



# M.Tech (Knowledge Engineering) – Final Year Project - SmartTrader – Phase 1 Report

## Domain Familiarization, Knowledge Acquisition and Project Planning

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## 2 Project Endorsement Certificate

Following is the letter of endorsement from PiQuant Capital Pte. Ltd  
(<http://www.piquantcapital.com>).

We extend our thanks to PiQuant members and Weying Lim for the project endorsement.

To: Director (Master of Technology in Knowledge Engineering programme)  
Institute Of Systems Science  
Eusoff Hall, 25 Heng Mui Keng Terrace, 119615

Subject: **Final Year Project for Master in Technology (Knowledge Engineering) program**

The team of students from KE25 listed below will undertake a research and development project, possibly leading to an implementable system on behalf of Piquant Capital Pte Ltd.

Lim Weiyang  
Elizabeth Tang Huifen  
Gao Yong  
Shriranga Kulkarni  
Nadarajasarma Sathasivaiyer

The topic of the project will relate to stock market trading in the U.S. market and seek to put into practice the skills, tools and techniques acquired by the students. The students will have the opportunity to work with the domain expert and understand the strategies in the organization and, suggest and apply knowledge-engineering techniques to provide identifiable benefits. The project may involve the experimental application and validation of several knowledge-engineering technologies such as random forest, clustering, neural net forecasting, ensemble methods etc to analyzing and predicting the stock market.

Piquant Capital Pte Ltd will endorse the objectives and strategies of the above Project and express its commitment to participate in this Project.

Sincerely,



Signed by



CEO of Piquant Capital



CIO of Piquant Capital

(GEORGE VARGHESE)

**PIQUANT CAPITAL PTE. LTD.**  
(Company Registration No: 201105998C)

## 3 Project Overview

### 3.1 Problem Description

To develop an intelligent software system capable to

- Generate a portfolio of US stocks information on any particular day based on the S&P1500,
- Help the traders/portfolio managers to make informed decisions about selecting stocks to generate their desired absolute return.

### 3.2 Project Scope and Objectives

Overall build a dynamic and robust US stock trading system based on a multi-factor model that is systematic, rigorously and carefully tested across time and thus giving consistent and profitable returns in real life that can closely match the back test. Both long and short positions should be considered and combined wherever possible.

1. Customizable based on user's risk profile and style preference through a user interface. This can be done through the use of appropriate screens combining various factors/metrics, leverage, number of stocks chosen (though this has to be of a sufficient size to achieve diversification and model efficacy) etc.
2. Use of appropriate KE techniques to enhance performance if possible though not at the expense of sacrificing the intuition (through appropriate use of factors) behind what drives stock performance

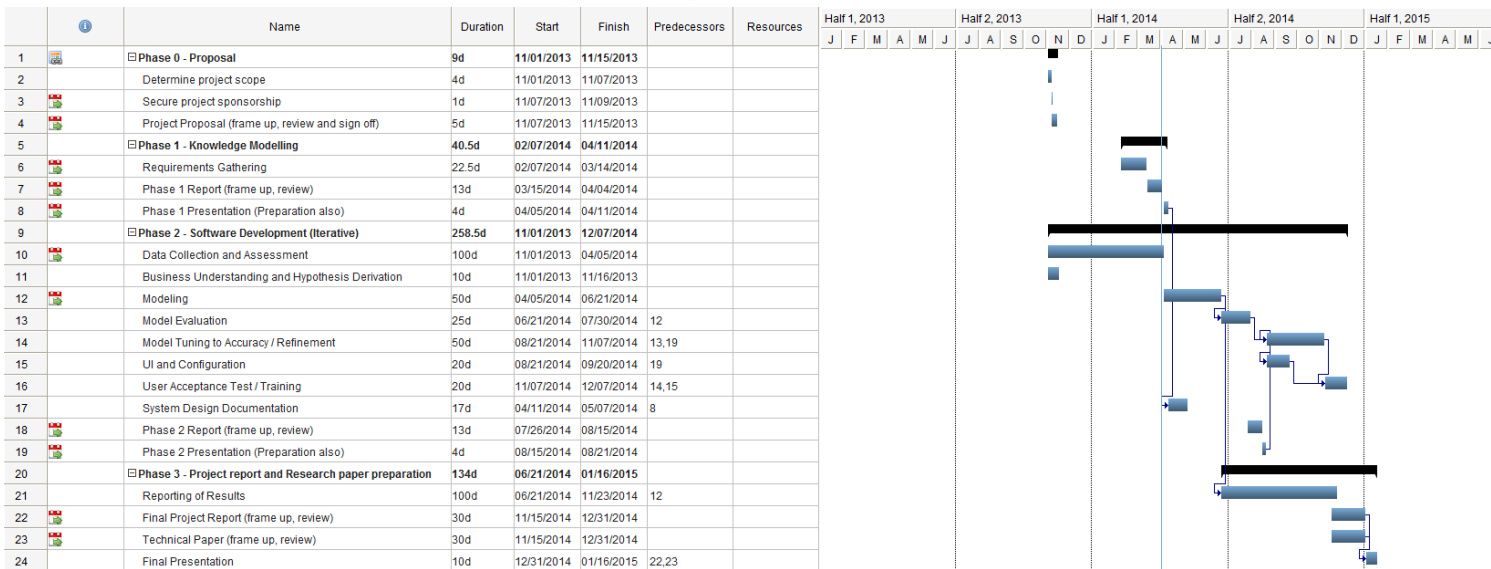
## 4 Project Planning

Project plan is created and maintained via “Ganttter” online which is powered by Google Docs, facilitating all team members to adhere to the schedule and progress collaboratively.

Following is the snapshot of project plan.

*Please refer to Appendix C for the full project plan.*

### 4.1 Snapshot of the current project plan



## 5 Domain Familiarization and Knowledge Acquisition

### 5.1 Domain Familiarization

The domain familiarization is an iterative and on-going process. The team members perform it both individually and collectively in order to get familiar with the domain and understand the various concepts involved in the domain.

#### 5.1.1 Domain familiarization steps – Iterative method:

1. Formulation of an initial set of stock level data needed.
2. Downloading the stock data at regular interval of time, to get familiar with the data.
3. Exploratory data analysis to understand the data better.
4. Data cleaning/factor scaling and modeling.
5. Appropriate scoring/normalization and relative ranking of stocks by each factor score and grouping into respective portfolio quadrants. This factor scoring has to be sector specific/even capitalization specific (each sector has its own characteristics) and based on what we understand about each factor.
6. Generate daily factor returns for all portfolio quadrants for each factor. The best quadrant should preferably perform best over time.
7. Combine and apply appropriate weightings to individual factors, then form broad composite factors. A final factor can be determined and “factor returns” can again be generated for this. To form a final factor, different broad composite factors can be combined at different periods based on some clustering technique. However, this should be approached carefully as factor rotation is not an easy task to achieve. If possible, weightings of composite factors can change across time. Otherwise, equal weighting usually works quite well. There can be multiple combinations of broad composite factors that can be constructed that can perform well at different times. This has to be researched and tested.
8. Determine market favorability. Can be primarily based on stock/sector level aggregate fundamental/technical information. Economic/Monetary policies/Sentiment data can be used wherever appropriate. This can help determine the level of risk to take at any point in time.
9. Portfolio construction/implementation. This is where appropriate costs and actual rebalancing of the portfolio/execution of trades has to be considered. Can be a fixed duration such as monthly or dynamic rebalancing. Appropriate leverage, net long/net short positions (if we also consider short positions) or quantity of stocks to recommend is also important based on appropriate risk to take.

*Please refer to appendix A for the Domain Familiarization model details.*

## 5.2 Knowledge Acquisition/Elicitation:

Knowledge acquisition and knowledge representation are the fundamental building blocks of knowledge-based systems (KBSs). How to efficiently elicit knowledge from experts and transform this elicited knowledge into a machine usable format is a significant and time consuming problem for KBS developers. Object-orientation provides several solutions to persistent knowledge acquisition and knowledge representation problems including transportability, knowledge reuse, and knowledge growth.

One of the initial and important processes in building the expert system is the Knowledge Acquisition for stock analysis and recommender in a certain area of interest. Since we had to get domain knowledge in the field of stocks, finance and related technology, we went through following procedures for accomplishing the knowledge elicitation process.

- 1) Primarily, interviewing Mr Yingwei Heng (Stanley Wang), a domain expert in the field of stocks trading and finance in general.
- 2) Discussions with Mr. Johnny Kwon, Investment manager for Woodsford Capital Management Ltd, Singapore.
- 3) Also do our own research in the stocks investment and financial domain using online/library resources.
- 4) Take guidance/assistance of our professor, Mr. Charles (for technical feasibility and clarification regarding implementation ways).

### 5.2.1 About the Interviewee:

Stanley Wang has a wealth of experience in the finance industry having worked in banks for a few years.

- He has considerable experience in trading equities, forex and warrants having traded for years.
- He has taken part and came in second in the Singapore round of an equity research competition organized by the CFA Institute.
- He believes that one can predict future market trend by analyzing historical data.

The interview was conducted online using Google hangouts air application and the further clarifications were discussed via mobile/email. The interview video was uploaded onto YouTube (<https://www.youtube.com/watch?v=UjAOcsTF1Aw>) with detailed transcript.

We followed mixture of unstructured interview/Semi-structured interview techniques for the domain knowledge acquisition.

During the early stage of the interview, elicitation followed **unstructured interview mode**, where session was free flowing which produced basics of knowledge domain [basically a broad discussion about the stocks and finance domain].



For later/final stages of the interview, **Semi-structured interview** mode was followed which is the main technique for elicitation, In this mode, Pre-defined questions were sent to expert prior to interview, supplementary questions asked at the interview. We followed this format since outcome of this kind of interview, can be used as part of validation.

Apart from the Interview with domain experts, we carried out our own research in finding the information about different aspects of stocks investment. Please refer to Reference section of the report for online references/resources used for the knowledge acquisition.

*Please refer to appendix B for the summary of Knowledge acquisition transcripts.*

## 6 User Requirement Specifications

### 6.1 Executive Summary

#### 6.1.1 Project Description

Portfolio equity managers/traders are in the business of managing clients' assets and need to generate reasonable returns to satisfy their clients and generate fees for themselves. They perpetually face difficult decisions such as which stocks to buy/sell, when to buy/sell and how much capital to commit at any point in time. They need to understand the possible underlying factors that drive both the stock market as a whole and individual stock returns. The ability to determine which factors work and when they work can give the portfolio manager/trader an edge over his competitors.

#### 6.1.2 Purpose and Scope of this Specification

The aim of this project is to develop an intelligent and dynamic software system which will generate a portfolio of US stock information from the S&P1500 based on a set of most relevant and important explanatory factors and accompanying models on any particular day, and help the traders/portfolio managers to make informed decisions about selecting the most ideal stocks to generate their desired absolute return. Below show the various scope of the project.

- Output will be a list of stocks which are expected to give high return relative to other stocks within universe on a particular day.
- User has the control over the number of maximum stocks in the list and the minimum possibility for the prediction.
- Factors selected by the models used in stock selection at any point in time and possible importance/explanatory ability.

##### 6.1.2.1 Possible Extensions

- Integration with trading systems for real time trading of stocks, based on the historical models and results generated. Incorporate costs, use appropriate/realistic holding periods and risk control mechanisms and back-test strategy over historical period
- Incorporate market favorability/direction which can possibly be based on a predictive model and advice on stock allocation accordingly.
- User preference over the selection of factors.
- Other stock selection methods based on various styles such as value or dividend investing, growth investing and trend/momentum trading etc.

#### 6.1.3 Benefits and Costs

Artificial intelligence and knowledge systems technology first surfaced in the latter part of the last century when they were used to predict market trends. Since then, there has been limited literature or widespread use of such technologies in the financial markets due to various reasons such as a lack

of trust in its predictive accuracy or a greater belief in individual judgment rather than using the computer to make a trading decision.

However, the benefits of using these technologies are multifold. First, the technologies and models used have become increasingly comprehensive and therefore complicated, with the ability to synthesize a large amount of data particularly with comprehensive stock level information involving a large universe such as S&P1500 and multiple attributes that the human being will be unable to perform easily by himself.

Second, non-linear decision making computer programs that attempt to make the “best” decision are attempting to more closely model the type of decision making used by humans in an effort to better reflect our comprehensive problem solving capabilities. This may eventually result in the closest we have come to technologically reproducing human logic and intelligence. Third, these systems can be dynamic and evolve constantly with the markets while being able to learn new models and relationships between data with the arrival of new financial data.

There are also possible disadvantages of a system based on artificial intelligence and predictive modeling. There are limitations as to how far these technologies can go because of the inseparable human element in the fluctuations in the stock market and how well these fluctuations can be modeled accordingly. In addition, it can be difficult to use such technologies appropriately and effectively without a solid understanding.

#### **6.1.4 Solution Outline**

The ability to accurately determine the crucial factors affecting stock returns at any point in time, their importance and how to model them effectively can give the portfolio manager an edge. The portfolio manager/domain expert’s role is to determine, based on his understanding of the stock market what such factors can be. Due to a multitude of explanatory factors and the difficulty in understanding precisely the mathematical relationship between factors and stock returns, artificial intelligence or knowledge systems technology can then be applied to better attempt to model or make sense of such relationships, possible in cases where there is non-linearity and some randomness.

