M2 MODELISATION FINANCIERE (MF)
M2 FINANCIAL MODELLING (MF)

Cours spécifiques à l'option Magistère Economie, Data Science et Finance

Risk and Decision
Risque et décision

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Dominique HENRIET – dominique.henriet@centrale-med.fr
Jiakun ZHENG – jiakun.zheng@centrale-med.fr
Clément DEPOUTRE – practitioner from BNP Paribas

COURSE DESCRIPTION AND OBJECTIVES

The course is organized in three parts. The first is devoted to understanding how to measure risk and to presenting the benchmark model of expected utility for decision making under risk. The second part presents various behavior biases that may impact decision making and the ways for measuring them. The third part finally presents the risk measure and risk management methods for banks.

COURSE OUTLINE

Part 1 - Risk and Expected utility
    1.1. Introduction: diversification and mutualization
    1.2. Risk measures
        1.2.1. Risk magnitude: cumulative distribution and quantile function
        1.2.2. Risk measures based on the quantile function, the actuarial approach
        1.2.3. Risk measures based on CDF, the expected utility approach
    1.3. Expected utility
        1.3.1. Risk Aversion in the expected utility approach
        1.3.2. The measure of risk aversion
        1.3.3. The characteristics of risk aversion
        1.3.4. Classical utility functions
Part 2 - Behavioral decision making
    2.1. Decision under risk
        2.1.1. Introduction to Expected Utility Theory, Risk Aversion and Measurement
        2.1.2. Behavioral Decision Theories under Risk
    2.2. Decision under uncertainty
        2.2.1. Eliciting Beliefs in Economics
        2.2.2. Multiple Priors and Ambiguity
    2.3. Time preferences
        2.3.1. Discounted Utility Theory: Time versus Risk
        2.3.2. Hyperbolic Discounting and Its Measurement
Part 3 - Introduction to financial risk management
    3.1. Risk management in banks
    3.2. Market risks
    3.3. Counterparty risks

KEY PROFESSIONAL SKILLS UPON GRADUATION

Understand how economic agents take decision under uncertainty, learn how to assess risk and how to compare risky situations

ORGANIZATION

Semester: S1
Teaching Hours: 24 h of lectures, in 8 sessions of 3 hours each
Comment: Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS

Gollier, C., Schlesinger, H. and Eeckhoudt, L. (2005). Economic and Financial Decisions Under Risk. Princeton University Press
Wakker, P. P. (2010). Prospect Theory: For Risk and Ambiguity. Cambridge university press.
Carvalho, A. (2016). An overview of applications of proper scoring rules. Decision Analysis, 13(4), 223-242.
.

Financial Risk Modelling
Modélisation des risques financiers

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Réda RAHAL – practitioner from BNP Paribas

COURSE DESCRIPTION AND OBJECTIVES

This course begins with the presentation of the regulatory framework; especially with the new market risk capital charge framework under FRTB (Fundamental Review of the Trading book). It will help the students to understand how the supervision on market risk; counterparty credit risk and credit risk are organized and how the associated capital charges are computed. Then we will study the different statistical approaches to measure the value-at-risk and the expected shortfall. Same exercises will be done for the Counterparty Credit Risk as well. In this part of the course, a section will be dedicated to the risk management of vanilla derivatives and exotic products. We will only see the main concepts (greeks, risk metrics, stress testing).

Advanced topics like Monte Carlo methods and stress testing models will also be addressed at least as an introduction.

