

Title: Instances of Machine Learning in Finance

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Abstract

a: We shall present three important instances where machine learning technology entered the world of Finance: deep portfolio optimization, deep calibration and deep simulation. Classical as well as recent results are presented in each lecture.

Lecture 1:

The basics of neural networks, the backpropagation algorithm, and fascinating perspectives of controlled ordinary differential equations are introduced. A very general recent view on universal approximation is provided here. Training methodologies are presented next from an optimization as well as from a Bayesian perspective and different algorithms are discussed. Deep portfolio optimization will serve as an important instance in Finance exemplifying the above concepts.

Lecture 2:

Training neural networks by itself is an unusual calibration problem, which sheds new light on calibration problems in general: a novel perspective on models and several approaches to calibrate classical models to data are introduced next. Deep calibration of Heston, Bates models, or local stochastic volatility models is exemplifying these concepts. Recent work on consistent recalibration problems is presented here.

Lecture 3:

Recurrent neural networks can be connected with controlled ordinary differential equations, whence theory of the latter provides important insights on the former. We introduce signature from rough path theory as a dynamical system, which provides a universal basis on spaces of functionals of continuous paths. Random projections are random representations allow for efficient computations of signature-like systems. Deep simulation serves as a guiding example in this lecture.