KE techniques that will be explored include linear regression, decision trees, adaboost, support vector machines, neural networks. These methods will be used on the resulting set of factors (through a technique like random forest and other methods like correlation analysis etc) and used to predict individual stock returns to understand which method may be more effective.

Clustering is another method that can be used on the entire set of factors to analyze relationships between stock returns and factor attributes.

Allowing the change of weights to vary across time for different composite factor groups such as valuation, profitability, price related attributes can be explored as well.

## 6.2 Product/Service Description

As this is a prediction system, and the result of the prediction is based on a set of underlying explanatory factors, the output produced may differ from actual results depending on the unforeseen events in the market. System will be tested with the past data and validated for maximum reliability. The accuracy of the system is dependent on the real time data collected as trained data.

### 6.2.1 Product Context

The system is an independent system having no direct dependencies with other systems such as live stock data feed or brokerage systems. The analysis results produced by systems. This system may be used as input for trading strategies which are currently out of scope of the system.

### 6.2.2 User Characteristics

This system has two types of users.

- Admin  
This mode is used to train the system and modify the core functionalities of the system. Only the system developer and system administrator have the privileges of Admin user.
- End User  
This mode is used by Traders/Portfolio Managers to generate the portfolio every day. This is the target mode (end user mode) of this system.

### 6.2.3 Constraints

Because of the huge data to be analyzed to generate the relevant models and resulting portfolios, a significant processing time and processing power will be required.

## 6.3 Dependencies

- This system will require a daily download of data from the market data server.
- Downloading the data and transferring to appropriate place to be completed before starting this process.

## 6.4 Functional requirements

Requirement No.	Requirement	Comments	Priority	Reviewed/ Approved
1	Data Availability	Downloading data from servers using appropriate tools/scripts	5	
2	Data Verification	Verifying the data for possible errors and missing values.	3	
3	Data Cleanup and preparation	Clean the data.	2	
4	Data Standardization	Rescale and Normalize.	2	
5	Data Analysis and Model Design and Implementation	Data mining and modeling	1	
6	Prediction	Predicted stocks with higher return.	1	

1 - Highest priority, 6 - Lowest priority

## 6.5 User Interface requirements

User has control over the following items:

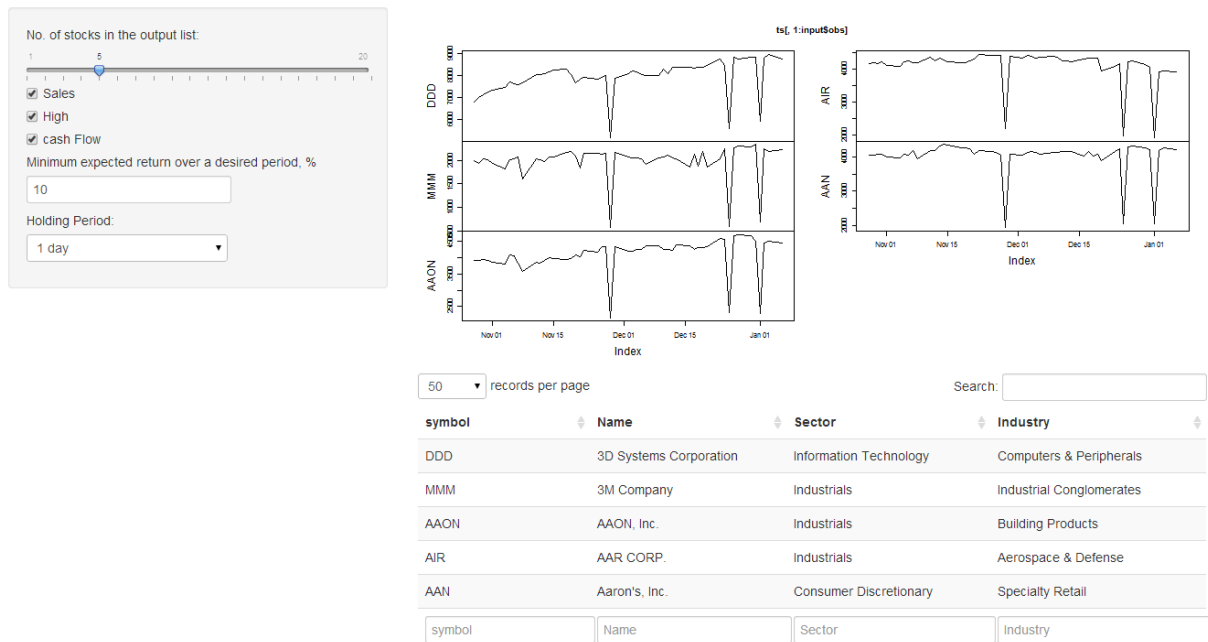
1. No. of stocks in the output list.
2. Minimum expected return over a desired period
3. Number and/or Type of variables to include/exclude for the prediction. (Possibly add on and for advanced users)

Possible Outputs:

1. List of stocks
2. Graphs
3. Variables analyzed, analyzed periods and details.

## Schematic Representation of SmartTrader Output

### SmartTrader



## 6.6 Performance Measurement

Performance will be measured as below:

1. Number of records processed and analyzed per unit time
2. System throughput

## 6.7 Maintenance

1. All the technical design and source code should be properly documented.
2. System should have interfaces to scale/extend in future.
3. Different levels of logging mechanisms are essential.

## 6.8 Data requirements

Requirement	Description
Types of information used by various functions	Market data ticks.
Frequency of use	Everyday
Data Security	Data should be protected from unauthorized access.

<b>Data entities and relationships</b>	Relationship and association between different data objects and variables should be designed
<b>Integrity constraints</b>	Data integrity refers to maintaining and assuring the accuracy and consistency of data over its entire life-cycle
<b>Data retention</b>	N/A
<b>Valid range, accuracy, and/or tolerance</b>	Range is different for different variables.
<b>Units of measure</b>	N/A
<b>Data formats</b>	CSV/XML, MSDB, or other applicable types
<b>Default or initial values</b>	N/A

## 7 System Design

### 7.1 Business Background

#### 7.1.1 Model Factors/Variables

##### 7.1.1.1 Objective Variable

Future stock returns over a desired holding period (a few possible selections such as 5, 10, 30 days) from the point where underlying predictive factor values are determined.

##### 7.1.1.2 Predictive Variables

Following table illustrates the list of possible factors or variables which can be used to knowledge exploration, data discovery pattern and analysis and predictive modelling:

No	Factor	Category	Period
1	Book Yield FY1	Valuation	Forward Looking
2	Book Yield FY2	Valuation	Forward Looking
3	Book Yield FY3	Valuation	Forward Looking
4	Dividend Yield FY1	Valuation	Forward Looking
5	Dividend Yield FY2	Valuation	Forward Looking
6	Dividend Yield FY3	Valuation	Forward Looking
7	Earnings Yield FY1	Valuation	Forward Looking
8	Earnings Yield FY2	Valuation	Forward Looking
9	Earnings Yield FY3	Valuation	Forward Looking
10	EBITDA Yield FY1	Valuation	Forward Looking
11	EBITDA Yield FY2	Valuation	Forward Looking
12	EBITDA Yield FY3	Valuation	Forward Looking
13	Free Cash Flow Yield FY1	Valuation	Forward Looking
14	Free Cash Flow Yield FY2	Valuation	Forward Looking
15	Free Cash Flow Yield FY3	Valuation	Forward Looking
16	Sales Yield FY1	Valuation	Forward Looking
17	Sales Yield FY2	Valuation	Forward Looking
18	Sales Yield FY3	Valuation	Forward



			Looking
19	EV_EBIT Mean Forward 12M	Valuation	Forward Looking
20	EV_EBITDA Mean Forward 12M	Valuation	Forward Looking
21	EV_Free Cash Flow Mean Forward 12M	Valuation	Forward Looking
22	EV_Sales Mean Forward 12M	Valuation	Forward Looking
23	PEG Mean FY1	Valuation	Forward Looking
24	Earnings Yield (Past 1 Year)	Valuation	Historical
25	Free Cash Flow Yield (Past 1 Year)	Valuation	Historical
26	Sales Yield (Past 1 Year)	Valuation	Historical
27	EV_EBIT (Past 1 Year)	Valuation	Historical
28	EV_EBITDA (Past 1 Year)	Valuation	Historical
29	Book Value FY1 Revision % (Past 3M)	Analyst Revision	Forward Looking
30	Book Value FY1 Revision %(Past 6M)	Analyst Revision	Forward Looking
31	Dividend FY1 Revision % (Past 3M)	Analyst Revision	Forward Looking
32	Dividend FY1 Revision %(Past 6M)	Analyst Revision	Forward Looking
33	Earnings FY1 Revision % (Past 3M)	Analyst Revision	Forward Looking
34	Earnings FY1 Revision %(Past 6M)	Analyst Revision	Forward Looking
35	EBITDA FY1 Revision % (Past 3M)	Analyst Revision	Forward Looking
36	EBITDA FY1 Revision %(Past 6M)	Analyst Revision	Forward Looking
37	Free Cash Flow FY1 Revision % (Past 3M)	Analyst Revision	Forward Looking
38	Free Cash Flow FY1 Revision %(Past 6M)	Analyst Revision	Forward Looking
39	Sales FY1 Revision % (Past 3M)	Analyst Revision	Forward Looking
40	Sales FY1 Revision %(Past 6M)	Analyst Revision	Forward Looking
41	Earnings FY1 Estimate Variability	Analyst Variation	Forward Looking
42	Earnings FY2 Estimate Variability	Analyst Variation	Forward Looking
43	Earnings FY3 Estimate Variability	Analyst Variation	Forward Looking
44	EBITDA FY1 Estimate Variability	Analyst Variation	Forward Looking
45	EBITDA FY2 Estimate Variability	Analyst Variation	Forward Looking
46	EBITDA FY3 Estimate Variability	Analyst Variation	Forward Looking
47	Earnings FY1 UpDngrade(3M)	Analyst Grading	Forward Looking
48	Earnings FY2 UpDngrade(3M)	Analyst Grading	Forward

			Looking
49	Earnings FY3 UpDngrade(3M)	Analyst Grading	Forward Looking
50	Earnings FY1 UpDngrade(6M)	Analyst Grading	Forward Looking
51	Earnings FY2 UpDngrade(6M)	Analyst Grading	Forward Looking
52	Earnings FY3 UpDngrade(6M)	Analyst Grading	Forward Looking
53	EBITDA FY1 UpDngrade(3M)	Analyst Grading	Forward Looking
54	EBITDA FY2 UpDngrade(3M)	Analyst Grading	Forward Looking
55	EBITDA FY3 UpDngrade(3M)	Analyst Grading	Forward Looking
56	EBITDA FY1 UpDngrade(6M)	Analyst Grading	Forward Looking
57	EBITDA FY2 UpDngrade(6M)	Analyst Grading	Forward Looking
58	EBITDA FY3 UpDngrade(6M)	Analyst Grading	Forward Looking
59	Earnings FY1 Analyst Coverage	Analyst Coverage	Forward Looking
60	Gross Margin Forward 12M	Profitability	Forward Looking
61	EBITDA Margin MeanForward 12M	Profitability	Forward Looking
62	EBITMargin Mean Forward 12M	Profitability	Forward Looking
63	Net Margin Mean Forward 12M	Profitability	Forward Looking
64	ROIC Mean FY1	Profitability	Forward Looking
65	Asset Turnover Mean Forward 12M	Profitability	Forward Looking
66	Net Debt/Ebitda Mean Forward 12M	Profitability	Forward Looking
67	Capex_Sales Mean Forward 12M	Profitability	Forward Looking
68	Dividend Payout	Profitability	Historical
69	Return on invested capital	Profitability	Historical
70	Cash flow return on invested capital	Profitability	Historical
71	Debt/Capital	Quality	Historical
72	Debt/Total Assets	Quality	Historical
73	Debt/EBITDA	Quality	Historical
74	Operating Cash Flow/Financing Cash Flow (Past 1 Year)	Quality	Historical
75	Operating Cash Flow/Earnings (Past 1 Year)	Quality	Historical
76	Cash Dividend / Cash Flow from Operations	Quality	Historical
77	Net Cash/Total Debt (Past 1 Year)	Quality	Historical
78	Change in Shares Outstanding (Past 3 months)	Quality	Historical
79	Change in Shares Outstanding (Past 6 months)	Quality	Historical
80	Change in Shares Outstanding (Past 12 months)	Quality	Historical
81	EPS_Long Term Growth Mean	Growth	Forward Looking
82	EPS FY1 Slope (Past 6 Months)	Growth	Forward

