# Shiny application for algorithmic trading

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# About Data Science Lab



Data Science Lab is an organization created in 2019 at the Faculty of Economics of the University of Warsaw.

We are a group consisting of academics, business professionals and students who were gathered together by our passion for uncovering the unknown and discovering practical applications to new tools and methods in data analysis, Machine Learning and Artificial Intelligence.

# Aim of the project

- prepare an application to **automatically backtest algorithmic strategies** with a range of indicators
- **educational application** related to my course at FES UW "Quantitative Strategies on High Frequency Data"
- help students:
    - **understand** how to assess the strategy
    - **verify** the results of their own take-home projects

# Mean-reverting or trending prices

- **trading strategies can be profitable only if securities prices are either mean-reverting or trending**
- otherwise, they are random-walking, and trading will be futile
- if you believe that prices are **mean reverting** and that they are currently **low** relative to some reference price, you should **buy** now and plan to sell higher later
- however, if you believe the prices are **trending** and that they are currently **low**, you should (short) **sell** now and plan to buy at an even lower price later
- the opposite is true if you believe prices are high
- a strategy that try to follow the trend are usually called **momentum strategies**
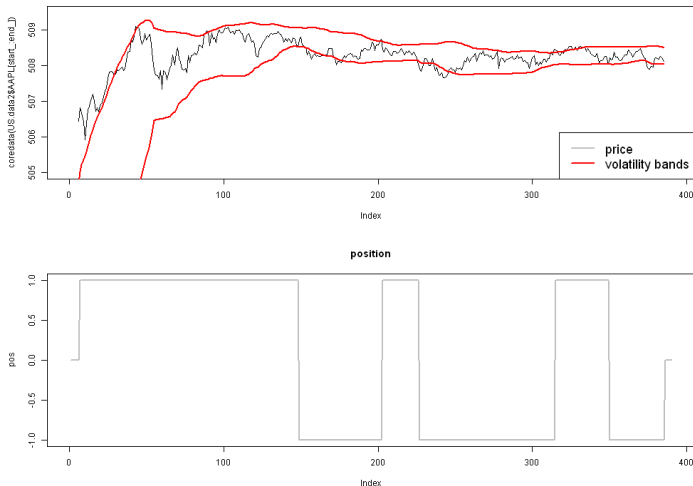
# Position

- taking position means buying/selling a traded security
- when expecting a price **increase** one may take **long** position ($+1$)
- when expecting a price **decrease** one may take **short** position ($-1$),
- being **flat** means taking no position ($0$)

# Trend following breakouts

- breakouts are intuitively appealing
- to get from one place to another, the market must cross all intervening points
- **large moves always begin with small moves**
- breakout systems enter the market on small moves, when the market crosses one of the intermediate points on the way to its destination: they buy into movement
- such breakout models are, consequently, trend-following

# VolBreak as entry/exit technique in momentum strategy
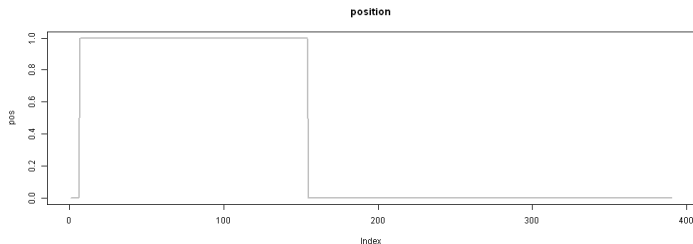
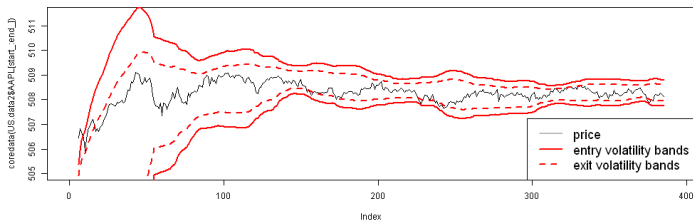# VolBreak as entry/exit technique in momentum strategy

Position for the MOMENTUM strategy in VolBreak:

- if $pos_{t-1} = 0$ and
    - $signal_{t-1} > upper.thr_{t-1} => pos_t = 1$ (long)
    - $signal_{t-1} < lower.thr_{t-1} => pos_t = -1$ (short)

- if $pos_{t-1} = 1$ and
    - $signal_{t-1} > lower.thr_{t-1} => pos_t = 1$ (keep long)
    - $signal_{t-1} < lower.thr_{t-1} => pos_t = -1$ (switch to short)

- if $pos_{t-1} = -1$ and
    - $signal_{t-1} < upper.thr_{t-1} => pos_t = -1$ (keep short)
    - $signal_{t-1} > upper.thr_{t-1} => pos_t = 1$ (switch to long)

