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Research Group

PORTFOLIO OPTIMIZATION WITH PREDICTIVE STOCK PRE-SELECTION

A strategy featuring EuroStoxx 50 (SX5E) and Machine Learning

Featuring

Tommaso Grandi
Luca Tramonti
David Moe
Riccardo Borgo

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Introduction

Data & Period

EuroStoxx 50 in the period Jan 2013 - Dec 2017

- 4 years for training and the last 1 year for testing
- No feature engineering
- 41 Stocks - those always present in the EuroStock during our training time period

Problem Statement

Is it possible to forecast the trend of these stocks, use those predictions to pre-select the top-N performing ones, and then build an Equal-Weight Portfolio that possibly performs better than the SX5E index (our Benchmark)?

Research questions

- Can we forecast the trend of the stocks to pre-select those that will perform well in the future?
- How can we approach this case? Is Machine Learning useful in this situation?
- Is it better to train a single model on each of the series or a global model for all of them?
- Which models can we use for predicting higly volatile time series?
- After forecasting and selecting the future top-performing stocks to compose a portfolio, which model can we leverage for its optimization?
- Are our strategies consistently overperforming the SX5E index?

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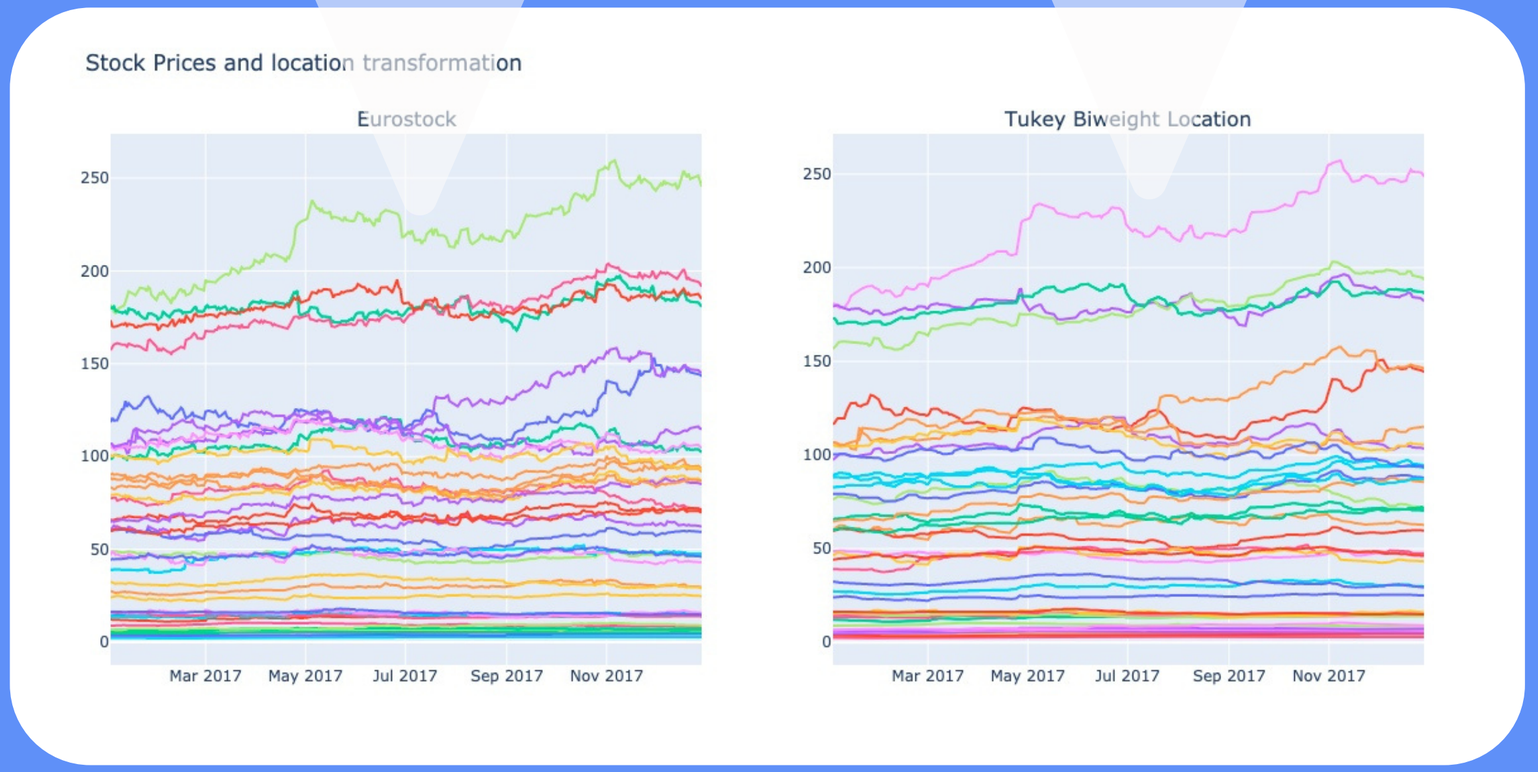
Preliminary Analysis & Data Processing

Original Stock Prices and Location Transformation

4-day rolling Location estimate!



