Submission By

DA24C021 - Venkatesh Duraiarasan

CS24M033 - Pradeep Peter Murmu

CS24M036 - Raju Guguloth

Assignment 1: Ontology Design

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Task - 1

A plain text description of the domain of interest and a list of concrete pieces of knowledge you would like to capture in the domain.

Knowledge to be captured:

Task - 2

the DL ontology (TBox)

Classes and Subclasses (Concept Inclusions -Subsumption Axiom)

DataProperties

Roles and its properties

Axioms

Task - 3

a write-up about the design choices made and the details of the design - the explanations for classes, properties, DL axioms, motivating situations/examples - of terms in the ontology.

Task - 1

A plain text description of the domain of interest and a list of concrete pieces of knowledge you would like to capture in the domain.

The domain of interest is **Financial Modeling**. The goal is to develop a basic ontology model which

aids

- **Equity research** by capturing limited details of current and historical information related to given equity instrument in order to assess a security/stock's financial health and also query and filter securities which satisfies certain financial ratio requirements.
- **Portfolio Management** - grouping securities which satisifies certain finacial ratios and market conditions

Developing ontological model will help in framing questions related to equity research in a systematic and concise manner. For example some sample questions are listed below

- Which Stocks are in GrowthStage and has high return in last quarter?
- Which Banking stock gave most return in year YYYY?
- Current year Stock price > Last year stock price?
- List stocks that are eligible to be in X portfolio?

Knowledge to be captured:

- **Financial Instrument**
  - Equity - Stock of a **Company** listed in some Market
  - Etf - Collection of stock
  - MutualFund - Collection of one or more Equity or Etf
  - FundofFund - Collection of one or more Mutual Fund
- **Equity**

  An Equity has following properties/relation :
  - Company (eg. Apple Inc, State Bank of India) - equity belongs to a company
  - Equity metrics
  - Risk metrics
  - Balance sheet metrics
  - Peers : Companies which are operating in same sectors or industry
- **Equity Metric**
  - Price : price of a stock
  - Return : return over specified period
  - Dividend
- **Risk Metric**
  - beta

- volatility
- sharpe ratio

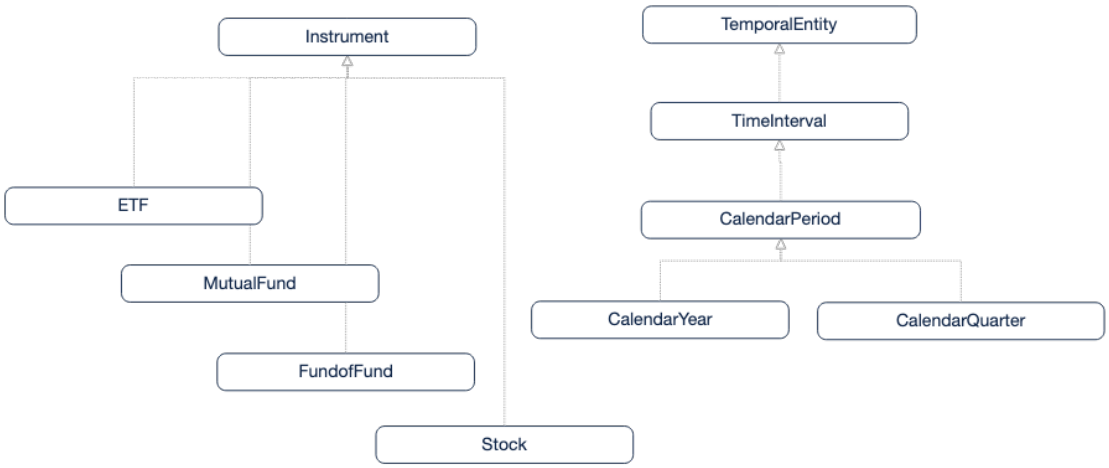
- **Balance Sheet Metric**
  - **Balance Sheet Ratios**
    - Current : Measures solvency
    - Quick : Measures liquidity
    - Debt-to-Worth : Measures financial risk
    - MarketValuation : MarketCapitalization+Debt
  - **Efficiency Ratios**
    - Sales-To-Assets : Measures the efficiency of Total Assets in generating sales
    - Return On Assets : Measures the efficiency of Total Assets in generating Net Profit
    - Return On Investment : Measures the efficiency of Net Worth in generating Net Profit
- **Market structure**
  - Category (eg. SmallCap, MidCap, LargeCap, etc)
  - MarketIndex : Index/Equity to which the stock is benchmarked against (Nifty, BankNifty)
  - Sector : market classification of stock (Banking , IT , Manafacturing)
  - Stage : Lifecycle stage at which company is in (DevelopmentStage, GrowthStage, SustainabilityStage, ExpansionStage)
- **Time aspects**
  - Year (FY2022, FY2023 etc)
  - Quarter (Q2023-1, Q2023-2, Q2023-3, ...)
- **StockScreener -** collection of equity
  - LowVolatile
  - HighGrowth - Stocks with low pe and high profit growth
  - Oversold - Stocks with RSI (Relative Strength Index) < 30

