

# Ontology Design

## Assignment 1

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Authors:  
A Anunaya (CS24M009)  
Debasmita Mandal (CS24M015)  
Arnav Karn (CS24M801)  
Kagose Yohanes Okoll (CS24M802)  
Kenaw Nuru Muhabe (CS24M803)

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# Abstract

This enhanced ontology captures a more detailed and comprehensive view of the stock market domain. By introducing specific investor types, broker roles, advanced trading mechanisms, and regulatory frameworks, we have addressed the complexity of the financial ecosystem. Additional relationships, such as those between investors, financial instruments, and regulatory bodies, provide richer semantics and enable better reasoning over stock market knowledge.

By focusing on more object properties and defining clear distinctions between key concepts, the ontology now more effectively represents real-world dynamics within the stock market. This improved design enables deeper insights into investor behaviors, regulatory compliance, and market conditions, which are crucial for accurate knowledge modeling in this domain.



Added content



Removed content

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

## Stock Market Domain Overview:

The stock market is a financial ecosystem where company stocks, bonds, and other financial instruments are bought, sold, and traded. Public companies issue shares to raise capital, which are then 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, and ensuring the smooth execution of transactions. These trades may occur on stock exchanges or in over-the-counter (OTC) markets, where transactions happen directly between parties.

## Investor Actions and Trade Orders:

Investors issue trade orders, such as market or limit orders, to buy or sell shares. Advanced trading mechanisms, including stop-loss orders and margin trading, provide flexibility for different trading strategies. The value of financial instruments like stocks, bonds, and mutual funds is influenced by various market trends, which are tracked by indices such as the NIFTY 50 or S&P 500. The stock market operates under the supervision of regulatory bodies like the Securities and Exchange Board of India (SEBI) or the U.S. Securities and Exchange Commission (SEC), which enforce rules to ensure fair practices.

## Financial Instruments and Market Trends:

Financial instruments vary from stocks and bonds to different types of mutual funds such as Balanced Funds, ELSS (Equity Linked Savings Scheme), and Debt Funds. The stock market is a dynamic system driven by supply and demand, market trends, and regulatory frameworks. Market trends like bull markets and bear markets define price movements over time, influencing investor decisions.

## Regulations and Compliance:

Regulatory bodies enforce compliance rules, ensuring companies, investors, and brokers follow set guidelines. Violations of these rules can lead to penalties imposed on the parties involved. Brokers play a variety of roles, including acting as market makers, discount brokers, or full-service brokers, each offering different levels of service and liquidity.

## 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, Short-Term Investors, Long-Term Investors.
- Trades: Transactions such as market orders, stop-loss orders, and limit orders.
- Broker: The intermediary facilitating trades.
- Broker Types: Market Maker, Discount Broker, Full-Service Broker.
- Market Index: A measure tracking a group of stocks.
- Market Trends: Movements in asset prices over time (bull markets, bear markets).
- 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.
- Compliance Rules: Regulations enforced by bodies like SEBI and SEC.
- Penalties: Consequences for rule violations.
- Portfolio Management: Risk and asset allocation based on investor preferences.

## 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
    - BalancedMutualFund
    - ELSSFund
    - DebtFund
- Investor
  - RetailInvestor
  - DomesticInstitutionalInvestor (DII)
  - ForeignInstitutionalInvestor (FII)
  - ShortTermInvestor
  - LongTermInvestor
  - SpeculativeInvestor
  - ValueInvestor
- TradeOrder

- MarketOrder
  - LimitOrder
  - StopLossOrder
  - TrailingStopOrder
- Transaction
  - FailedTransaction
  - SuccessfulTransaction
  - MarginTrading
  - ShortSelling
- Broker
  - MarketMaker
  - DiscountBroker
  - FullServiceBroker
- MarketIndex
- PublicCompany
- IPO
- MarketTrend
  - UpwardTrend
  - DownwardTrend
  - SidewaysTrend
- RegulatoryBody
- ComplianceRule
- Penalty
- Portfolio
- RiskLevel
  - HighRisk
  - LowRisk
- MarketCondition
  - BullMarket
  - BearMarket
  - HighVolatility
- Dividend
  - QuarterlyDividend
  - AnnualDividend
- 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
- violatesRule: Investor/Company/Broker → ComplianceRule
- enforcesRule: RegulatoryBody → ComplianceRule
- imposesPenalty: RegulatoryBody → Penalty
- penalizes: Penalty → Investor/Company/Broker
- holdsPortfolio: Investor → Portfolio
- contains: Portfolio → FinancialInstrument
- engagesIn: Investor → MarginTrading/ShortSelling
- hasRisk: FinancialInstrument → RiskLevel
- occursDuring: Transaction → MarketCondition
- belongsToSector: Company → Sector
- operatesInMarket: Company → GeographicMarket