Tukey Bi-Weight M-Estimator for Location

$$\hat{\mu} = \frac{\sum_{i=1}^{N} w_i x_i}{\sum_{i=1}^{N} w_i}$$

$$w_i = \begin{cases} (1 - ((\frac{x_i - m}{c})^2)^2) & \text{if } |x_i - m| \leq c \\ 0 & \text{otherwise} \end{cases}$$

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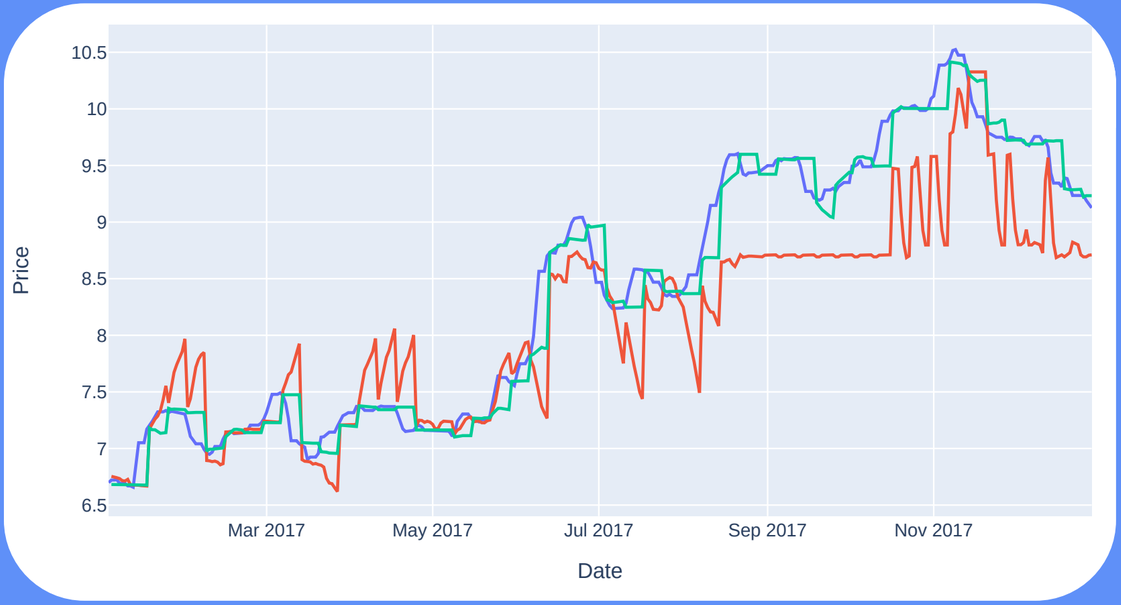
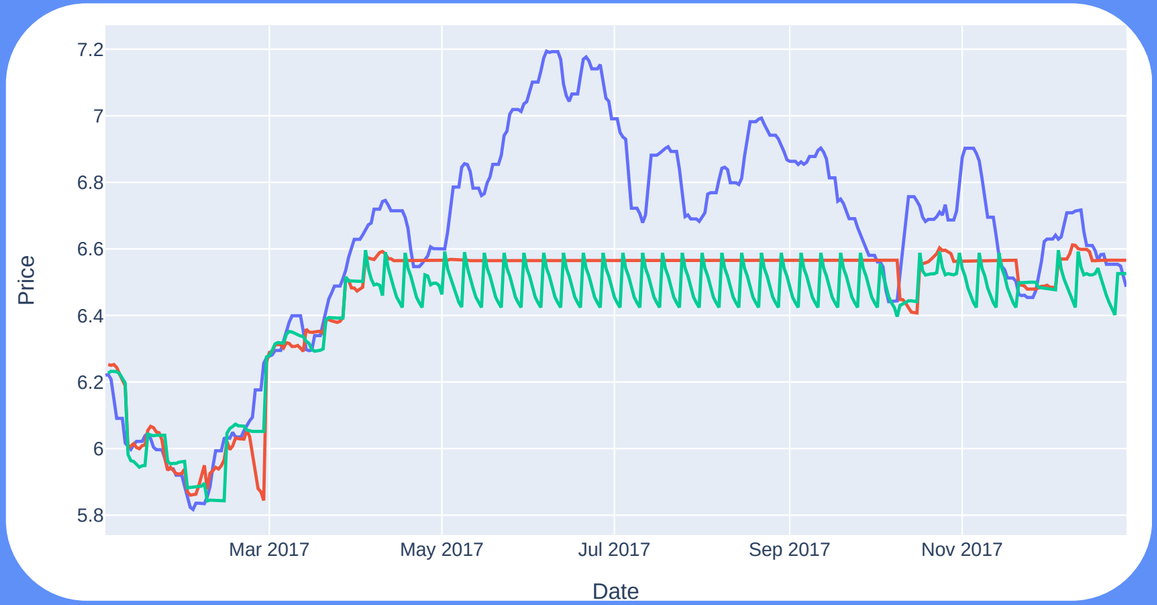
Model: Single vs Multiple Series

