Données et Décisions Economiques et Financières
Data and Decisions in Economy and Finance
2021-2022
(2020-2021 and 2019-2020)

Syllabus de l'option DDEFi

L'option 3A DDEFi a été ouverte à partir de l'année académique 2019-2020. Le présent document est une photographie de la structure de l'option DDEFi lors de l'année académique 2021-2022. Bien qu'il y ait eu quelques évolutions entre les années académiques 2019-2020 et 2021-2022, les élèves de ces trois promotions devraient pouvoir trouver les informations concernant les cours suivis (programme, volume horaire, ECTS,...).
L'option DDEFi a pris la suite de l'option MMEFi qui a été proposée de l'année académique 2015 - 2016 à l'année académique 2018-2019.
Ce document est proposé à titre informatif pour les personnes ayant besoin de justifier du programme d'étude.

Responsable de l'option : Prof. Renaud Bourlès (Ecole centrale de Marseille)
Contact pour le présent document : Prof. Christophe Pouet (Ecole centrale de Marseille)

3rd Year Track DDEFi Syllabus

The 3rd year track DDEFi has been offered since academic year 2019-2020. This document describes the syllabus for academic year 2021-2022. There have been slight modifications since academic year 2019-2020. Students from academic years 2019-2020, 2020-2021 and 2021-2022 can refer to this document for information about coure units (content, hours, ECTS credits). This document is available for information purpose only to alumni who need to provide detailed information about the study programme.
The 3rd year track DDEFi follows the 3rd year track MMEFi which was offered from academic year 2015-2016 until academic year 2018-2019 (included).

Head of the track MMEFi: Prof. Renaud Bourlès (Ecole centrale de Marseille)
Contact for this document: Prof. Christophe Pouet (Ecole centrale de Marseille)

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Website: https://www.centrale-marseille.fr/

Option 3A
Données et Décisions Économiques et Financières (DDEFi)

For international students, this page is also available in the following languages

- English

L'option DDEFi en quelques lignes

Prenant la suite de l'option MMEFi (Mathématiques, Management, Economie et Finance), l'option 3A DDEFi offre aux élèves de 3ème année un choix diversifié d'enseignements centrés sur les mathématiques appliquées, l'économie et la finance et le traitement des données dans ces domaines. L'option permet aux élèves de se spécialiser au fur et à mesure de l'avancement du semestre. Elle offre des cours autour de la finance de marché, l'actuariat, le financement et la stratégie de l'entreprise, le traitement des données économiques et financières Dans un monde technologique et économique complexe, les mathématiques et leurs applications sont au coeur des instruments de décision : qu'il s'agisse de modéliser, de mesurer et de contrôler les risques liés aux phénomènes économiques ou aux instruments financiers, les outils mathématiques associés à la compréhension fine des phénomènes offrent des compétences largement appréciées dans de nombreux secteurs d'activité.

En parallèle de l'option DDEFi, les élèves peuvent suivre l'un des Masters suivants :

- Master Aix-Marseille School of Economics (AMSE), spécialité Finance quantitative et Assurance (correspondant Centrale Marseille : Renaud Bourlès)
- Master Mathématiques Appliquées et Statistique, parcours Data Science (en cours d'organisation avec l'option DDEFi, correspondant Centrale Marseille : Christophe Pouet)

Vous pouvez visiter la page dédiée aux Masters pour connaître les conditions de suivi en parallèle de l'option DDEFi.

Objectifs de la formation

Former des ingénieurs généralistes capables d'appréhender et de modéliser des situations complexes à partir de données financières et économiques pour élaborer des stratégies pertinentes de décision dans les domaines de la gestion, de la finance et de l'assurance. L'ingénieur généraliste de Centrale Marseille est capable de dialoguer avec les nombreux spécialistes intervenant en finance et en assurance et de faire la synthèse de points de vue venant de domaines différents. L'accent est mis sur les approches quantitatives et le traitement des données.

Structure de la formation

L'option DDEFi permet de valider 12 ECTS pour les cours et 5 ECTS pour le projet, soit un total de 17 ECTS.

Dedicated information for international students

Si vous êtes étudiant en échange de crédits à Centrale Marseille, vous trouverez plus d'informations sur la page de présentation en anglais.

If you are an incoming exchange student at Centrale Marseille, please check the English webpage with dedicated information for you.

Corps professoral

Il est composé d'enseignants-chercheurs de Centrale Marseille, d'enseignants-chercheurs et chercheurs extérieurs ainsi que de nombreux intervenants professionnels. Liste détaillée ici.

