

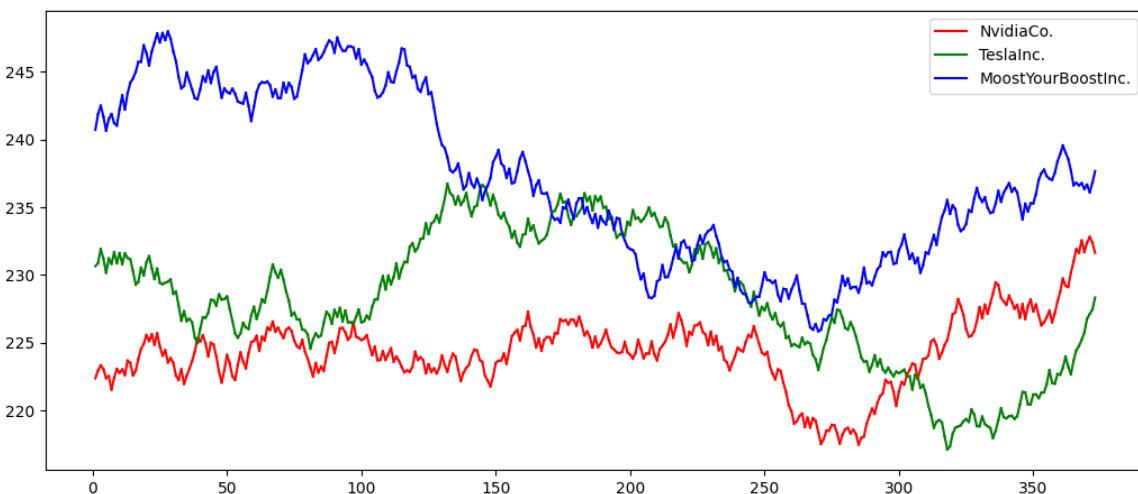
Bourse Simulation

Folgende Simulationen sind mit 4 Banken und 2 Börsen erstellt worden. Hierbei haben wir 5 Wertpapiere im Umlauf, von denen jede Bank eine zufällige Anfangszahl von 1 - 1000 hat. Der Wert jedes Wertpapiers ist anfangs initialisiert und schwankt dann um einen zufälligen Prozentsatz zwischen High- und Low Course (jeweils zwischen 0% und 5%).

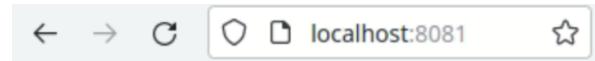
Die Wertpapiere sind exklusiv den Börsen zugeteilt, entsprechend ist innerhalb der Börse der Preis jedes Wertpapiers und dessen Schwankung definiert. Die Banken erhalten diese Wertpapiere in Form einer CSV: Name, Betrag in Euro, Anzahl (zwischen 1-5), Börse von der geschickt wurde.

```
- : sudo docker — Konsole
File Edit View Bookmarks Plugins Settings Help
New Tab Split View
- : sudo docker
0 NVDA 308.988911 492
1 AAPL 240.508364 605
2 TSLA 341.321625 1179
3 FB 319.052154 554
4 MYB 333.572111 631
This is your new portfolio value: 1106388.5 €
#####
BANK 0 just bought 4 AAPL securities from the BOURSE 1 bourse.
- : sudo docker
0 NVDA 306.888881 552
1 AAPL 239.333797 944
2 TSLA 342.186699 259
3 FB 311.140155 945
4 MYB 327.169035 861
This is your new portfolio value: 1059680.11 €
#####
BANK 3 just bought 3 AAPL securities from the BOURSE 1 bourse.
- : sudo docker
0 NVDA 309.477426 183
1 AAPL 240.822889 338
2 TSLA 344.637093 380
3 FB 320.214714 448
4 MYB 335.759147 413
This is your new portfolio value: 548557.61 €
#####
BANK 1 just bought 1 MYB securities from the BOURSE 1 bourse.
- : sudo docker
abbreviation currentPrice count
0 NVDA 271.998487 473
1 AAPL 212.129111 437
2 TSLA 284.303214 755
3 FB 264.987708 694
4 MYB 292.314334 257
This is your new portfolio value: 695030.88 €
#####
BANK 2 just bought 3 MYB securities from the BOURSE 1 bourse.
- : sudo bash < - : sudo docker >
14:54
28/05/2023
```

