Multi-Agent Stock Market Simulation

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Contextualize the addressed problem

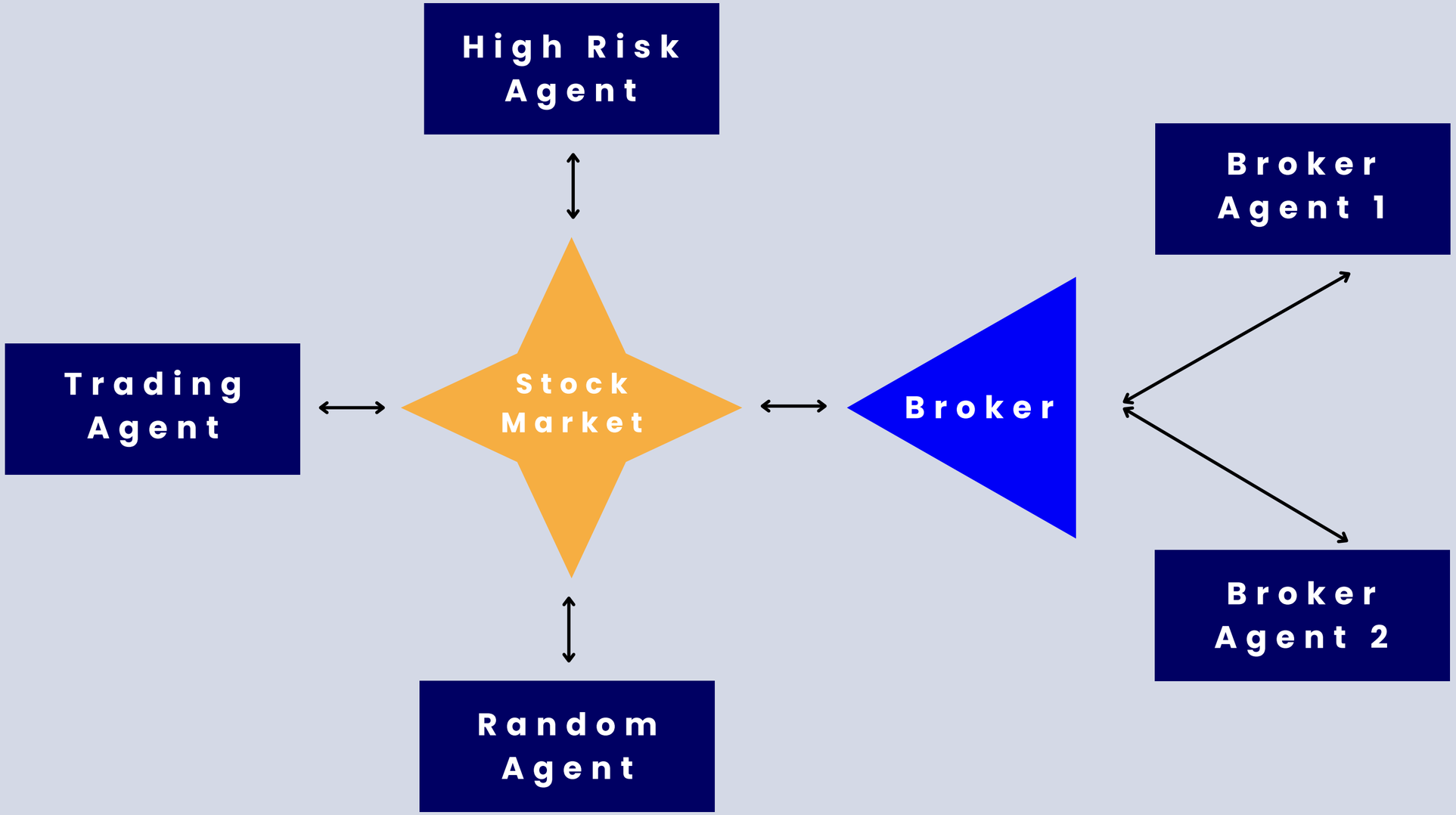
Objective

The goal of this project is to design and implement a stock market simulation with multiple agents.