Liste des unités d'enseignement

Vous pouvez cliquer sur les noms des UE pour avoir une description.

Projet : de mi-Septembre à fin Mars				
Nom	**Code**	**ECTS**	**Volume horaire**	**Responsable**
Projet DDEFi		5	100h	

Période 1 : Tronc Commun				
Nom	**Code**	**ECTS**	**Volume horaire**	**Responsable**
Projet Data		3	60h	
Modèles et décisions		3	72h	

Période 2 : choix d'un parcours (1 cours au choix)				
Nom	**Code**	**ECTS**	**Volume horaire**	**Responsable**
Finance		3	72h	
Données et décisions		3	72h	

Période 3 : choix d'une spécialisation (1 cours au choix)				
Nom	**Code**	**ECTS**	**Volume horaire**	**Responsable**
Mathématiques financières		3	72h	
Finance d'entreprise		3	72h	
Actuariat		3	72h	
Analyse et données		3	72h	

L'option DDEFi est l'héritière de l'option MMEFi () et des options MAF () et GP2I (). Des informations sur les anciens programmes peuvent être trouvées sur une page spécifique.

Au Semestre 9, les élèves complètent l'option avec

- le tronc commun 3A de management (4 ECTS)
- l'UE Langues et Cultures Internationales (3 ECTS)

- la filière métier (6 ECTS) : celles qui ont le plus d'affinités avec l'option DDEFi sont Audit & Conseil (AUC), Entrepreneuriat (ENT), Recherche & Développement (R&D), Management Organisationnel (MO) et Production-Logistique (PRL).

Insertion professionnelle, poursuite d'études

- Banques, finance : BP2S, BNP-Paribas, Amundi,…
- Assurance, actuariat : Axa, Crédit Agricole Assurances,…
- Audit, conseil, services : Mazars, E&Y, Solucom, Orange,…
- Industrie : Chanel,…

Pour une liste détaillée des stages des trois dernières années, vous pouvez consulter la page Stages

Pour les emplois occupés par les diplômés de l'option DDEFi à la sortie de Centrale Marseille ou après quelques années, les élèves admis dans l'option DDEFi pourront consulter les informations disponibles dans le groupe LinkedIn *3A "Données et Décisions Economiques et Financières", Centrale Marseille*. L'adhésion à ce groupe dépend de l'admission dans l'option DDEFi.

Pour les élèves souhaitant approfondir leurs connaissances après l'obtention du diplôme d'Ingénieur généraliste de l'Ecole centrale de Marseille, une poursuite d'études est possible. Voici quelques exemples de formations ayant accepté les élèves de l'option DDEFi par le passé :

- Mastères spécialisés HEC, ESSEC, ESCP, EM Lyon
- Mastères spécialisés ENSAE (Actuariat, Finance de marché, Data Science)
- Mastère spécialisé IFP School
- Mastère spécialisé Mines de Paris
- Master Mathématiques et applications Université Paris Dauphine (Paris Sciences et Lettres) : MASEF, ISF, Actuariat
- Master MFD Ecole Nationale des Ponts et Chaussées et Université Gustave Eiffel
- Mastère spécialisé Ecole Nationale des Ponts et Chaussées M.S. Infrastructure Project Finance
- Master M2MO Université Paris Diderot
- Master London School of Economics
- MBA Collège des Ingénieurs

Flux d'informations en statistiques, économie et finance

AMF

- Séance publique de la Commission des sanctions (2022/05/05 07:31)
- La réglementation sur les ventes à découvert (VAD) (2022/05/04 14:00)

BCE

- ECB amends monetary policy implementation guidelines (2022/05/05 08:00)
- Fabio Panetta: Interview with La Stampa (2022/05/05 06:00)

Commission Européenne

Economie et l'Euro :

- Avenir de l'Europe: propositions ambitieuses de la plénière de la Conférence, pour une révision des traités par europa.eu/newsroom (2022/04/29 22:00)
- Pacte vert: Moderniser les règles de l'UE relatives aux émissions industrielles afin d'orienter les grandes industries dans la transition écologique à long terme par europa.eu/newsroom (2022/04/04 22:00)

Statistiques :

- Dernière enquête Eurobaromètre (juillet-août): la conjoncture économique est la principale préoccupation des citoyens de l'UE dans le contexte de la pandémie de COVID-19 par europa.eu/newsroom (2020/10/22 22:00)
- Sécurité routière : les routes européennes deviennent plus sûres mais les progrès demeurent trop lents par europa.eu/newsroom (2020/06/10 22:00)

3rd Year Track DDEFi
Data, Decisions in Economics and Finance
(Données, Décisions Economiques et Financières in French)

Graduate Program outlines

The graduate program is designed to offer a wide range of courses into several fields : Mathematical Finance, Insurance or Quantitative Management.