COURSE OUTLINE

1. Introduction: bonds and OTC transactions
2. Modelling defaults: structural models and ratings
3. Banking regulation on credit risk; market and counterparty credit risk
4. Overview of the VaR methodologies and pros/cons for each
5. Monte Carlo techniques applied in Finance

KEY PROFESSIONAL SKILLS UPON GRADUATION

Understand how the supervision financial risks organized
Know how to model and compute the associated capital charges are computed

ORGANIZATION

Semester: S1
Teaching Hours: 24 h of lectures, in 8 sessions of 3 hours each
Comment: Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS

Roncalli T. (2016). Risk Management & Financial Regulation (http://thierry-roncalli.com)
Options, Futures, and Other Derivatives, John Hull.
Value at Risk: The New Benchmark for Managing Financial Risk, Philippe Jorion
The xVA Challenge: Counterparty Credit Risk, Funding, Collateral, and Capital, Jon Gregory

Credit Risk Models
Modèles de risque de crédit

COURSE LANGUAGE
English in Aix

TEACHER
Practitioners from Deloitte

COURSE DESCRIPTION AND OBJECTIVES
The aim of this course is to understand how credit risk is modeled, measured and regulated in the financial sector.

COURSE OUTLINE
The first 12 hours are devoted to lectures with the following outline:
1. Introduction to credit risk
2. Scoring models and probability of default
3. LGD and CCF models
4. Margin of Conservatism
5. Application

The last 12 hours are devoted to the running of the DRiM (Data for Risk Management) inter-University Challenge (presentation of the subject, off-class and in-class work and final presentation by the students).

KEY PROFESSIONAL SKILLS UPON GRADUATION
Understand how credit risk is modelled, measured and regulation
Know how to build and estimate a credit risk model

ORGANIZATION
Semester: S1
Teaching Hours: 24 h of lectures
Comment: 4 lectures of 3 hours each and a 12-hour project

Financial Econometrics
Econométrie de la finance

COURSE LANGUAGE
English in Aix

TEACHER
Sullivan HUE – sullivan.hue@univ-amu.fr

COURSE DESCRIPTION AND OBJECTIVES
The goal of the course is to study the main econometric models and techniques allowing to analyse financial time series. The end of the course is devoted to the analysis of market risk.

COURSE OUTLINE
1) Describing Financial Data
2) Univariate Time Series Analysis
3) Volatility Modeling : Conditional Heteroscedastic Models
4) Market risk measures : VaR and ES
5) Backtesting market risk measure

KEY PROFESSIONAL SKILLS UPON GRADUATION
To understand stylized facts of financial data
To know how to take into account these stylized facts with statistical models
To understand the advantages and limits of ARMA and ARCH/GARCH models
To understand how to measure market risk

ORGANIZATION
Semester: S1
Teaching Hours: 24 h of lectures, in 8 sessions of 3 hours each
Comment: For each chapter, 60% of the course is devoted to a theoretical presentation and 40% of the course is devoted to an empirical application.

BIBLIOGRAPHY AND TEXTBOOKS
Brooks C. (2008) Introductory Econometrics for Finance, 2nd Edition, Cambridge University Press
J. Danielsson (2011) Financial Risk Forecasting, Wiley
Backtesting, P. Christoffersen (2008)

MANDATORY PREREQUISITES
Econometrics, Time-Series analysis (ARMA models), R, Python

KEYWORDS
Stylized facts, ARMA, ARCH, GARCH, VaR, ES, backtesting

Corporate Finance
Finance d'entreprise

COURSE LANGUAGE
English in Ecole Centrale Marseille

TEACHER
Gaël LEBOEUF – gael.leboeuf@univ-amu.fr

COURSE DESCRIPTION AND OBJECTIVES
Understand tools and techniques used in Corporate Finance. (from financial statement analysis and investment decision to financial structure and M&A)

COURSE OUTLINE
Chapter 1: Firms and Financial Markets
Chapter 2: Introduction to Financial Statements Analysis
Chapter 3: The Time Value of Money
Chapter 4: Investment Decision Rules
Chapter 5: Fundamentals of Capital Budgeting
Chapter 6: Estimating the cost of capital
Chapter 7: Startup financing
Chapter 8: Crowdfunding
Chapter 9: Initial Public Offering

KEY PROFESSIONAL SKILLS UPON GRADUATION
Financial statement reading and analysis
Capital budgeting
Understanding capital structure