IBE SQ EQUITY Stock:
Improvement: a “positive” and a ”negative” forecasting example





Single vs Multi series LightGBM

	Improvement	% Improvment
MEAN	0.077	17.64
MIN	-2.06	-23.14
MAX	1.26	70.24

Real
Predictions Single Forecaster
Predictions Multi Series Forecaster

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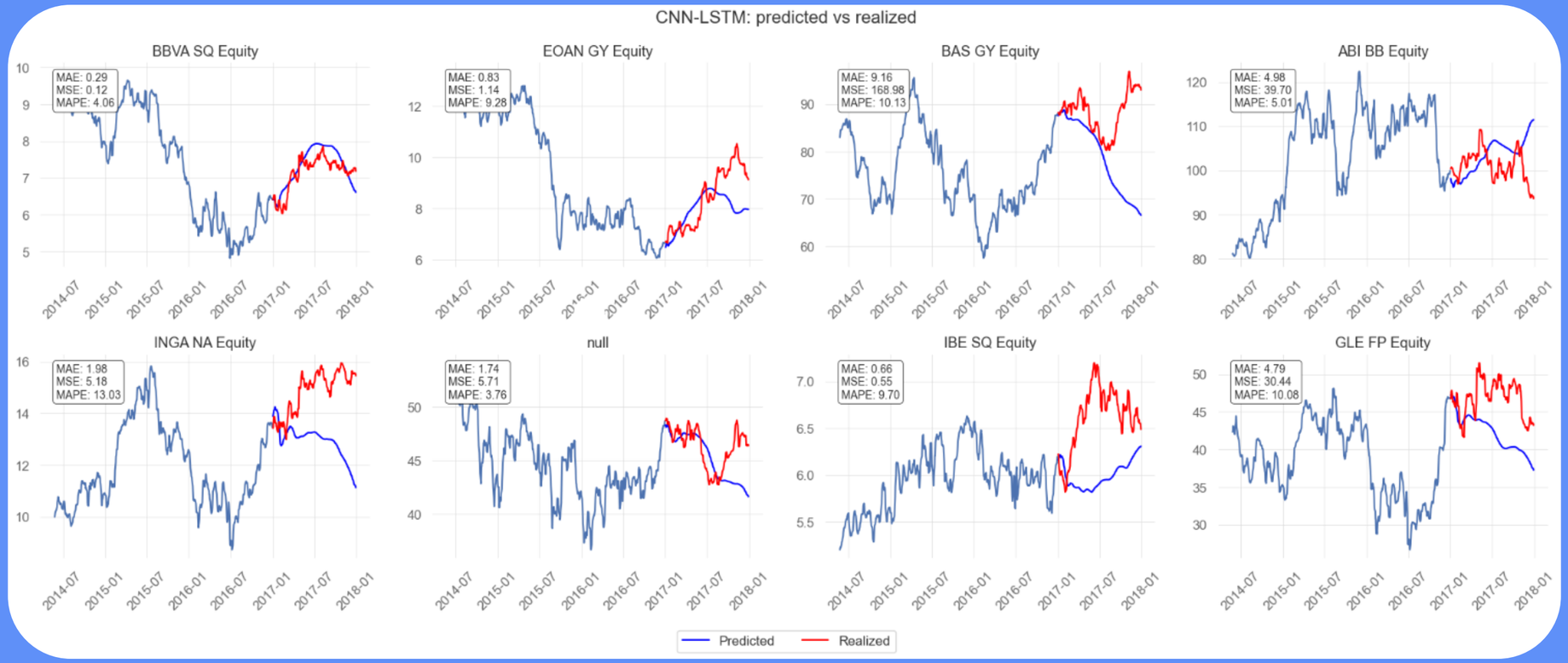
Single-Step One Year Forecast

Models		Findings			
LSTM	→	Inconsistent and exploding predictions			
CNN encoder + LSTM decoder	→	CANDIDATE	→	Simulations → 1	👑
BiLSTM	→	Inconsistent and exploding predictions			
CNN encoder + BiLSTM decoder	→	CANDIDATE	→	Simulations → 2	