Task - 2

the DL ontology (TBox)

Now we will model the key concepts and relationships in order to capture above domain knowledge

Classes and Subclasses (Concept Inclusions -Subsumption Axiom)

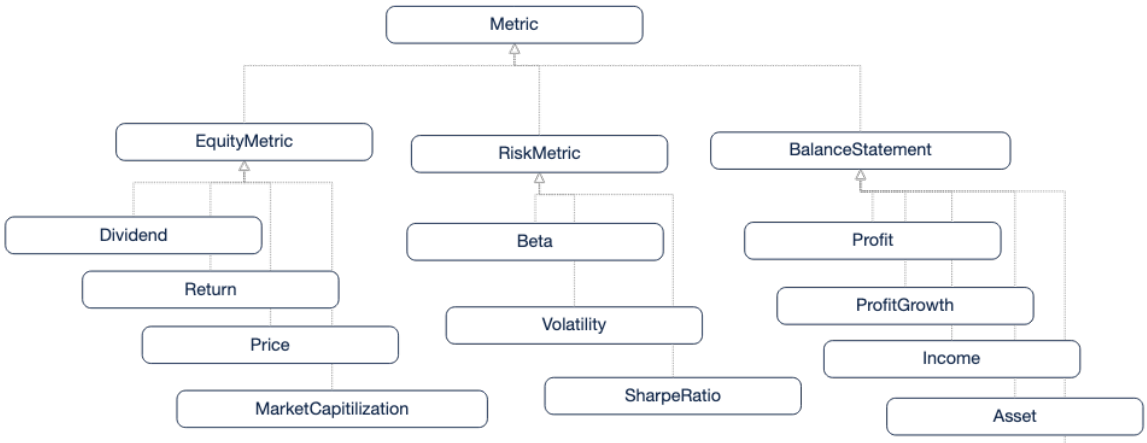


- Instrument
  - Stock
  - Etf
  - MutualFund
  - FundofFund
- TemporalEntity (referred from FIBO)
  - TimeInterval
    - CalendarPeriod
      - CalendarYear
      - CalendarQuarter
  - Company
  - BusinessStage
  - Sector
  - MarketIndex

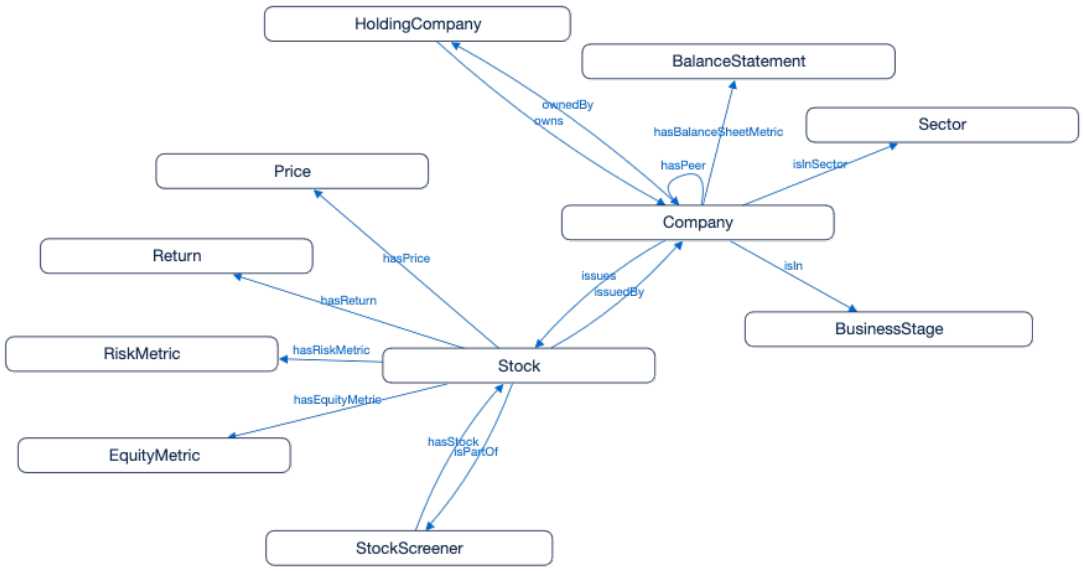
- Portfolio (aka. StockScreener)