ORGANIZATION
Semester: S1
Teaching Hours: 24 h of lectures, in 8 sessions of 3 hours each + 4 h of tutorials
Comment: Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS
J. Berk & P. DeMarzo, « Corporate finance », Prentice Hall; 5th edition, 2019
Useful websites:
- Aswath Damodaran at NYU : Course and video materials, formulas, spreadsheets, Estimated risk premium, Cost of capital by sector and more : http://pages.stern.nyu.edu/~adamodar/
- Annual reports and legal informations on French listed companies: http://www.amf-france.org/Recherche-avancee?formId=BDIF
- Financial data on listed companies : https://fr.finance.yahoo.com/

Portfolio Management
Gestion de portefeuille

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Grégoire HUG – practitioner from WeeFin

COURSE OUTLINE

Lecture 1

Introduction to Portfolio Management
1. The asset management industry
2. The investment theory basics
3. Main asset classes

The Fixed Income asset class (1/2)
1. Sources of risk and return
2. Main strategies
3. Application on a fixed bond

Lecture 2

The Fixed Income asset class (2/2)
1. Fixed Income products and associated strategies
2. Calculation example - fixed bond
3. Rate curves bootstrapping
4. Application on a callable bond

Back to Equity
1. Equity Market history and overview
2. Classic steps in an investment process
3. Active vs Passive Investment management
4. Application on an equity European portfolio

Group Activity (Design of an investment strategy)

Lecture 3

Alternative Asset classes
1. Currency
2. Private Equity
3. Real Estate
4. Private Debt
5. Infrastructure

Risk and Performance Measurement
1. Performance Measurement
2. Risk and Performance Metrics
3. Risk Measurement

Group Activity (Design of an investment strategy)

Lecture 4

Asset Allocation
1. Asset allocation based on investment profile
2. Capital Protection

Innovation in Asset Management
1. Smart Beta portfolios & passive indexing
2. Alternative data sources
3. ESG (intro)
4. Crypto funds

Group Activity

KEY PROFESSIONAL SKILLS UPON GRADUATION

Learn what is the asset management industry and what are each player's target
Understand the portfolio management theory basics – how to build a portfolio
Cover all major asset classes to have a deep financial culture

ORGANIZATION

Semester: S1

Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each + 4 h of tutorials
Comment: Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS
Options, futures & other derivatives – John Hull
Market Finance – Roland Portait & Patrice Poncet
The Handbook of Fixed Income Securities – Franck J. Fabozzi

Applied Finance
Finance appliquée

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Practitioner

COURSE DESCRIPTION AND OBJECTIVES

The course aims at presenting how the models studied in the program are applied on both corporate and market finance.

COURSE OUTLINE

1. Applied corporate finance – From startup to IPO… and LBO
   Introduction / Presentation
   Application areas of
   Accounting Basic Methods
   Valuation methods
   We know how to value a company. Now what? Different types of operation
   Introduction to Fintech and start-up ecosystem
2. Applied market finance – Options: Pricing, Hedging & Risk Management
   Market finance: players and products
   Future and forward: pricing & hedging
   Options: replication and pricing
   Sensitivity of options: the greeks
   Volatility and stress tests

KEY PROFESSIONAL SKILLS UPON GRADUATION

Understand the similarities in the concepts of market and corporate finance
Understand how finance products can be used to manage risk
Know how to evaluate and to value a company

ORGANIZATION

Semester: S1
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each + 4 h of tutorials
Comment: Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS

Vernimmen, P. (2021). Finance d'entreprise. Dalloz.
Hull, J. (2018). Options, Futures, and Other Derivatives, 10th Edition. Pearson

Economics, Finance and Crisis
Economie, finance et crises

COURSE LANGUAGE
English in Aix

TEACHER
Marco FONGONI – marco.fongoni@univ-amu.fr

COURSE DESCRIPTION AND OBJECTIVES
Using both empirical evidences and theoretical concepts, this course aims at explaining how economic and financial issues are closely related, and how shocks and crises can propagate. It also explains the interactions between financial markets and economic cycles (in light of the recent crises).

