CHAPTER II

FINANCIAL MARKET AND DATA MINING

2.1 Introduction

In economics, a financial market is a mechanism that facilitates people to easily buy and sell financial securities such as stocks and bonds, commodities such as precious metals or agricultural goods, and other fungible items of value at low transaction costs and at prices that reflect the efficient-market hypothesis.

Trade or commerce is the willing exchange of goods, services, or both. A mechanism that permits trade is called a market. The original form of trade was barter, the direct exchange of goods and services. Modern traders negotiate through a medium of exchange, such as money. As a result, buying can be separated from selling, or earning.

The invention of money and later credit, paper money and non-physical money, greatly simplified and promoted trade.

2.2 Types of Financial Market

An economy which relies primarily on interactions between buyers and sellers to allocate resources is known as a market economy. The financial markets can be divided into different subtypes:

1. Capital markets which consist of:

   a. Stock markets, which provide financing through the issuance of shares or common stock, and enable the subsequent trading thereof.
b. **Bond markets**, which provide financing through the issuance of bonds, and enable the subsequent trading thereof.

2. **Commodity markets**, which facilitate the trading of commodities.

3. **Money markets**, which provide short term debt financing and investment.

4. **Derivatives markets**, which provide instruments for the management of financial risk.

5. **Insurance markets**, which facilitate the redistribution of various risks.

6. **Futures markets**, which provide standardized forward contracts for trading products at some future date. It is a transaction in which delivery of the commodity is deferred until after the contract has been made. Although the delivery is made in the future, the price is determined on the initial trade date. The Futures Market is a market of contracts to buy and sell goods at specified prices and times. It exists because buyers and sellers of goods wish to lock in prices for future delivery, but market conditions can make the actual futures contract fluctuate considerably in value. Most investors in the futures market are not interested in the actual goods but only in the profit that can be realized in trading the contracts.

7. **The Options Market** is similar to the Futures Market in that an option is a contract that gives the right (but not the obligation) to trade a stock at a certain price before a specified date. They can be traded on their own or purchased as a form of insurance against price fluctuations within a certain time frame.
8. Foreign exchange markets (FOREX), which facilitate the trading of foreign exchange. The FOREX is the biggest, in terms of value of trades, investment market in the world. FOREX traders buy one currency against another and can profit from small changes in value. Most FOREX trades are entered and exited in one 24 hour span, and traders have to keep a close watch on the market in order to make profitable trades.

All these markets are quite risky and require considerable knowledge and experience to prevent substantial losses. They also require close attention to market movements. Stocks, on the other hand, are less risky because movements of the market are usually gradual. Although short term investment strategies are possible, most view stocks as long term investments.

Trading is the activity of buying and selling financial instruments for the purpose of gaining a profit [33]. Securities are traded in two kinds of markets: primary and secondary market. Newly formed or issued securities are bought or sold in primary markets. When a corporation decides to issue stock to the public, it is undertaking a primary distribution. This first sale of stock is in the primary market and the money received goes to the company.

Secondary markets allow investors to sell securities that they hold or buy existing securities. It is a market where investors purchase securities or assets from other investors, rather than from issuing companies themselves. India’s “The Stock Exchange”, Mumbai (BSE) and the National Stock Exchange (NSE) are secondary markets. In any secondary market trade, the cash proceeds go to an investor rather than to the underlying company.
or entity directly. It is the behaviour of the secondary market that is of interest for everyone and the data mining research put in this work also was focused on this perspective.

If everyone who bought stock simply kept it and waited to collect dividends, there would be no secondary market.

2.3 Data Mining

Data mining is the process of extraction of interesting, non-trivial, implicit, previously unknown and potentially useful patterns or knowledge from huge amount of data [35].

Data mining is a single step in a larger process of Knowledge Discovery in Databases (KDD). KDD is considered to be a more encompassing process that includes data warehousing, target data selection, data cleaning, preprocessing, transformation and reduction, data mining, model selection, evaluation and interpretation, and finally consolidation and use of the extracted “knowledge”.

