advantere
School of
Management

TEACHING GUIDE

Course Information	
Full Name	Quantitative Methods in Finance
Code	0000012205
Degree	Master in Finance
Level	Postgraduate Official Master´s Degree
Term	First quarter
Credits	5,0 ECTS
Type	Mandatory
Responsible	Emilio Llorente Cano
Office hours	Continuous availability via email

Professor Information	
Professor	
Name	Emilio Llorente Cano
Department / Area	Advantere School of Management
CV	https://www.linkedin.com/in/emilio-llorente-cano-frm-b79904/?originalSubdomain=es
Office	Continuous availability via email
Email	e.llorente@advantere.org

SPECIFIC COURSE INFORMATION

Course contextualization

Contribution to the professional profile of the degree

Quantitative analysis of financial asset markets

The financial professional must, in investment advice and the creation of management products, incorporate the latest advances in data science into economic knowledge. All this in a logical and understandable framework, based on the application of mathematical optimization technologies, artificial intelligence and risk analysis. Through the application of the different topics developed within the course, the asset manager can obtain an analysis of the financial market in real time, and make portfolio decisions according to new scenarios, always in compliance with the client's requirements.

Knowledge of the objectives of the financial product or service (robust design of the mandate), Analysis of the economic-financial environment (relevant variables and their computational treatment) and **Construction of investment portfolios** (under mathematical optimization models) are necessary and demanded areas in the world of current professional management.

Machine Learning. Through the construction of the decision process we will be able to detect and describe structural patterns in the behavior of the market. Our goal is to make sense of the enormous volume, variety and speed at which data is generated that can affect the behavior of investable assets. Thus, we will transform them into relevant information that is ultimately used to make asset allocation decisions in all assets that can be part of the investment universe of a client or product (for example, an Investment Fund).

Econphysics. Violent market movements can be caused by a self-imitative effect of positive feedback between the intervening traders. Imitation at the local level, that is, among those close to each other in a communication network, gradually accumulates, ultimately tending to global cooperative behavior among all market agents. This cooperation deviates asset prices from their fundamental values to a critical point, at which point most market operators decide to execute the same (sell) order at the same time, causing a serious drop in the market. The critical point is not just an idea, but a mathematically explained event in complex nonlinear dynamical systems.

Competences – Objectives

Competences

GENERAL

CG.1	Learning by projects: Ability to develop and execute collective financial projects in their different phases based on real situations, proposing real solutions and making all interactions with the team, clients and any other participant efficient.	
	RA1	Ability to commit to the development of experimental collective projects based on the real world, managing and aligning the client's needs with the available resources, optimally distributing the work, communicating and projecting its different phases, proposing real solutions and making all the tasks efficient. interactions with the team, customers and other stakeholders..
CG.9	Digital competence: Employ, take advantage of and use, efficiently and safely, the technological and digital resources that are applied in the financial management of organizations.	
	RA1	Being able to critically, creatively and safely use information and communication technologies in financial management in organizations, using applications and taking advantage of internet resources.

SPECIFIC

CE.10	Know how to identify the main financial and non-financial risks that any company faces and apply advanced models for their control and management.	
	RA3	Know and apply the mathematical and financial models of risk management.
CE.12	Know and apply the programming and modeling necessary to create defined functions, statistical, econometric and mathematical analysis through computer programs.	
	RA1	Knows how to use statistical, mathematical and econometric tools for data analysis and preparation of research and reports, mastering the main basic statistical, mathematical and econometric concepts necessary for financial operations and financial research.
	RA2	He knows the R, Python and Excel environments, being able to develop programs based on predefined models, in such a way that he provides solutions to various financial problems efficiently.

THEMES AND CONTENT

Contents - Themes

Module 1

Knowing theMATLAB® Programming Enviroment

Basic algebraic operations

Scripts and Functions

Programming Basics

Probability Theory and Statistics

advantere
School of
Management

Basic concepts in probability

Probabilistic distributions

Advanced Concepts in Probability and Statistics

Monte Carlo Simulations
Stochastic Processes
Brownian Motion
Ito's Lemma
Brownian Geometric Motion

Linear and Non-Linear Programming

Linear, Quadratic and Non-Linear

Efficient Frontier Solutions

Product Design Principles / Investment Process

Building an investment process and financial product

Regulatory environment: Suitability test

Combinatorial mathematical problems

Risk aversion based on Fuzzy Logic methods

Product and Investment Mandate Design

Marginal Statistical Characteristics of the Investment Universe

Joint statistical characteristics of the Investment universe
Final mandate of the portfolio

Computational and Systematic Analysis of Financial Markets

Market analysis

Introduction to Machine Learning
Classification and Regression Trees: Entropy
Support Vector Machines: Mathematical Optimization

Portfolio Design Mathematical Problem

Objectives

Restrictions

Systematic decision model

From Data to Macroeconomic Information

advantere
School of
Management

Macroeconomic Data

Macroeconomic Factors: YCS, Economic Surprises, Inflation Surprises, Monetary Policy, Option Adjusted Spreads Statistical

Transformations: Macroeconomic Information

From Data to Fundamental Valuation Information

- Value Data
- Value Factors: Earnings Revisions, ExpectedFree Cash Flows, ...