COURSE OUTLINE
Introduction and macroeconomics refreshers
Financial Markets & Crises
Macroeconomic Policy.

KEY PROFESSIONAL SKILLS UPON GRADUATION
Understanding the determinants of the business cycle,
Understanding the purpose and functioning of financial markets,
Understanding how the business cycle and the financial cycle interact, amplifying and propagating shocks, generating economic crises,
Understanding the role of macroeconomic policy, and how it responds to economic crises,
Analysing, and critically thinking about, recent economic events and crises.

ORGANIZATION
Semester: S1
Teaching Hours: 24 h of lectures, in 6 sessions of 4 hours each
Comment: First 3 classes devoted to lectures for students to understand and acquire the key concepts, last 3 devoted to student presentations on topics related to economic and financial crises and the corresponding policies.
Examination Method: Partial continuous assessment

BIBLIOGRAPHY AND TEXTBOOKS
Mishkin (2011) Over the Cliff: From the Subprime to the Global Financial Crisis.
Bean et al. (2010) Monetary policy after the fall
Kuttner(2018) Outside the Box: Unconventional Monetary Policy in the Great Recession and Beyond.
Dell'Arricciaet al. (2018) Unconventional Monetary Policies in the Euro Area, Japan, and the United Kingdom
Bernanke (2020) The New Tools of Monetary Policy

Sustainable Finance
Finance durable

COURSE LANGUAGE

English in Aix

TEACHER

Practitioners form WeeFin

COURSE OUTLINE

Lecture 1: Introduction to sustainable finance and main concepts
Lecture 2: Current financial context, regulation and greenwashing
Lecture 3: Sustainability quantification (ESG scores, portfolio temperature, ...)
Lecture 4: Practical cases on sustainable fund management and student presentation

KEY PROFESSIONAL SKILLS UPON GRADUATION

Understand the role non-financial data is financial institutions decision making
Understand how non-financial data are built and used

ORGANIZATION

Semester: S1
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each

End-of-Studies Project in Finance
Projet de fins d'études en finance

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Renaud BOURLES – renaud.bourles@centrale-med.fr

COURSE DESCRIPTION AND OBJECTIVES

In this course, a company proposes a project based on a current financial issue, which may include access to real data. Students work in groups of 4 to 5 to analyse the problem and develop a solution. The project culminates in an oral presentation delivered to the company.

COURSE OUTLINE

1. Introduction and presentation of the subject by the company
2. Group work and final oral presentation

KEY PROFESSIONAL SKILLS UPON GRADUATION

Deliver clear and professional presentations in a business context
Apply financial knowledge and analytical skills to solve real-world problems

ORGANIZATION

Semester: S1
Examination Method: Project

MANDATORY PREREQUISITES

Financial modelling, Risk measure, financial econometrics

KEYWORDS

Real-world problems, current financial issues, oral presentation

Professionalisation Workshops
Ateliers de professionnalisation

COURSE LANGUAGE

English

COURSE DESCRIPTION AND OBJECTIVES

This workshop is designed to guide students in their transition from academic training to the job market. **Participation in all activities is mandatory.**

It combines several complementary components:

- **Afterworks** (on campus or online), where companies and institutions introduce themselves to students, share insights into their missions, and discuss opportunities for collaboration.
- A **Career Day**, organized in two parts: first, recent graduates present their career paths, current positions, and how their training helped them enter the job market; second, a large recruitment fair brings together around 50 local, national, and international companies and institutions to offer internships and job opportunities.
- A course entitled *"Building a Strong Application"*, providing practical tools and strategies for professional integration.
  It is divided into three parts:
  - First part (lecture): Preparing for interviews (best practices, preparation methods, and self-presentation); searching for an internship or a job abroad (application strategies, networks, and resources); negotiating salaries (key principles for successful negotiation).
  - Second part (workshops): Small-group sessions offered to M2 students, focusing on CV writing and mock interview practice.
  - Third part (AMF): Students will be supported for preparing the AMF (French Financial Market Authority) certification through lectures and on-line preparation.