Die Schwankung der Wertpapiere einer Börse kann auch anhand folgendes Graphen visualisiert werden:



Auf der dynamisch erstellten Website kann man sich das gesamte Vermögen der Bank ausgeben lassen, als Mitarbeiter Wertpapiere kaufen oder verkaufen oder sich als Kunde Geld einzubzahlen lassen. Für letztere Funktionalität war es erforderlich einen separaten Geldbetrag zu implementieren - das *Vault value*, wodurch sich das Portfolio aus Vault value und Gesamtheit aller Wertpapiere zusammen setzt:



Banking Program

Total Portfolio

Security:

Amount:

Money: \$

Im folgenden zeige ich Screenshots der jeweiligen Funktionalitäten, angefangen mit dem Ausgeben des Gesamtvermögens:

```
| 3           FB    215.944106    92
| 4           MYB   247.292884   437
| Vault value : 86633.0
| This is your new portfolio value: 583437.13 $
```

The result is: 585170.27 \$

Das Kaufen von Wertpapieren soll hier auch als funktionaler Test dienen:

```
BANK 0 just sold 5 AAPL securities to the BOURSE 0 bourse.
abbreviation currentPrice count
0          NVDA    227.489737    155
1          AAPL    189.201446    742
2          TSLA    244.939532    773
3          FB     229.142638    117
4          MYB    249.209276    368
Vault value : 86633.0
This is your new portfolio value: 570138.34 $
#####
*****
BANK 0 just bought 50 FB securities via Web-Interface
abbreviation currentPrice count
0          NVDA    227.489737    155
1          AAPL    189.201446    742
2          TSLA    244.939532    773
3          FB     229.142638    167
4          MYB    249.209276    368
Vault value : 86633.0
This is your new portfolio value: 581595.47 $
*****
```

BANK 0 got 50 FB security

Ebenso das Verkaufen von Wertpapieren:

```
vault value : 32274.0
This is your new portfolio value: 668508.79 $
#####
#####
The price of NVDA security got updated: 223.197 -> 223.021
BANK 0 just sold 3 NVDA securities to the BOURSE 0 bourse.
abbreviation currentPrice count
0      NVDA    223.021004   673
1      AAPL    191.136582   950
2      TLSA    231.094681   865
3      FB     209.011530   387
4      MYB    239.471738    96
Vault value : 32274.0
This is your new portfolio value: 667720.54 $
#####
*****
BANK 0 just sold 20 MYB securities via Web-Interface
abbreviation currentPrice count
0      NVDA    223.021004   673
1      AAPL    191.136582   950
2      TLSA    231.094681   865
3      FB     209.011530   387
4      MYB    239.471738    76
Vault value : 32274.0
This is your new portfolio value: 662931.1 $
*****
```

BANK 0 lost 20 MYB security

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Errorhandling ist ebenso implementiert, sollte man falsche oder gar keine Angaben machen:

Invalid POST request.

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Please fill out all boxes

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Ebenso funktioniert das Auszahlen von einem Kunden:

```
-bank_server0-1 | #####
-bank_server0-1 | The price of FB security got updated: 202.744 -> 200.103
-bank_server0-1 | BANK 0 just bought 3 FB securities from the BOURSE 0 bourse.
-bank_server0-1 | abbreviation currentPrice count
-bank_server0-1 | 0      NVDA    210.340391   902
-bank_server0-1 | 1      AAPL    180.127168   129
-bank_server0-1 | 2      TLSA    219.616368   674
-bank_server0-1 | 3      FB     200.102598   840
-bank_server0-1 | 4      MYB    228.034114   295
-bank_server0-1 | Vault value : 83566.0
-bank_server0-1 | This is your new portfolio value: 679907.1 $
-bank_server0-1 | #####
-bank_server0-1 | -----
-bank_server0-1 | A Customer just payed out 50000 $ from BANK 0
-bank_server0-1 | abbreviation currentPrice count
-bank_server0-1 | 0      NVDA    210.340391   902
-bank_server0-1 | 1      AAPL    180.127168   129
-bank_server0-1 | 2      TLSA    219.616368   674
-bank_server0-1 | 3      FB     200.102598   840
-bank_server0-1 | 4      MYB    228.034114   295
-bank_server0-1 | Vault value : 33566.0
-bank_server0-1 | This is your new portfolio value: 629907.1 $
```