DataProperties

- Metric (xsd:float)
  - EquityMetric
    - Return
    - Dividend
    - MarketCapitalization
    - PE
    - RSI
    - Price
  - RiskMetric
    - Beta
    - Volatility
    - Sharpe ratio
  - BalanceStatement
    - Profit
    - ProfitGrowth
    - Income
    - Asset
    - Liability
    - MarketValuation

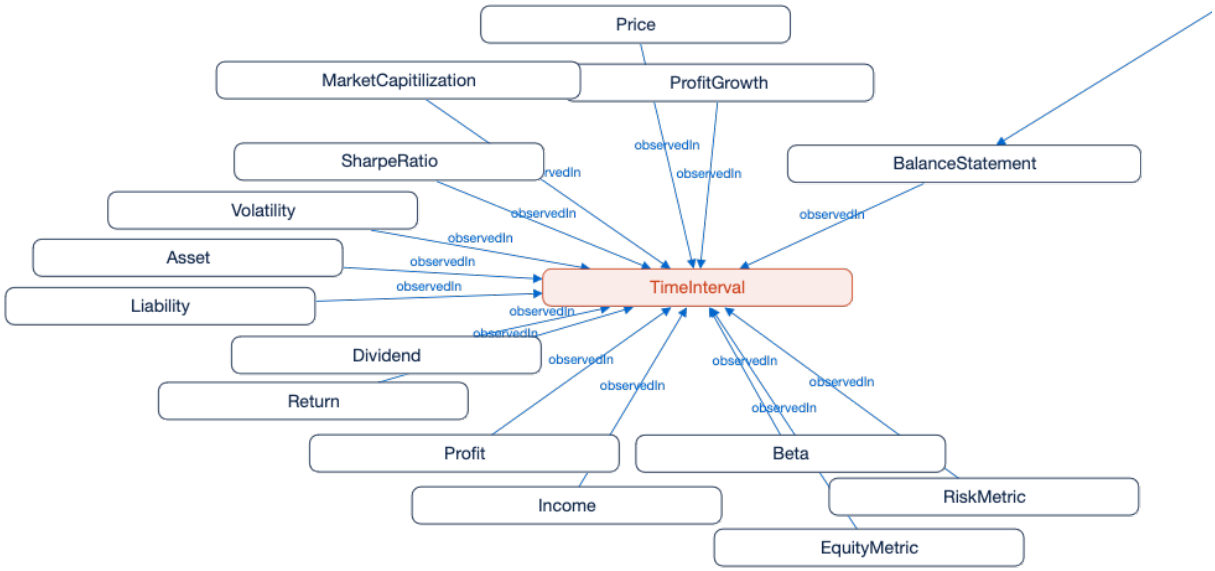


Roles and its properties



- **owns** : A company can own other company
  - owns⊆Company×Company
  - `Trans` (`owns`), (Transitive : If Company A owns Company B and Company B owns Company C then Company A owns Company B)
  - `Irref` (`owns`), (Irreflexive : No company can own itself)
  - `Asym` (`owns`), (Asymmetric : If Company A owns company B then Company B cannot own Company A)
  - `isOwnedBy`$\equiv$`owns`$^{-1}$, (Inverse relation , If A owns B then B is owned by A)
- **has** $\subseteq$ (Instrument $\times$ Instrument) A instrument can be part of other instrument
  - Transitive : `Trans` (`has`)
  - Irreflexive : `Irref` (`has`)
  - Asymmetric : `Asym` (`has`)
- **hasPeer** $\subseteq$ (Company$\times$ Company)
  - Transitive : `Trans` (`hasPeer`)
  - Reflexive : : `Ref` (`hasPeer`)
- **isIn**: (Company$\rightarrow$ BusinessStage)