**Caution!** this strategy is always in the market if entry and exit thresholds have the same multiplier!

# 2VolBreak as entry/exit technique in momentum strategy

# 2VolBreak as entry/exit technique in momentum strategy

Position for the MOMENTUM strategy in 2VolBreak:

- if $pos_{t-1} = 0$ and
    - $signal_{t-1} > upper.entry.thr_{t-1} => pos_t = 1$ (long)
        - $signal_{t-1} < lower.entry.thr_{t-1} => pos_t = -1$ (short)

- if $pos_{t-1} = 1$ and
    - $signal_{t-1} > lower.exit.thr_{t-1} => pos_t = 1$ (keep long)
        - $signal_{t-1} <= lower.exit.thr_{t-1}$ and
          $signal_{t-1} >= lower.entry.thr_{t-1} => pos_t = 0$ (go flat)
        - $signal_{t-1} < lower.entry.thr_{t-1} => pos_t = -1$ (switch to short)

- if $pos_{t-1} = -1$ and
    - $signal_{t-1} < upper.exit.thr_{t-1} => pos_t = -1$ (keep short)
        - $signal_{t-1} >= upper.exit.thr_{t-1}$ and
          $signal_{t-1} <= upper.entry_{t-1} => pos_t = 0$ (go flat)
        - $signal_{t-1} > upper.entry.thr_{t-1} => pos_t = 1$ (switch to long)

# Moving averages

- like breakouts, moving averages are relatively simple and extremely popular among technical traders
- entries may be generated using moving averages in any of several ways
  – the market may be entered when:
    - prices cross over a moving average
    - a faster moving average crosses a slower one
    - the slope of a moving average changes direction

- additional variety is introduced by the fact that there are many types of moving averages, eg. simple moving averages, exponential moving averages, to mention only a few.

# Types of moving averages

- moving averages differ in how they weigh the sample points that are averaged and in how well they adapt to changing conditions
- the differences between moving averages arose from efforts to reduce lag and increase responsiveness
- the most popular moving averages are:
  - Simple moving average:

$$\bar{x} = \frac{1}{m} \sum_{k=0}^{m-1} x_{t-k}$$

  - Exponential moving average:

$$\bar{x} = \frac{1}{\sum_{k=0}^{m-1} w_k} \sum_{k=0}^{m-1} w^k x_{t-k}$$

# 2MAs as entry/exit technique in momentum strategy
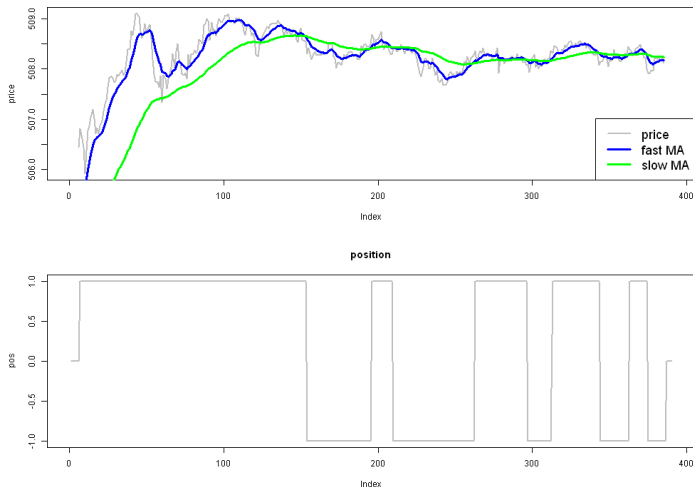
# 2MAs as entry/exit technique in momentum strategy

Position for the MOMENTUM strategy in 2MAs:

- if $fastMA_{t-1} > slowMA_{t-1} => pos_t = 1$ (long)
- if $fastMA_{t-1} <= slowMA_{t-1} => pos_t = -1$ (short)

**Caution!** this strategy is always in the market !

# Application functionalities

- allow to use **single assets or portfolios** of assets (with equal initial weights)
- historical daily data from **top 50 S&P 500 constituents** used as an example
- allow for **long or short positions**
- **identify trends** and adjust position accordingly
- use **different entry/exit techniques**: intersecting MAs, single or double volatility breakout
- allow to **manually define parameters** for entry/exit techniques
- **automated optimization** of the parameters for a selected portfolio
- **summarizing results**
- **include transactional** costs
- selecting the summary metric
- comparison with different benchmarks (e.g. buy and hold)

# Application functionalities – in progress

- uploading own data – also high frequency
- applying pair trading within the portfolio (automated selection of pairs)
- defining the rebalancing frequency
- defining additional rules (e.g. being flat for weekends or specific time intervals)
- defining additional stop-loss rules
- generating report from the optimization in html or pdf or doc
- application is available at: https://pwojcik.shinyapps.io/algotrade/

## Thank you

**THANK YOU FOR YOUR ATTENTION!**