Prediction examples on 10 random stocks

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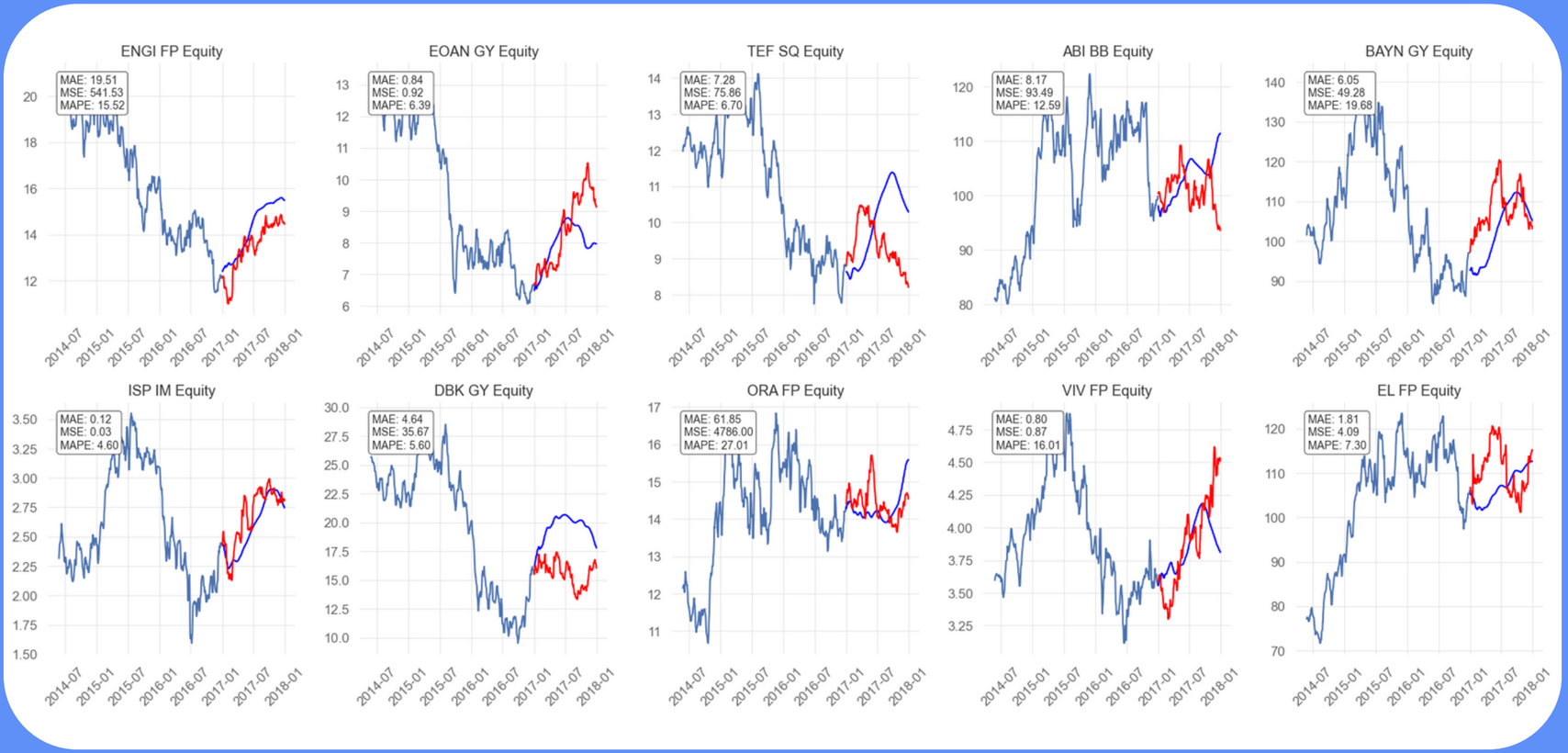
Single-Step One Year Forecast - A first run

A first run... Which stocks were selected for the 5, 7, 10 sized portfolios? Why?



Performances of portfolios with these stocks on this run

	Performance (%)
Top 5	8.537
Top 7	9.337
Top 10	10.014
SX5E Index	8.737

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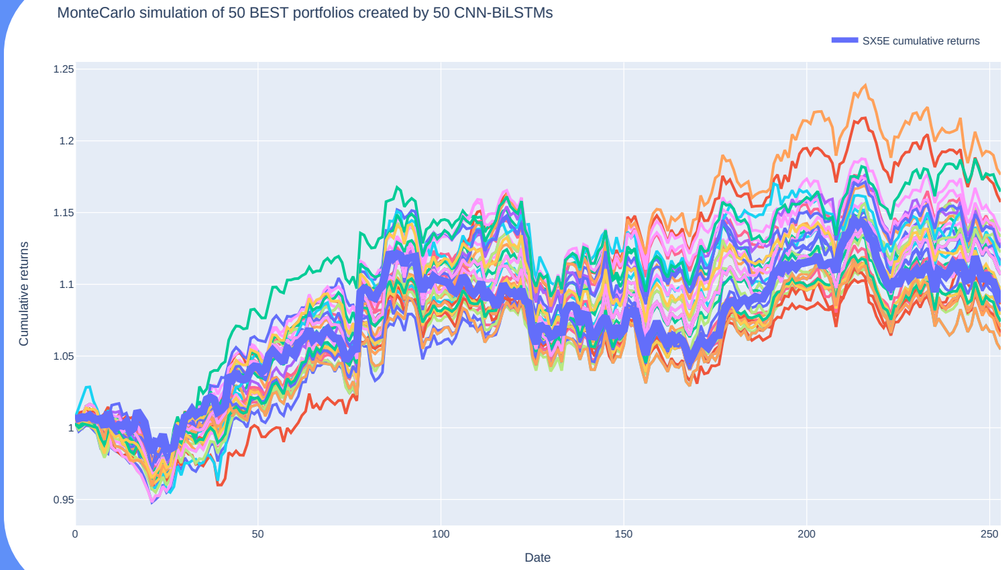
Single-Step One Year Forecast - CNN-BiLSTM