Together, these activities give students concrete experience, direct contact with employers, and essential skills to confidently approach their future careers.

KEY PROFESSIONAL SKILLS UPON GRADUATION

By the end of the workshop, students will possess the essential skills to approach the job market with confidence. They will know how to present themselves effectively, understand recruiters' expectations in France and abroad, and activate a professional network. Through lectures and practical workshops, they will be able to prepare strong applications, succeed in interviews, and conduct salary negotiations with assurance. They will lastly be able to pass a certification allowing to work within the French financial market.

ORGANIZATION

Semester: S1
Teaching Hours: 10 h of tutorials
Comment: Students will do the AMF certification.

Stochastic Calculus
Calcul stochastique

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Gaëtan FOURNIER – gaetan.fournier@univ-amu.fr

COURSE DESCRIPTION AND OBJECTIVES

This course provides a rigorous introduction to stochastic calculus, focusing on continuous-time stochastic processes, particularly Brownian motion and Itô calculus. The course introduces key concepts used in theoretical finance, such as filtrations, martingales, stopping times, stochastic integrals, and stochastic differential equations (SDEs).

COURSE OUTLINE

1- Introduction to derivatives
2- Reminders on probability theory
3- Martingales
4- Brownian motion
5- Stochastic integrals
6- Itô calculus
7- Girsonav theorem
8- Black-Scholes model
9- Model sensitivities (greeks)

KEY PROFESSIONAL SKILLS UPON GRADUATION

Understand stochastic calculus and know how to apply its main results
Know how to apply stochastic methods to price financial products
Understand the mathematical contexts under which the classical financial mathematics models hold
Know and understand the relevance and limits of financial mathematics models

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille
Examination Method: Final written exam

BIBLIOGRAPHY AND TEXTBOOKS

Introduction to Stochastic Calculus Applied to Finance (Lamberton - Lapeyre)

Volatility Models
Modèles de volatilité

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Ismaïl AKIL – practitioner from Bank of America

COURSE DESCRIPTION AND OBJECTIVES

The course aims at presenting how mathematical finance models can accommodate the real-world observation of non-deterministic variances of the underlying processes.

COURSE OUTLINE

1. Elementary financial mathematics notions
2. PDE: Black Scholes and risk neutral measure
3. Dupire's local volatility: advantages and drawbacks
4. Stochastic volatility (Heston and SABR)
5. Tutorial: discretization of the Heston's model

KEY PROFESSIONAL SKILLS UPON GRADUATION

Know how to apply stochastic methods to price financial products
Understand the impact of volatility on the profit and losses of a hedged position
Know how to build numerical methods for pricing financial products

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each + 4 h of tutorials
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS

El Karoui, N. (2004) Couverture des risques dans les marchés financiers. Ecole Polytechnique

Interest Rate Models
Modèles de taux

COURSE LANGUAGE
English in Ecole Centrale Marseille

TEACHER
Abderrahim BEN JAZIA – practitioner from Meta-Modelling

COURSE DESCRIPTION AND OBJECTIVES
The course aims at presenting the frameworks used to model the evolution of interest rate curves. The students will both learn the theoretical models and how to numerically solve and calibrate them.

