Deep learning project: Option pricing in neural networks

Project purpose

Show that implementation of option pricing functions is possible in a convolutional neural network or other 'modern' neural network. Identify systematic differences between a simple Black-Scholes-Merton (BSM) model with one stochastic state variable and the more complex Heston model with two stochastic state variables. Fine-tune the network in order to achieve a high degree of accuracy using only few observations for estimation. Optional element: Identify the most important contributions in the estimation (training) data to the predicted prices modelled in the network.

Expected elements to be included

1. Monte Carlo simulation of European equity option prices under two different models: 1) A BSM model with the equity spot price as state variable, 2) A Heston model with the equity spot price and the variance, i.e. squared volatility, of the equity spot price as state variables. The simulated prices are split into an estimation/training set and sets for validation and testing. The model parameters should be "identical" in the two simulated models to ease comparison between the models and their results. The simulation is expected to be finalized by end of week 39, 2017.

2. Copy the implementation of option pricing as described in reference [1] in a feedforward neural network, FFNN, for both models. Document the accuracy etc. of the network in both models.

3. Expand the implementation in step 2 to a convolution neural network, CNN, or other 'modern' neural network.

4. Fine-tune the implementation from step 3 (e.g. the convolutional kernel, #units, #layers, activation functions) with the aim of achieving a high degree of accuracy in the network using only few observations for estimation (training), preferably with a lot less observations than 240,000 which are used in reference [1].

5. Optional element: Identify the most important contributions in the estimation (training) data to the predicted prices modelled in the network by following the approach in [2]. This can be seen as a kind of sensitivity analysis.

References

[1] Culkin, Robert and Das, Sanjiv R., Machine Learning in Finance: The Case of Deep Learning for Option Pricing, unpublished paper, 02 August 2017.

[2] Koh, Pang Wei and Liang, Percy, Understanding Black-box Predictions via Influence Functions, arXiv.org, 10 July 2017.