Technology and economy are more and more complex. Mathematics and their applications are the heart of the decision tool needed in this world: they help to model, evaluate and control risks associated to industrial processes, economical phenomena or financial products. The knowledge of mathematical tools associated to a deep understanding of theses phenomena is largely appreciated in many areas.

Depending on the status of the student, the student can also attend a Master program in parallel with the track DDEFi :

- Master Aix-Marseille School of Economics (AMSE), track Finance Quantitative et Assurance (information contact at Centrale Marseille: Renaud Bourlès)
- Master in Applied Mathematics and Statistics, track Data Science (information contact at Centrale Marseille: Christophe Pouet)

Goals

Prepare students to become highly skilled engineers able to recognize and model complex problems in order to develop adequate strategical decisions

The main topics are finance, insurance, probability, statistics, scientific computing, optimization, mathematical modelling for risks in economy and finance, actuarial science, marketing, quantitative management.

Important information for exchange students

EXCHANGE STUDENTS: This section contains VERY IMPORTANT information for preparing your mobility.

Number of accepted students

The 3rd Year scientific tracks such as DDEFi have a limited number of accepted students. Priority is given to Centrale Marseille engineering degree students. Nevertheless, the track DDEFi has always been able to accept exchange students (usually 3 or 4).

Academic calendar

Please note the special duration of Semester 9: the 3rd Year **Fall-Winter semester extends from early September to end of March/early April**. Check with your local coordinator if it fits your mobility window.

Language of instruction

If you intend to come for one year at Ecole centrale de Marseille, please note that depending on the number of credits taken, your proficiency in French must be at least at intermediate level (level B1 or higher recommended).

Please note that the instruction language is English for many course units in the track DDEFi.

Number of credits for a full exchange year

If you intend to come for one year, the Spring semester will necessarily be a research or work placement (equivalent to a Master Thesis, 30 ECTS). We cannot offer courses during the Spring semester to students who attend 3rd year courses. This is due to academic calendar constraints.

Please check the information below about credits.

Availability of courses

- Courses may be cancelled with very short notice (e.g. if not enough students sign up for the course), although that should happen very seldom in the 3rd year track DDEFi.
- Courses may be overbooked (too many students sign up) preventing you from taking the course. Priority is given to degree-seeking students.

Structure of the program

The track DDEFi allows a student to validate 12 ECTS for courses and 5 ECTS for a team project. If as an exchange student you need to validate between 18 and 30 ECTS during a semester, please read CAREFULLY what is written below the table.

Academic Team

Instructors are from Centrale Marseille, from other HEI's (such as Aix-Marseile Université or Kedge BS) or highly skilled practitionners from renowned companies. Full list of instructors available in French here

List of course units

Warning! This list will change for academic year 2022-2023. The courses will be more or less the same but the course units will be different. We will update the table below as soon as possible.

The DDEFi track offers 12 ECTS credits for the taught courses and 5 ECTS credits for the DDEFi project (team project with a private company).

The structure of the program DDEFi is the following

Team Project : from mid-September to end of March					
English Name	**French name**	**Code**	**ECTS**	**Contact hours**	**Coordinator**
DDEFi project	Projet DDEFi		5	100h	

Period 1 : Common core					
English Name	**French name**	**Code**	**ECTS**	**Contact hours**	**Coordinator**
Data science project	Projet Data		3	60h	
Models and Decisions	Modèles et décisions		3	72h	

Period 2 : major (1 course unit to be chosen)					
English Name	**French name**	**Code**	**ECTS**	**Contact hours**	**Coordinator**
Finance	Finance		3	72h	
Data and decisions	Données et décisions		3	72h	

Period 3 : specialised course unit (1 course unit to be chosen)					
English Name	**French name**	**Code**	**ECTS**	**Contact hours**	**Coordinator**
Mathematical finance	Mathématiques financières		3	72h	
Corporate finance	Finance d'entreprise		3	72h	
Actuarial science	Actuariat		3	72h	
Data analysis	Analyse et données		3	72h	

If as an exchange student, you need between 18 and 30 ECTS for your exchange semester, then you have to choose courses in the following offer (beware that most courses are in French)

- 3rd Year Common Core in Management (4 ECTS)
- International cultures and foreign languages (3 ECTS) : for example you can attend a course called French as a Foreign Language (the introduction week for international students has also an intensive French language course that can lead to credits).
- Professional track (6 ECTS) : the professional tracks that best suit the track DDEFi are Audit & Counselling (AUC), Entrepreneurship (ENT), Research & Development (R&D), Organisational Management (MO) et Production-Logistics (PRL).