COURSE OUTLINE
1. A Mathematical Toolkit
2. Interest rates, swaps and options
3. One-factor Short-Rates Models
4. Two-factor Short-Rates Models
5. The Health-Jarrow-Morton (HJM) Model
6. The change of numeraire
7. Derivatives Pricing under the Libor Market Model

KEY PROFESSIONAL SKILLS UPON GRADUATION
Know how to apply stochastic methods to price financial products
Know how to numerically solve and simulated financial mathematics models

ORGANIZATION
Semester: S2
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each + 4 h of tutorials
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS
Brigo, D., & Mercurio, F. (2007). Interest rate models-theory and practice: with smile, inflation and credit. Springer Science & Business Media
Privault, N. (2012). An elementary introduction to stochastic interest rate modeling. World Scientific

Structured Finance
Financement structuré

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Amaury SCHOENAUER – practitioner from Monte Cristo Advisory

COURSE DESCRIPTION AND OBJECTIVES

The aim of this course is to present how and why investors and banks structure products mixing debt and equity using special purpose vehicles.

COURSE OUTLINE

1. Main market players and rationale for using structured finance
2. Promoters Credits
   - Understanding the Promoter's logic
   - Understanding Credit Risk
   - Assessing the risks for the banker
3. Investor Credit
   - Conceptualization
   - Leverage and Loan to Value (LTV)
   - Debt Service Cover Ratio (DSCR) and Interest Cover Ratio (ICR)
   - Slicing of Debt
4. Due diligence and points of vigilance of the banker
   1. Leases and Rental Conditions
   2. Valuation Report
5. Other operations
6. Perspectives on Market Finance (Securitization)

KEY PROFESSIONAL SKILLS UPON GRADUATION

Understand how bankers can manage risks using structured finance
Know the advantages and drawbacks of structured operations
Understand how these operations can allow for financing large industrial projects

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each + 4 h of tutorials
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS

Vernimmen, P. (2021). Finance d'entreprise. Dalloz

Management Finance
Financement de projet

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Mehdi EL ALAOUI – practitioner from World Bank – IFC
Oliver VANDOOREN – practitioner from Sigée Finance

COURSE DESCRIPTION AND OBJECTIVES

The aim of this course is to present the tools used to finance large infrastructure projects, in particular those related to renewable energies.

COURSE OUTLINE

1. The main steps of project finance
   - Tender
   - Structuring
   - Optimization
2. Financial modelling
   - The issue of circularity
   - Internal rate of return and gearing ratio
   - Case study
3. The case of renewable energy projects
   - Prices and costs of renewables
   - Bank versus funds
   - How to set the price of a project?

KEY PROFESSIONAL SKILLS UPON GRADUATION

Know how to build a financial model and challenge its assumptions
Understand how these operations can allow for financing large industrial projects
Know the advantage and drawbacks of PPPs

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS

Workshop in Corporate Finance
Ateliers en financement d'entreprise

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Mathieu REBBI – practitioner from Eight advisory
Hugues CHABALIER – practitioner from 2C Finance

COURSE DESCRIPTION AND OBJECTIVES

The aim of this course is to present the tools and methods for start-up financing and transaction advisory.

COURSE OUTLINE

1. Financial modelling using Excel
2. The specificities of Transaction Services Advisory
3. Advising start-ups (on their business model and in making them viable)
4. Projects with real start-ups

KEY PROFESSIONAL SKILLS UPON GRADUATION

Know how to build a financial model and challenge its assumptions
Understanding the specificities of start-up financing and advising

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each + 4 h of tutorials
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

Economics of Insurance
Economie de l'assurance

COURSE LANGUAGE
English in Ecole Centrale Marseille

TEACHER
Jiakun ZHENG – jiakun.zheng@univ-amu.fr
Emilie SOIX – practitioner from +Simple

COURSE DESCRIPTION AND OBJECTIVES
The aim of this course is to provide with the basis of the theoretical analysis of insurance pricing.

COURSE OUTLINE
1. Introduction: Risk attitude and preferences
2. The single risk model
3. Product differentiation
4. Unobservable criteria
5. Moral hazard
6. Extensions and exercises
7. Topic: Duration models and life tables

KEY PROFESSIONAL SKILLS UPON GRADUATION
Understand how individual behaviors aggregate in the insurance market and how prices form
Know the principles driving the pricing of insurance products and be able to apply it to simple products

ORGANIZATION
Semester: S2
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS
Schlessinger, The Theory of Insurance Demand. Handbook of Insurance.