Best Performing



Worst Performing

Top	Frequency
7	27
5	16
10	7

	Benchmark	Best Perfoming	Worst Performing
Sharpe Ratio	0.88	0.91	0.64
Max drawdown	-6.79	-6.13	-6.30
Avg Return (Annualized)	9.25	10.89	7.48
Annualized Vol	9.93	11.07	11.00

	Min	Max
Best Performing	8.55	19.23
Worst Performing	4.92	15.54

N° of worst portfolios that underperformed the SX5E index: 33

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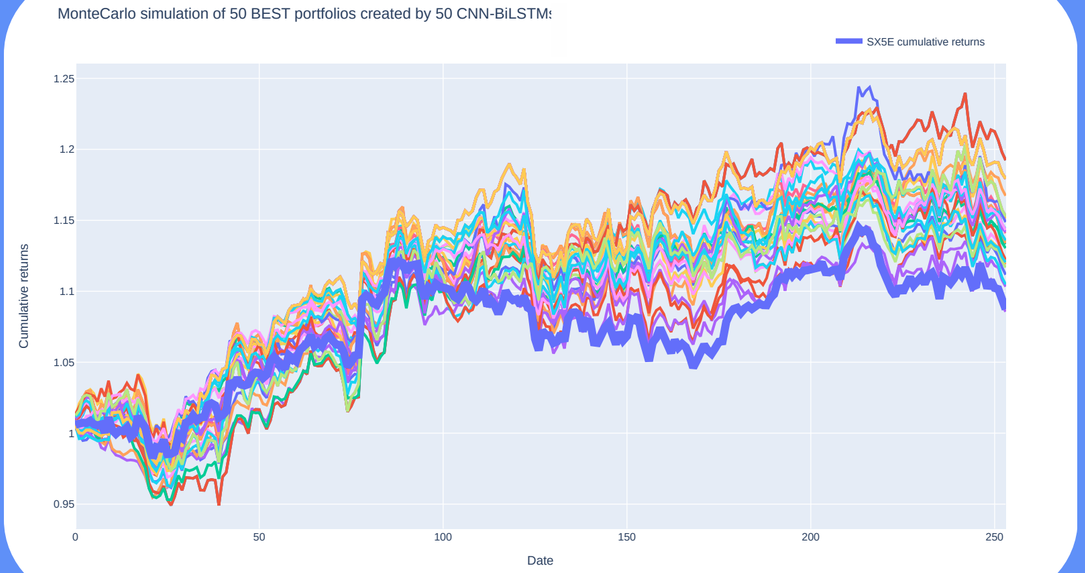
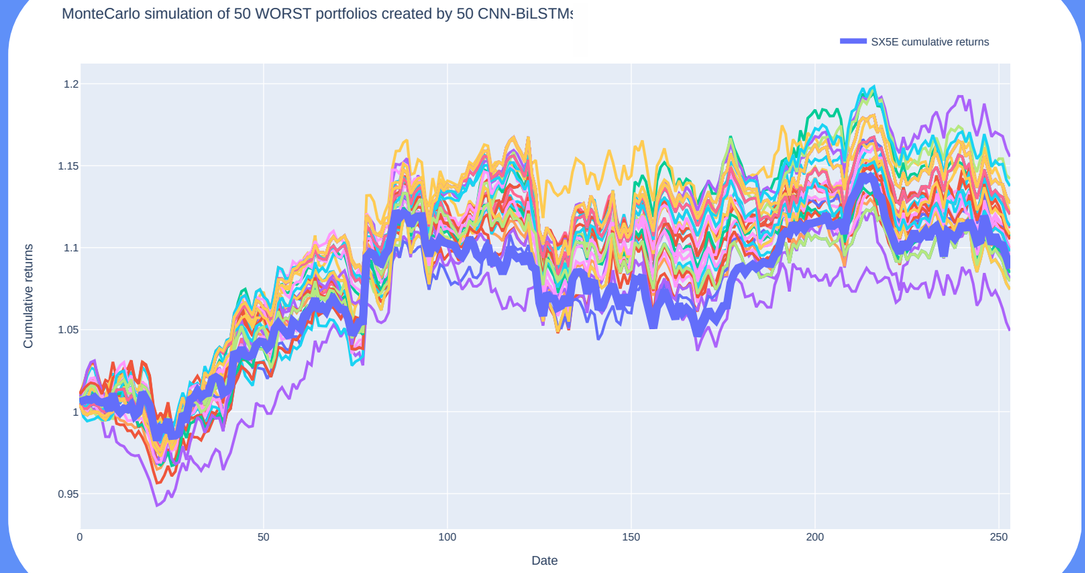
Single-Step One Year Forecast - CNN-LSTM

Best Performing



Worst Performing



Top	Frequency
7	23
5	12
10	15

	Benchmark	Best Perfoming	Worst Performing
Sharpe Ratio	0.88	1.25	0.94
Max drawdown	-6.79	-6.27	-6.22
Avg Return (Annualized)	9.25	16.17	11.24
Annualized Vol	9.93	11.94	11.29