The relationship exists among data, information, knowledge and wisdom is defined below. This is pictorially represented as knowledge pyramid in Figure 2.1.

Data are any facts, numbers, or text that can be processed by a computer. In other words, it is the basic, discrete, objective facts such as who, what, when, where, and about something.
The patterns, associations, or relationships among all this data can provide **Information**. It is related to each other through a context such that it provides a useful story, as an example, the linking of who, what, when, where data to describe a specific person at a specific time.

Information can be converted into **Knowledge** about historical patterns and future trends. Information that has been culturally understood such that it explains the how and the why about something or provides insight and understanding into something is knowledge [53].

**Wisdom** is the most benevolent use of knowledge and power. It is placing knowledge into a framework that allows the knowledge to be applied to different and not necessarily intuitive situations.

---

Figure 2.1 Knowledge Pyramid
The inference from the Pyramid is that data begets information begets knowledge begets wisdom. An additional implication is that there is more data than information, more information than knowledge, and more knowledge than wisdom.

Data mining finds patterns and relationships in data by using sophisticated techniques to build models which are abstract representations of reality. A good model is a useful guide for understanding the business and making decisions. The view of Fayyad [25] is that any algorithm that enumerates patterns from data, or fits models to data is data mining. Data mining can be classified into two categories: descriptive data mining and predictive data mining [35].

2.3.1 Descriptive Data Mining

It describes the data set in a concise manner and presents interesting general properties of the data. This enables to view sets of summarized data in concise, descriptive terms. Such data descriptions may provide an overall picture of a class of data or distinguish it from a set of comparative classes. The simplest kind of descriptive data mining is concept description. Concept description is sometimes called description when the concept to be described refers to a class of objects. A concept usually refers to a collection of data such as stereos, frequent buyers, graduate students, and so on. As a data mining task, concept description is not a simple enumeration of the data. Instead, it generates descriptions for characterization and comparison of the data. Characterization provides a concise and succinct summarization of the given collection of data, while concept or class comparison, also known as discrimination provides descriptions comparing two or more collections of data.
2.3.2 Predictive Mining

It is an analytic process designed to explore large amounts of data in search of consistent patterns and/or systematic relationships between variables, and then to validate the findings by applying the detected patterns to new subsets of data. The ultimate goal is prediction - and predictive data mining is the most common type of data mining and one that has the most direct business applications.

It is used to forecast explicit values, based on patterns determined from known results. For example, from a database of customers who have already responded to a particular offer, a model can be built that predicts which prospects are likeliest to respond to the same offer.

When market beating strategies are discovered via data mining, there are a number of potential problems in making the leap from a back-tested strategy to successfully investing in future real world conditions. The first problem is determining the probability that the relationships are not random at all market conditions. This is done using large historic market data to represent varying conditions and confirming that the time series patterns have statistically significant predictive power for the following two potential reasons.

1. High probability of profitable trades and
2. High profitable returns for the investment.

The temporal nature of the financial stock market data resembles the evolving empirical and evidential data [51]. This has lead to the design of a model for organizing the large volume of evidence that an intelligence analyst may have at her / his disposition [50].
2.4 The Stock

A stock represents partial ownership of a company or the smallest share possible. Companies issue stocks to raise capital. Those who buy stock are the investors, actually buying a portion of the company. Even a small share, gives investors rights or ownership, to a say in how the company is run and a share in the profits (if any). While stocks give owners certain rights, they do not carry obligation in case the company defaults or faces a lawsuit. In a worst-case scenario the stock will become worthless but that is the limit to the investor's liability.

Companies may need a cash injection to expand or to acquire new properties and hence issue stocks to raise capital. Each stock issue is limited to a certain number of shares, and when they are issued they are given a par value. The market quickly adjusts that par value according the perceived health of the company and its potential for growth.

Investors believe that the company will continue to grow and the value of the shares will rise accordingly and buy stocks. Investors who acquire stock in a new company are taking more of a risk than buying shares of well-established companies. But the potential gain is much greater. Those who bought Microsoft shares early in the game and did not sell them witnessed an exponential rise in the value.