Actuarial Science 1
Actuariat 1

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Practitioners from AXA

COURSE DESCRIPTION AND OBJECTIVES

The aim of the course is to present the main issues related to the pricing of insurance products, and the specificities of insurance business.

COURSE OUTLINE

1. Introduction to actuarial science
   a. Life insurance model: fair premiums and prudent pricing
   b. Non-life specificities: provisioning and variability of non-life risks
2. Life Insurance, saving products, and accounting
   a. Introduction on Mathematical Reserves
   b. Saving contracts and performance distribution mechanisms
   c. Performance indicators for an insurance company
3. Non-Life Insurance
   a. Mechanisms of Non-Life Insurance
   b. Loss experience and reserving
   c. Introduction to Non-Life Reinsurance

KEY PROFESSIONAL SKILLS UPON GRADUATION

Know the principles driving the pricing of insurance products and be able to apply it to simple products
Understand the need of provisioning and know the basic model to compute provisions
Know how to choose a pricing model according to the risks and issues of an insurer

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each + 8 h of tutorials
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS

Charpentier, Computational Actuarial Science with R,
Tosetti, Weiss and Poncelin, Les outils de l'actuariat vie.

Actuarial Science 2
Actuariat 2

COURSE LANGUAGE

English in Ecole Centrale Marseille

TEACHER

Practitioners from AXA

COURSE DESCRIPTION AND OBJECTIVES

The aim of the course is to present the recent developments in actuarial sciences related to prudential regulation, disability insurance or long-term care.

COURSE OUTLINE

1. Valuing an insurance portfolio
2. Asset-liability management in insurance
3. Accounting and financial communication of insurance companies
4. The current regulation: IFRS17
5. CAT risk and CAT reinsurance
6. Focus on long-term care

KEY PROFESSIONAL SKILLS UPON GRADUATION

Know the current regulation and its impact on insurance pricing and provisioning
Know how to measure the profitability of an insurance product and of an insurance portfolio

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures, in 4 sessions of 6 hours each
Comment: Elective. Class at Centrale Marseille; joined with the "Economics and Finance" curriculum at Centrale Marseille

BIBLIOGRAPHY AND TEXTBOOKS

Charpentier, Computational Actuarial Science with R,
Tosetti, Weiss and Poncelin, Les outils de l'actuariat vie.

Big Data Tools (MAG)
Outils des Big Data (MAG)

COURSE LANGUAGE
English in Marseille

TEACHER
Hervé MIGNOT – practitioner from Equancy

COURSE OUTLINE
1. Hadoop. HDFS. MapReduce. Stockage et calculs distribués. Déploiement d'un cluster.
2. Préparation, stockage et traitement des big data : Pandas, Hive and Pig
3. Data visualisation avec matplotlib & seaborn
4. Alternatives : solutions propriétaires, bases NoSQL, ElasticSearch

ORGANIZATION
Semester: S1
Teaching Hours: 24 h of lectures
Comment: Class exclusive for Magistere students.

Machine Learning and New Data (MAG)
Machine learning et nouvelles données (MAG)

COURSE LANGUAGE

English in Marseille

TEACHER

Quentin LIPPMANN – quentin.lippmann@univ-amu.fr

COURSE DESCRIPTION AND OBJECTIVES

This course proposes to study the processing and analysis of unstructured data, and more specifically textual data and images.

COURSE OUTLINE

This course is divided in two parts of 12 hours each. The first part covers text as data. The second is about image as data.

Part 1 – Text as Data

Block 1 – Foundations of NLP

Students will learn about the complete document-pre-processing pipeline, beginning with tokenisation and the construction of n-grams. They will create Bag-of-Words representations and apply TF–IDF weighting to highlight discriminative terms. We will then move to distributed word representations through word embeddings, extract entities with Named-Entity Recognition, and analyse sentence structure by performing dependency parsing.