	Min	Max
Best Performing	5.46	17.64
Worst Performing	3.54	12.93

N° of worst portfolios that underperformed the SX5E index: 12

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Monthly Rebalance Strategy

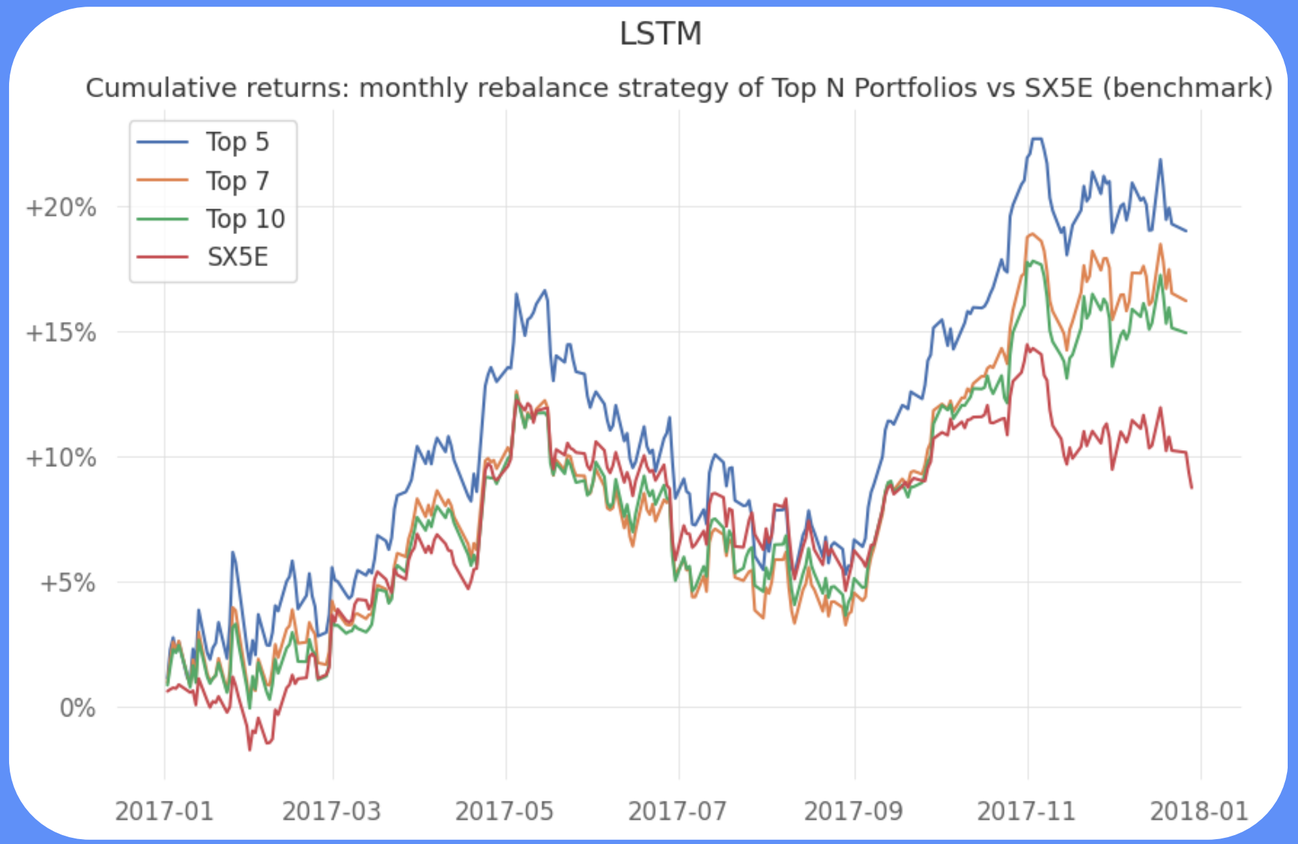
The strategy

- Equal weight strategy
- Monthly rebalancing according to a 1 month ahead forecast
- Forecast: 21 steps ahead (1 month ahead)
- Refit of the model at the end of the each realized month (before the forecast of the following month)

Assumptions

- Choosing a top N strategy will constrain the investor to continue reinvesting in the ranked top N performing stocks of each month, for the whole period