- **isInSector**: (Company→ Sector),
- **contains**: (Sector→ Company),
- **benchmarkedBy**: (Instrument→MarketIndex)
- **isInScreener**: (Stock→StockScreener)
- **hasStock**: (Stock Screener→Stock)
- **hasPrice** : (Stock→ Price)
- **hasReturn** : (Stock→ Return)
- **hasVolatility** : (Stock→ Return)
- **hasMarketCapitalization** : (Stock→ Return)
- **hasMarketValuation** : (Stock→ Return)
- **hasEquityMetric**:(Stock→ EquityMetric)
- **hasRiskMetric**:(Stock→ RiskMetric)
- **hasBalanceSheetMetric**:(Company→ EquityMetric)



- **observedIn** : (Metric→ TimePeriod)

Axioms

- Company should be a part of some sector

> Company $\sqsubseteq \exists$ isInSector.Sector

- Company must be in some type of business lifecycle stage

> Company $\sqsubseteq$ $= 1$ isInStage.BusinessStage

- Holding company is a company which owns another company

> HoldingCompany$\equiv$Company $\sqcap$ $\exists$owns.Company

- Heirarchial role of Instruments
  - Etf $\sqsubseteq \exists$ has.Stock
  - MutualFund $\sqsubseteq \exists$ has.Stock $\sqcup \exists$ has.ETF
  - FundofFund $\sqsubseteq \exists$ has.ETF $\sqcup \exists$ has.MutualFund
- Portfolio holds at least one stock:

> Portfolio $\sqsubseteq \exists$ holds.Stock

- A stock must have a price, return, and volatility:

> Stock $\sqsubseteq \exists$ hasPrice.Price $\sqcap \exists$ hasReturn.Return $\sqcap \exists$ hasVolatility.Volatility

- Price, return, and volatility are observed in specific time periods:

> Price $\sqsubseteq \exists$ observedIn.TimeInterval

> Return $\sqsubseteq \exists$ observedIn.TimeInterval

> Volatility $\sqsubseteq \exists$ observedIn.TimeInterval

- Midcap : companies with a moderate market valuation ranging from Rs. 5,000 crores to Rs. 20,000 crores

> Midcap $\sqsubseteq$ Stock $\sqcap$ (hasMarketValuation.(≥ 5000)) $\sqcap$ (hasMarketValuation.(≤ 20000))

- Smallcap : company whose market capitalization is less than Rs 5,000 crores are known as small-cap companie

> Smallcap $\sqsubseteq$ Stock $\sqcap$ (hasMarketValuation.(< 5000))

- Largecap : company with market caps of ₹20,000 crore or more

> Largecap $\sqsubseteq$ Stock $\sqcap$ (hasMarketValuation.(> 20000))

- LowVolatile stocks have volatility lesser than 0.3:

> LowVolatileStocks $\sqsubseteq$ Stock $\sqcap$ (hasVolatility.(< 0.3))

- LowVolatile portfolio holds more than 3 equities each having volatility lesser than 0.3:

> LowVolatile $\sqsubseteq \exists$ hasStock.(LowVolatileStocks)) $\sqcap$ (≥ 3 hasStock)

- HighGrowth - Stocks with low pe(<10) and high profit growth (>40%)

  $HighGrowthStocks \sqsubseteq Stock \sqcap (hasPE.(< 10) \sqcap hasProfitGrowth.ProfitGrowth.(>40))$

- HighGrowth portfolio holds more than 3HighGrowthStocks equities

  $HighGrowth \sqsubseteq \exists hasStock.(HighGrowthStocks) \sqcap (\geq 3\ hasStock.Stock)]$

- Oversold - Stocks with RSI (Relative Strength Index) < 30

  $OversoldStocks \sqsubseteq Stock \sqcap (hasRSI.RSI < 30)$

- Company, Stock has always a unique name

  $Company \sqsubseteq (= 1\ hasName.Name)$
  $Stock \sqsubseteq (= 1\ hasName.Name)$

- CompanyName and StockName are disjoint

  $CompanyName \sqcap StockName \sqsubseteq \bot$

Task - 3

a write-up about the design choices made and the details of the design - the explanations for classes, properties, DL axioms, motivating situations/examples - of terms in the ontology.