You just payed out 50000\$ from BANK 0

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Und genauso das Einzahlen von einem Kunden:

```
-bank_server0-1 | #####  
-bank_server0-1 | The price of AAPL security got updated: 112.211 -> 111.917  
-bank_server0-1 | BANK 0 just bought 4 AAPL securities from the BOURSE 0 bourse  
-bank_server0-1 | abbreviation currentPrice count  
-bank_server0-1 | 0 NVDA 138.344455 845  
-bank_server0-1 | 1 AAPL 111.916556 85  
-bank_server0-1 | 2 TLSA 139.647349 644  
-bank_server0-1 | 3 FB 126.066005 819  
-bank_server0-1 | 4 MYB 135.855339 243  
-bank_server0-1 | Vault value : 124066.0  
-bank_server0-1 | This is your new portfolio value: 476673.77 $  
-bank_server0-1 | #####  
-bank_server0-1 | -----  
-bank_server0-1 | A Customer just deposited 90500 $ to BANK 0  
-bank_server0-1 | abbreviation currentPrice count  
-bank_server0-1 | 0 NVDA 138.344455 845  
-bank_server0-1 | 1 AAPL 111.916556 85  
-bank_server0-1 | 2 TLSA 139.647349 644  
-bank_server0-1 | 3 FB 126.066005 819  
-bank_server0-1 | 4 MYB 135.855339 243  
-bank_server0-1 | Vault value : 214566.0  
-bank_server0-1 | This is your new portfolio value: 567173.77 $  
-bank_server0-1 | -----
```

You just deposited 90500\$ to BANK 0

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Round trip time zwischen zwei Banken

Im Folgenden leiht Bank1 der Bank0 15143€. Die *Round Trip Time* dafür ist darüber angegeben und beträgt ca. 0.00133 Sekunden bzw. 0,133 Millisekunden:

```
|bank_server0-1 | The price of TLSA security got updated: 457.948 -> 468.059
|bank_server0-1 | BANK 0 just sold 3 TLSA securities to the BOURSE 0 bourse.
|bank_server0-1 |   abbreviation  currentPrice  count
|bank_server0-1 |   0          NVDA      477.243041    704
|bank_server0-1 |   1          AAPL      389.845923    744
|bank_server0-1 |   2          TLSA      468.058885    914
|bank_server0-1 |   3          FB       423.350133    779
|bank_server0-1 |   4          MYB      496.436968    470
|bank_server0-1 | Vault value : 116929.0
|bank_server0-1 | This is your new portfolio value: 1733874.41 $
|bank_server0-1 | #####
|bank_server0-1 | ### This request took 0.0013310909271240234seconds ###
|bank_server0-1 | XXXXXXXXXXXXXXXXXXXXXXXXX
|bank_server0-1 | You just got 15143€ from bank 1
|bank_server0-1 | XXXXXXXXXXXXXXXXXXXXXXXXX
```