Statistical transformations: Value Information

From Data to Market Sentiment Information

Sentiment Data

Sentiment Factors: Merton Credit Models, Implied Volatility Surfaces, ...

Statistical Transformations: Sentiment Information

Statement of the Decision Problem in a Computational Environment

Solution to Information Complexity

- Volume, Variety, Velocity Paradox of
- Dimensionality

Machine learning clustering methods

Ask the Machine

Creating classes

MultiClass vs.Multilabel

Best Fit Algorithm

Asset Allocation framework based on Machine Learning

Factors

Classes /Labels

Machine Learning Algorithm

Out-of-Sample Backtesting

advantere
School of
Management

Machine Learning Input / Output Model

Backtesting

Success Ratios

Real Time Decision

Real-time decision making

Interpretability

Explainability

Market Analysis and Portfolio Mandate

Mean-Variance Portfolio Optimization

Analytical Solution

Mean-Conditional VaR Portfolio Optimization

Stochastic Programming

PCA Maximum Diversification Portfolio Optimization

Numerical Solution

Portfolio Risk Analysis

Market Risk Environment

Distance Arrays

Graph Theory

Hidden Markov Models

Portfolio Risk

GARCH & Glosten, Jagannathan, and Runkle model

Monte-Carlo Simulations

Copulas

advantere
School of
Management

TEACHING METHODOLOGY

General methodological course aspects

Presential Methodology: Activities

Cooperative work of students who, in pairs or small groups, are given a task, case or assumption that requires sharing information and resources among members in order to achieve the common goal. Based on the case method, studied by each student and discussed by each group before the individual interventions of each general session.
The case method stimulates inductive learning. From the analysis of concrete examples, the different tools of analysis are built and general rules of application to all types of companies and sectors are induced. Therefore, prior study of the cases and active participation in the discussions of the general sessions is essential.

Exhibitions about their skills and abilities to get a job.

The presentations must be evaluated and critiqued by the rest of the classmates or by the professor in order to go deeper into the course.
Lessons of an expository and participative nature.

Non-presential Methodology: Activities

Individual study.

Individual reading of different types of texts (cases, books, magazines, articles, press, Internet publications, reports on practical experiences, etc.) related to the study courses.

Cooperative work of students who, in pairs or small groups, undertake a project that requires the sharing of information and resources among members in order to achieve a common goal.

advantere
School of
Management

SUMMARY OF STUDENT WORK HOURS

PRESENTIAL HOURS					
Professor Exhibition	Student exhibition. Debates and group dynamics	Exercises and problem solving. Elaboration of applied work	Analysis and documentation	Tutorial sessions	Development of real projects for organizations
10	15	23	0	1	1
NON-PRESENTIAL HOURS					
Professor Exhibition	Student exhibition. Debates and group dynamics	Exercises and problem solving. Elaboration of applied work	Analysis and documentation	Tutorial sessions	Development of real projects for organizations
0	0	43,5	50	3	3

ECTS CREDITS: 5,0 (150,00 hours)

EVALUATION AND GRADING CRITERIA

Graded Activities	Evaluation Criteria	% of Total Grade
Assessment of individual or group work carried out by students, some of them presented in class	• Work adequacy to the objectives set • On-time delivery • Goal adequacy and focus • Results achieved • Compliance with deadlines • The participation of ALL members of each team in the presentations and elaborations is required	50
Performance of oral and written examinations, public defenses and multiple-choice tests, concept tests and resolution of practical cases as exams	• Throughout the program, exams or written tests will be given to test the solidity of the concepts acquired. • In order to pass the course, the final exams and tests of each section of the course must be passed. If there are several exams in the same section or block of a course, the weighted average of them must be higher than 5.0 as a necessary condition to pass the course.	35
Participation and utilization of the classes	• When we talk about participation, it is clear that both the positive and negative ones are counted and that the quality of participation is as important as the quantity. The students' participation in class, the quality and timeliness of their interventions, the quality in the preparation and presentation of their work, predisposition and commitment, initiative, attendance.	15

Grades

The evaluation criteria for the subject are governed by the following rules:

1-All students must comply with 100% attendance on the days established for this course. Any absence must be justified.

2-The final grade corresponds to the sum of the graded activities, the evaluation criteria and the % of the total grade described in the Evaluation and Grading Criteria section.