			Looking
83	EPS Actual - slope (Past 6 Months)	Growth	Historical
84	EPS Actual - slope (Past 12 Months)	Growth	Historical
85	EPS Actual - slope (Past 36 Months)	Growth	Historical
86	EPS Actual - slope (Past 60 Months)	Growth	Historical
87	EPS Actual - slope over std (Past 36 Months)	Growth	Historical
88	EPS Actual - slope over std (Past 60 Months)	Growth	Historical
89	Sales Per Share Actual - slope (Past 6 Months)	Growth	Historical
90	Sales Per Share Actual - slope (Past 12 Months)	Growth	Historical
91	Sales Per Share Actual - slope (Past 36 Months)	Growth	Historical
92	Sales Per Share Actual - slope (Past 60 Months)	Growth	Historical
93	Sales Per Share Actual - slope over std (Past 36 Months)	Growth	Historical
94	Sales Per Share Actual - slope over std (Past 60 Months)	Growth	Historical
95	Net Margin Actual - slope over std (Past 12 Months)	Growth	Historical
96	Net Margin Actual - slope over std (Past 36 Months)	Growth	Historical
97	Price Slope (Past 20 Days)	Technical	Historical
98	Price Slope (Past 50 Days)	Technical	Historical
99	Price Slope (Past 100 Days)	Technical	Historical
100	Price Slope (Past 200 Days)	Technical	Historical
101	Price Slope Over std (Past 20 Days)	Technical	Historical
102	Price Slope Over std (Past 50 Days)	Technical	Historical
103	Price Slope Over std (Past 100 Days)	Technical	Historical
104	Price Slope Over std (Past 200 Days)	Technical	Historical
105	Money Flow (14 Days)	Technical	Historical
106	Money Flow (50 Days)	Technical	Historical
107	RSI (14 Days)	Technical	Historical
108	RSI (50 Days)	Technical	Historical
109	Price Momentum (20 Days)	Technical	Historical
110	Price Momentum (50 Days)	Technical	Historical
111	Price Momentum (100 Days)	Technical	Historical
112	Price Momentum (200 Days)	Technical	Historical
113	Price/200D Moving Average	Technical	Historical
114	Price/52 week high	Technical	Historical
115	Price/52 week low	Technical	Historical
116	Short Interest (%)	Technical	Historical

### 7.1.2 Model Process

Following steps are formulated to cover the Data Model and Analysis Process:

- As a first step, data files containing underlying factors will be downloaded at regular intervals of time (end of the day), historically for a period of 5-10 years.
- Factor values will evolve on a daily basis across the universe of stocks.
- As factors input values change every day, the model will dynamically evolve over time too. A model will be created either daily or at a fixed duration such as weekly or monthly.
- Data processing and the use of techniques in the model will however remain consistent over time so that the model can be evaluated at different stages over time. This is to ensure that the model keeps up to date (machine learning technique)

with constantly evolving market information, always selecting the best set of factor inputs for modeling.

- To ensure that the model is performing well out of sample, we will use the initial models at various stages in time using data from the initial period.
- For each of these models, 80% of the stock universe will be used for training and the other 20% will be used for testing. In subsequent periods, the full universe will be used for creating the models and using them for prediction as all stocks should be taken in consideration to maximize opportunities.

### 7.1.3 Model Outcome

“Future returns” of each stock for a specified duration will be predicted.

The duration used should ideally be of a minimum duration such as 5 days in order for there to be sufficient time for stocks to perform. The stocks with the best predicted returns will be evaluated for how they perform in real life.

The accuracy rate will be calculated based on how well the selected stocks actually performed in returns terms compared to other stocks, subjected to a threshold. For example, if the top 10% of stocks are chosen, a stock will be given a successfully prediction if it ranks in say the top 30% of stocks. The accuracy rate can be determined by the percentage of successfully predictions.

## 7.2 System Architecture

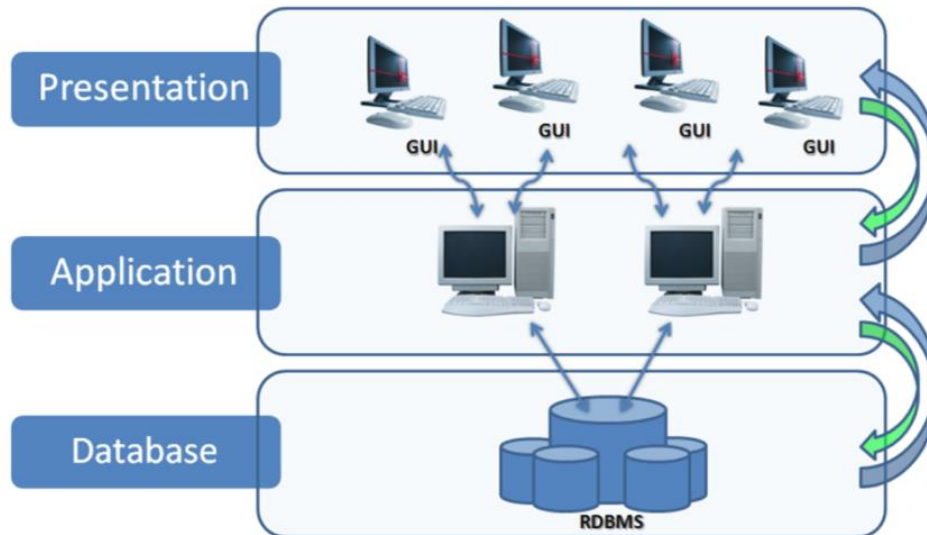
### 7.2.1.1 Architecture Overview

The system will be based on typical 3-tier Client/Server architecture for scalability, modularity, robustness and maintainability. The 3 layers are as shown below.

- Presentation layer
- Application layer
- Repository layer

The overall architecture can be represented as follows:

## 3-Tier Client/Server Architecture



## 7.2.2 Core Components

There will be a couple of core functional components within each layer and on top of them façade will be defined to expose functionality and service for the adjacent upper layer to consume.

### 7.2.2.1 Repository Layer

This layer will mainly manage incoming/outgoing data flow on the repository level to ensure data integrity, availability, consistency and maintainability:

- Data importing component: import stock data update on a periodic or ad-hoc basis
- Data accessing component: provide data access for upper and other components

### 7.2.2.2 Application Layer

This layer will encapsulate business inferential rule/logic, perform the various processes on request, and generate sensible and concrete outcomes as expected

- Inferential engine component
- Data intelligence enablement component
- User investment profiling component
- Factoring analytical and computational component

### 7.2.2.3 Presentation Layer

This layer is what administrator and end user will liaise with to initiate informative queries and perform predictive tasks:

- Interactive graphical user interface
- User input collection, validation, representation and transformation component
- Reporting/exporting component

## 7.3 Solution Technology

### 7.3.1 Technology Candidacy

To align with project objectives and fulfil the architectural requirements with the context of limited manpower and time, the technology candidates should possess the following merits to outstand:

- Maturely adoptable
- RAD (rapid application development) capable
- Rich open source resource available

- Flatter learning curve

### 7.3.2 Technology Selection

It consists of selection of technologies for the fundamental aspects/parts of the system design.

Aspects/Parts	Selection	Assessment
<b>Database</b>	MS SQL Server 2008	Prerequisite of sponsor for compatibility and integration
<b>Presentation</b>	ASP.NET Web Form or MVC	<ul style="list-style-type: none"> <li>• Mature</li> <li>• RAD well supported</li> </ul>
<b>Application</b>	R R.NET NMath C#.NET	<ul style="list-style-type: none"> <li>• .NET background and foundation of team</li> <li>• Open source resource richness</li> </ul>

## 7.4 Development Methodology

- Agile adherent
- CRISP
- Agile modeling, processing, and delivering
- Scrum planning and scheduling

## 7.5 Development Platform, Framework and Tool

There are 2 heterogeneous technologies proposed to take advantage of: R and .NET. In-between there is bridging framework/library like R.NET and NMath.

The major tools used include but not limited to:

- Microsoft Visual Studio
- R/RStudio IDE
- Microsoft SQL Server Management Studio

## 8 Appendix A: Domain Familiarization

Please find below the Domain Familiarization of the US Stock Knowledge Model

```

/*****
/* US Stock Knowledge Model */
*****/

/***** S T A R T *****/

/*****
KNOWLEDGE-MODEL us-stock;
*****/

/*****
DOMAIN-KNOWLEDGE us-stock-domain;
*****/

/*****
DOMAIN-SCHEMA stock-selection-schema;
*****/

/* 1st of 3 main concepts stock-list */
CONCEPT stock-list;
DESCRIPTION:
    "A description of the basic characteristics of each stock";
ATTRIBUTES:
    company: STRING;
    symbol: STRING;
    market-cap (millions): FLOAT;
    volume (millions): FLOAT;
    cap-category: {large, mid, small};
    style-selection: {dividend, growth, momentum, value};
    price-chg%10d: FLOAT
    price-chg%1m: FLOAT
    price-chg%3m: FLOAT
    price-chg%6m: FLOAT
    pos-earning-growth2y: BOOLEAN
    pos-earning-growth4y: BOOLEAN
    pos-earning-growth6y: BOOLEAN
    earning-growth3y: FLOAT
    earning-growth6y: FLOAT
    earning-growth9y: FLOAT
    pe-fy1: FLOAT
    p-sales-fy1: FLOAT
    div-yield%: FLOAT
    pos-div-growth5y: BOOLEAN
    pos-div-growth10y: BOOLEAN
    pos-div-growth15y: BOOLEAN

```



```

risk-match-cf: {-1 - 1}
stock-attractiveness-cf: {-1 - 1}
recommendation-rank: {-1 - 1}

/* RULE-TYPE 1 determines 'sector' */
sector: {consumer-staples, consumer-discretionary, energy,
financials, health-care, industrials, materials, technology,
telecommunication-services, utilities};

/* RULE-TYPE 2 determines 'risk-match-certainty-factor' */
risk-match-certainty-factor: {between -1 and 1}

/* RULE-TYPE 3 determines 'stock-attractiveness-certainty-factor' */
stock-attractiveness-certainty-factor: {between -1 and 1}

/* RULE-TYPE 4 determines 'recommendation-rank' */
recommendation-rank: {between -1 and 1};
END CONCEPT stock-list;

/* SUB SET OF 1st of 3 main concepts stock-list */
CONCEPT stock-risk-feature;
DESCRIPTION:
    "features of a stock that can affect the riskiness of a stock";
SUB-TYPE-OF: stock-list
ATTRIBUTES:
    cap-category: {large, mid, small}
    liquidity: volume-category;
    price-volatility: FLOAT;
    earning-volatility: FLOAT;
    sector: {consumer-staples, consumer-discretionary, energy,
financials, health-care, industrials, materials, technology,
telecommunication-services, utilities};
    stock-risk-cf: {-1 - 1}
END CONCEPT stock-risk-feature;

VALUE-TYPE volume-category;
TYPE: ORDINAL;
VALUE-LIST: {<500000,>=500000};
END VALUE-TYPE volume-category;

/* SUB SET OF 1st of 3 main concepts stock-list */
CONCEPT stock-attractiveness-feature-inherent-market-feature;
DESCRIPTION:
    "features of a stock that can affect the attractiveness of a
stock";
SUB-TYPE-OF: stock-list
ATTRIBUTES:
    peg: FLOAT;
    ebitda-margin: FLOAT;
    roic: FLOAT;
    net-debt-equity-ratio: FLOAT;
    stock-attractiveness-inherent-market-feature-cf: {0 - 1};

```

```

END CONCEPT stock-attractiveness-feature-inherent-market-feature;
/* SUB SET OF 1st of 3 main concepts stock-list */
CONCEPT stock-attractiveness-feature-inherent-derived;
DESCRIPTION:
"derived features of a stock that can affect the attractiveness of a stock";
SUB-TYPE-OF: stock-list
ATTRIBUTES:
market-favourability: {high, medium, low}
//(derived from Market Favourability CF)
cap-category-attractiveness-cf: {0 - 1}
sector-attractiveness-cf: {0 - 1}
stock-attractiveness-from-market-favourability-cf: {0 - 1}
END CONCEPT stock-attractiveness-feature-inherent-derived;

```

```

/* SUB SET OF 1st of 3 main concepts stock-list */
CONCEPT stock-style-feature;
DESCRIPTION:
"Stock level style feature to be matched with Customer Style Profile ";
SUB-TYPE-OF: stock-list
ATTRIBUTES:
style-selection: {dividend, growth, momentum, value};
price-momentum-preference: {<4weeks,4weeks-12weeks,>12weeks};
no-consecutive-years-increasing-earnings: {2,4,6};
earning-growth-rate: {10%-20%,20%-30%,>30%};
yrs-used-for-earning-growth: {3,6,9}
price-earning-ratio: {<6,6-10,10-15};
price-sales-ratio: {0-0.5,0.5-1,1-1.5};
dividend-yield-required: {0-2%,2%-4%,>4%};
dividend-growth-desired: {5%-8%,8%-12%,>12%};
no-consecutive-positive-years-dividend-growth: {5-10,10-15,>15,};
END CONCEPT stock-style-feature;

```

```

/* 2nd of 3 main concepts macroeconomic-and-stock-market-conditions */
CONCEPT macroeconomic-and-stock-market-conditions;
DESCRIPTION:
"overall macroeconomic and stock market conditions";
ATTRIBUTES:
market-favourability-cf: {between 0 and 1};
macroeconomic-conditions-cf: {between -1 and 1};
stock-market-conditions-cf: {between -1 and 1};
END CONCEPT macroeconomic-and-stock-market-conditions;

```

```

/* SUB SET OF 2nd of 3 main concepts macroeconomic-and-stock-market-conditions */
CONCEPT macroeconomic-conditions;
DESCRIPTION:
"Economic factors that influence the state of the whole economy, such as changes in employment levels, gross national product (GNP), and prices (deflation or inflation)";
SUB-TYPE-OF: macroeconomic-and-stock-market-conditions
ATTRIBUTES:
inflation-rate: {<0% or >4%: bearish, 0% - 2%: bullish, 2% - 4%: neutral};