Simulation overview

The simulation is based on historical stock data and contains multiple different stocks which values change everyday. The agents have different strategies for buying and selling, as well as different quantities of money and its managment.

Overall system of agents



Agent architectures and strategies

- Strategy based on random number
- Influeced by media
- Changes threshold based on performance

- Acts like an intermediary
- Charges fees to the agents
- Holds some stocks

- Utilizes linear regression when buying
- Sells when the price rises
- Has max budget for a company stocks

- Compares with anterior values
- Sum of diference of prices
- Buys as many stocks as possible

- Buys a max of 3 stocks
- Fixed stock distribution money
- Predicts the current price

- Defines a barrier of profit and loss
- Tracks the highest and lowest prices
- Only buys when the price is down

Interaction and communication protocols

Stock Market

Has a cyclical behaviour and waits until receiving a message from the agents. In the message it is requested to perform a action, buying or selling a number of a specific stock. The stock market makes the transaction and updates the owned stocks and remaining cash of the agent and sends a message of confirmation.

Broker

Has a cyclical behavior and receives messages from 2 of the agents, similar to the stock market. Acts as an intermediary between the agents and the stock market as it sends a message to the last one, specifying the request of the agents to be processed. Charges a small fee per transaction.

Agents

The agents have a periodic behaviour. They evaluate if it is worth to buy or sell a stock based on their metrics. They perform their actions once a day

Interface


Agent Interface
11-03-2021
Update
Messages
Alexandre
Beatriz
João
Pedro
Maria
Helena
Portfolio value
Value of the stocks
7000
6000
5000
4000
3000
2000
1000
0
Alexandre
Beatriz
João
Pedro
Maria
Helena
Agents
Change of the stocks value
Stocks
275
250
225
200
175
150
125
100
META
AAPL
TSLA
GOOGL
2021-02-23
2021-03-11
Data


Agent Interface
11-03-2021
Update
Messages
Alexandre
Beatriz
João
Pedro
Maria
Helena
Beatriz
Alexandre
Maria
Variable
Value
Remaining Cash
120397.04
Portfolio Value
1613.08
Total Value
122010.12
GOOGL
AAPL
AMZN
TM
AVGO
LLY
BRK-B
Owned Stocks
Beatriz - broker@localhost
Number of Shares
8
7
6
5
4
3
2
1
0
GOOGL
AAPL
AMZN
TM
AVGO
LLY
BRK-B
GOOG
Stocks

Results

	Day 0 - Money	Day 1 - Money	Day 1- Stocks	Day 33 - Money	Day 33 - Stocks
Broker Agent 1	**3000**	**310.63**	**TM: 9, GOOGL: 8, AAPL: 4**	**132.24**	**GOOGL: 5, LLY: 2, AMZN: 10**
Broker Agent 2	**4500**	**22.22**	**AMZM: 28**	**15.06**	**BRK-B: 15**
Trading Agent	**10000**	**8540.57**	**NKE: 7, NFLX: 1**	**63.94**	**NFLX : 4, GOOGL: 21, MSFT: 15, BRK-B: 6**
Random Agent	**2000**	**352.30**	**JPM: 6, AVGO: 1, SBUX: 4**	**453.27**	**2222.SR: 7, SBUX: 12**
High Risk Agent	**5000**	**5000**	**-**	**32.05**	**VERV: 20, ACRS: 56, HD: 5, ACM: 25**

*Results may vary depending on the day the simulation starts.

Conclusion

This work has demonstrated to us the potential of multiagent systems as well as comprehend the interdependence and dynamics of autonomous agents in different environments. With our results we can conclude that there are not any perfect strategies as the agents only use simple information to predict the stock prices. Despite the agents not always making the best actions, we are satisfied with the results as the decision making is very different between them.

