# USE CASES AI, MARKET RISK AND ROBOT ADVISORY

## USE CASE #1

### MARKET STRUCTURE DISCOVERY WITH CLIQUE FORESTS PLATFORMS

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We propose a topological learning algorithm for the estimation of the conditional dependency structure of large sets of random variables from sparse and noisy data. The algorithm, named Maximally Filtered Clique Forest (MFCF), produces a clique forest and an associated Markov Random Field (MRF) by generalising Prim's minimum spanning tree algorithm. To the best of our knowledge, the MFCF presents three elements of novelty with respect to existing structure learning approaches. The first is the repeated application of a local topological move, the clique expansion, that preserves the decomposability of the underlying graph. Through this move the decomposability and calculation of scores is performed incrementally at the variable (rather than edge) level, and this provides better computational performance and an intuitive application of multivariate statistical tests. The second is the capability to accommodate a variety of score functions and, while this paper is focused on multivariate normal distributions, it can be directly generalised to different types of statistics. Finally, the third is the variable range of allowed clique sizes which is an adjustable topological constraint that acts as a topological penalizer providing a way to tackle sparsity at lo semi-norm level; this allows a clean decoupling of structure learning and parameter estimation. The MFCF produces a representation of the clique forest, together with a perfect ordering of the cliques and a perfect elimination ordering for the vertices. As an example we propose an application to covariance selection models and we show that the MCFC outperforms the Graphical Lasso for a number of classes of matrices.

Keywords: Markov random fields, clique forest, topological learning, structure learning, TMFG, LoGo, chordal graphs

## USE CASE #2

### CONVERGENCE AND DIVERGENCE IN EUROPEAN BOND CORRELATIONS

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From 2004 to 2015, the market perception of the sovereign risks of the euro area government bonds experienced several different phases, reflected in a clear time structure of the correlation matrix between the yield changes. “Core” and “peripheral” bonds cluster in a bloc-like structure, but the correlations between the blocs are time-dependent and even become negative in periods of stress. Using noise-filtered partial correlation influences, this time dependency can be evaluated and

visualized using network graphs. Our results support the view that market-implied spillover risks have decreased since the European rescue and stability mechanisms came into force in 2011. EFSF bond issues have been trading as part of the "core" bloc since 2011. In 2015, spillover risks reappeared during the Eurogroup's negotiations with Greece, although the periphery yields did not show risk spreads that were as large as those in 2012.

Keywords: Contagion risk; correlation networks; euro area; sovereign bonds; European Stability Mechanism; financial stability

## USE CASE #3

### SOVEREIGN RISK ZONES IN EUROPE DURING AND AFTER THE DEBT CRISIS

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We employ a machine learning approach to build a European sovereign risk stratification using macroeconomic fundamentals and contagion measures, proxied by copula-based credit default swap (CDS) dependencies over the period 2008–2017, for France, Germany, Greece, Ireland, Italy, Portugal, and Spain. By adopting a recursive partitioning strategy, we detect specific risk zones varying from safe to high risk based on key predictors, and we construct their specification by assigning specific risk thresholds. While key macroeconomic fundamentals such as Debt/GDP and the unemployment rate remained the same and maintained the same risk thresholds during the subperiods 2008–2013 and 2013–2017, the CDS spreads contagion dropped significantly over the post-Quantitative Easing years, lowering the corresponding risk thresholds. We estimate an impact on CDS spreads approximately of −105 basis points in the period 2013–2017 due to contagion mitigation.

Keywords: Contagion, Copula, Credit default swaps, Machine learning, Regression trees, Systemic

risk

## USE CASE #4

### ARE CRYPTOCURRENCIES CONNECTED TO FOREX? A QUANTILE CROSS-SPECTRAL APPROACH

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This paper analyzes the connectedness between forex and cryptocurrencies using the quantile cross-spectral approach. The sample covers six forex and six cryptocurrencies over the period of September 2015–December 2017. Compared with the results obtained from standard correlations and DMCA, the quantile cross-spectral approach provides richer information on the dependence structure across different quantiles and frequencies. The results show that there are some significant negative dependencies between forex and cryptocurrencies from both the short- and long-term perspectives; thus, it is worth diversifying between these two asset groups. Moreover, the connection between cryptocurrencies is not as strong as is widely believed.

Keywords: Cryptocurrencies, Forex, Quantile dependence, Cross-spectral, Diversification

## USE CASE #5

## NETWORK MODELS TO IMPROVE ROBOT ADVISORY PORTFOLIO MANAGEMENT

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Robot advisory services are rapidly expanding, responding to a growing interest people have in directly managing their savings. Robot advisors may reduce costs and improve the quality of the service, making user involvement more transparent. However, they may underestimate market risks, especially when highly correlated assets are being considered, leading to a mismatch between investors' expected and actual risk. The aim of the paper is to enhance robot advisory portfolio allocation, taking users' preference into account. In particular, we demonstrate how Random Matrix Theory and Network models can be combined to construct investment portfolios that provide lower risks with respect to standard Markovitz portfolios. To demonstrate the advantages of this approach we employ the observed returns of a large set of ETFs, which is representative of the financial products at the ground of the activity of robot advisors.