```

```
unemployment-rate: {<5%: bullish, 5%-6%: neutral, >6%: bearish};
unemployment-trend: {uptrend,flat,downtrend}
average-weekly-unemployment-claim: {<350,000: bullish, 350,000 - 400,000:
neutral, >400,000: bearish};
unemployment-claim-trend: {uptrend,flat,downtrend};
yield-curve-slope: {upward-sloping,flat,downward-sloping};
retail-sale-trend: {uptrend,flat,downtrend};
pmi: {<50,>=50};
END CONCEPT macroeconomic-conditions;
```

```
/* SUB SET OF 2nd of 3 main concepts macroeconomic-and-stock-market-
conditions */
```

```
CONCEPT stock-market-conditions;
```

```
DESCRIPTION:
```

```
"Market conditions is a term that refers to the state of an stock";
```

```
SUB-TYPE-OF: macroeconomic-and-stock-market-conditions
```

```
ATTRIBUTES:
```

```
indicator-1: {very-bearish,bearish,neutral,bullish,very-bullish};
```

```
indicator-2: {very-bearish,bearish,neutral,bullish,very-bullish};
```

```
indicator-3: {very-bearish,bearish,neutral,bullish,very-bullish};
```

```
indicator-4: {very-bearish,bearish,neutral,bullish,very-bullish};
```

```
indicator-5: {very-bearish,bearish,neutral,bullish,very-bullish};
```

```
END CONCEPT stock-market-conditions;
```

```
/* 3rd of 3 main concepts customer-profile */
```

```
CONCEPT customer-profile;
```

```
DESCRIPTION:
```

```
"Customer level profile; each customer has one profile";
```

```
ATTRIBUTES:
```

```
customer-name: STRING;
```

```
customer-address: STRING;
```

```
customer-phone: NATURAL;
```

```
END CONCEPT customer-profile;
```

```
/* SUB SET OF 3rd of 3 main concepts customer-profile */
```

```
CONCEPT customer-risk-profile;
```

```
DESCRIPTION:
```

```
"features of a customer's ability to buy stock";
```

```
SUB-TYPE-OF: customer-profile
```

```
ATTRIBUTES:
```

```
overall-risk-tolerance-cf: {between -1 and 1};
```

```
risk-tolerance-ability-cf: {between -1 and 1};
```

```
risk-tolerance-willingness-cf: {between -1 and 1};
```

```
END CONCEPT customer-risk-profile;
```

```
/* SUB SET OF customer-risk-profile, which is SUB SET OF 3rd of 3 main
concepts customer-profile */
```

```
CONCEPT customer-risk-profile-ability;
```

```
DESCRIPTION:
```

```
"features of a customer's ability to buy stock";
```

```
SUB-TYPE-OF: customer-risk-profile
```

```
ATTRIBUTES:
```

```
age: {20-35,36-45,46-55,56-65}
```

```
net-assets: {<25000,25000-100000,100000-250000,250000-500000,>500000};
job-stability: {very-unstable, rather-unstable, a-bit-stable, stable, very-
stable};
monthly-income: {<2500,2500-5000,5000-7500,7500-10000,>10000};
liquidity-needs: {very-low, low, medium, high, very-high};
END CONCEPT customer-risk-profile-ability;
```

```
/* SUB SET OF customer-risk-profile, which is SUB SET OF 3rd of 3 main
concepts customer-profile */
```

```
CONCEPT customer-risk-profile-willingness;
```

```
DESCRIPTION:
```

```
"features of a customer's willingness to buy a stock";
```

```
SUB-TYPE-OF: customer-risk-profile
```

```
ATTRIBUTES:
```

```
thrill-factor: {very-low, low, medium, high, very-high};
job-security-preference: {very-high, high, medium, low, very-low};
investment-risk-tolerance: {very-low, low, medium, high, very-high};
job-compensation-preference: {all-salary, mainly-salary, equal-mix-salary-
commission, mainly-commission, all-commission};
aversion-to-previous-stock-loss: {very-high, high, medium, low, very-low};
END CONCEPT customer-risk-profile-willingness;
```

```
/* SUB SET OF 3rd of 3 main concepts customer-profile */
```

```
CONCEPT customer-style-profile;
```

```
DESCRIPTION:
```

```
"features of customer's personality";
```

```
SUB-TYPE-OF: customer-profile
```

```
ATTRIBUTES:
```

```
style-selection: {dividend, growth, momentum, value};
price-momentum-preference: {<4weeks,4weeks-12weeks,>12weeks};
no-consecutive-years-increasing-earnings: {2,4,6};
earning-growth-rate: {10%-20%,20%-30%,>30%};
yrs-used-for-earning-growth: {3,6,9}
price-earning-ratio: {<6,6-10,10-15};
price-sales-ratio: {0-0.5,0.5-1,1-1.5};
dividend-yield-required: {0-2%,2%-4%,>4%};
dividend-growth-desired: {5%-8%,8%-12%,>12%};
no-consecutive-positive-years-dividend-growth: {5-10,10-15,>15,};
END CONCEPT customer-style-profile;
```

```
/*******/
```

```
/* 4 RULE TYPEs */
```

```
/*******/
```

```
/* 1st of 4 RULE TYPEs */
```

```
RULE-TYPE update-stock-risk;
```

```
ANTECEDENT: customer-risk-profile; CARDINALITY: 1;
               stock-risk-feature; CARDINALITY: 1+;
```

```
CONSEQUENT: stock-risk-feature; CARDINALITY: 1+;
```

```
CONNECTION-SYMBOL: update-stock-risk;
```

```
END RULE-TYPE update-stock-risk;
```

```

/* 2nd of 4 RULE TYPES */
RULE-TYPE filter-stock-style;
ANTECEDENT: customer-style-profile;
CARDINALITY: 1;
           style-feature; CARDINALITY: 1+;
CONSEQUENT: stock-style-feature: 1+;
CONNECTION-SYMBOL: filter-stock-style;
END RULE-TYPE filter-stock-style;

/* 3rd of 4 RULE TYPES */
RULE-TYPE update-stock-favourability;
ANTECEDENT: macroeconomic-and-stock-market-conditions;
           CARDINALITY: 1;
           stock-attractiveness-feature-derived;
           CARDINALITY: 1+;
CONSEQUENT: stock-attractiveness-feature-derived;
           CARDINALITY: 1+;
CONNECTION-SYMBOL: update-stock-favourability;
END RULE-TYPE update-stock-favourability;

/* 4th of 4 RULE TYPES */
RULE-TYPE recommend-stock;
ANTECEDENT: stock-list;
           CARDINALITY: 1;
CONSEQUENT: stock-list;
           CARDINALITY: 1;
CONNECTION-SYMBOL: recommend-stock;
END RULE-TYPE recommend-stock;

/*****/
END DOMAIN-SCHEMA stock-selection-schema;
/*****/

/*****/
/* Detailed RULEs */
/*****/

/* 1st of 4 KNOWLEDGE-BASEs */
KNOWLEDGE-BASE filter-stock-style-model;
USES:
    filter-stock-style FROM filter-stock-style-kb;

/* Filter By dividend Style */
customer-style-profile.style-selection = 'dividend'

AND

/* First By dividend Yield */
(customer-style-profile.dividend-yield-required = '0% - 2%'
filter-stock-style stock-list.div-yield% >=0 AND stock-list.div-yield%
< 2

```

```

customer-style-profile.dividend-yield-required = '2% - 4%'
filter-stock-style stock-list.div-yield% >= 2
AND stock-list.div-yield% < 4

customer-style-profile.dividend-yield-required = '>=4%'
filter-stock-style CHARACTERISTICS stock-list.div-yield% >= 4

)

AND
/* Second By minimum no of years of consecutive dividend growth */
(
customer-style-profile.no-consecutive-positive-
years-dividend-growth = '>=5 years'
filter-stock-style CHARACTERISTICS stock-list.pos-div-growth5y = TRUE

OR

customer-style-profile.no-consecutive-positive-
years-dividend-growth = '>=10 years'
filter-stock-style CHARACTERISTICS stock-list.pos-div-growth10y = TRUE

OR

customer-style-profile.no-consecutive-positive-
years-dividend-growth = '>=15 years'
filter-stock-style stock-list.pos-div-growth15y = TRUE

AND
/* Third By dividend growth desired */
(customer-style-profile.dividend-growth-desired = '>=5%'
filter-stock-style CHARACTERISTICS stock-list.Divgrowth% >=5

OR

customer-style-profile.dividend-growth-desired = '>=8%'
filter-stock-style CHARACTERISTICS stock-list.Divgrowth% >=8

OR

customer-style-profile.dividend-growth-desired = '>=12%'
filter-stock-style stock-list.Divgrowth% >=12

)

/* Filter By growth Style */
customer-style-profile.style-selection = 'growth'

AND
/* First By no of consecutive years of increasing earnings */

```

```
(customer-style-profile.no-consecutive-years-increasing-earnings = 2  
filter-stock-style stock-list.pos-earning-growth2y = TRUE
```

OR

```
customer-style-profile.no-consecutive-years-  
increasing-earnings = 4  
filter-stock-style stock-list.pos-earning-growth4y = TRUE
```

OR

```
customer-style-profile.no-consecutive-years-  
increasing-earnings = 6  
filter-stock-style stock-list.pos-earning-growth6y = TRUE
```

)

AND

```
/* Second By earnings growth rate */
```

```
(customer-style-profile.earnings-growth-rate = '10% - 20%'
```

AND

```
customer-style-profile.yrs-used-for-earnings-growth = '3 years'
```

```
filter-stock-style stock-list.earning-growth3y > 10 and stock-  
list.earning-growth3y <= 20
```

OR

```
(customer-style-profile.earnings-growth-rate = '20% - 30%'
```

AND

```
customer-style-profile.yrs-used-for-earnings-growth = '3 years')
```

```
filter-stock-style stock-list.earning-growth3y > 20 and  
stock-list.earning-growth3y <= 30
```

OR

```
(customer-style-profile.earnings-growth-rate = '>=30%'
```

AND

```
customer-style-profile.yrs-used-for-earnings-growth = '3 years')
```

```
filter-stock-style stock-list.earning-growth3y >= 30%
```

OR

```
(customer-style-profile.earnings-growth-rate = '10% - 20%'
```

AND

```
customer-style-profile.yrs-used-for-earnings-growth = '6 years')
```

```
filter-stock-style stock-list.earning-growth6y > 10 and  
stock-list.earning-growth6y <= 20
```

OR

```
(customer-style-profile.earnings-growth-rate = '20% - 30%'
AND
customer-style-profile.yrs-used-for-earnings-growth = '6 years')
```

```
filter-stock-style stock-list.earning-growth6y > 20 and
stock-list.earning-growth6y <= 30
```

OR

```
(customer-style-profile.earnings-growth-rate = ' >=30%'
AND
customer-style-profile.yrs-used-for-earnings-growth = '6 years')
```

```
filter-stock-style stock-list.earning-growth6y >= 30
```

OR

```
(customer-style-profile.earnings-growth-rate = '10% - 20%'
AND
customer-style-profile.yrs-used-for-earnings-growth = '9 years')
```

```
filter-stock-style stock-list.earning-growth9y > 10 and stock-
list.earning-growth9y <= 20
```

OR

```
(customer-style-profile.earnings-growth-rate = '20% - 30%'
AND
customer-style-profile.yrs-used-for-earnings-growth = '9 years')
```

```
filter-stock-style stock-list.earning-growth9y > 20 and stock-
list.earning-growth9y <= 30
```

OR

```
(customer-style-profile.earnings-growth-rate = ' >=30%'
AND
customer-style-profile.yrs-used-for-earnings-growth = '9 years')
```

```
filter-stock-style stock-list.earning-growth9y >= 30
```

```
/* Filter By momentum Style */
```

```
customer-style-profile.style-selection = 'momentum'
```

AND

```
(customer-style-profile.price-momentum-preference = '< 4 weeks'
```



```
filter-stock-style stock-list.price-chg%10d > 5 and stock-list.price-  
chg%1m > 10
```

OR

```
customer-style-profile.price-momentum-preference = '4 weeks - 12 weeks'  
filter-stock-style stock-list.price-chg%1m > 10 and stock-list.price-  
chg%3m > 20
```

OR

```
customer-style-profile.price-momentum-preference = '> 12 weeks'  
filter-stock-style stock-list.price-chg%3m > 20 and stock-list.price-  
chg%6m > 40
```

```
/* Filter By value Style */  
customer-style-profile.style-selection = 'value'  
AND
```

```
/* First by price-earnings-ratio */  
(customer-style-profile.price-earnings-ratio = '5-8'  
filter-stock-style stock-list.pe-fy1 >5 and stock-list.pe-fy1 <=8
```

OR

```
customer-style-profile.price-earnings-ratio = '8-11'  
filter-stock-style stock-list.pe-fy1 >8 and stock-list.pe-fy1 <=11
```

OR

```
customer-style-profile.price-earnings-ratio = '11-15'  
filter-stock-style stock-list.pe-fy1 >11 and stock-list.pe-fy1 <=15  
)
```

AND

```
/* Second by price-sales-ratio */  
(customer-style-profile.price-sales-ratio = '0 - 0.5'  
filter-stock-style stock-list.p-sales-fy1 >0 and stock-list.p-sales-fy1  
<=0.5
```

OR

```
customer-style-profile.price-sales-ratio = '0.5 - 1'  
filter-stock-style stock-list.p-sales-fy1 >0.5 and stock-list.p-sales-  
fy1 <=11
```