2.5 Stock Markets

The term “Stock Market” is commonly used to encompass both the physical location for buying and selling stocks as well as the overall activity of the market within a certain country. “The stock market was down today” is an expression referring to the combined activity of many stock exchanges.
2.5.1 Stock Exchanges

A stock exchange, securities exchange or bourse in Europe is a corporation or mutual organization which provides trading facilities for stock brokers and traders, to trade stocks and other securities. Stock exchanges also provide facilities for the issue and redemption of securities as well as other financial instruments and capital events including the payment of income and dividends. The securities traded on a stock exchange include: shares issued by companies, unit trusts and other pooled investment products and bonds. To be able to trade a security on a certain stock exchange, it has to be listed there. Usually there is a central location at least for recordkeeping, but trade is less and less linked to such a physical place, as modern markets are electronic networks, which gives them advantages of speed and cost of transactions.

Trade on an exchange is by members only. The initial offering of stocks and bonds to investors is by definition done in the primary market and subsequent trading is done in the secondary market. A stock exchange is often the most important component of a stock market. Supply and demand in stock market is driven by various factors which, as in all free markets, affect the price of stocks.

There is usually no compulsion to issue stock via the stock exchange itself, nor must stock be subsequently traded on the exchange. Such trading is said to be off exchange or over-the-counter. This is the usual way that bonds are traded. Increasingly, stock exchanges are part of a global market for securities.
Stock trading is done on stock exchanges like the New York Stock Exchange (NYSE) or National Association of Securities Dealers Automated Quotation System (NASDAQ). The Stock Exchange, Mumbai (BSE) and the National Stock Exchange (NSE) are the India’s two leading Exchanges. There are 20 other regional Exchanges, connected via the Inter-Connected Stock Exchange (ICSE). The BSE and NSE allow nationwide trading via their VSAT systems. The Companies listed on a public exchange have shares that can be bought and sold on the open market. The partial ownership in a smaller company that is not listed on a stock exchange could also be bought, but that is a very different type of investment than buying stocks.

The “Stock Exchange” is the correct term for the physical location for trading stocks. Each country may have many different stock exchanges and usually a particular company’s stocks are traded on only one exchange, although large corporations may be listed in several different locations.

Stock exchanges exist throughout the world and it is possible to buy or sell stocks on any of them. The only restriction is the opening hours of each exchange. Both the NYSE and NASDAQ, for example operate from 9:30 a.m. to 4:00 p.m. Eastern Time from Monday to Friday. Other exchanges have similar opening hours based on their local time. In the Hong Kong Stock Exchange, the trading hours is between 9:30 p.m. and 4:00 a.m. New York time. The major stock exchanges of the world are Tokyo Stock Exchange - Japan, London Stock Exchange - Europe, Frankfurt Stock Exchange - Europe, SWX Swiss Exchange - - Europe, Shanghai Stock Exchange - China and NYSE - USA, NASDAQ – USA, and Amex – USA.
2.5.1.1 Stock Exchanges in India

All the Stock exchanges functioning in India are listed below.

- Bombay Stock Exchange
- National Stock Exchange
- Regional Stock Exchanges
  - Ahmedabad Stock Exchange
  - Bangalore Stock Exchange
  - Bhubaneshwar Stock Exchange
  - Calcutta Stock Exchange
  - Cochin Stock Exchange
  - Coimbatore Stock Exchange
  - Delhi Stock Exchange
  - Guwahati Stock Exchange
  - Hyderabad Stock Exchange
  - Jaipur Stock Exchange
  - Ludhiana Stock Exchange
  - Madhya Pradesh Stock Exchange
  - Madras Stock Exchange
  - Magadh Stock Exchange
  - Mangalore Stock Exchange
  - Meerut Stock Exchange
  - OTC Exchange Of India
  - Pune Stock Exchange
  - Saurashtra Kutch Stock Exchange
  - Uttar Pradesh Stock Exchange
  - Vadodara Stock Exchange
2.5.2 Stock Index

An Index is a comprehensive measure of market trends, intended for investors who are concerned with general stock market price movements. An Index comprises stocks that have large liquidity and market capitalization. Each stock is given a weightage in the Index equivalent to its market capitalization. At the NSE, the capitalization of NIFTY comprising of fifty selected stocks is taken as a base capitalization, with the value set at 1000. Similarly, BSE Sensitive Index or “Sensex” comprises 30 selected stocks. The Index value compares the day's market capitalization in comparison with base capitalization and indicates how prices in general have moved over a period of time.