An alternative solution is to attend courses from a Master programme or see if some joint courses between DDEFi track and Master programmes can be recognized as Master

courses in your transcript of academic records (you usually get more ECTS credits in a Master programme than in the DDEFi track, even for the same course). **Please contact the DDEFi track coordinator for more information.**

Career prospects and postgraduate studies

- Banks, finance : BP2S, BNP-Paribas, Amundi,…
- Insurance, actuarial science : Axa, Crédit Agricole Assurances,…
- Audit, counselling, services : Mazars, E&Y, Solucom, Orange,…
- Industry : Chanel,…

For a more complete list of companies, please check the webpage (in French) Employeurs potentiels : du stage au premier emploi

After their graduation at Ecole centrale de Marseille, some students have attended one of the following graduate/postgraduate programmes:

- Mastères spécialisés HEC, ESSEC, ESCP, EM Lyon
- Mastères spécialisés ENSAE (Actuariat, Finance de marché)
- Mastère spécialisé IFP School
- Mastère spécialisé Mines de Paris
- Master MASEF, IEF Université Paris Dauphine
- Master Mathématiques Appliqées à la Finance Ecole Nationale des Ponts et Chaussées et Université Paris-Est Marne-la-Vallée
- Master M2MO Université Paris Diderot
- Master London School of Economics
- MBA Collège des Ingénieurs

Projet DDEFi

- Titre en anglais : DDEFI project
- Code du cours : à venir
- Crédits ECTS : 5
- Période : de septembre à fin mars
- Responsable : Renaud Bourlès
- Tuteur(s) : professionnels, enseignants-chercheurs du corps professoral
- Evaluation : rapport, soutenance orale et évaluation du tuteur

Description

Le projet DDEFi est un travail qui met les élèves en situation professionnelle dès le début de la 3A et qui les confronte à un problème complexe posé par une entreprise (PME, grand groupe, start-up), une association, une structure publique ou un chercheur. Il est proposé sous la forme d'un travail de groupe afin que les élèves puissent mettre en application les outils introduits dans les cours de gestion et de management dispensés dans le cursus ingénieur de Centrale Marseille.

Si vous êtes une entreprise ou une structure souhaitant proposer un sujet, vous pouvez contacter le responsable de l'UE, Renaud Bourlès, pour connaître les modalités de collaboration.

Clients des projets

Les clients des projets sont des entreprises, des associations, des structures para-publiques, des laboratoires de recherche,…

L'option DDEFi remercie les entreprises qui confient régulièrement des projets aux élèves et contribuent ainsi à la formation des ingénieurs centraliens de Marseille : BNP-Paribas, BP2S, Axa, AOPS Conseil, E&Y, Marseille Innovation, Goji Markets, BonPlanCinema, InPact, Abel4Com, Happy Capital, WeeFin.

Exemples de projets

- Construction de pricers automatisés pour l'analyse du besoin en couverture pour une start-up financière
- Construction d'un indice de marché optimal (smart benchmark) limité aux entreprises dites “socialement responsables” pour un grand groupe financier
- Construction d'un outil d'analyse, de sélection, et de notation des entreprises pour une start-up financière
- Contribution au développement de la stratégie financière et commerciale d'une start-up
- Création d'un générateur de scenarii financiers et économiques pour un grand groupe financier
- Etude de l'impact du turnover sur les provisions des engagements sociaux (dans le cadre d'un contrat de recherche)
- Proposition de méthodes d'évaluation de stock-options (dans le cadre d'un contrat de recherche)
- Réalisation d'une étude de marché et d'un plan marketing pour une start-up
- Réalisation d'un outil de prévisions de trésorerie dans une activité de trading de matières

premières pour un grand groupe financier
- Réalisation d'un “benchmarking” de la gestion privée pour une start-up financière
- Validation de modèles d'inflation pour un grand groupe financier
- …

Course unit: Data science project

Course metadata

- Title in French: Projet data
- Course code: tba
- ECTS credits: 3
- Teaching hours: 60h
- Type: advanced course
- Language of instruction: French
- Coordinator: tba
- Instructor(s): Alexandre Chirié (Mantiks), Maximilien Defourné (Mantiks)
- *Last update 27/08/2021 by C. Pouet*

Brief description

The course consists of a theoretical part and a practical part, simulating a business project.