OR

```
customer-style-profile.price-sales-ratio = '1 - 1.5'  
filter-stock-style stock-list.p-sales-fy1 >1  
and stock-list.p-sales-fy1 <=1.5
```

)

**END KNOWLEDGE-BASE** filter-stock-style-model;

*/\* 2nd of 4 KNOWLEDGE-BASEs \*/*

**KNOWLEDGE-BASE** update-stock-favourability-model;

USES:

    update-stock-favourability FROM stock-selection-schema;

EXPRESSIONS:

*/\* Abstraction rules \*/*

    inflation-rate: {bearish,bullish,neutral};

    unemployment-rate: {bullish,neutral,bearish};

    unemployment-trend: {uptrend,flat,downtrend}

    average-weekly-unemployment-claim: {bullish,neutral,bearish};

    unemployment-claim: {uptrend,flat,downtrend};

    yield-curve-slope: {upward-sloping,flat,downward-sloping};

    retail-sale: {uptrend,flat,downtrend};

    pmi: {<50,>=50};

*/\* Macroeconomic conditions \*/*

*/\* 1. Inflation Rate for the past 6 months \*/*

macroeconomic-conditions.inflation-rate < 0%

OR

macroeconomic-conditions.inflation-rate > 4%

update-stock-favourability inflation-rate-cf = -0.8

macroeconomic-conditions.inflation-rate = '0% - 2%'

update-stock-favourability inflation-rate-cf = +0.9

macroeconomic-conditions.inflation-rate = '2% - 4%'

update-stock-favourability inflation-rate-cf = +0.5

*/\* 2. Unemployment Rate over the past 6 months (Absolute) \*/*

macroeconomic-conditions.unemployment-rate < 5%

update-stock-favourability unemployment-rate-cf = +0.7

macroeconomic-conditions.unemployment-rate = '5% - 6%'

update-stock-favourability unemployment-rate-cf = +0.5

macroeconomic-conditions.unemployment-rate > 6%

update-stock-favourability unemployment-rate-cf = +0.3

*/\* 3. Unemployment trend over the past 6 months \*/*

macroeconomic-conditions.unemployment-trend = uptrend

update-stock-favourability unemployment-trend-cf = -0.7

macroeconomic-conditions.unemployment-trend = flat

update-stock-favourability unemployment-trend-cf = +0.5

macroeconomic-conditions.unemployment-trend = downtrend

update-stock-favourability unemployment-trend-cf = +0.8

```

/* 4. Average-weekly-unemployment-claim for the past 4 weeks */
macroeconomic-conditions.average-weekly-unemployment-claim < 350,000
update-stock-favourability unemployment-claim-cf = +0.7

macroeconomic-conditions.average-weekly-unemployment-claim =
`350,000 - 400,000`
update-stock-favourability unemployment-claim-cf = +0.5

macroeconomic-conditions.average-weekly-unemployment-claim > 400,000
update-stock-favourability unemployment-claim-cf = -0.6

/* 5. Unemployment-claims over the past 6 months - trend */
macroeconomic-conditions.unemployment-claim-trend = uptrend
update-stock-favourability unemployment-claim-trend-cf = -0.7

macroeconomic-conditions.unemployment-claim-trend = flat
update-stock-favourability unemployment-claim-trend-cf = +0.5

macroeconomic-conditions.unemployment-claim-trend = downtrend
update-stock-favourability unemployment-claim-trend-cf = +0.8

/* 6. Yield-curve-slope */
macroeconomic-conditions.yield-curve-slope = upward-sloping
update-stock-favourability yield-curve-slope-cf = +0.9

macroeconomic-conditions.yield-curve-slope = flat
update-stock-favourability yield-curve-slope-cf = +0.5

macroeconomic-conditions.yield-curve-slope = downward-sloping
update-stock-favourability yield-curve-slope-cf = -0.8

/* 7. Retail Sales Trend */
macroeconomic-conditions.retail-sale-trend = Uptrend
update-stock-favourability retail-sale-trend-cf = +0.8

macroeconomic-conditions.retail-sale-trend = Flat
update-stock-favourability retail-sale-trend-cf = +0.5

macroeconomic-conditions.retail-sale-trend = Downtrend
update-stock-favourability retail-sale-trend-cf = -0.7

/* 8. ISM Manufacturing PMI */
macroeconomic-conditions.pmi > 50
update-stock-favourability pmi-cf = 0.7

macroeconomic-conditions.pmi <= 50
update-stock-favourability pmi-cf = 0.4

/* Working Goal - macroeconomic-conditions */

```

```
inflation-rate-cf
AND
unemployment-rate-cf
AND
unemployment-trend-cf
AND
unemployment-claim-cf
AND
unemployment-claim-trend-cf
AND
yield-curve-slope-cf
AND
retail-sale-trend-cf
AND
pmi-cf
```

```
CREATE WORKING GOAL =
macroeconomic-and-stock-market-conditions.macroeconomic-conditions-cf
```

```
/* stock market conditions */
```

```
/* 1. Indicator 1 - 20D MA Ratio of no of positive returns/no of
negative
returns */
```

```
stock-market-conditions.indicator-1 = '0 - 0.3 (very-bearish)'
update-stock-favourability indicator-1-cf = -0.8
```

```
stock-market-conditions.indicator-1 = '0.3 - 0.8 (bearish)'
update-stock-favourability indicator-1-cf = -0.6
```

```
stock-market-conditions.indicator-1 = '0.8 - 1.2 (neutral)'
update-stock-favourability indicator-1-cf = +0.5
```

```
stock-market-conditions.indicator-1 = '1.2 - 2 (bullish)'
update-stock-favourability indicator-1-cf = +0.6
```

```
stock-market-conditions.indicator-1 = '>2 (very-bearish)'
update-stock-favourability indicator-1-cf = +0.8
```

```
/* 2. Indicator 2 - 20D MA Ratio of no of daily +4% moves/no of -4%
moves
*/
```

```
stock-market-conditions.indicator-2 = 0 - 0.3 (very-bearish)
update-stock-favourability indicator-2-cf = -0.8
```

```
stock-market-conditions.indicator-2 = 0.3 - 0.8 (bearish)
update-stock-favourability indicator-2-cf = -0.6
```

```
stock-market-conditions.indicator-2 = 0.8 - 1.2 (neutral)
update-stock-favourability indicator-2-cf = +0.5
```

```
stock-market-conditions.indicator-2 = 1.2 - 2 (bullish)
update-stock-favourability indicator-2-cf = +0.6
```

```
stock-market-conditions.indicator-2 = >2 (very-bearish)
update-stock-favourability indicator-2-cf = +0.8
```

```
/* 3. Indicator 3 - 20D MA Ratio of no of quarterly +25% moves/no of -
25%
moves */
```

```
stock-market-conditions.indicator-3 = 0 - 0.3 (very-bearish)
update-stock-favourability indicator-3-cf = -0.8
```

```
stock-market-conditions.indicator-3 = 0.3 - 0.8 (bearish)
update-stock-favourability indicator-3-cf = -0.6
```

```
stock-market-conditions.indicator-3 = 0.8 - 1.2 (neutral)
update-stock-favourability indicator-3-cf = +0.5
```

```
stock-market-conditions.indicator-3 = 1.2 - 2 (bullish)
update-stock-favourability indicator-3-cf = +0.6
```

```
stock-market-conditions.indicator-3 = >2 (very-bearish)
update-stock-favourability indicator-3-cf = +0.8
```

```
/* 4. Indicator 4 - No of names above 200D MA/Number of names below
200D
MA */
```

```
stock-market-conditions.indicator-4 = 0 - 0.3 (very-bearish)
update-stock-favourability indicator-4-cf = -0.8
```

```
stock-market-conditions.indicator-4 = 0.3 - 0.8 (bearish)
update-stock-favourability indicator-4-cf = -0.6
```

```
stock-market-conditions.indicator-4 = 0.8 - 1.2 (neutral)
update-stock-favourability indicator-4-cf = +0.5
```

```
stock-market-conditions.indicator-4 = 1.2 - 2 (bullish)
update-stock-favourability indicator-4-cf = +0.6
```

```
stock-market-conditions.indicator-4 = >2 (very-bearish)
update-stock-favourability indicator-4-cf = +0.8
```

```
/* 5. Indicator 5 - VIX (measure of implied volatility of S&P500 out of
the money options) */
```

```
stock-market-conditions.indicator-5 = <10
OR (stock-market-conditions.indicator-5 = >=25
AND stock-market-conditions.indicator-5 = <35)
update-stock-favourability indicator-5-cf = -0.6
```

```
stock-market-conditions.indicator-5 = >=10
AND stock-market-conditions.indicator-5 = <18
update-stock-favourability indicator-5-cf = +0.8
```

```

stock-market-conditions.indicator-5 = >=18
AND stock-market-conditions.indicator-5 = <25
update-stock-favourability indicator-5-cf = +0.5

stock-market-conditions.indicator-5 = >=35
update-stock-favourability indicator-5-cf = -0.9

/* Working Goal - stock-market-conditions indicators */
indicator-1-cf
AND
indicator-2-cf
AND
indicator-3-cf
AND
indicator-4-cf
AND
indicator-5-cf

CREATE WORKING GOAL =
macroeconomic-and-stock-market-conditions.stock-market-conditions-cf

/* Working Goal - market favourability-cf */
macroeconomic-and-stock-market-conditions.macroeconomic-conditions-cf
AND
macroeconomic-and-stock-market-conditions.stock-market-conditions-cf

CREATE WORKING GOAL =
macroeconomic-and-stock-market-conditions.market-favourability-cf

/* Determine market favourability */
macroeconomic-and-stock-market-conditions.market-favourability-cf >=
0.8
AND
macroeconomic-and-stock-market-conditions.market-favourability-cf < 1
update-stock-favourability market-favourability = high

macroeconomic-and-stock-market-conditions.market-favourability-cf >=
0.5
AND
macroeconomic-and-stock-market-conditions.market-favourability-cf < 0.8
update-stock-favourability market-favourability = medium

macroeconomic-and-stock-market-conditions.market-favourability-cf >= 0
AND
macroeconomic-and-stock-market-conditions.market-favourability-cf < 0.5
update-stock-favourability market-favourability = low

/* Determine stock features attractiveness as a result of market
favourability */

/* Determine stock cap category (Feature 1) attractiveness */

```

```

/* High market favourability */
market-favourability = high
AND
(stock-list.cap-category = large

update-stock-favourability

stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness-
cf = 0.6

OR

stock-list.cap-category = mid

update-stock-favourability

stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness
-cf = 0.6

OR

stock-list.cap-category = small

update-stock-favourability

stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness
-cf = 0.8

)

/* Medium market favourability */
market-favourability = medium

AND

(stock-list.cap-category = large

update-stock-favourability

stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness
-cf = 0.7

OR

stock-list.cap-category = mid

```

```

update-stock-favourability

    stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness
    -cf = 0.6

OR

    stock-list.cap-category = small

update-stock-favourability

    stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness
    -cf = 0.6

)

/* Low market favourability */
market-favourability = low
AND
(stock-list.cap-category= large

update-stock-favourability

    stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness
    -cf = 0.8

OR

    stock-list.cap-category = mid

update-stock-favourability

    stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness
    -cf = 0.4

OR

    stock-list.cap-category = small

update-stock-favourability

    stock-attractiveness-feature-inherent-derived.cap-category-
attractiveness
    -cf = 0.2

)

```



```

/* Determine sector category (Feature 2) attractiveness */

/* High market favourability */
market-favourability = high
AND
(stock-list.sector = 'consumer-staples'
OR stock-list.sector = 'health-care'
OR stock-list.sector = 'utility')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf
= 0.4

market-favourability = high

AND

(stock-list.sector = 'materials'
OR stock-list.sector = 'industrials'
OR stock-list.sector = 'Telecommunications')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf
= 0.6

market-favourability = high
AND

(stock-list.sector = 'technology'
OR stock-list.sector = 'consumer-discretionary'
OR stock-list.sector = 'financials'
OR stock-list.sector = 'energy')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf
= 0.8

/* Medium market favourability */
market-favourability = medium
AND

(stock-list.sector = 'consumer-staples'
OR stock-list.sector = 'health-care'
OR stock-list.sector = 'utility')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf

```

= 0.5

market-favourability = medium  
AND

(stock-list.sector = 'materials'  
OR stock-list.sector = 'industrials'  
OR stock-list.sector = 'Telecommunications')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf  
= 0.5

market-favourability = medium  
AND

(stock-list.sector = 'technology'  
OR stock-list.sector = 'consumer-discretionary'  
OR stock-list.sector = 'financials'  
OR stock-list.sector = 'energy')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf  
= 0.7

/\* Low market favourability \*/  
market-favourability = low

AND

(stock-list.sector = 'consumer-staples'  
OR stock-list.sector = 'health-care'  
OR stock-list.sector = 'utility')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf  
= 0.9

market-favourability = low  
AND

(stock-list.sector = 'materials'  
OR stock-list.sector = 'industrials'  
OR stock-list.sector = 'Telecommunications')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf

= 0.4

market-favourability = low

AND

(stock-list.sector = 'technology'  
OR stock-list.sector = 'consumer-discretionary'  
OR stock-list.sector = 'financials'  
OR stock-list.sector = 'energy')

update-stock-favourability

stock-attractiveness-feature-inherent-derived.sector-attractiveness-cf  
= 0.2

/\* Stock attractiveness inherent market features \*/

/\* Valuation (PEG) \*/

stock-attractiveness-feature-inherent-market-feature.peg >= 0  
AND stock-attractiveness-feature-inherent-market-feature.peg < 1  
update-stock-favourability peg-cf = 0.9

stock-attractiveness-feature-inherent-market-feature.peg >= 1  
AND stock-attractiveness-feature-inherent-market-feature.peg < 1.7  
update-stock-favourability peg-cf = 0.6

stock-attractiveness-feature-inherent-market-feature.peg >= 1.7  
AND stock-attractiveness-feature-inherent-market-feature.peg < 2.4  
update-stock-favourability peg-cf = 0.3

stock-attractiveness-feature-inherent-market-feature.peg >= 2.4  
AND stock-attractiveness-feature-inherent-market-feature.peg < 3  
update-stock-favourability peg-cf = -0.2

stock-attractiveness-feature-inherent-market-feature.peg < 0  
OR stock-attractiveness-feature-inherent-market-feature.peg >= 3  
update-stock-favourability peg-cf = -0.9

/\* EBITDA-Margin (%) \*/

stock-attractiveness-feature-inherent-market-feature.ebitda-margin >= 25  
update-stock-favourability ebitda-margin-cf = 0.9

stock-attractiveness-feature-inherent-market-feature.ebitda-margin >= 18  
AND stock-attractiveness-feature-inherent-market-feature.ebitda-margin < 25  
update-stock-favourability ebitda-margin-cf = 0.7

stock-attractiveness-feature-inherent-market-feature.ebitda-margin >= 10

```

AND stock-attractiveness-feature-inherent-market-feature.ebitda-margin
< 18
update-stock-favourability ebitda-margin-cf = 0.4

stock-attractiveness-feature-inherent-market-feature.ebitda-margin >= 0
AND stock-attractiveness-feature-inherent-market-feature.ebitda-margin
< 10
update-stock-favourability ebitda-margin-cf = -0.2

stock-attractiveness-feature-inherent-market-feature.ebitda-margin < 0
update-stock-favourability ebitda-margin-cf = -0.7

/* ROIC (Return on invested capital %) */
stock-attractiveness-feature-inherent-market-feature.roic > 15
update-stock-favourability roic-cf = 0.9

stock-attractiveness-feature-inherent-market-feature.roic >= 10
AND
stock-attractiveness-feature-inherent-market-feature.roic <= 15
update-stock-favourability roic-cf = 0.7

stock-attractiveness-feature-inherent-market-feature.roic >= 5
AND
stock-attractiveness-feature-inherent-market-feature.roic < 10
update-stock-favourability roic-cf = 0.3

stock-attractiveness-feature-inherent-market-feature.roic >= 0
AND
stock-attractiveness-feature-inherent-market-feature.roic < 5
update-stock-favourability roic-cf = -0.3

stock-attractiveness-feature-inherent-market-feature.roic < 0
update-stock-favourability roic-cf = 0.9

/* Net debt equity ratio */
stock-attractiveness-feature-inherent-market-feature.net-debt-equity-
ratio < -20
update-stock-favourability net-debt-equity-ratio-cf = 0.9

stock-attractiveness-feature-inherent-market-feature.net-debt-equity-
ratio >= -20
AND
stock-attractiveness-feature-inherent-market-feature.net-debt-equity-
ratio < 0
update-stock-favourability net-debt-equity-ratio-cf = 0.7

stock-attractiveness-feature-inherent-market-feature.net-debt-equity-
ratio >= 0
AND
stock-attractiveness-feature-inherent-market-feature.net-debt-equity-
ratio < 20
update-stock-favourability net-debt-equity-ratio-cf = 0.4

```

```

stock-attractiveness-feature-inherent-market-feature.net-debt-equity-
ratio >= 20
AND
stock-attractiveness-feature-inherent-market-feature.net-debt-equity-
ratio < 40
update-stock-favourability net-debt-equity-ratio-cf = -0.4

stock-attractiveness-feature-inherent-market-feature.net-debt-equity-
ratio >= 40
update-stock-favourability net-debt-equity-ratio-cf = -0.8

/* Compute stock-attractiveness-inherent-market-feature-cf */
peg-cf
ebitda-margin-cf
roic-cf
net-debt-equity-ratio-cf

AVERAGES TO

stock-attractiveness-inherent-market-feature.stock-attractiveness-
inherent-market-feature-cf

/* Determine stock attractiveness inherent derived due to market
favourability */

stock-list.risk-match-cf
AND
stock-attractiveness-inherent-derived.cap-category-attractiveness-cf
AND
stock-attractiveness-inherent-derived.sector-attractiveness-cf

AVERAGES TO

stock-attractiveness-inherent-derived.stock-attractiveness-from-
market-favourability-cf

/* Determine overall stock attractiveness */

stock-attractiveness-inherent-market-feature.stock-attractiveness-
inherent-market-feature-cf
AND
stock-attractiveness-inherent-derived.stock-attractiveness-from-
market-favourability-cf

AVERAGES TO stock-list.stock-attractiveness-cf

END KNOWLEDGE-BASE update-stock-favourability-model;

/* 3rd of 4 KNOWLEDGE-BASEs */
KNOWLEDGE-BASE update-stock-risk-model
  USES:

```

```

update-stock-risk FROM update-stock-risk-kb;

/* market capitalization size */
stock-risk-feature.cap-size = large
update-stock-risk cap-size-cf = 0.9

stock-risk-feature.cap-size = mid
update-stock-risk cap-size-cf = 0.5

stock-risk-feature.cpa-size = small
update-stock-risk cap-size-cf = 0.3

/* liquidity */
stock-risk-feature.liquidity >= 500000
update-stock-risk liquidity-cf = 0.7

stock-risk-feature.liquidity <500000
update-stock-risk liquidity-cf = 0.3

/* sector */
stock-risk-feature.sector = consumer-staples
OR stock-risk-feature.sector = health-care
OR stock-risk-feature.sector = utility
update-stock-risk sector-cf = 0.8

stock-risk-feature.sector = materials
OR stock-risk-feature.sector = industrials
update-stock-risk sector-cf = 0.5

stock-risk-feature.sector = technology
OR stock-risk-feature.sector = consumer-discretionary
OR stock-risk-feature.sector = financials
update-stock-risk sector-cf = 0.3

/* price volatility */
stock-risk-feature.price-volatility <=18%
update-stock-risk price-volatility-cf = 0.9

stock-risk-feature.price-volatility >18%
AND stock-risk-feature.price-volatility <=24%
update-stock-risk price-volatility-cf = 0.7

stock-risk-feature.price-volatility >24%
AND stock-risk-feature.price-volatility <=40%
update-stock-risk price-volatility-cf = 0.5

stock-risk-feature.price-volatility >40%
AND stock-risk-feature.price-volatility <= 60%
update-stock-risk price-volatility-cf = -0.1

stock-risk-feature.price-volatility >60%
update-stock-risk price-volatility-cf = -0.6

```

```

/* earning volatility */
stock-risk-feature.earning-volatility <=14%
update-stock-risk earning-volatility-cf = 0.9

stock-risk-feature.earning-volatility >14%
AND
stock-risk-feature.earning-volatility <=24%
update-stock-risk earning-volatility-cf = 0.7

stock-risk-feature.earning-volatility >24%
AND
stock-risk-feature.earning-volatility <=40%
update-stock-risk earning-volatility-cf = 0.4

stock-risk-feature.earning-volatility >40%
AND
stock-risk-feature.earning-volatility <=60%
update-stock-risk earning-volatility-cf = -0.2

stock-risk-feature.earning-volatility >60%
update-stock-risk earning-volatility-cf = -0.7

/* Compute stock-risk-cf */
market-cap-cf
liquidity-cf
price-volatility-cf
earning-volatility-cf

AVERAGES TO stock-risk-feature.stock-risk-cf

/*Determine customer's overall risk tolerance*/

/* Risk ability */
/* Age*/
customer-risk-profile-ability.age = '20 - 35'
update-stock-risk age-cf = 0.8

customer-risk-profile-ability.age = '36 - 45'
update-stock-risk age-cf = 0.6

customer-risk-profile-ability.age = '46 - 55'
update-stock-risk age-cf = 0.4

customer-risk-profile-ability.age = '56 - 65'
update-stock-risk age-cf = -0.2

customer-risk-profile-ability.age = '>65'
update-stock-risk age-cf = -0.4

/* Net assets */
customer-risk-profile-ability.net-assets = '<$25,000'

```

```
update-stock-risk net-assets-cf = -0.2
```

```
customer-risk-profile-ability.net-assets = '$25,000 - $100,000'  
update-stock-risk net-assets-cf = 0.2
```

```
customer-risk-profile-ability.net-assets = '$100,000 - $250,000'  
update-stock-risk net-assets-cf = 0.4
```

```
customer-risk-profile-ability.net-assets = '$250,000 - $500,000'  
update-stock-risk net-assets-cf = 0.6
```

```
customer-risk-profile-ability.net-assets = '>$500,000'  
update-stock-risk net-assets-cf = 0.8
```

```
/* Job stability */
```

```
customer-risk-profile-ability.job-stability = 'very-unstable'  
update-stock-risk job-stability-cf = -0.2
```

```
customer-risk-profile-ability.job-stability = 'rather-unstable'  
update-stock-risk job-stability-cf = 0.2
```

```
customer-risk-profile-ability.job-stability = 'a-bit-unstable'  
update-stock-risk job-stability-cf = 0.4
```

```
customer-risk-profile-ability.job-stability = 'stable'  
update-stock-risk job-stability-cf = 0.6
```

```
customer-risk-profile-ability.job-stability = 'very-stable'  
update-stock-risk job-stability-cf = 0.8
```

```
/* Monthly income */
```

```
customer-risk-profile-ability.monthly-income = '<$2,500'  
update-stock-risk monthly-income-cf = -0.2
```

```
customer-risk-profile-ability.monthly-income = '$2,500 - $5,000'  
update-stock-risk monthly-income-cf = 0.2
```

```
customer-risk-profile-ability.monthly-income = '$5,000 - $7,500'  
update-stock-risk monthly-income-cf = 0.4
```

```
customer-risk-profile-ability.monthly-income = '$7,500 - $10,000'  
update-stock-risk monthly-income-cf = 0.6
```

```
customer-risk-profile-ability.monthly-income = '>$10,000'  
update-stock-risk monthly-income-cf = 0.8
```

```
/* Liquidity needs */
```

```
customer-risk-profile-ability.liquidity-needs = 'very-low'  
update-stock-risk liquidity-needs-cf = -0.2
```

```
customer-risk-profile-ability.liquidity-needs = 'low'
```



```

update-stock-risk liquidity-needs-cf = 0.2

customer-risk-profile-ability.liquidity-needs = 'medium'
update-stock-risk liquidity-needs-cf= 0.4

customer-risk-profile-ability.liquidity-needs = 'high'
update-stock-risk liquidity-needs-cf = 0.6

customer-risk-profile-ability.liquidity-needs = 'very-high'
update-stock-risk liquidity-needs-cf = 0.8

/* Compute customer risk ability cf */

age-cf
net-assets-cf
job-stability-cf
monthly-income-cf
liquidity-needs-cf

AVERAGES TO customer-risk-profile.risk-tolerance-ability-cf

/* Risk willingness */

/* Thrill factor */
customer-risk-profile-willingness.thrill-factor = very-low
update-stock-risk thrill-factor-cf = -0.5

customer-risk-profile-willingness.thrill-factor = low
update-stock-risk thrill-factor-cf = 0.2

customer-risk-profile-willingness.thrill-factor = medium
update-stock-risk thrill-factor-cf = 0.4

customer-risk-profile-willingness.thrill-factor = high
update-stock-risk thrill-factor-cf = 0.6

customer-risk-profile-willingness.thrill-factor = very-high
update-stock-risk thrill-factor-cf = 0.8

/* Job security preference */
customer-risk-profile-willingness.job-security-preference = very-high
update-stock-risk job-security-preference.cf = -0.5

customer-risk-profile-willingness.job-security-preference = high
update-stock-risk job-security-preference.cf = 0.2

customer-risk-profile-willingness.job-security-preference = medium
update-stock-risk job-security-preference.cf = 0.4

customer-risk-profile-willingness.job-security-preference = low
update-stock-risk job-security-preference.cf = 0.6

```

```

customer-risk-profile-willingness.job-security-preference = very-low
update-stock-risk job-security-preference.cf = 0.8

/* Investment risk tolerance */
customer-risk-profile-willingness.investment-risk-tolerance = very-low
update-stock-risk investment-risk-tolerance.cf = -0.2

customer-risk-profile-willingness.investment-risk-tolerance = low
update-stock-risk investment-risk-tolerance.cf = 0.1

customer-risk-profile-willingness.investment-risk-tolerance = medium
update-stock-risk investment-risk-tolerance.cf = 0.2

customer-risk-profile-willingness.investment-risk-tolerance = high
update-stock-risk investment-risk-tolerance.cf = 0.4

customer-risk-profile-willingness.investment-risk-tolerance = very-high
update-stock-risk investment-risk-tolerance.cf = 0.6

customer-risk-profile-willingness.investment-risk-tolerance = Very,
very-high
update-stock-risk investment-risk-tolerance.cf = 0.8

/* Job compensation preference */
customer-risk-profile-willingness.job-compensation-preference = 'all-
salary'
update-stock-risk job-compensation-preference.cf = -0.2

customer-risk-profile-willingness.job-compensation-preference =
'mainly-salary'
update-stock-risk job-compensation-preference.cf = 0.1

customer-risk-profile-willingness.job-compensation-preference = 'equal-
mix-of-salary-and-commission'
update-stock-risk job-compensation-preference.cf = 0.2

customer-risk-profile-willingness.job-compensation-preference =
'mainly-commission'
update-stock-risk job-compensation-preference.cf = 0.5

customer-risk-profile-willingness.job-compensation-preference = 'all-
commission'
update-stock-risk job-compensation-preference.cf = 0.7

/* Aversion to previous stock loss */
customer-risk-profile-willingness.aversion-to-previous-stock-loss =
very-low
update-stock-risk aversion-to-previous-stock-loss.cf = -0.2

customer-risk-profile-willingness.aversion-to-previous-stock-loss = low
update-stock-risk aversion-to-previous-stock-loss.cf = 0.1