Block 2 – Large Language Models

Students will learn about the transformer architecture and its self-attention mechanism, compare pre-training with fine-tuning, and experiment with in-context learning. They will study Reinforcement Learning from Human Feedback as an alignment method and practice prompt-engineering patterns to steer model behaviour. We will tackle hallucination and explore retrieval-augmented generation as a mitigation strategy.

Part 2 – Image as Data

Block 1 – Image Fundamentals

Students will learn about digital image representation and colour spaces, then examine convolution operations—kernel size, stride, padding—and their effect on the receptive field. They will study activation and pooling layers for feature extraction and understand bounding-box regression. Anchor-based and anchor-free object-detection strategies will be compared.

Block 2 – Facial Analysis, Segmentation & Generative AI

Students will learn about classical Haar cascades versus modern RetinaFace detectors for face localisation. They will map facial landmarks, build embedding-based recognition pipelines, and evaluate systems using FAR, FRR, ROC curves, and demographic-bias checks. Promptable segmentation models will be introduced, followed by diffusion-based generative models for image synthesis.

All the concepts are applied and illustrated in Python applications.

KEY PROFESSIONAL SKILLS UPON GRADUATION

To learn how to process and analyse textual data
To learn how to process and analyse images

ORGANIZATION

Semester: S1
Teaching Hours: 24 h of lectures
Comment: Class exclusive for Magistere students.

End-of-Studies Project (MAG)
Projet de fin d'études (MAG)

COURSE LANGUAGE

French in Marseille

TEACHER

A teacher + a practitioner

COURSE DESCRIPTION AND OBJECTIVES

The end-of-studies project is carried out in collaboration with a company from October to March. This project enables students to carry out operational engineering work in data science and to compare theory with applications in the professional world.

KEY PROFESSIONAL SKILLS UPON GRADUATION

To be able to tackle a data science problem and write a report to answer it.
To know how to work as a team and to meet a set of specifications.

ORGANIZATION

Semester: S1
Comment: Class exclusive for Magistere students. Bimonthly meetings with supervisors, and autonomous work between meetings.
Examination Method: Project + Defense

Topics in Data Science (MAG)
Sujets en Data Science (MAG)

COURSE LANGUAGE

English in Marseille

TEACHER

Pierre MICHEL – pierre.michel@univ-amu.fr
Christophe HURLIN – practitioner

COURSE DESCRIPTION AND OBJECTIVES

This course aims to raise students' awareness of topical issues in data science.

COURSE OUTLINE

1. Conformal prediction
   a. Introduction and theoretical foundations
   b. Conformal prediction for regression
   c. Conformal prediction for classification
2. Algorithmic fairness
   a. Introduction to algorithmic fairness
   b. Framework for fairness in machine learning
   c. Measuring algorithmic fairness
   d. Testing for algorithmic fairness
   e. Mitigating algorithmic biases

KEY PROFESSIONAL SKILLS UPON GRADUATION

Understand how to make conformal prediction for regression and classification
Understand algorithmic fairness, and how to measure it, test it and mitigate its biases.

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures
Comment: Class exclusive for Magistere students.

Projects in Data Science (MAG)
Projets en Data Science (MAG)

COURSE LANGUAGE

English in Marseille

TEACHER

Pierre MICHEL – pierre.michel@univ-amu.fr
Christophe HURLIN – practitioner

COURSE DESCRIPTION AND OBJECTIVES

This course is complementary to the course of « Topics in data science ». The goal of this course is to make students work on projects related to the topics studied in the other course.

KEY PROFESSIONAL SKILLS UPON GRADUATION

To be able to tackle a data science problem and write a report to answer it.

ORGANIZATION

Semester: S2
Teaching Hours: 24 h of lectures
Comment: Class exclusive for Magistere students.