A first trial



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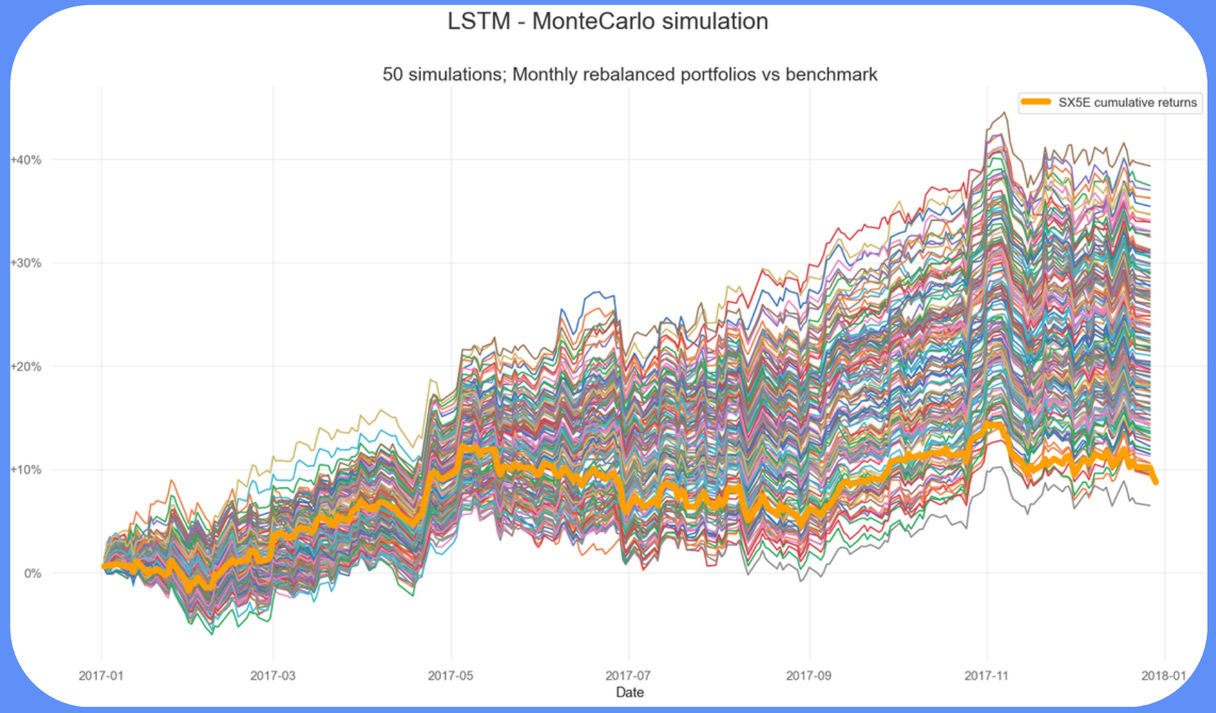
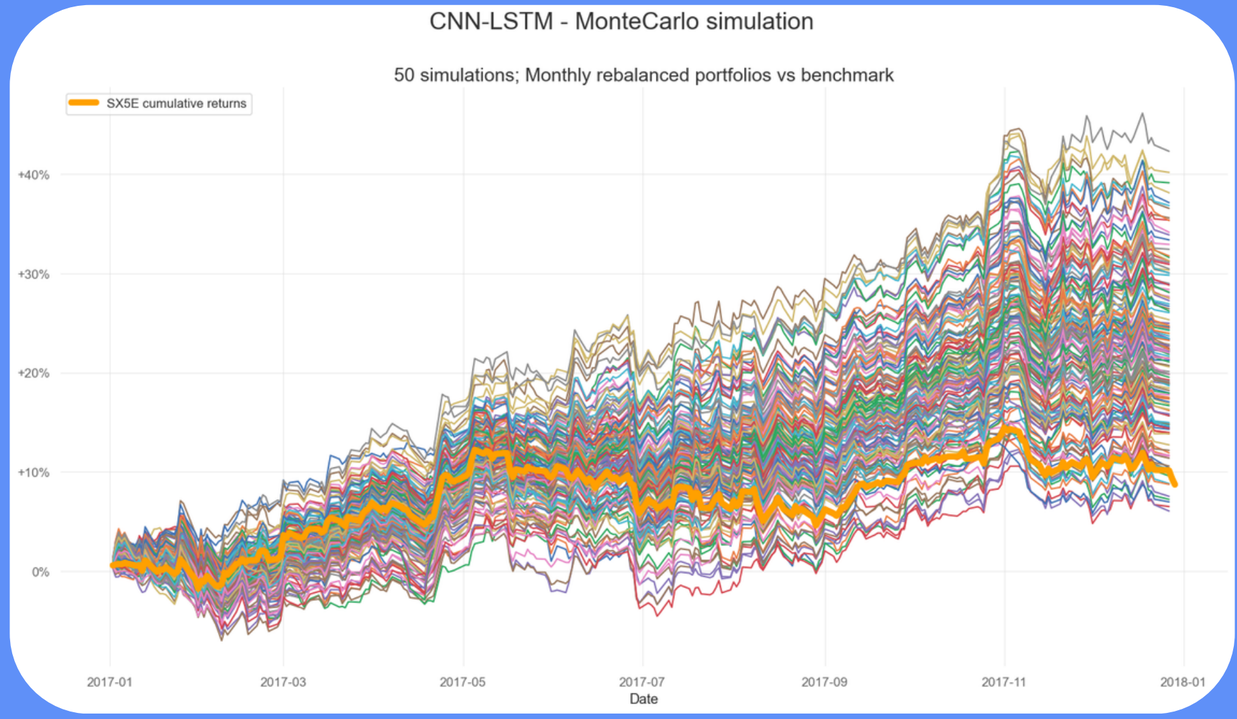
Monthly Rebalance Strategy



