Ontology Design

Assignment 1

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1. Plain Text Description of the Domain (Stock Market)

Stock Market Domain Overview:

The stock market is a financial system where company stocks and other financial instruments are bought, sold, and traded. Publicly listed companies issue shares to raise capital, which are traded by various investors, including retail investors, domestic institutional investors (DIIs), and foreign institutional investors (FIIs). Brokers act as intermediaries facilitating trades between buyers and sellers. Trades occur on exchanges or over-the-counter (OTC).

Investors issue trade orders, such as market or limit orders, to buy or sell shares. The value of financial instruments such as shares and bonds is influenced by market trends, which are tracked by indices like the NIFTY 50 or S&P 500. Regulatory bodies, such as the Securities and Exchange Board of India (SEBI) or the U.S. Securities and Exchange Commission (SEC), oversee stock market operations and establish rules to ensure fair trading practices. Additionally, companies may distribute profits to shareholders in the form of dividends. The stock market operates as a dynamic system governed by supply, demand, and regulatory frameworks.

Key Knowledge to Capture in the Ontology:

- Stock Market: The marketplace where shares and securities are traded.
- Company: An entity issuing stocks and bonds.
- Financial Instruments: Shares, bonds, and mutual funds.
- Investor Types: Retail Investors, DIIs, FIIs.
- Trades: Transactions such as market orders, and limit orders.
- Broker: The intermediary facilitating trades.
- Market Index: A measure tracking a group of stocks.
- Market Trends: Movements in asset prices over time.
- Public Companies: Companies listed on stock exchanges.
- Initial Public Offering (IPO): The first stock sale by a company to the public.
- Over-the-Counter (OTC) Trading: Trading is done directly between two parties.
- Dividend, Profit, Loss: Key financial outcomes of trading.

2. DL Ontology (TBox)

This defines the concepts, relationships, and axioms of our ontology using Description Logic.

Key Concepts (Classes):

- StockMarket
- Company
- FinancialInstrument
    - Share
    - Bond
    - MutualFund
- Investor
    - RetailInvestor
    - DomesticInstitutionalInvestor (DII)
    - ForeignInstitutionalInvestor (FII)
- TradeOrder
    - MarketOrder
    - LimitOrder
- Transaction
    - FailedTransaction
    - SuccessfulTransaction
- Broker
- MarketIndex
- PublicCompany
- IPO
- MarketTrend
- Dividend
- Profit
- Loss

Properties (Relationships):

- hasInvestor: StockMarket → Investor
- issuesStock: Company → Share
- facilitatesTrade: Broker → TradeOrder
- placesOrder: Investor → TradeOrder
- executesTransaction: TradeOrder → Transaction
- isTradedAt: FinancialInstrument → StockMarket
- trackedBy: FinancialInstrument → MarketIndex
- observesTrend: MarketIndex → MarketTrend
- paysDividend: Company → Dividend

- earnsProfit: Investor → Profit
- suffersLoss: Investor → Loss
- hasPrice: TradeOrder → Price
- hasDate: Transaction → Date
- issuedBy: FinancialInstrument → Company
- hasIPO: PublicCompany → IPO
- resultsIn: TradeOrder → Transaction

DL Axioms:

- Company ⊑ ∃ issuesStock.Share
  (Every company issues at least one share)

- Investor ⊑ (RetailInvestor ⊔ DomesticInstitutionalInvestor ⊔ ForeignInstitutionalInvestor)
  (Every investor is either a retail investor, DII, or FII)

- TradeOrder ⊑ MarketOrder ⊔ LimitOrder
  (Every trade order is either a market order or a limit order)

- PublicCompany ⊑ Company ⊓ ∃ hasIPO.IPO
  (A public company is a company that has had an IPO)

- Share ⊑ ∃ issuedBy.Company
  (Every share is issued by some company.)

- Bond ⊑ ∃ issuedBy.Company
  (Every bond is issued by some company.)

- Investor ⊑ ∃ placesOrder.TradeOrder
  (Every investor places at least one trade order.)

- TradeOrder ⊑ ∃ resultsIn.(SuccessfulTransaction ⊔ FailedTransaction)
  (Every trade order results in a transaction.)

- Investor ⊑ ∃ earnsProfit.Profit ⊔ ∃ suffersLoss.Loss
  (Every investor either earns a profit or suffers a loss.)

- Company ⊑ (∃ paysDividend.Dividend ⊔ ¬∃ paysDividend.Dividend)
  (A company may or may not pay dividends.)

- MarketIndex ⊑ ∃ observesTrend.MarketTrend
  (Every market index observes at least one market trend.)

- FinancialInstrument ⊑ (∃ trackedBy.MarketIndex ⊔ ¬∃ trackedBy.MarketIndex)
  (Every financial instrument is tracked by at least one market index.)

- SuccessfulTransaction ⊑ Transaction
  (SuccessfulTransaction is a subsumption of Transaction.)

- FailedTransaction ⊑ Transaction
  (FailedTransaction is a subsumption of Transaction.)

- UntrackedFinancialInstrument ⊑ FinancialInstrument
  (UntrackedFinancialInstrument is a subsumption of FinancialInstruction)

3. Design Write-up

Design Choices:

Class Hierarchy:

We chose to model FinancialInstrument as the superclass with Share, Bond, and MutualFund as subclasses to represent the different types of securities.
Investor is divided into three types: RetailInvestor, DII, and FII based on typical investor roles in the stock market.
TradeOrder is similarly divided into MarketOrder and LimitOrder to reflect different trading mechanisms.

Class Explanations:

- StockMarket: A system where trades are executed.
- Company: A business entity that issues shares or bonds. Some companies may distribute profits in the form of dividends, but this is optional.
- FinancialInstrument: Represents assets like shares or bonds, with Share being a specific type.
- TradeOrder: Instructions to execute a trade, subclassed into MarketOrder (immediate execution) and LimitOrder (conditional execution).
- MarketIndex: Tracks performance trends in the stock market.

Properties:

- placesOrder: Links an Investor to a TradeOrder, representing how investors initiate trades.
- executesTransaction: Connects a TradeOrder to a Transaction, showing the result of a trade order being executed.
- facilitatesTrade: Relates a Broker to a TradeOrder, reflecting their intermediary role in trading.
- hasPrice: Captures the price per share in a TradeOrder.
- hasDate: Tracks the date when a Transaction occurred.
- paysDividend: Links a Company to a Dividend, representing companies that choose to distribute profits to their shareholders.

Motivating Examples:

Example 1:
A RetailInvestor places a MarketOrder to buy 100 shares of a Company. The Investor initiates the TradeOrder (a MarketOrder), which is then executed through a Transaction, with a specific price captured via the hasPrice property and the execution date recorded via the hasDate property.

Example 2:
A PublicCompany has issued shares in an IPO and now trades its shares on the StockMarket. Depending on its financial policy, the company may pay Dividends to its shareholders, but it might also choose to reinvest profits instead.