## DL Axioms:

- $\text{Company} \sqsubseteq \exists \text{ issuesStock.Share}$   
(Every company issues at least one share)
- $\text{Investor} \sqsubseteq (\text{RetailInvestor} \sqcup \text{DomesticInstitutionalInvestor} \sqcup \text{ForeignInstitutionalInvestor})$   
(Every investor is either a retail investor, DII, or FII)
- $\text{TradeOrder} \sqsubseteq \text{MarketOrder} \sqcup \text{LimitOrder}$   
(Every trade order is either a market order or a limit order)
- $\text{PublicCompany} \sqsubseteq \text{Company} \sqcap \exists \text{ hasIPO.IPO}$   
(A public company is a company that has had an IPO)
- $\text{Share} \sqsubseteq \exists \text{ issuedBy.Company}$   
(Every share is issued by some company.)
- $\text{Bond} \sqsubseteq \exists \text{ issuedBy.Company}$   
(Every bond is issued by some company.)

- $\text{Investor} \sqsubseteq \exists \text{ placesOrder.TradeOrder}$   
(Every investor places at least one trade order.)
- $\text{TradeOrder} \sqsubseteq \exists \text{ resultsIn.}(\text{SuccessfulTransaction} \sqcup \text{FailedTransaction})$   
(Every trade order results in a transaction.)
- $\text{Investor} \sqsubseteq \exists \text{ earnsProfit.Profit} \sqcup \exists \text{ suffersLoss.Loss}$   
(Every investor either earns a profit or suffers a loss.)
- $\text{Company} \sqsubseteq (\exists \text{ paysDividend.Dividend} \sqcup \neg \exists \text{ paysDividend.Dividend})$   
(A company may or may not pay dividends.)
- $\text{MarketIndex} \sqsubseteq \exists \text{ observesTrend.MarketTrend}$   
(Every market index observes at least one market trend.)
- $\text{FinancialInstrument} \sqsubseteq (\exists \text{ trackedBy.MarketIndex} \sqcup \neg \exists \text{ trackedBy.MarketIndex})$   
(Every financial instrument is tracked by at least one market index.)
- $\text{Investor} \sqsubseteq \exists \text{ placesOrder.TradeOrder} \sqcap \exists \text{ holdsPortfolio.Portfolio}$   
(Every investor places at least one trade order and holds a portfolio)
- $\text{FinancialInstrument} \sqsubseteq (\exists \text{ trackedBy.MarketIndex} \sqcup \exists \text{ hasRisk.RiskLevel})$   
(Every financial instrument is tracked by at least one market index and has a risk level)
- $\text{Company} \sqsubseteq (\exists \text{ paysDividend.Dividend})$   
(A company may or may not pay dividends)
- $\text{Portfolio} \sqsubseteq \exists \text{ contains.FinancialInstrument}$   
(Every portfolio contains financial instruments)
- $\text{RegulatoryBody} \sqsubseteq \exists \text{ enforcesRule.ComplianceRule}$   
(Every regulatory body enforces at least one compliance rule)
- $\text{Penalty} \sqsubseteq \exists \text{ penalizes.}(\text{Investor} \sqcup \text{Company} \sqcup \text{Broker})$   
(A penalty is imposed on an investor, company, or broker)
- $\text{Investor} \sqsubseteq \exists \text{ violatesRule.ComplianceRule}$   
(An investor may violate a compliance rule)
- $\text{TradeOrder} \sqsubseteq \exists \text{ resultsIn.}(\text{SuccessfulTransaction} \sqcup \text{FailedTransaction})$   
(Every trade order results in either a successful or failed transaction)
- $\text{SuccessfulTransaction} \sqsubseteq \text{Transaction}$

(SuccessfulTransaction is a subsumption of Transaction.)

- FailedTransaction  $\sqsubseteq$  Transaction

(FailedTransaction is a subsumption of Transaction.)

- UntrackedFinancialInstrument  $\sqsubseteq$  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.