```

```

customer-risk-profile-willingness.aversion-to-previous-stock-loss =
medium
update-stock-risk aversion-to-previous-stock-loss-cf = 0.2

customer-risk-profile-willingness.aversion-to-previous-stock-loss =
high
update-stock-risk aversion-to-previous-stock-loss-cf = 0.5

customer-risk-profile-willingness.aversion-to-previous-stock-loss =
very-high
update-stock-risk aversion-to-previous-stock-loss-cf = 0.7

/* Compute customer risk willingness cf */
thrill-factor-cf
AND
job-security-preference-cf
AND
investment-risk-tolerance-cf
AND
job compensation-preference-cf
AND
aversion-to-previous-stock-loss-cf

AVERAGES TO customer-risk-profile.risk-tolerance-willingness-cf

/* Compute customer overall risk tolerance cf */
customer-risk-profile.risk-tolerance-ability-cf
AND
customer-risk-profile.risk-tolerance-willingness-cf

CREATES WORKING GOAL = customer-risk-profile.overall-risk-tolerance-cf
/* Determine risk match */
customer-risk-profile.overall-risk-tolerance-cf
AND
stock-risk-feature.stock-risk-cf

update-stock-risk stock-list.risk-match-cf

END KNOWLEDGE-BASE update-stock-risk-model

/* 4th of 4 KNOWLEDGE-BASEs */
KNOWLEDGE-BASE update-recommendation-rank-model
  USES:
    update-recommendation-rank FROM update-recommendation-rank-kb;

/* Determine recommendation rank based on risk match and stock
attractiveness */

stock-list.risk-match-cf
AND
stock-list.stock-attractiveness-cf

```

```

        recommend-stock stock-list.recommendation-rank

END KNOWLEDGE-BASE update-recommendation-rank-model

/*****/
END DOMAIN-KNOWLEDGE us-stock-domain
/*****/

/*****/
INFERENCE-KNOWLEDGE us-stock-recommendation;
/*****/

/* 1st of 4 INFERENCES: filter-stock-style */
KNOWLEDGE-ROLE customer-style-profile;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: customer-style-profile;
END KNOWLEDGE-ROLE customer-style-profile;

KNOWLEDGE-ROLE stock-style-feature;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: stock-style-feature SET OF stock-list;
END KNOWLEDGE-ROLE stock-style-feature;

KNOWLEDGE-ROLE filter-stock-style-model;
    TYPE: STATIC;
    DOMAIN-MAPPING: filter-stock-style FROM filter-stock-style-kb;
END KNOWLEDGE-ROLE filter-stock-style-model;

INFERENCE filter-stock-style;
    ROLES:
        INPUT:         customer-style-profile;
                     stock-style-feature;
        OUTPUT:        stock-style-feature;
        STATIC:         filter-stock-style;
    SPECIFICATION: "Input1 is a set of customer style profile (customer
        level), Input2 is a set of stock style features (stock level). Output
        is the same set of stock list rated with style features (stock
        level).";
END INFERENCE filter-stock-style;

/* 2nd of 4 INFERENCES: update-stock-risk */
KNOWLEDGE-ROLE customer-risk-profile;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: customer-risk-profile;
END KNOWLEDGE-ROLE customer-risk-profile;

KNOWLEDGE-ROLE stock-risk-feature;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: stock-risk-feature SET OF stock-list;
END KNOWLEDGE-ROLE stock-risk-feature;

```

```

KNOWLEDGE-ROLE update-stock-risk-model;
    TYPE: STATIC;
    DOMAIN-MAPPING: update-stock-risk FROM update-stock-risk-kb;
END KNOWLEDGE-ROLE update-stock-risk-model;

INFERENCE update-stock-risk;
    ROLES:
        INPUT:      customer-risk-profile;
                     stock-risk-feature;
        OUTPUT:     stock-risk-feature;
        STATIC:      update-stock-risk;
    SPECIFICATION: "Input1 is a set of customer risk profile (customer
    level), Input2 is a set of stock risk features (stock level). Output
    is the same set of stock list rated with risk features (stock
    level).";
END INFERENCE update-stock-risk;

/* 3rd of 4 INFERENCES: update-stock-favourability */
KNOWLEDGE-ROLE macroeconomic-and-stock-market-conditions;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: macroeconomic-and-stock-market-conditions;
END KNOWLEDGE-ROLE macroeconomic-and-stock-market-conditions;

KNOWLEDGE-ROLE stock-attractiveness-feature-inherent-Market-Feature;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: stock-attractiveness-feature-inherent-Market-Feature
    SET OF stock-list;
END KNOWLEDGE-ROLE stock-attractiveness-feature-inherent-Market-Feature;

KNOWLEDGE-ROLE stock-attractiveness-feature-inherent-derived;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: stock-attractiveness-feature-inherent-derived SET OF
    stock-list;
END KNOWLEDGE-ROLE stock-attractiveness-feature-inherent-derived;

KNOWLEDGE-ROLE update-stock-favourability-model;
    TYPE: STATIC;
    DOMAIN-MAPPING: update-stock-favourability FROM
    update-stock-favourability-kb;
END KNOWLEDGE-ROLE update-stock-favourability-model;

INFERENCE update-stock-favourability;
    ROLES:
        INPUT:      macroeconomic-and-stock-market-conditions;
                     stock-attractiveness-feature-inherent-Market-Feature;
        OUTPUT:     stock-attractiveness-feature-inherent-derived;
        STATIC:      update-stock-favourability;
    SPECIFICATION: "Input1 is a set of macroeconomic-and-stock-market-
    conditions (world level & stock market/sector level), Input2 is a set
    of stock Favourability (attractiveness) features (stock level).

```

```

        Output is the same set of stock list rated with Favourability
        features (stock level).";
END INFERENCE update-stock-favourability;

/* 4th of 4 INFERENCES: update-recommendation-rank */
KNOWLEDGE-ROLE stock-risk-feature;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: stock-risk-feature SET
    OF stock-list;
END KNOWLEDGE-ROLE stock-risk-feature;

KNOWLEDGE-ROLE stock-attractiveness-feature-inherent-derived;
    TYPE: DYNAMIC;
    DOMAIN-MAPPING: stock-attractiveness-feature-inherent-derived
    SET OF stock-list;
END KNOWLEDGE-ROLE stock-attractiveness-feature-inherent-derived;

KNOWLEDGE-ROLE update-recommendation-rank-model;
    TYPE: STATIC;
    DOMAIN-MAPPING: update-recommendation-rank
    FROM update-recommendation-rank-kb;
END KNOWLEDGE-ROLE update-recommendation-rank-model;

INFERENCE update-recommendation-rank;
    ROLES:
        INPUT: stock-risk-feature;
                stock-attractiveness-feature-inherent-derived;
        OUTPUT: stock-risk;
        STATIC: update-recommendation-rank;
    SPECIFICATION:
        "Input1 is a set of stock risk feature (stock level), Input2 is a
        set of stock favourability
        features (stock level). Output is the same set of stock list rated
        with final/overall
        Recommendation Rank (stock level).";
END INFERENCE update-recommendation-rank;

/*****/
END INFERENCE-KNOWLEDGE us-stock-recommendation;
/*****/

/*****/
TASK-KNOWLEDGE us-stock-recommendation-task;
/*****/

/* Main Task & Task Method: us-stock-assessment-process-task */
/* Main Task & Task Method have 4 respective SUB-Task & Task Method*/
TASK us-stock-assessment-process-task;
    DOMAIN-NAME: us-stock-domain;

```

```

GOAL: "Update/Rank all the stock in stock list base on Customer Risk
      profile, Customer Style profile, and parameters of
      Macroeconomic-and-Stock-market-conditions, ";
ROLES:
    INPUT: stock-list;
           customer-risk-profile SET OF customer-profile;
           customer-style-profile SET OF customer-profile;
           macroeconomic-and-stock-market-conditions;
    OUTPUT: stock-list.recommendation-rank: "with Recommendation Rank";
END TASK us-stock-assessment-process;;

TASK-METHOD us-stock-assessment-process-task-method;
REALIZES: us-stock-assessment-process-rask;
DECOMPOSITION:
    TASKS: filter-stock-style, update-stock-risk, update-stock-favourability, update-recommendation-rank;
ROLES:
    INTERMEDIATE:
        stock-list.recommendation-rank: "with Recommendation Rank";
CONTROL-STRUCTURE:
    filter-stock-style(stock-list.stock-style-feature + customer-
        profile.customer-style-profile -> stock-list.style-selection);
    update-stock-risk(stock-list.stock-risk-feature + customer-
        profile.customer-risk-profile -> stock-list.risk-match-cf);
    update-stock-favourability(stock-list.stock-attractiveness-feature-
        inherent-market-feature + macroeconomic and stock-market-conditions ->
        stock-list.stock-attractiveness-cf);
    update-recommendation-rank(stock-list.risk-match-cf + stock-
        list.stock-attractiveness-cf -> stock-list.recommendation-rank);
END TASK-METHOD us-stock-assessment-process-task-method;

/* 1st of 4 SUB Task/Method of Main Task & Task Method: filter-stock-style
*/
TASK filter-stock-style;
DOMAIN-NAME: us-stock-domain;
GOAL: "Compare between the stock-style-feature and customer-style-features,
      identify and retain stock in stock-list if the stock-style-feature
      matches customer-style-features.";
ROLES:
    INPUT: stock-style-feature SET OF stock-list;
           customer-style-profile SET OF customer-profile;
    OUTPUT: stock-list.style-selection: "dividend, growth, momentum, value";
END TASK filter-stock-style;

TASK-METHOD filter-stock-style-task-method;
REALIZES: filter-stock-style;
DECOMPOSITION:
    INFERENCES: filter-stock-style;
ROLES:
    INTERMEDIATE:
        stock-list.style-selection: "dividend , growth, momentum, value";
CONTROL-STRUCTURE:

```

```

        WHILE NOT END OF stock-list DO
            IF      stock-list.style-selection =
                    customer-style-profile.style-selection;
                RETAIN the stock in stock-list
            ELSE
                REMOVE the stock from stock-list
        END WHILE
END TASK-METHOD filter-stock-style-task-method;

/* 2nd of 4 SUB Task/Method of Main Task & Task Method: update-stock-risk
*/
TASK update-stock-risk;
DOMAIN-NAME: us-stock-domain;
GOAL: "Compare between the stock-risk-feature and customer-risk-features,
        identify and update stock-risk-feature when it's matched with
        customer-risk-features.";
ROLES:
INPUT: stock-risk-feature SET OF stock-list;
        customer-risk-profile SET OF customer-profile;
OUTPUT: stock-list.risk-match-cf: {-1 - 1};
END TASK update-stock-risk;

TASK-METHOD update-stock-risk-task-method;
REALIZES: update-stock-risk;
DECOMPOSITION:
    INFERENCES: update-stock-risk;
ROLES:
    INTERMEDIATE:
        stock-list.risk-match-cf: {-1 - 1};
CONTROL-STRUCTURE:
    WHILE NOT END OF stock-list DO
        stock-list.risk-match-cf := normalized-gap between customer-risk-
        profile and stock-list.stock-risk-feature;
    END WHILE
END TASK-METHOD update-stock-risk-task-method;

/* 3rd of 4 SUB Task/Method of Main Task & Task Method: update-stock-
favourability */
TASK update-stock-favourability;
DOMAIN-NAME: us-stock-domain;
GOAL: "Compare between stock-list.stock-attractiveness-feature-inherent-
        Market-Feature and stock attractiveness due to macroeconomic-and-
        stock-market-conditions, to update stock-attractiveness certainty
        factor.";
ROLES:
INPUT:
stock-attractiveness-feature-inherent-market-feature SET OF stock-list
macroeconomic-and-stock-market-conditions
OUTPUT: stock-list.stock-attractiveness-cf: {-1 - 1};
END TASK Update-Stock-Favourability;

TASK-METHOD update-stock-favourability-task-method;
REALIZES: update-stock-favourability;