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Results

Results of the day 1

```
broker_agent2 sends: Buy AMZN : 28
stockmarket received: Buy 28 shares of AMZN for $4433.45 from broker@localhost
Error: Could not connect to the interface server.
Transaction complete

broker_agent2 owns {'AMZN': 28} shares and $22.22 in cash
4500 is the total value of broker_agent2's portfolio

random_agent sends: Buy 6 shares of JPM for $833.02
stockmarket received: Buy 6 shares of JPM for $833.02 from random_agent@localhost
Error: Could not connect to the interface server.
Transaction complete

random_agent sends: Buy 1 shares of AVGO for $432.23
stockmarket received: Buy 1 shares of AVGO for $432.23 from random_agent@localhost
Error: Could not connect to the interface server.
Transaction complete

random_agent sends: Buy 4 shares of SBUX for $382.45
stockmarket received: Buy 4 shares of SBUX for $382.45 from random_agent@localhost
Error: Could not connect to the interface server.
Transaction complete

random_agent owns {'JPM': 6, 'AVGO': 1, 'SBUX': 4} shares and $352.30 in cash
2000 is the total value of random_agent's portfolio

altorisco owns {} shares and $5000.00 in cash
5000 is the total value of altorisco's portfolio
```

```
----- Day 1 -----
trading_agent sends: Buy 7 shares of NKE for $919.63
stockmarket received: Buy 7 shares of NKE for $919.63 from trading_agent@localhost
Error: Could not connect to the interface server.
Transaction complete

trading_agent sends: Buy 1 shares of NFLX for $539.80
stockmarket received: Buy 1 shares of NFLX for $539.80 from trading_agent@localhost
Error: Could not connect to the interface server.
Transaction complete

trading_agent owns {'NKE': 7, 'NFLX': 1} shares and $8540.57 in cash
10000.0 is the total value of trading_agent's portfolio

broker_agent sends: Buy TM : 9 GOOGL : 8 AAPL : 4
stockmarket received: Buy 9 shares of TM for $1358.91 from broker@localhost
Error: Could not connect to the interface server.
stockmarket received: Buy 8 shares of GOOGL for $812.02 from broker@localhost
Error: Could not connect to the interface server.
stockmarket received: Buy 4 shares of AAPL for $491.82 from broker@localhost
Error: Could not connect to the interface server.
Transaction complete

broker_agent owns {'TM': 9, 'GOOGL': 8, 'AAPL': 4} shares and $310.63 in cash
3000 is the total value of broker_agent's portfolio
```

*Results may vary depending on the day the simulation starts.

