# Abstracts of papers to be presented at the MACHINE LEARNING FOR FINANCE workshop

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**Stock price forecasting over adaptive timescale using Supervised Learning and Receptive Fields**
Cimino Mario, Monaco Manilo, Vaglini Gigliola (University of Pisa, Italy)
Abstract: *Pattern recognition in financial time series is not a trivial task, due to level of noise, volatile context, lack of formal definitions and high number of pattern variants. A current research trend involves machine learning techniques and online computing. However, medium-term trading is still based on human-centric heuristics, and the integration with machine learning support remains relatively unexplored. The purpose of this study is to investigate potential and perspectives of a novel architectural topology providing modularity, scalability and personalization capabilities. The proposed architecture is based on the concept of Receptive Fields (RF), i.e., sub-modules focusing on specific patterns, that can be connected to further levels of processing to analyze the price dynamics on different granularities and different abstraction levels. Both Multilayer Perceptrons (MLP) and Support Vector Machines (SVM) have been experimented as a RF. Early experiments have been carried out over the FTSE-MIB index.*

**Machine Learning, pricing and risk measures**
Cocco Flavio, Rossi Pietro (Prometeia, Italy)
Abstract: *In this work we are interested in building the future distribution of profit and losses (P&L) of a portfolio. As is well known this problem has a direct solution if we consider only assets whose future prices have a fast analytical solution. If we are not within this context, and the only way to compute the PV of an asset is via Monte Carlo, we are in the unpleasant situation that for each scenario we must perform a new simulation. The problem can easily turn out to be intractable. One way out of this deadlock is to resort to techniques inspired by the 'Least Square Monte Carlo' (LSM) to estimate, via back propagation, the continuation value of the portfolio produced by the 'optimal strategy'. The approach we follow is along the lines of the LSM method, but with some, hopefully, signicant variation. Interpolation is done using 'feed forward neural networks' (FFNN). This seems to cure the 'dimensionality curse' associated with the polynomial interpolators and FFNN ability to learn (fit) the price of the portfolio is remarkable. Rather than using just one trajectory to propagate back the continuation value, from each time horizon we perform a short MC with very few trajectories that, at each horizon, we use to train the network to 'learn' the correct price. Once we have the coecients of the trained network at each t we launch a large simulation and compute the desired distribution using our network. The idea behind, that we want to check in this work, is that even with relatively few trajectory in the training phase, we can still obtained an unbiased set of FFNN capable to produce the correct distribution.*

**Forecasting benchmarks of long-term stock returns via Machine Learning**
Kyriakou Ioannis, Parastoo Mousavi, Jens Perch Nielsen, Michael Scholz (Case Business School, University Of London, United Kingdom)
Abstract: *Recent advances in pension product development seem to favour alternatives to the risk free asset often used in the ?nancial theory as a performance standard for measuring the value generated by an investment or a reference point for determining the value of a ?nancial instrument. To this end, we apply the simplest machine learning technique, namely, a fully nonparametric smoother with the covariates and the smoothing parameter chosen by cross-validation to forecast stock returns in excess of different benchmarks, including the short-term interest rate, long-term interest rate, earnings-by-price ratio, and the in?ation. We ?nd that, net-of-in?ation, the combined earnings-by-price and long-short rate spread form our best-performing two-dimensional set of predictors for future annual stock returns. This is a crucial conclusion for actuarial applications that aim to provide real-income forecasts for pensioners.*

**A comparison of Reinforcement Learning algorithms performances in financial trading systems**
Corazza Marco, Fasano Giovanni, Gusso Riccardo, Pesenti Raffaele (Ca' Foscari University of Venice, Italy)
Abstract: *In this work we implement and analyze the performances of different Reinforcement Learning (RL) algorithms, and of their different implementations, in financial trading system applications. Reinforcement Learning algorithms aim to find an optimal policy, that is an optimal mapping from the variables describing the state of the system to actions available to the agent, by interacting with the environment in order to maximize a numerical return. In this contribution we compare the results obtained considering different on-policy (SARSA) and off-policy (Q-Learning, Greedy-GQ) RL algorithms applied to daily trading in Italian stock market. We consider both the issues related to the computational implementation of the algorithms and those originating from practical application to stock markets, in an effort to improve previous results while keeping a simple and understandable structure of the used models.*