Überprüfen des korrekten request/response Verhaltens

Das Schicken von Geldbeträgen erfolgt über die im Praktikum 2 hinzugefügte Vault value. Der Betrag, den eine Bank anfragt, liegt zwischen 10.000€ - 20.000€. Entsprechend sieht man wie der Geldbetrag von 12.346€ vom Vault value abgezogen wird:

```
|bank_server1-1 | Vault value : 24964.0
|bank_server1-1 | This is your new portfolio value: 356480.27 $
|bank_server1-1 | #####
|bank_server1-1 | XXXXXXXXXXXXXXXXXXXXXXXX
|bank_server1-1 | You just lend 12346€ to bank 0
|bank_server1-1 | XXXXXXXXXXXXXXXXXXXXXXXX
|bank_server1-1 | #####
|bank_server1-1 | The price of NVDA security got updated: 221.689 -> 219.929
|bank_server1-1 | BANK 1 just sold 1 NVDA securities to the BOURSE 0 bourse.
|bank_server1-1 |   abbreviation  currentPrice  count
|bank_server1-1 |   0          NVDA      219.928650    749
|bank_server1-1 |   1          AAPL      188.365931    221
|bank_server1-1 |   2          TLSA      229.448543     99
|bank_server1-1 |   3          FB       207.769048    369
|bank_server1-1 |   4          MYB      239.983080    101
|bank_server1-1 | Vault value : 12618.0
|bank_server1-1 | This is your new portfolio value: 342593.91 $
|bank_server1-1 | #####
```

Dieser Betrag landet nun auf dem bank server, welcher die request gesendet hat und wird korrekt ins Portfolio eingerechnet:

```
-bank_server0-1 | Vault value : 21533.0
-bank_server0-1 | This is your new portfolio value: 723777.36 $
#####
-bank_server0-1 | ### This request took 0.003495931625366211 seconds ###
-bank_server0-1 | XXXXXXXXXXXXXXXXXXXXXXXXX
-bank_server0-1 | You just got 12346€ from bank 1
-bank_server0-1 | XXXXXXXXXXXXXXXXXXXXXXXXX
-bank_server0-1 | #####
-bank_server0-1 | The price of TLSA security got updated: 227.945 -> 227.014
-bank_server0-1 | BANK 0 just bought 2 TLSA securities from the BOURSE 0 bourse.
-bank_server0-1 |   abbreviation  currentPrice  count
-bank_server0-1 |   0          NVDA      221.802453    620
-bank_server0-1 |   1          AAPL      188.535613    572
-bank_server0-1 |   2          TLSA      227.014333    547
-bank_server0-1 |   3          FB       207.727495    453
-bank_server0-1 |   4          MYB      239.031790    998
-bank_server0-1 | Vault value : 33879.0
-bank_server0-1 | This is your new portfolio value: 736070.02 $
#####
-bank_server0-1 |
```

Überprüfen des Stornierens einer Request:

Wir überprüfen auch, ob eine Bank eine Anfrage stornieren kann. Dies passiert wenn eine Bank, von der geliehen werden soll, weniger als $2,5 * \text{den angefragten Betrag}$ hat. In unserem Beispiel sendet bank0 eine request:

```
-bank_server0-1 | Vault value : 772757.0
-bank_server0-1 | This is your new portfolio value: 1373712.9 $
#####
-bank_server0-1 | ### This request took 0.0013723373413085938 seconds ###
-bank_server0-1 | XXXXXXXXXXXXXXXXXXXXXXXXX
-bank_server0-1 | Lending money rejected
-bank_server0-1 | XXXXXXXXXXXXXXXXXXXXXXXXX
-bank_server0-1 | #####
-bank_server0-1 | The price of NVDA security got updated: 255.391 -> 257.947
-bank_server0-1 | BANK 0 just sold 1 NVDA securities to the BOURSE 0 bourse.
-bank_server0-1 |   abbreviation  currentPrice  count
-bank_server0-1 |   0          NVDA      257.947094    470
-bank_server0-1 |   1          AAPL      210.224473    446
-bank_server0-1 |   2          TLSA      267.489795    245
-bank_server0-1 |   3          FB       245.485619    675
-bank_server0-1 |   4          MYB      270.728587    575
-bank_server0-1 | Vault value : 772757.0
-bank_server0-1 | This is your new portfolio value: 1374658.97 $
```

Diese wurde abgelehnt, da Bank 1, welche die Request erhalten hat, mit einem Portfolio Value von ~19750€ in keinem Fall $2,5 * \text{den Request Betrag}$ besitzt:

```
-bank_server1-1 | The price of NVDA security got updated: 255.146 -> 255.11
-bank_server1-1 | BANK 1 just bought 4 NVDA securities from the BOURSE 0 bourse
-bank_server1-1 |   abbreviation  currentPrice  count
-bank_server1-1 |   0          NVDA      255.109863    828
-bank_server1-1 |   1          AAPL      208.268117    341
-bank_server1-1 |   2          TLSA      263.032552    267
-bank_server1-1 |   3          FB       236.112439    807
-bank_server1-1 |   4          MYB      270.842268    416
-bank_server1-1 | Vault value : -635943.0
-bank_server1-1 | This is your new portfolio value: 19750.21 $
#####
-bank_server1-1 |
```