```



```

DECOMPOSITION:
  INFERENCES: update-stock-favourability;
ROLES:
  INTERMEDIATE:
    stock-list.stock-attractiveness-cf: {-1 - 1};
CONTROL-STRUCTURE:
  WHILE NOT END OF stock-list DO
    stock-list.stock-attractiveness-certainty-factor:= normalized-gap
    between macroeconomic-and-stock-market-conditions and stock-
    list.stock-attractiveness-feature-inherent-market-feature;
  END WHILE
END TASK-METHOD update-stock-favourability-task-method;

/* 4th of 4 SUB Task/Method of Main Task & Task Method: update-stock-
recommendation-rank */
TASK update-stock-recommendation-rank;
DOMAIN-NAME: us-stock-domain;
GOAL: " compute the final stock-list.recommendation-rank based on CF
merging between: stock-list.risk-match-certainty-factor and stock-
list.stock-attractiveness-certainty-factor.";
ROLES:
INPUT:      stock-list.risk-match-cf;
            stock-list.stock-attractiveness-cf;
OUTPUT:     stock-list.recommendation-rank: {-1 - 1};
END TASK update-stock-recommendation-rank;

TASK-METHOD update-stock-recommendation-rank-task-method;
REALIZES: update-stock-recommendation-rank;
DECOMPOSITION:
  INFERENCES: update-stock-recommendation-rank;
ROLES:
  INTERMEDIATE:
    stock-list.recommendation-rank: {-1 - 1};
CONTROL-STRUCTURE:
  WHILE NOT END OF stock-list DO
    stock-list.recommendation-rank-match := CF-merger between stock-
    list.risk-match-cf and stock-list.stock-attractiveness-cf;
  END WHILE
END TASK-METHOD update-stock-recommendation-rank-task-method;

/*****
END TASK-KNOWLEDGE us-stock-recommendation-task;
*****/
/*****
END KNOWLEDGE-MODEL us-stock;
*****/

/***** E N D *****/

```

## 9 Appendix B: Knowledge Acquisition Transcript

*Following is the summary of the transcript of the knowledge elicitation and acquisition process.*

### **1. We will like to find out more about investing in stocks. What are the advantages and disadvantages of investing the stock market?**

The stock market is a great way of putting your capital to work for you. In the long run, the right stocks will create returns that should more than sufficiently beat inflation and help to build a portfolio of wealth that should put one in a strong financial situation and possibly help with retirement needs. It should preferably at least be considered in a part of anyone's portfolio given its strong return potential compared to other instruments such as savings or even bonds. That said, the stock market is a treacherous place and is not for the fainted hearted with its constant swing and gyrations and even occasional market crash. If one chooses the wrong stocks or invest at the wrong time, he can even cause his wealth to erode rapidly. As such, it is important that one takes the trouble to educate himself about how best to go about investing in stocks. The effort in doing so can potentially pay dividends in the long term.

### **2. We have heard that the U.S market is a great place to start an investing journey. Is that true? What advantages does the U.S market offer?**

Indeed, the U.S market is one of the most attractive, if not the most attractive market in the world to invest in. There are several advantages that I can mention here. They include the fact that the U.S market is the most highly capitalized market in the world, highly liquid and efficient and is home to many of the top companies in the world such as McDonalds, Google, Starbucks, Microsoft and Procter and Gamble to name a few. Any investor should be able to find his niche or favoured method of investing in this market given such a wide range of choices.

### **3. Is the stock market for everyone? Are there any personal circumstances that one should evaluate when considering an investment in the stock market?**

Well, I guess it is not for everyone. As the stock market can involve a high level of risk, it is definitely not for the uninformed and risk adverse person. What I mean is if you do not understand what to look up for when selecting stocks and rely frequently on hearsay or advice from friends who are equally as clueless as you are, then you might be better off not touching it. When considering any investment in the stock market, it is important to first identify traits that will have a bearing on the type of risk that you can undertake. I will say there are two main components to evaluate one's overall risk tolerance. There are his ability to take risk as well as his willingness to take risk. Ability to take risk will include factors such as his age, his personal wealth, future liquidity needs and their size, stability of his job and size of his paycheck and so on. This aspect of risk tolerance has more to do with a person's existing circumstances. On the other hand, willingness to take risk is a person's inherent characteristic and can be determined based on how risk adverse the person is when it comes to losing money, the amount of drawdown in his stock trading account he can accept before feeling very uncomfortable, how often he invest simply for the thrill of seeing his stock trading account goes up in value or how adverse he is towards making a new investment in a stock which he previously lost money in but which appears to have huge potential again.

#### **4. Can stocks be classified as having different level of risks? What can affect the risks affecting a stock?**

Definitely. Various attributes of a stock can affect its riskiness. Not all stocks are the same in terms of return and risk profile. Factors that can affect stock risk include its market capitalization (Generally, large cap stocks are safer than small cap stocks not least because they are more liquid, such to less manipulation because of their large size as well as being more well established and less prone to failures.), the sector it is in (Consumer staples, health care, utility stocks are generally safer compared to technology and financials or even consumer discretionary stocks whose performance can vary closely to the state of the economy). Earnings volatility over the years is an important factor as well as a high value on this measure means that the stock can be highly cyclical and very dependent on the economy, causes it to possibly have more wild swings in price. Likewise, price volatility can also affect stock risk as it may potentially mean a large fall in price.

#### **5. What are the criteria that can be used to select a stock investment or how attractive it is?**

This is where fundamental analysis comes in. It is the favoured method used by many investors, including investment greats like Warren Buffett and Peter Lynch. It considers various components such as the financial health of the company, how profitable the company is as well as how reasonably valued it is. In considering financial health, the amount of debt relative to equity can determine if a company is likely to experience financial hardship when times are hard. In considering profitability, profit margins and return on invested capital can indicate how good the company is in turning each dollar of sales into actual earnings and how much earnings the company is generating on the capital used. Finally, even with strong profitability and financial health, it is important to understand if the stock of the company is reasonably valued and whether there is continued good growth going forward. After all, a good company does not necessarily mean a good stock and a good company might be unnecessarily bid up in price and becomes too expensive. A good valuation metric that combines both valuation and growth is the price-earnings growth ratio which measures the price-earnings per percentage of growth. Typically, a PEG under 1 is considered to be a favourable value.

#### **6. Are there various styles of investing in the stock market? If so, what are they and what should an investor look out for?**

Yes. There are different ways that an investor can play the stock market. There are quite a few dominant themes in the stock market. There are themes such as value investing, growth investing, dividend investing as well as momentum trading. Each has its merits and suits different kinds of investors. In value investing, the key is to identify stocks which are cheap so that there is a chance of buying them low and selling them high. That said, prices can continue going lower without necessarily turning higher and other fundamental criteria need to be evaluated as well. Metrics to determine valuation can be price-earnings ratio, price-sales ratio, price-cashflow ratio etc. For price earnings ratio, a value of 15 is considered reasonable and a value below that can be considered cheap. For price-sales ratio, 1.5 is about fair and below 1 is considered cheap. For growth investing, the key is to identify stocks that experience earnings growth year over year. These stocks can experience a good surge in price especially if earnings continue to stay strong in the coming years. However, growth stocks tend to have higher expectations embedded in them and as such can turn lower in price quickly if they do not perform as well as expected in earnings growth in future. In

dividend investing, an investor identifies stocks that distributes a good amount of dividends every year and preferably increase its dividend year over year over the past years. This means the investor can enjoy much profit in terms of dividends over the years with a low cost basis even as the price does not appreciate much. Finally, in momentum trading, the investor's tries to ride on strong upwards price momentum for a relatively short period of time without necessarily considering the company's underlying fundamental characteristics and instead rely on strong price movement. The investor has to be nimble enough to get out of the market when the tide turns against him as momentum can fade as quickly as it goes up.

**7. Are there external factors that can affect the price of a stock besides the inherent characteristics of each stock?**

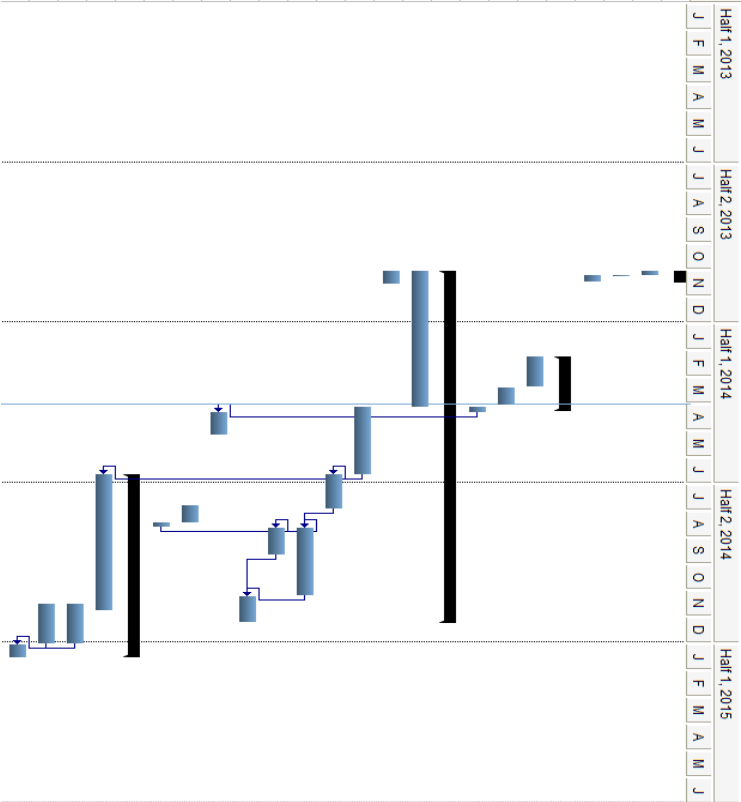
Yes. While the stock market averages tend to move up over a long period of time, there exist secular bull and bear markets along the way. One should vary his allocation to stocks according to how favourable the market is. To have a sense of whether the market is favourable, two broad factors can be taken into consideration. First, macroeconomic factors should be considered. This will affect the corporate earnings of companies, how much companies are willing to invest and hence the price of their stocks. There are various important economic factors to consider, mainly the leading indicators. They include the inflation rate, the interest rate which can be determined by the yield curve and fed reserve actions, the unemployment rate and its recent month-over-month trend, weekly unemployment claims, trend of retail sales and manufacturing PMI. All these factors can foretell potential turning points in the stock market and alert the investor to the possibility of reducing exposure to equities. The second broad factor more directly measures stock market conditions and the underlying bullishness of the market. This has to do with aggregates of metrics relating to stock prices. They include measures such as 20 Day moving average of no of positive returns versus negative returns, 20 Day moving average of no of +4% moves versus -4% moves, 20 Day moving average of quarterly +25% versus -25% moves and ratio of no of names above 200 Day moving average versus no of names below 200 Day moving average. VIX which is the implied volatility of various S&P500 out of the money options otherwise known as the fear factor is also a good gauge of a potential turning point in the stock market.

**8. Does market favourability impact different types of stock differently? Are there stocks which generally perform better during bull markets and versus during bear markets?**

Yes. When the market is favourable, it is better to invest in cyclical stocks. Such stocks should be in sectors such as consumer discretionary (including housing stocks), technology and financials. On the other hand, when the market is not favourable, it is better to invest in defensive stocks in sectors such as health care, utilities and consumer staples. The stocks in these sectors tend to do better because they deal with products that are still consumed whether or not times are good. Also, small cap stocks will do better in a strong market environment compared to large cap stocks because investors are more optimistic and willing to take on more risk when they invest in stocks.

## 10 Appendix C: Project Schedule

	1	Name	Duration	Start	Finish	Predecessors	Resources
1		Phase 0 - Proposal	9d	11/01/2013	11/15/2013		
2		Determine project scope	4d	11/01/2013	11/07/2013		
3		Secure project sponsorship	1d	11/07/2013	11/09/2013		
4		Project Proposal (frame up, review and sign off)	5d	11/07/2013	11/15/2013		
5		Phase 1 - Knowledge Modelling	40.5d	02/07/2014	04/11/2014		
6		Requirements Gathering	22.5d	02/07/2014	03/14/2014		
7		Phase 1 Report (frame up, review)	13d	03/15/2014	04/04/2014		
8		Phase 1 Presentation (Preparation also)	4d	04/05/2014	04/11/2014		
9		Phase 2 - Software Development (Iterative)	258.5d	11/01/2013	12/07/2014		
10		Data Collection and Assessment	100d	11/01/2013	04/05/2014		
11		Business Understanding and Hypothesis Derivation	10d	11/01/2013	11/16/2013		
12		Modeling	50d	04/05/2014	06/21/2014		
13		Model Evaluation	25d	06/21/2014	07/30/2014		
14		Model Tuning to Accuracy / Refinement	50d	08/21/2014	11/07/2014		
15		UI and Configuration	20d	08/21/2014	09/20/2014		
16		User Acceptance Test / Training	20d	11/07/2014	12/07/2014		
17		System Design Documentation	17d	04/11/2014	05/07/2014	8	
18		Phase 2 Report (frame up, review)	13d	07/26/2014	08/15/2014		
19		Phase 2 Presentation (Preparation also)	4d	08/15/2014	08/21/2014		
20		Phase 3 - Project report and Research paper preparation	134d	06/21/2014	01/16/2015		
21		Reporting of Results	100d	06/21/2014	11/23/2014	12	
22		Final Project Report (frame up, review)	30d	11/15/2014	12/31/2014		
23		Technical Paper (frame up, review)	30d	11/15/2014	12/31/2014		
24		Final Presentation	10d	12/31/2014	01/16/2015	22,23	



## 11 References

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- <http://www.microsoft.com/en-us/server-cloud/products/sql-server/>
- <http://finance.yahoo.com/stock-center/>
- <http://www.stocknod.com/stock-market-for-beginners/>
- And NUS Library Resources

