Laboratory assignment

Component 2

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1 Problem Description

This specified multi-agent system is a simplified model of a stock market environment with various interacting agents. Each agent has its own assigned role which dictates its behavior. Each Trader has a certain capital and holds stocks in different companies. Traders can buy or sell stocks based on specific criteria, with some occasionally making random trades. The Trader can be either a Trend Trader or an Info Trader. The Trend Trader agent makes decisions based on the last several stock prices of a company, whereas the Info Trader makes decisions based on notifications about company projects, adjusting their actions based on the success or failure of those projects and the amount of stock they hold in each company, which further influences their trust. A Regulator agent adjusts company stock prices based on recent market transactions to stabilize the market. Companies randomly announce project updates, including successes or failures, which are then communicated to Info Traders. The system operates with unlimited stocks for each company, with a minimum stock price constraint.

2 High-level MAS specification

Let:

- $\mathcal{C} = \{C_1, C_2, \ldots, C_n\}$ be the set of companies.
- $\mathcal{T} = \{T_1, T_2, \ldots, T_m\}$ be the set of trader agents which is composed by TT - Trend Traders and IT - Info Traders. $TT \cup IT = \mathcal{T}$ and $TT \cap IT = \emptyset$.
- $\mathcal{R}$ be the Regulator agent.

2.1 Inputs to the MAS system

- The number of agents: n_{TT} (the number of TT agents), n_{IT} (the number of Info Traders), so $\mid \mathcal{T} \mid = n = n_{TT} + n_{IT}$, and $m = \mid \mathcal{C} \mid$ (the number of Companies).
- Initial stock prices: $\mathcal{P}_0 : \mathcal{C} \to \mathbb{R}_{>0}$ and the minimum stock price $\mathcal{P}_{min}$.
- Initial trader capital: $\mathcal{K}_0 : \mathcal{T} \to \mathbb{R}_{\geq 0}$.
- The length of the historical stock price sequences $k \in \mathbb{N}^*$, and the threshold $t : TT \to \mathbb{R}_{\geq 0}$ for each Trend Trader.

2.2 Outputs for the MAS system

- Updated stock prices: $\mathcal{P}_t : \mathcal{C} \to \mathbb{R}_{\geq \mathcal{P}_{\min}}$.
- Executed trades (logs): $\mathcal{H}_t = \{(T_i, C_j, \text{amount}, \text{price})\}$.
- Updated capital and stock ownership: $\mathcal{K}_t, \mathcal{S}_t$.

2.3 Types of Agents

Agent	Abstract Architecture	Concrete Architecture	Justification
TrendTrader (TT)	State Based	Deliberative	Uses historical data to perform goal-directed trend analysis. Maintains internal state.
InfoTrader (IT)	Perception Based	Hybrid	Reacts to external events (reactive) and makes decisions based on internal trust model (deliberative).
Company (C)	State Based	Reactive	Emits events without planning; reacts randomly. Holds an internal state just to know if the project event notification is the risk factor or the success/failure of the last project.
Regulator (R)	Purely Reactive	Reactive	Adjusts prices directly based on transaction data; no planning or internal modeling.

2.4 Specification of Agents

2.4.1 Trader Agent (T_i, Generic)

Each trader T_i operates using a behavior function:

$$f_{T_i} : \text{Percepts}_{T_i} \to \text{Actions}_{T_i}$$

$$\text{Actions}_{T_i} = \{\text{buy}(C_j, price, amount), \text{sell}(C_j, price, amount), \text{idle}\}$$

- To fluctuate the market, each trader can make a random decision at random times to either buy or sell a stock.

2.4.2 TrendTrader (TT_i)

- Inputs: $\text{Percepts}_{TT} = \{\mathcal{P}(C_j) \mid C_j \in \mathcal{C}\}$ (the current price of company's stock, the last $k-1$ stock prices are retained by each agent in their state).
- Task: Analyze price trends and make trade decisions accordingly.

2.4.3 InfoTrader (IT_i)

- Inputs: $\text{Percepts}_{IT} = \{\text{ProjectEvent}(C_j, risk \mid succeded \mid failed)\}$
- Task: React to project events and trade based on trust level (computed based on the amount of stocks in that company).

2.4.4 Company Agent (C_j)

- Inputs: None
- Outputs: $e = \text{ProjectEvent}(C_j, risk \mid succeded \mid failed)$ (the risk of the project when there is no project yet and the success / fail of the last project, based on the risk factor, so the company should retain the last proposed project in its state).
- Task: Randomly emit events to affect InfoTrader behavior.

2.4.5 Regulator Agent ($\mathcal{R}$)

- Inputs: Trade history $\mathcal{H}_t$. It takes the decision based on a certain number of stock prices for each company in their descending order, therefore it doesn't have a state.
- Outputs: Adjusted stock prices $\mathcal{P}_{t+1}$.
- Task: Ensure market stability by adjusting stock prices based on activity.

2.5 Communications Among Agents

The system will use a Publisher-Subscriber (Pub-Sub) Model for asynchronous event-driven communication. The main components will be:

Sender	**Receiver**	**Message Type**	**Notation**
Company C_j	InfoTrader IT_i	ProjectEvent	$e = \text{ProjectEvent}(C_j, state)$

3 Agents' Roles Within the MAS

- **TrendTrader (TT_i):** Investor that takes decisions based on patterns investor using price history.
- **InfoTrader (IT_i):** Investor that takes decisions based on trust reacting to company events.
- **Company (C_j):** Event generator that influence the market volatility.
- **Regulator ($\mathcal{R}$):** Market stabilizer through price regulation.