Learning outcomes

- Understand the workflow of a data science project in a business context
- Be able to account for business (collection of needs, project lifecycle, communication) and technical (data, machine learning, scaling) constraints

Course content

1. Data science in business
    - The main issues
    - Examples of data project
2. Starting a data science project
    - The constraints of data science projects
    - Finding data
    - Acquiring information
    - Playing with data
3. Lifecycle of a project
    - The Bias-Variance tradeoff
    - Feature Selection
    - Feature Engineering
    - Defining a metric
4. The basic models
    - Regressions (linear, polynomial, penalized et logistic)
    - Decision trees (random forest and gradient boosting)
5. Focus Natural Language Processing (NLP)
    - Word Embedding
    - Example: Sentiment analysis

Bibliography

Check the availability of the books below at Centrale Marseille library.

- Zeng, A and Casari, A. Feature Engineering for Machine Learning. O'Reilly Media.
- Müller, A. and Guido, S. Introduction to Machine Learning with Python. O'Reilly Media.

Course unit: Models and Decisions

Course metadata

- Title in French: Modèles et Décisions
- Course code: tba
- ECTS credits: 3
- Teaching hours: 72h
- Type: ground course
- Language of instruction: English and French
- Coordinator: tba
- Instructor(s): Dominique Henriet, Christophe Pouet, Clément Depoutre (BNP Paribas), Gaël Leboeuf (Aix-Marseille Université)
- *Last update 27/08/2021 by C. Pouet*

Brief description

This course unit is divided into three parts:

- **Risk and decision** (24 hours) taught by Dominique Henriet and Clément Depoutre
- **Statistics and decisions** (24 hours) taught by Christophe Pouet
- **Corporate finance** (24 hours) taught by Gaël Leboeuf

Learning outcomes

- Understand how to take decision under uncertainty
- Learn how to assess risk and how to compare risky situations
- Learn how to model, estimate and predict time series
- Understand how capital structure affects the value of the firm

Course content

Risk and decision

1. Introduction: diversification and mutualization
2. Risk measure
3. Expected utility
4. Supply and demand: the price of risk
5. The value of information
6. Market & Counterparty Risk Management

Statistics and decisions

1. Reminder on probability: conditional expectation
2. Stochastic processes in discrete and continuous time

3. ARMA process: definition, existence, characteristics (autocovariance, partial autocovariance)
4. Estimation of ARMA processes: identification, parameters estimation and validation
5. Extensions: SARIMA, ARCH and GARCH processes

Corporate finance

1. The Corporation
2. Introduction to Financial Statements Analysis
3. Financial Decision Making and the Law of One Price
4. The Time Value of Money
5. Investment Decision Rules
6. Fundamentals of Capital Budgeting
7. Capital Markets and The Pricing of Risk
8. Optimal Portfolio Choice and the Capital Asset Pricing Model
9. Estimatong the Cost of Capital
10. Capital Structure in a Perfect Market
11. Mergers and Acquisitiions

Bibliography

Check the availability of the books below at Centrale Marseille library.

1. Risk and decision
   - course ebook
   - Gollier, C., Schlesinger, H. and Eeckhoudt, L. (2005). Economic and Financial Decisions Under Risk. Princeton University Press
2. Statistics and decisions
   - course handout
   - Brockwell, P.J. and Davis, R.A. (1991). Time Series: Theory and Methods. Second Edition. New York: Springer Verlag.
   - Box, J.E.P. and Jenkins, G.M. (1970). Time Series Analysis; Forecasting and Control. San Francisco: Holden Day.
3. Corporate finance
   - Berk, J. and DeMarzo, P. (2019) Corporate finance. Prentice Hall; 5th edition.
   - Aswath Damodaran at NYU: Course and video materials, formulas, spreadsheets, estimated risk premium, Cost of capital by sector and more.
   - The Vernimmen handbook homepage: Course and video materials, formulas, spreadsheets, corrected exercises and case studies, newsletter, financial data on 7,000 listed companies and more.
   - AMF. Annual reports and legal informations on French listed companies.
   - Yahoo! Finance. Financial data on listed companies.