Results

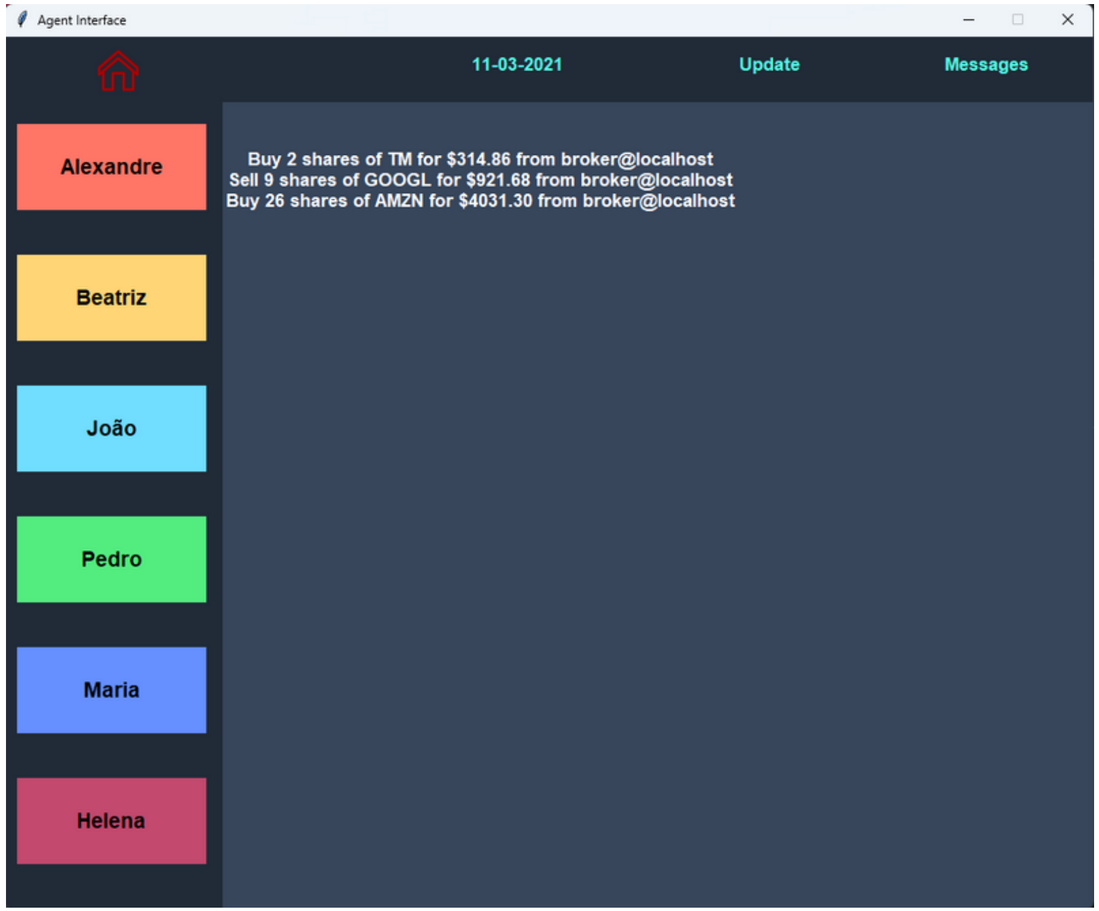
Results of the day 33

```
----- Day 33 -----
trading_agent owns {'NKE': 0, 'NFLX': 4, 'GOOGL': 21, 'MSFT': 15, 'UNH': 0, 'BRK-B': 6, 'LLY': 0} shares and $63.94 in cash
9963.44 is the total value of trading_agent's portfolio

broker_agent owns {'TM': 0, 'GOOGL': 5, 'AAPL': 0, 'AVGO': 0, 'LLY': 2, 'AMZN': 10} shares and $132.24 in cash
2727.88 is the total value of broker_agent's portfolio

broker_agent2 owns {'AMZN': 0, 'BRK-B': 15, 'GOOG': 0} shares and $15.06 in cash
4013.01 is the total value of broker_agent2's portfolio

random_agent sends: Sell 3 shares of SBUX for $320.47
stockmarket received: Sell 3 shares of SBUX for $320.47 from random_agent@localhost
Error: Could not connect to the interface server.
Transaction complete

random_agent owns {'2222.SR': 7, 'WMT': 0, 'JPM': 0, 'SBUX': 12, 'AVGO': 0} shares and $453.27 in cash
1923.83 is the total value of random_agent's portfolio

altorisco owns {'VERV': 20, 'ACRS': 56, 'HD': 5, 'ACM': 25} shares and $32.05 in cash
6007.1 is the total value of altorisco's portfolio
```

*Results may vary depending on the day the simulation starts.

Interface


Agent Interface
11-03-2021
Update
Messages
Alexandre
Beatriz
João
Pedro
Maria
Helena
Alexandre
Variable
Value
Remaining Cash
700.96
Portfolio Value
2016.55
Total Value
2717.51
TM
GOOGL
AAPL
AVGO
LLY
AMZN
Owned Stocks
Alexandre - broker_agent@localhost
Number of Shares
0
2
4
6
8
TM
GOOGL
AAPL
AVGO
LLY
AMZN
Stocks


Agent Interface
11-03-2021
Update
Messages
Alexandre
Beatriz
João
Pedro
Maria
Helena
Buy 2 shares of TM for $314.86 from broker@localhost
Sell 9 shares of GOOGL for $921.68 from broker@localhost
Buy 26 shares of AMZN for $4031.30 from broker@localhost