastic optimization

Evaluation : written examination and/or project (shared with other courses).

Acquired skills : Master the basics from supervised and unsupervised in order to use the main platforms recently released like tensorflow, pytorch, etc. in view of financial application.

MÉTHODES

Course and small classes

Professional seminars/meetings

MODALITÉS D'ÉVALUATION

- written final exam + pricing/calibration project joint with "Numerical methods"
- written final exam + computing project joint with « Stochastic Calculus & Control ou Derivatives
- Take home QCM + computing project joint with « Derivatives"
- Take home QCM + computing project joint with « Numerical methods"
- Written examination (QCM)
- Written examination + project (joint with other courses)

Evaluation depends on each course

LES + DE LA FORMATION

The job of Quant / Strat (quantitative analyst) is constantly changing due to the post-crisis regulatory upheavals, technological changes (GPU), the unceasing mathematical and algorithmic advances (Machine Learning).

This effervescence is reflected on the one hand by new requirements in terms of calculation and risk control at the level of companies themselves, local or foreign regulatory authorities and the other by the arrival of new technological tools (parallelism), algorithmics (machine learning), mathematics (forward simulation, multilevel methods, etc.) and new models

(rough volatility).

The purpose of the training is to allow both a (re) leveling of the participants but also to give them an overview of this constantly evolving situation as well as the tools to support it or even to impulse it.

POUR CANDIDATER

- Send in : Resume + Cover letter + Last obtained diploma
 - A recommendation letter in case of pursuing this degree on behalf of a company
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