Course unit: Finance

Course metadata

- Title in French: Finance
- Course code: tba
- ECTS credits: 3
- Teaching hours: 72h
- Type: advanced course
- Language of instruction: English
- Coordinator: tba
- Instructor(s): Grégoire Hug (WeeFin), Bolanjinva Randrianarizafy (Natixis), Julien Belon (Arx Corporate Finance), Vincent Bonnamy (La Banque Postal Asset Management)
- *Last update 24/03/2021 by C. Pouet*

Brief description

This course is taught by highly skilled professionals in finance.

This course unit is divided into three parts:

- **Portfolio management** (24 hours) taught by Grégoire Hug.
- **Credit risk** (24 hours) taught by Bolanjinva Randrianarizafy: this part is dedicated to credit risk and its role in banking regulation.
- **Applied finance** (24 hours) taught by Julien Belon and Vincent Bonnamy: this part is about the theoretical aspects of corporate and market finance applied in real life.

Learning outcomes

- Understand the similarities in the concepts of market and corporate finance
- Understand how finance products can be used to manage risk
- Know how to organize an investment process
- Know how to evaluate and to value a company
- Understand the definition, measurement and pricing of credit risk
- Know how banks are regulated
- Know the various jobs of finance

Course content

Portfolio management

1. Introduction to portfolio management
2. Equity Investing and investment process
3. Fixed Income Investing - basics
4. Fixed Income Investing - advanced
5. Alternative asset classes and Performance Measurement

6. Asset management trends
7. Project: Portfolio construction

Credit risk

1. Introduction: bonds and OTC transactions
2. Modeling defaults: structural models and ratings
3. Structured financing: plain-vanilla, asset financing, securitization etc.
4. Banking regulation on credit risk

Applied finance

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

Bibliography

Check the availability of the books below at Centrale Marseille library.

1. Portfolio management
    - Roland Portait, Patrice Poncet (2014). Market Finance.
    - Franck J. Fabozzi (2012). The Handbook of Fixed Income Securities.
2. Credit risk
    - Gourieroux C. and Tiomo, A. (2007) Risque de crédit : une approche avancée, Economica.
    - Merton R. (1998) Continuous time finance, Blackwell Publishers.
    - Bruyere R., Cont R., Fery L., Jaeck C. and Spitz T. (2005). Credit derivatives, Wiley.
    - Roncalli T. (2016). Risk Management & Financial Regulation (website)
3. Applied finance
    - Vernimmen, P. (2021). Finance d’entreprise. Dalloz.
    - Hull, J. (2018). Options, Futures, and Other Derivatives, 10th Edition. Pearson

Course unit: Data and Decisions

Course metadata

- Title in French: Données et Décisions
- Course code: tba
- ECTS credits: 3
- Teaching hours: 72h
- Type: advanced course
- Language of instruction: French
- Coordinator: tba
- Instructor(s): François Brucker, Michaël Chalamel (L'Oréal), Franck Chevalier (EY), Emmanuel Daucé, Christophe Pouet
- *Last update 24/03/2021 by C. Pouet*

Brief description

This course unit is divided into three parts:

- **Statistical learning** (24 hours) taught by Christophe Pouet.
- **Python for data science** (24 hours) taught by François Brucker and Emmanuel Daucé.
- **Advising using data** (24 hours)taught by Michaël Chalamel and Franck Chevalier.

Learning outcomes

- Know how to model and program an estimation problem
- Know how to model and program a classification problem
- Know how to acquire and aggregate data
- Know how to use data to take decisions
- Understand the importance of data governance and data quality

Course content

Statistical learning

1. Introduction
    1. Classical problems: regression, classification
    2. Supervised, unsupervised and semi-supervised learning
    3. Curse of dimensionality
2. Regression
    1. Multiple linear regression, OLS method
    2. Shrinkage-type methods (LASSO, Ridge)
    3. k-nearest neighbors
3. Classification
    1. Logistic regression
    2. k-nearest neighbors

    3. SVM
    4. Rosenblatt perceptron and neuronal networks

Python for data science

1. Dataframe: data exploration and data description
2. Spotting patterns using factor
    1. Principal Component Analysis
    2. Correspondence analysis
3. Prediction using trend analysis
    1. Linear regression
    2. Logistic regression
4. Data classification
    1. Classification using partitions
    2. Hierarchical methods

Data-driven decision making

1. What is data?
2. How do we take decision?
3. Data governance and data quality
4. How to develop data-based decision making?
5. Data platform and data architecture

Bibliography

Check the availability of the books below at Centrale Marseille library.