	Benchmark	Top 5	Top 7	Top 10
Sharpe Ratio	0.89	1.68	1.71	1.69
Max drawdown	-6.79	-6.11	-5.60	-5.07
Avg Returns, annualized	9.28	24.43	23.37	21.68
Annualized Vol	9.94	12.86	12.11	11.49

N° of portfolios that underperformed the SX5E index: 1



	Benchmark	Top 5	Top 7	Top 10
Sharpe Ratio	0.89	1.67	1.63	1.52
Max drawdown	-6.79	-6.66	-5.94	-5.68
Avg Returns, annualized	9.28	25.65	23.16	20.23
Annualized Vol	9.94	13.50	12.61	11.93

N° of portfolios that underperformed the SX5E index: 5

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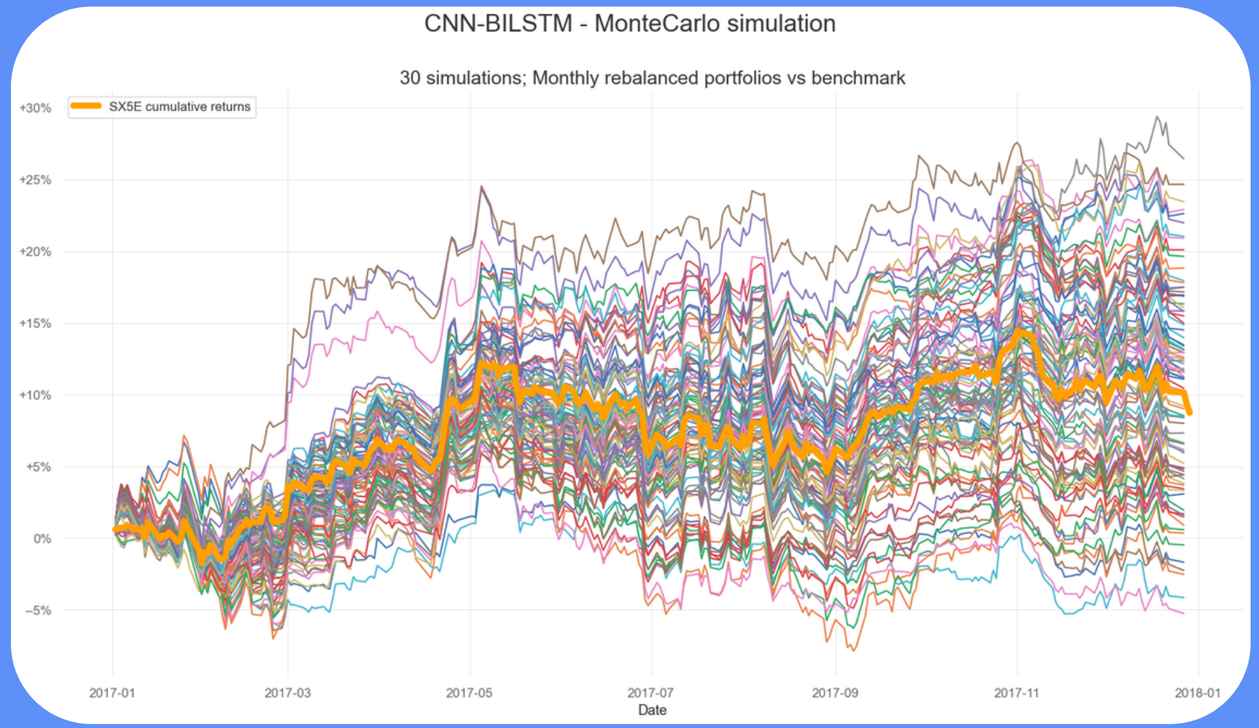
Monthly Rebalance Strategy

CNN-BILSTM



	Benchmark	Top 5	Top 7	Top 10
Sharpe Ratio	0.89	0.85	0.84	0.83
Max drawdown	-6.79	-8.43	-7.65	-7.17
Avg Returns, annualized	9.28	12.39	11.47	10.64
Annualized Vol	9.94	13.54	12.72	11.99

N° of portfolios that underperformed the SX5E index: 37

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Conclusions

The original strategy of the paper from which we took inspiration, seems partially replicable. However, the best-performing model of the paper (CNN-BILSTM) was discarded in both of our strategies. Simple LSTMs performed better than Bilateral LSTMs.

Is Machine Learning useful in this situation?

Yes, even considering the high stochasticity of financial data, the results are showing that in this specific use-case it's really useful to use Machine Learning models. Furthermore, it's relevant to mention that we are not forecasting the exact prices in order to perform a pre-selection of stocks, but rather the trends over the considered period of the investment.

Are our strategies consistently overperforming the SX5E index?

Yes, using pseudo-MonteCarlo simulations, on average our strategies outperformed the index, with only a few portfolios that underperformed it for the best models.
The monthly rebalance strategy is the more effective and profitable (as expected), but deviates slightly from the original strategy presented in the paper.

Insipration Paper: https://www.mdpi.com/2227-7072/10/3/64

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Thank you for your attention!