Jede Bank hat ihr eigenes Topic, auf dem sie in einem bestimmten Intervall das eigene Portfolio veröffentlicht. Alle Banken haben die Topics der anderen Banken subscribed. Wenn eine Bank unter einen bestimmten Betrag fällt, entscheidet die Bank, ob sie helfen möchte oder nicht. Diese Information in Form eines Booleans wird an einen Broker übermittelt, der zählt, sobald alle Banken geantwortet haben, wie viele zugestimmt haben und gibt die Anzahl an helfenden Banken an diese zurück, damit sie wissen, welchen Anteil sie überweisen sollen.

Man benötigt mehr als 1 Bank die helfen möchte

```
-bank_server0-1 | #####
-bank_server0-1 | The price of AAPL security got updated: 190.95 -> 191.016
-bank_server0-1 | BANK 0 just sold 5 AAPL securities to the BOURSE 0 bourse.
-bank_server0-1 | abbreviation currentPrice count
-bank_server0-1 | 0 NVDA 223.487264 416
-bank_server0-1 | 1 AAPL 191.016080 968
-bank_server0-1 | 2 TSLA 233.822205 620
-bank_server0-1 | 3 FB 214.861152 35
-bank_server0-1 | 4 MYB 247.014987 42
-bank_server0-1 | Vault value : -436462.0
-bank_server0-1 | This is your new portfolio value: 4276.81 $
-bank_server0-1 | #####
-bank_server0-1 | just published bank0 portfolio
-bank_server0-1 | Not enough banks found for lending
-bank_server0-1 | #####
```

Mehrere Banken bezahlen einen Geldbetrag

Die Anzahl der helfenden Banken ist einsehbar, entsprechend anteilig ist der Geldbetrag der einzelnen Banken.

```
bank_server0-1 | #####
-bank_server0-1 | The price of TSLA security got updated: 213.884 -> 214.639
-bank_server0-1 | BANK 0 just sold 2 TSLA securities to the BOURSE 0 bourse.
-bank_server0-1 | abbreviation currentPrice count
-bank_server0-1 | 0 NVDA 200.170911 821
-bank_server0-1 | 1 AAPL 174.059181 618
-bank_server0-1 | 2 TSLA 214.638983 289
-bank_server0-1 | 3 FB 189.340631 409
-bank_server0-1 | 4 MYB 223.501831 549
-bank_server0-1 | Vault value : -514766.0
-bank_server0-1 | This is your new portfolio value: 19316.39 $
-bank_server0-1 | #####
-bank_server0-1 | just published bank0 portfolio
-bank_server0-1 | ----- 2x banks lended you 20000$ in total
-bank_server0-1 | #####
-bank_server0-1 | The price of FB security got updated: 189.341 -> 188.99
-bank_server0-1 | BANK 0 just sold 5 FB securities to the BOURSE 0 bourse.
-bank_server0-1 | abbreviation currentPrice count
-bank_server0-1 | 0 NVDA 200.170911 821
-bank_server0-1 | 1 AAPL 174.059181 618
-bank_server0-1 | 2 TSLA 214.638983 289
-bank_server0-1 | 3 FB 188.989917 404
-bank_server0-1 | 4 MYB 223.501831 549
-bank_server0-1 | Vault value : -494766.0
-bank_server0-1 | This is your new portfolio value: 38228.0 $
```