1. Statistical Learning
    - James G., Witten D., Hastie T. and al. (2013). An introduction to statistical learning: with applications in R. New York: Springer
    - Hastie T., Tibshirani R. and Friedman J. (2013). The elements of statistical learning: data mining, inference, and prediction. New York: Springer.
    - Cornillon P-A., Matzner-Løber E. et al. (2010). Régression avec R. Paris: Springer.
2. Python for data science
    - Jannach, D., Zanker, M., Felfernig, A. and Friedrich, G. (2010). Recommender Systems: An Introduction. Cambridge.
3. Advising using data
    - tba

Course unit: Corporate Finance

Course metadata

- Title in French: Finance d'entreprise
- Course code: tba
- ECTS credits: 3
- Teaching hours: 72h
- Type: specialized course
- Language of instruction: English and French
- Coordinator: tba
- Instructor(s): Amaury Schoenauer (Caisse d'Epargne CEPAC), Mehdi El Alaoui (International Finance Corporation), Benoît Forgues (Rgreen), Olivier Vandooren (Sigée Finance), Julien Belon (Arx Corporate Finance), Hugues Chabalier (2CFinance),

Mathieu Rebbi (EY)

- *Last update 24/03/2021 by C. Pouet*

Brief description

This course unit is divided into three parts:

- **Structured finance** (24 hours) taught by Amaury Schoenauer,
- **Project finance** (24 hours) taught by Mehdi El Alaoui, Benoît Forgues and Olivier Vandooren,
- **Workshop in corporate finance** (24 hours) taught by Julien Belon, Hugues Chabalier and Mathieu Rebbi.

Learning outcomes

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

Course content

Structured finance

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
    - Leases and Rental Conditions
    - Valuation Report
5. Other operations
6. Perspectives on Market Finance (Securitization)

Project finance

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?

Workshop in corporate finance

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

Bibliography

Check the availability of the books below at Centrale Marseille library.

1. Structured finance
    - Vernimmen, P. (2021). Finance d’entreprise. Dalloz.
2. Project finance
    - tba
3. Workshop in corporate finance
    - tba

Course unit: Mathematical finance

Course metadata

- Title in French: Mathématiques financières
- Course code: tba
- ECTS credits: 3
- Teaching hours: 72h
- Type: specialized course
- Language of instruction: English
- Coordinator: tba
- Instructor(s): Sébastien Darses (AMU), Ismaïl Akil (tba), Abderrahim Ben Jazia (RSM Paris)
- *Last update 27/08/2021 by C. Pouet*

Brief description

The aim of the course is to provide students with mathematical methods that allow valuating financial assets.

This course unit is divided into three parts:

- **Stochastic calculus and introduction to the Black-Scholes model** (24 hours) taught by Sébastien Darses.
- **Volatility models** (24 hours) taught by Ismaïl Akil.
- **Interest rate models** (24 hours) taught by Abderrahim Ben Jazia.

Learning outcomes

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

Course content

Stochastic calculus and introduction to the Black-Scholes model

1. Gaussian variable and stochastic processes
2. Brownian motions
3. Stochastic integration and semi-martingales
4. Stochastic differential equations
5. Parabolic partial differential equations and semigroups
6. Measure change and Girsanov theorem

7. Introduction to financial mathematics

Volatility models

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

Interest rate models

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

Bibliography

Check the availability of the books below at Centrale Marseille library. - Stochastic calculus

- Evans, L. (2010). An Introduction to Stochastic Differential Equation. American Mathematical Society.
- Le Gall, J.-F. (2006). Intégration, Probabilités et Processus Aléatoires. Ecole Normale Supérieure de Paris

- Volatility models

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

- Interest rate models

- 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.

Course unit: Actuarial science

Course metadata

- Title in French: Actuariat
- Course code: tba
- ECTS credits: 3
- Teaching hours: 72h
- Type: specialized course
- Language of instruction: English
- Coordinator: Renaud Bourlès
- Instructor(s): Mitra Fouladirad, Alexis Louass (Ecole Polytechnique-Institut Polytechnique de Paris), Arnaud Goussebaïle (ETH Zürich) Xavier Guerrault (AXA), Renaud Mouyrin (AXA), Matthias Servel (AXA), Corinne Cherki (AXA), Alban Davand (AXA), Carelle Merlo (AXA, Emmanuelle Mimart (AXA), Sofiane Ournidi (AXA), Yannick Ropert (AXA)
- *Last update 27/08/2021 by C. Pouet*

Course description

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

This course unit is divided into three parts:

- **Economics of insurance** (24 hours) taught by Alexis Louass and Arnaud Goussebaïle.
- **Actuarial science 1** (24 hours) taught by Mitra Fouladirad, Xavier Guerrault, Renaud Mouyrin, Matthias Servel.
- **Actuarial science 2** (24 hours) taught by Xavier Guerrault, Corinne Cherki, Alban Davand, Carelle Merlo, Emmanuelle Mimart, Sofiane Ournidi, Yannick Ropert.

