Julius-Maximilians-
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data science

Lehrstuhl X
Data Science

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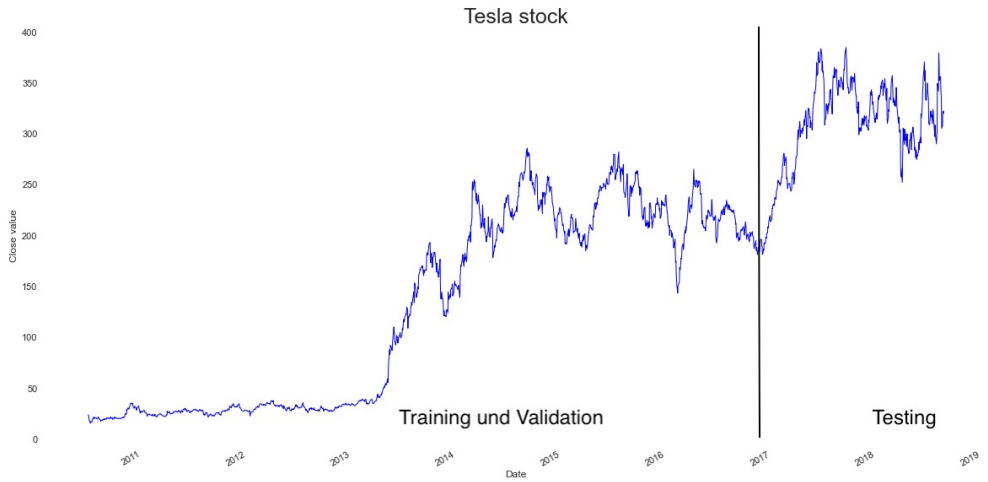
Evaluation von Algorithmic Trading auf Basis neuronaler Netze

Bachelorarbeit

Agenten

- basieren auf neuronalen Netzen
- Zeitreihenanalyse des Wertpapierkurses
- führen selbständig Transaktionen durch
- Belohnung: Vermögen plus Wertpapiere



objectively assess the performance of algorithmic trading strategies, including the TDQN algorithm.

5.1. Testbench

In the literature, the performance of a trading strategy is generally assessed on a single instrument (stock market or others) for a certain period of time. Nevertheless, the analysis resulting from such a basic approach should not be entirely trusted, as the trading data could have been specifically selected so that a trading strategy looks profitable, even though it is not the case in general. To eliminate such bias, the performance should ideally be assessed on multiple instruments presenting diverse patterns. Aiming to produce trustful conclusions, this research paper proposes a testbench composed of 30 stocks presenting diverse characteristics (sectors, regions, volatility, liquidity, etc.). The testbench is depicted in Table 2. To avoid any confusion, the official reference for each stock (ticker) is specified in parentheses. To avoid any ambiguities concerning the training and evaluation protocols, it should be mentioned that a new trading strategy is trained for each stock included in the testbench. Nevertheless, for the sake of generality, all the algorithm hyperparameters remain unchanged over the entire testbench.

Regarding the trading horizon, the eight years preceding the publication year of the research paper are selected to be representative of the current market conditions. Such a short-time period could be criticised because it may be too limited to be representative of the entire set of financial phenomena. For instance, the financial crisis of 2008 is rejected, even though it could be interesting to assess the robustness of trading strategies with respect to such an extraordinary event. However, this choice was motivated by the fact that a shorter trading horizon is less likely to contain significant market regime shifts which would seriously harm the training stability of the trading strategies. Finally, the trading horizon of eight years is divided into both training and test sets as follows:

- **Training set:** 01/01/2012 → 31/12/2017.
- **Test set:** 01/01/2018 → 31/12/2019.

A validation set is also considered as a subset of the training set for the tuning of the numerous TDQN algorithm hyperparameters. Note that the RL policy DNN parameters θ are fixed during the execution of the trading strategy on the entire test set, meaning that the new experiences acquired are not valued for extra training. Nevertheless, such practice constitutes an interesting future research direction.

To end this subsection, it should be noted that the proposed testbench could be improved thanks to even more diversification. The obvious addition would be to include more stocks with different financial situations and properties. Another interesting addition would be to consider different training/testing time periods while excluding the significant market regime shifts. Nevertheless, this last idea was discarded in this scientific article due to the important time already required to produce results for the proposed testbench.

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Quelle: Théate, Thibaut & Ernst, Damien. (2020). 'An Application of Deep Reinforcement Learning to Algorithmic Trading'

Motivation

- spricht Problem an
- macht es aber nicht wesentlich besser:
  - nur 30 Aktien
  - nur Top-Aktien
  - nur 5 Jahre
  - keine Commodities (Rohstoffe, …)
  - kein Validation-Set

Motivation

Related Work

- wenige, selbst gewählte Aktien
- kurze Zeiträume
- nur Top-Aktien
- Ergebnisse wenig aussagekräftig

meine Arbeit

- mehr Daten
- Commodities (Rohstoffe, …)
- Vergleich unterschiedlicher Märkte, Kontinente, Branchen

⟶ Ziel: objektive Bewertung der Performance

Ausgangslage

- bestehende Repositories mit Agenten (basierend auf neuronalen Netzen)
  - Repository 1
    - können pro Tag nur eine Aktie kaufen/verkaufen
    - Input: Wertentwicklung einer Aktie
    - kleine Datensätze
  - Repository 2
    - state-of-the-art Agent

beides nicht aussagekräftig evaluiert

- Datensätze
  - amerikanischer Markt (ca. 6400 Aktien aus NASDAQ, 50 Jahre, täglich)
  - asiatischer, europäischer Markt
  - Commodities, Branchen, Indizes (z.B. Dax, Dow Jones)

Q-Learning Agent

Vorgehensweise

1. Framework anpassen
   - realistische Marktbedingungen (Transaktionskosten, …)
   - Datensatz
   - Hyperparameteroptimierung
   - …
2. Evaluation der Agenten
3. Erweiterung des besten Agenten aus Repository 1
   a. Zählvariable (mehr Aktien handeln pro Tag)
   b. Kontextdata (korrelierende Zeitreihen als zusätzlichen Input)

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