Entsprechend abgezogen wird der Geldbetrag von anderen Banken

```
-bank_server2-1 | just published bank2 portfolio
-----#
-bank_server2-1 | The price of NVDA security got updated: 201.705 -> 200.106
-bank_server2-1 | BANK 2 just sold 2 NVDA securities to the BOURSE 0 bourse.
-bank_server2-1 |   abbreviation  currentPrice  count
-bank_server2-1 |   0          NVDA      200.105608  160
-bank_server2-1 |   1          AAPL      179.799467  100
-bank_server2-1 |   2          TLSA      213.841677  915
-bank_server2-1 |   3          FB       192.670366  404
-bank_server2-1 |   4          MYB      224.331695  505
-bank_server2-1 | Vault value : 2611.0
-bank_server2-1 | This is your new portfolio value: 439399.32 $
-----#
-bank_server2-1 | just published bank2 portfolio
-----#
-bank_server2-1 | The price of AAPL security got updated: 179.799 -> 174.974
-bank_server2-1 | BANK 2 just bought 2 AAPL securities from the BOURSE 0 bourse
-bank_server2-1 |   abbreviation  currentPrice  count
-bank_server2-1 |   0          NVDA      200.105608  160
-bank_server2-1 |   1          AAPL      174.973892  102
-bank_server2-1 |   2          TLSA      213.841677  915
-bank_server2-1 |   3          FB       192.670366  404
-bank_server2-1 |   4          MYB      224.331695  505
-bank_server2-1 | Vault value : -7389.0
-bank_server2-1 | This is your new portfolio value: 429266.71 $
-----#
-----#
-bank_server1-1 | #####
-bank_server1-1 | The price of TLSA security got updated: 214.301 -> 213.337
-bank_server1-1 | BANK 1 just bought 2 TLSA securities from the BOURSE 0 bourse
-bank_server1-1 |   abbreviation  currentPrice  count
-bank_server1-1 |   0          NVDA      200.160608  125
-bank_server1-1 |   1          AAPL      177.417673  418
-bank_server1-1 |   2          TLSA      213.337088  213
-bank_server1-1 |   3          FB       192.198323  319
-bank_server1-1 |   4          MYB      227.658168  729
-bank_server1-1 | Vault value : 75487.0
-bank_server1-1 | This is your new portfolio value: 447382.54 $
-----#
-bank_server1-1 | ----- You lended bank 0 about 10000.0$
-bank_server1-1 | just published bank1 portfolio
-----#
-bank_server1-1 | The price of NVDA security got updated: 200.161 -> 199.585
-bank_server1-1 | BANK 1 just sold 4 NVDA securities to the BOURSE 0 bourse.
-bank_server1-1 |   abbreviation  currentPrice  count
-bank_server1-1 |   0          NVDA      199.584785  121
-bank_server1-1 |   1          AAPL      177.417673  418
-bank_server1-1 |   2          TLSA      213.337088  213
-bank_server1-1 |   3          FB       192.198323  319
-bank_server1-1 |   4          MYB      227.658168  729
-bank_server1-1 | Vault value : 65487.0
-bank_server1-1 | This is your new portfolio value: 436512.22 $
-----#
```

Zeit eines Protokolldurchlaufs

```
| just published bank0 portfolio
| #####
| The price of FB security got updated: 205.161 -> 205.093
| BANK 0 just sold 2 FB securities to the BOURSE 0 bourse.
| abbreviation currentPrice count
| 0 NVDA 218.230805 917
| 1 AAPL 187.089319 229
| 2 TLSA 224.733291 298
| 3 FB 205.093406 882
| 4 MYB 234.957013 186
| Vault value : -528158.0
| This is your new portfolio value: 6368.0 $
| #####
| ----- 2x banks lended you 20000$ in total
| --- 1.1274299621582031 seconds ---
| #####
| The price of MYB security got updated: 234.957 -> 234.593
| BANK 0 just bought 3 MYB securities from the BOURSE 0 bourse.
| abbreviation currentPrice count
| 0 NVDA 218.230805 917
| 1 AAPL 187.089319 229
| 2 TLSA 224.733291 298
| 3 FB 205.093406 882
| 4 MYB 234.592955 189
| Vault value : -508158.0
| This is your new portfolio value: 27004.07 $
| #####
| #####
| The price of TLSA security got updated: 224.733 -> 224.515
| BANK 0 just bought 2 TLSA securities from the BOURSE 0 bourse.
| abbreviation currentPrice count
```