# Forecasting Volatility: An Application

Multivariate Statistical Methods and Applications

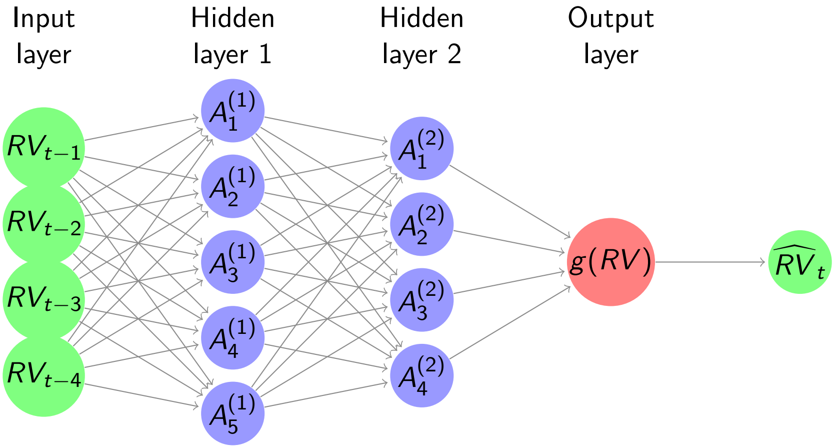
Anatol Sluchych

January 25, 2024

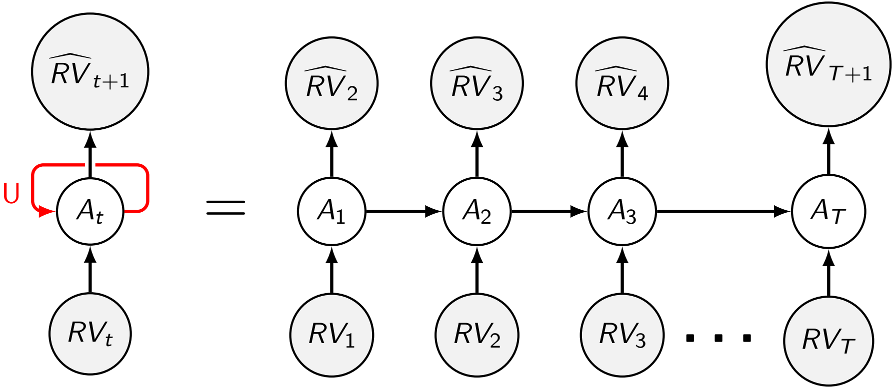
# Outline

# Multilayer Perceptron

- *uni-directional* feedforward neural network



# Recurrent Neural Networks




- *bi-directional* neural network with feedback loops
- long short-term memory:
    - RNN extension
    - LSTM cells

# Data

Daily data:

- 11.01.2023 - 10.01.2024
- top 100 components of S&P 500 index
  Sector Composition
- 251 days
- 25 100 observations

Realized volatility:

- hourly closing price
- missing data filled with previous observation
- returns: price log difference
- $\mathrm{RV}_{i,t}^{(h)} := \sum_{s=t-h+1}^{t} r_{i,s}^2$, for period $[t-h, t]$
- overnight information excluded

# Model Comparison

Table 1: Out-of-sample performance

| Model | MSE | QLIKE |
|---|---|---|
| Random Walk | | |
| VAR | | |
| MLP | | |
| LSTM | | |

# References I

Bucci, Andrea (2020).
Realized Volatility Forecasting with Neural Networks.
*Journal of Financial Econometrics 18*, 502-531.

Hastie, Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman (2009).
The Elements of Statistical Learning: Data Mining, Inference, and Prediction.
*Springer Science & Business Media*.

James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani (2021).
An Introduction to Statistical Learning: with Applications in R (Second Edition).
*Springer Science & Business Media*.

Zhang, Chao, Yihuang Zhang, Mihai Cucuringu, and Zhongmin Qian (2023).
Volatility Forecasting with Machine Learning and Intraday Commonality.
*Journal of Financial Econometrics*, forthcoming.

# Stock Sector Division

Table 2: Components in each sector according to TRBC Sector Classification

| Sector | Number | Tickers |
|---|---|---|
| Technology | 32 | AAPL ACN ADBE ADI ADP AMAT AMD AVGO CMCSA CRM CSCO GOOGL GOOG IBM INTC INTU LRCX MA META MSFT NFLX NOW NVDA ORCL PANW QCOM T TMUS TXN UBER V VZ |
| Healthcare | 19 | ABBV ABT AMGN BMY CVS DHR ELV GILD ISRG JNJ LLY MDT MRK PFE REGN SYK TMO UNH VRTX |
| Financials | 13 | AXP BAC BLK BX C CB GS JPM MMC MS PGR SCHW WFC |
| Consumer Cyclicals | 11 | AMZN BKNG COST DIS HD LOW MCD NKE SBUX TSLA TJX |
| Consumer Non-Cyclicals | 9 | BRKb GE HON KO MDLZ PEP PG PM WMT |
| Industrials | 9 | BA CAT DE ETN LMT RTX SPGI UNP UPS |
| Others | 7 | AMT COP CVX LIN NEE PLD XOM |

Back