Classes

- Company - A registered business according to laws.
- CompanyName - Represents the name of the company. This Class was omitted in the final design as it can be modelled as datatype
- StockName - Represents the name of the stock of the company. This Class was omitted in the final design as it can be modelled as datatype
- Category - Classification of financial instruments based on characteristics like market capitalization

(e.g., SmallCap, MidCap, LargeCap). This Class was omitted in the final design as its subclasses can be modelled as an expression

- BusinessStage - Represents the lifecycle stage of a company, such as DevelopmentStage, GrowthStage, SustainabilityStage, ExpansionStage.
- Sector - Represents the industry sector to which a company belongs, such as Technology, Finance, or Healthcare.
- MarketIndex - A measure representing the performance of a segment of the stock market. Eg. NIFTY, BankNifty
- Instrument
  - Stock - Represents an equity that signifies ownership in a company.
  - ETF - An exchange-traded fund that holds a collection of stocks or other assets and is traded on an exchange.
  - MutualFund - A fund that pools money from multiple investors to invest in a diversified portfolio of stocks, bonds or other assets.
  - FundofFund - An investment fund that holds shares in other investment funds.
- TemporalEntity
  - TimeInterval - Represents a period of time during which a metric or event is measured.
  - CalenderPeriod -
    - CalenderYear - Represents a full year.
    - CalenderQuarter - Represents a quarter of a year.
- Metric
  - EquityMetric - Measures specific attributes of equity investments.
    - Return - The profit or loss from an instrument.
    - Dividend - The portion of a company's earnings distributed to shareholders (who owns stocks).
    - MarketCapitalization - The total market value of a company's stocks.
  - RiskMetric - Measures the risk associated with investments.
    - Beta - A measure of an investment's volatility relative to the market.
    - Volatility - The degree of variation of a trading stock price over time.
    - Sharpe ratio - A measure of risk-adjusted return, comparing the return of an investment to its risk.
  - BalanceStatement - Represents financial metrics
    - Profit - The net income of a company after expenses.
    - Price - The current trading value of instrument.

- Income - Earnings generated by a company from its operations and sales.
- Asset - Resources owned by a company that have economic value.
- Liability - Financial obligations or debts owed by a company.

Properties

- owns - (Company→Company) A company can own other company.
- has - (Instrument → Instrument) A instrument can be part of other instrument.
- hasPeer - (Company→ Company) A company which is in similar sector (IT, Banking etc.) as another company.
- isInStage - (Company→ BusinessStage) Links a company to the specific stage of its business lifecycle (e.g., growth stage, maturity stage).
- belongsTo - (Company→ Sector) Indicates the sector or industry to which a company belongs (e.g., technology, finance).
- benchmarkedBy - (Instrument→MarketIndex) Relates an instrument to the market index against which it is benchmarked.
- isIn: (Stock→Portfolio) Describes the inclusion of a stock within a specific investment portfolio.
- holds - (Portfolio→Stock) Represents the relationship where a portfolio holds a stock.
- hasPrice - (Stock→ Price) The price of the stock.
- hasReturn - (Stock→ Return) The return (profit/loss) on a stock.
- hasDividend : (Stock→ Dividend) The dividend distributed by the company per stock to its shareholders.
- hasMarketCapitalization - (Stock → MarketCapitalization) Relates a stock to its total market capitalization.
- observedIn - (Metric→ TimePeriod) Links metrics to the time period during which they are observed.
  (MonetaryAmount→ TimePeriod) Links monetary amount to the time period during which they are observed.
- hasProfit - (Profit → Company) Indicates the profit generated by the company.
- hasValue - (Metric→ NumericValue) Describes the value of a specific metric as a numerical value.

Design choices

- Use of Transitive roles : The company can have ownership chain say Company A can own Company B and Company B owns Company C which was captured by transitive role `owns`. Similar transitive role `has` also captures relation like Etf has Stock and Mutual fund can have both Stock and ETFs.

- Concept Disjointness : The company and stock name should be disjoint to represent different entities. Stock is a financial instrument representing the company's business.
- Inverse Role :
  - (Company $\sqsubseteq \exists$isInSector.Sector) A company will definitely belong to a sector but (Sector $\sqsubseteq \forall$ has.Company) a sector can have 0 or many companies.