**Artificial Intelligence, data, ethics: an holistic approach for risks and regulation**
Bogroff Alexis, Guegan Dominique (Université Paris 1 Panthéon-Sorbonne, France)
Abstract: *An extensive list of risks relative to big data frameworks and their use through models of artificial intelligence is provided along with measurements and implementable solutions. Bias, interpretability and ethics are studied in depth, with several interpretations from the point of view of developers, companies and regulators. Reflections suggest that fragmented frameworks increase the risks of models misspecification, opacity and bias in the result. Domain experts and statisticians need to be involved in the whole process as the business objective must drive each decision from the data extraction step to the final activatable prediction. We propose an holistic and original approach to take into account the risks encountered all along the implementation of systems using artificial intelligence from the choice of the data and the selection of the algorithm, to the decision making.*

**An investigation of money laundering determinants with Object Oriented Bayesian Networks**
De Giuli Maria Elena (University of Pavia, Italy), Resta Marina (University Of Genoa, Italy)
Abstract: *We use Object-Oriented Bayesian Networks (OOBNs) to assess the impact of Money Laundering (ML) activity on the domestic market. ML is in a tough spot within the European Regulation Framework, and it has been already examined with a variety of techniques such as regression and social networks analysis, as well as the maximization of the expected utility from ML. The choice of the determinants is a crucial point, too,but the examined literature suffers for a basic issue. Usually, in fact, the determinants are picked up from one or at least two sectors per time but in this way the comprehensive view which considers all the interplays among factors and sectors is completely missing. To get rid of this misleading effect, we apply the OOBN methodology whose potential stands in showing the interplays in and between possible ML determinants. Our study is carried on the domestic market where we analyze data covering all business sectors (at the NACE division disaggregation) and including social, political, economic, technological, environmental and legislative indicators, as well as proxies for qualitative variables and illicit activity based on hand–made data collection. The results provide a comprehensive view for the phenomenon in Italy and offer a starting point for further research.*

**Bayesian Global Optimization for Automated Machine Learning in Finance**
Archetti Francesco (Consorzio Milano Ricerche, Italy), Candelieri Antonio (University of Milan, Italy)
Abstract: *Bayesian Optimization has become the reference approach for model selection and hyperparameter optimization in the Machine Learning community. This allows to "take the human out of the loop" and generate very frequently updated algorithms which are often required in financial trading. A significant example of this approach is to exploit Gaussian Processes and Bayesian Optimization to forecast the movement of the yield curve and to improve the classical mean-variance model, cosidering the following decision variables: the turnover between two rebalancing dates, the window length that control the estimation of returns and the horizon that measures the risk of assets.*

**Machine Learning for pricing American options in high dimension**
Goudenège Ludovic, Molent Andrea, Zanette Antonino (University of Udine, Italy)
Abstract: *In this talk we present three efficient methods which allow one to compute the price of American basket options in the multi-dimensional Black-Scholes model. The proposed methods, which are based on Gaussian Process Regression, are termed GPR Monte Carlo, GPR Tree and GPR Exact Integration. Specifically, they are backward dynamic programming algorithms which consider a finite number of uniformly distributed exercise dates. At each time step, the value of the option is computed as the maximum between the exercise value and the continuation value. This is done only for a finite set of points and then Gaussian Process Regression is exploited to approximate the whole value function. The technique employed to compute the continuation value identifies each of the three proposed methods: GPR-Monte Carlo employs Monte Carlo simulation, GPR-Tree a Tree step and GPR-Exact Integration a semi-analytical formula for integration. Numerical tests show that the algorithms are fast and reliable, and they can be used to price American options on very large baskets of assets, overcoming the problem of the curse of dimensionality. Moreover, we also consider the rough Bergomi model, which provides stochastic volatility with memory, and we present how to adapt the GPR-Tree and GPR-Exact Integration methods for pricing American options in this non-Markovian framework.*