The stock markets closely follow the economic health of a country. When the economy is doing well, the market is said to be in a bullish mode. Bull markets occur during times of high economic production, low unemployment and low inflation. Bear markets, on the other hand, follow downtrends in the economy. Inflation and unemployment are rising and stock prices are falling.

Fluctuations in stock prices are also driven by supply and demand, which in turn are determined to a large extent on investor psychology. Seeing a stock rise in price may cause investors to jump on the bandwagon and this rush to buy drives the price even faster. A falling price can have the same effect. These are short term fluctuations. Stock prices tend to normalize after such runs.

As the stocks must be bought and sold on a stock exchange, an individual investor needs a broker to make transactions for him. Brokers take orders to buy or sell a certain stock. The order may include instructions to trade at a certain price or simply what the
market will bear. Once the broker receives the order, he attempts to execute it by finding a buyer or seller as the case may be. The buyer or seller is also represented by a broker and each broker receives a commission on the sale.

Stocks have several advantages over saving investments. Since the stocks represent ownership in a company they give the holder rights to participate in major decisions the company faces. Every share represents one vote and shareholders are regularly asked to vote on important matters. Ownership also allows stockholders to benefit from any profits the company makes. Profits are distributed in the form of dividends, and may be issued once or twice a year at the discretion of the company directors. If the company prospers the value of the stock will rise and the quantum of profits distributed also increases. The downside of this is that if the company does poorly the value of the stocks may fall.

When compared with savings investments like bonds or bank certificates of deposit, stocks have the potential to earn more money. But they carry the risk of loss. Learning about the stock market and the various investment strategies can help to minimize loss, and most investors find they do much better on the stock market than is possible with any kind of savings investment.

2.6 Stock Prices and Quotes

In glancing through the stock prices listed in the newspaper one might wonder how stocks are priced and what affects price movement? After all, there is a wide variety of prices and some well-known companies are traded for relatively low prices while obscure listings may sell at high prices.
To a certain extent stock prices are determined by investor confidence but that confidence in turn is based on real or perceived performance. Companies report their financial status on a quarterly basis when they disclose cash flow, sales and earnings. These hard numbers are the foundation of a company's worth, but investor speculation can undermine or override actual financial data.

Rumors abound on the stock market, and if there is news that a company is about to make a strategic move buyers may flock to buy that stock. As with any other market, the principal of supply and demand applies. If there is a sudden upsurge in investor interest, the price of a stock will rise accordingly. Conversely, fear among investors can cause a stock price to plummet. In the long run, however, company performance and worth are the biggest factors in determining stock prices.

Stock prices are available from many sources. Newspapers carry market summaries of the day's movements and online sources can provide current prices around the clock. Stock brokers can also provide quotes either online or by telephone in the case of full-service brokers.

A stock quote table in a newspaper or Internet web site contains useful information that can help the investor make decisions about buying or selling stocks. A typical stock quote table is shown in Table 2.1. Being able to read a stock table is a necessary skill for anyone interested in the stock market.

