

# First Banco Santander Financial Engineering School

Centre de Recerca Matemàtica, Barcelona

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## Class 1: Backtesting of Financial Risk Models, 2nd March 2021

### Part A: Theory (1.5 hours)

1. Fundamentals of Financial Risk Modelling
  - a. Portfolios and risk factors
  - b. Loss distributions
  - c. Measures of risk
  - d. Financial time series
  - e. Regulatory framework (Basel III)
2. Fundamentals of Backtesting
  - a. VaR exceptions
  - b. Tests for counts and spacings
  - c. Unconditional and conditional backtesting
  - d. Tests for expected shortfall
  - e. Comparative tests based on elicibility concept
3. New Backtesting Methods Using PIT values
  - a. PIT values
  - b. The spectral backtesting framework
  - c. Multinomial backtesting
  - d. Martingale difference tests

### Part B: Practical Examples with R (1.5 hours)

- Quantile estimation
- Financial time series in R with rugarch
- Simulation studies in R with simsalapar
- Spectral backtesting in R with spectralBacktest

### Literature:

- McNeil A.J., Frey, R. and Embrechts, P. (2015). Quantitative Risk Management: Concepts Techniques & Tools, Princeton University Press, (2nd edition).
- Gordy, M.B. and McNeil A.J. (2020), Spectral backtests of forecast distributions with application to risk management, Journal of Banking & Finance, 116.

## Class 2: Models for Dependent Risks Using Copulas, 9th March 2021

### Part A: Theory (1.5 hours)

1. Fundamentals of Copulas
  - a. Definition and properties
  - b. Examples
  - c. Simulation
  - d. Estimation with maximum likelihood
  - e. Estimation with rank correlation
2. Attainability of Kendall Rank Correlations
  - a. Motivation: eliciting measures of dependence
  - b. Concordance probabilities

- c. Extremal mixture copulas
  - d. Concordance signatures
  - e. Testing for attainability
3. Copulas for time series
- a. ARMA copulas
  - b. D-vine copulas
  - c. V-transforms
  - d. Examples (including Bitcoin)

Part B: Practical Examples with R (1.5 hours)

- Simulating copulas in R with copula package
- Estimating copulas in R with copula
- Attainable rank correlations in R with KendallSignature
- Time series copulas in R with tscopula

Literature:

- McNeil A.J., Frey, R. and Embrechts, P. (2015). Quantitative Risk Management: Concepts Techniques & Tools, Princeton University Press, (2nd edition).
- McNeil A.J., Neslehova, J.G. and Smith, A.D. (2020). On attainability of Kendall's tau matrices and concordance signatures, <https://arxiv.org/abs/2009.08130>.
- McNeil A.J. (2021). Modelling volatile time series with v-transforms and copulas, *Risks* 9(1).
- Bladt, M. and McNeil A.J. (2020). Time series copula models using d-vines and vtransforms: an alternative to GARCH modelling, <https://arxiv.org/abs/2006.11088>.