3-Individual and group work must be submitted on time and in the form specified by the subject`s teacher.

4-A final grade lower than 5 implies the need to take an extraordinary exam. The final grade for this exam may not exceed the median of the passing grades at the time of the schedule exams.

The evaluation criteria for enrolling in a second year:

The student enrolled in the second-year course mut fulfill the individual and group tasks established by the course professor. The same evaluation criteria described in the Evaluation and Grading Criteria section will be maintained.

In circumstances not covered by this Teaching Guide, the Advantere School of Management Regulation and the General Regulation of Comillas will apply.

Health alert criteria:

The student must be permanently identified, in class with an identification poster and remotely with their full name. Students should not change the spaces they occupy in the classroom, until indicated by a professor or the direction of the program.

Failure to comply with any of the health recommendations during the teaching sessions may lead to failure in the course.

BIBLIOGRAPHIES

Basic Bibliographies

1. Machine Learning: A Probabilistic Perspective (Adaptive Computation and Machine Learning series), Kevin P. Murphy
2. Pattern Recognition and Machine Learning (Information Science and Statistics), Christopher M. Bishop
3. Portfolio Management under Stress: A Bayesian-Net Approach to Coherent Asset Allocation, Riccardo Rebonato, Alexander Denev
4. Data Mining: Practical Machine Learning Tools and Techniques, Third Edition (The Morgan Kaufmann Series in Data Management Systems), Ian H. Witten, Eibe Frank, Mark A. Hall
5. Pattern Recognition, Fourth Edition, Sergios Theodoridis, Konstantinos Koutroumbas
6. Chaos and Time-Series Analysis, Julien Clinton Sprott
7. Nonlinear Time Series Analysis, Holger Kantz, Thomas Schreiber
8. Nonlinear Dynamics And Chaos: With Applications To Physics, Biology, Chemistry, And Engineering, Steven H. Strogatz
9. Complex and Chaotic Nonlinear Dynamics: Advances in Economics and Finance, Mathematics and Statistics, Thierry Vialar, Alain Goergen
10. A Wavelet Tour of Signal Processing: The Sparse Way, Stephane Mallat
11. Wavelet Methods for Time Series Analysis (Cambridge Series in Statistical and Probabilistic Mathematics), Donald B. Percival, Andrew T. Walden
12. An Introduction to Wavelets and Other Filtering Methods in Finance and Economics, Ramazan Gencay, Faruk Selcuk, Brandon Whitcher
13. An Introduction to High-frequency Finance, Ramazan Gencay, Michel Dacorogna, Ulrich Muller, Richard Olsen, Olivier Pictet
14. Why Stock Markets Crash: Critical Events in Complex Financial Systems, Didier Sornette
15. Detection of Crashes and Rebounds in Major Equity Markets, Wanfeng Yan, Reda Rebib, Ryan Woodard, Didier Sornette
16. Identification and Forecasts of Financial Bubbles, Wanfeng Yan
17. Fitting the Log Periodic Power Law to Financial crashes: a critical analysis, David S. Bree, Nathan Lael Joseph
18. Financial Modelling: Theory, Implementation and Practice (The Wiley Finance Series), Joerg Kienitz, Daniel Wetterau
19. Implementing Models of Financial Derivatives: Object Oriented Applications with VBA (Wiley Finance), Nick Webber
20. Implementing Models in Quantitative Finance: Methods and Cases (Springer Finance), Gianluca Fusai, Andrea Roncoroni
21. Financial Modeling Under Non-Gaussian Distributions (Springer Finance), Eric Jondeau, Ser-Huang Poon, Michael Rockinger
22. An Introduction to the Mathematics of Financial Derivatives, Second Edition (Academic Press Advanced Finance), Salih N. Neftci
23. A Monte-Carlo method for portfolio optimization under partially observed stochastic volatility, R. Desai, T. Lele, F. Viens
24. Fornari, F.; Mele, A. Stochastic volatility in financial markets – Crossing the bridge to continuous time. Kluwer A.P., 2000.
25. Quantitative Portfolio Optimisation, Asset Allocation and Risk Management: A Practical Guide to Implementing Quantitative Investment Theory, Mikkel Rasmussen (Finance and Capital Markets Series)
26. Extreme Value Methods with Applications to Finance (Chapman & Hall/CRC), Serguei Y. Novak
27. Statistical Analysis of Extreme Values: with Applications to Insurance, Finance, Hydrology and Other Fields, Rolf-Dieter Reiss, Michael Thomas
28. EVIM: A Software Package for Extreme Value Analysis in MATLAB, Ramazan Gencay, Faruk Selcuk
29. Modelling Extremal Events: for Insurance and Finance (Stochastic Modelling and Applied Probability), Paul Embrechts, Claudia Klüppelberg, Thomas Mikosch