Learning outcomes

- 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
- Understand the need of provisioning and know the basic model to compute provisions
- Know the current regulation and its impact on insurance pricing and provisioning
- Know how to value an insurance portfolio

Course content

Economics of insurance

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

Actuarial science 1

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

Actuarial science 2

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

Bibliography

Check the availability of the books below at Centrale Marseille library.

1. Economics of insurance
    - course handout
    - Picard, P., Economic Analysis of Insurance Fraud. Handbook of Insurance.
    - Schlessinger, H., The Theory of Insurance Demand. Handbook of Insurance.
2. Actuarial science 1 and 2
    - Charpentier A. (ed.), Computational Actuarial Science with R, Chapman and Hall/CRC.
    - Tosetti A., Weiss F. et Poncelin T., Les outils de l'actuariat vie, Economica .

Course unit: Data and analytics

Course metadata

- Title in French: Analyses et données
- Course code: tba
- ECTS credits: 3
- Teaching hours: 72h
- Type: specialized course
- Language of instruction: French
- Coordinator: tba
- Instructor(s): Augustin Amann (S4M), Vincent Archer (S4M), Aurélien Poissonier (DGAFP), Régis Chenavaz (Kedge BS), Antoine Winckels (Air France)
- *Last update 24/03/2021 by C. Pouet*

Brief description

This course unit is divided into three parts:

- **Quantitative marketing** (24 hours) taught by Augustin Amann and Vincent Archer,
- **Data and macroeconomics** (24 hours) taught by Aurélien Poissonier,
- **Yield management** (24 hours) taught by Régis Chenavaz and Antoine Winckels.

Learning outcomes

- Know how to use data in a strategic approach
- Know how to present a model, its results and its insights
- Know how to assess data suitability to a specific issue
- Know how to model intertemporal strategic decisions
- Know how to combine model and data to take pricing decisions

Course content

Quantitative marketing

1. Data processing
    - Data: a story of representation
    - Data in business
    - From segmentation to dynamic targeting
2. Marketing from a Data Scientist point of view
    - Context: the data world
    - Scoring
    - Statistics
    - Correlations
    - Automatic learning
    - Supervised classification

    - Perspectives

Data and macroeconomics

This course aims at giving a broad view of macroeconomic data. It is structured around three questions:

1. Can we measure everything?
2. Can we sum everything?
3. Can we compare everything?

These questions will allow to tackle multiple sources for macroeconomic data, their methodology, their limits, and to discuss their common applications. At the end of the course, students should have acquired enough hindsight to use pertinent macroeconomic data to answer a practical question.

Yield management

1. Dynamic pricing
    - Modeling firm's intertemporal price-setting decisions
    - The price-quality relationship
    - Modeling project: managerial decision in an intertemporal framework.
2. Application to yield management in air transport
    - Single leg resource management
    - Network resource management
    - Demand forecasting

Bibliography

Check the availability of the books below at Centrale Marseille library.

1. Quantitatve marketing
    - Abiteboul, S., « Sciences des données : de la logique du premier ordre à la Toile », Leçon inaugurale du Collège de France : site de Serge Abiteboul au Collège de France (vidéo et documents de la leçon inaugurale)
2. Data and macroeconomics
    - INSEE
    - Eurostat
    - Datagora
3. Yield management
    - Sorger, G. Reference price formation and optimal marketing strategies, In Optimal Control Theory and Economic Analysis 3, G. Feichtinger (editor), Elsevier Science Publishers (North-Holland, 1988).
    - Talluri, K. T., Van Ryzin, G. J., The Theory and Practice of Revenue Management, Springer 2004.
    - Belobaba, Peter. 16.75J Airline Management, Spring 2006. MIT OpenCourseWare.
    - Frumin, Michael, and Moshe Ben-Akiva. 1.201J Transportation Systems Analysis: Demand and Economics, Fall 2008. MIT OpenCourseWare.