**Columns 1 & 2: 52-Week High and Low:** These are the highest and lowest prices at which a stock has traded over the previous 52 weeks or one year. This typically does not include the previous day's trading.
<table>
<thead>
<tr>
<th>Stock</th>
<th>Ticker</th>
<th>Yield</th>
<th>Yield</th>
<th>P/E</th>
<th>Vol</th>
<th>High</th>
<th>Low</th>
<th>Close</th>
<th>Net chg</th>
</tr>
</thead>
<tbody>
<tr>
<td>ResMed RMD</td>
<td>52.5</td>
<td>3831</td>
<td>42.00</td>
<td>39.51</td>
<td>41.50</td>
<td>-1.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revision A REV</td>
<td>162</td>
<td>6.09</td>
<td>5.90</td>
<td>6.09</td>
<td>+0.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TioTinto RTP</td>
<td>2.30</td>
<td>3.2</td>
<td>168</td>
<td>72.75</td>
<td>71.84</td>
<td>72.74</td>
<td>+0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RitchieBr RBA</td>
<td>20.9</td>
<td>15</td>
<td>24.49</td>
<td>24.29</td>
<td>24.49</td>
<td>-0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RiteAld RAD</td>
<td>31028</td>
<td>4.50</td>
<td>4.20</td>
<td>4.31</td>
<td>+0.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RobtHalf RHI</td>
<td>26.5</td>
<td>6517</td>
<td>27.15</td>
<td>26.50</td>
<td>26.50</td>
<td>+0.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rockwell ROK</td>
<td>1.02</td>
<td>2.1</td>
<td>14.5</td>
<td>47.99</td>
<td>47.00</td>
<td>47.54</td>
<td>+0.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Column 3: Company Name & Type of Stock:** This column lists the name of the company. If there are no special symbols or letters following the name, it is common stock. Different symbols imply different classes of shares. For example, "pf" means the shares are preferred stock.

**Column 4: Ticker Symbol:** This is the unique alphabetic name which identifies the stock. In most of the financial TV channels, the ticker tape move across the screen, quoting the latest prices alongside this symbol. Ticker symbol is the only key for looking stock quotes online and the ticker symbol for a particular company may be obtained online at [http://finance.yahoo.com](http://finance.yahoo.com).

**Column 5: Dividend Per Share:** This indicates the annual dividend payment per share. If this space is blank, the company does not currently pay out dividends.
**Column 6: Dividend Yield:** It is the percentage returns on the dividend. It is calculated as annual dividends per share divided by price per share.

**Column 7: Price/Earnings Ratio:** This is calculated by dividing the current stock price by earnings per share from the last four quarters.

**Column 8: Trading Volume:** This figure shows the total number of shares traded for the day, listed in hundreds. To get the actual number traded, add "00" to the end of the number listed.

**Column 9 & 10: Day High and Low:** This indicates the price range at which the stock has traded at throughout the day. In other words, these are the maximum and the minimum prices that people have paid for the stock.

**Column 11: Close:** The close is the last trading price recorded when the market closed on the day. If the closing price is up or down more than 5% than the previous day's close, the entire listing for that stock is bold-faced. The close is merely an indicator of past performance and except in extreme circumstances serves as a ballpark of what is expected to be paid.

**Column 12: Net Change:** This is the value change in the stock price from the previous day's closing price. When there is news about a stock being "up for the day," it means the net change was positive.

There may be additional columns for information about the following.

- Bid Price - the price a buyer is willing to pay
• Ask Price - the price a seller is willing to sell
• Market Cap - outstanding shares multiplied by current market price

2.7 Types of Trading

The stock market is a reliable indicator of the actual value of companies which issue stock. Values of stocks are based on verifiable financial data such as sales figures, assets and growth. This reliability makes the stock market a good choice for long term investing and well-run companies should continue to grow and provide dividends for their stockholders.

The stock market also provides opportunities for short-term investors. Restlessness of the market or skittishness can cause prices to fluctuate quite rapidly and investor psychology can cause prices to fall or rise, even if there is no financial basis for these variations.

News reports, government announcements about the economy, and even rumors can cause investors to become nervous or to suspect that a company will increase in value. When the price starts to fall or rise, other investors will jump on the bandwagon, causing an even faster acceleration in price. Eventually the market will correct itself, but for savvy short-term investors who watch the market closely, these price changes can offer opportunities for profitable trading.

Short term traders are divided into three categories: Position Traders, Swing Traders, and Day Traders.
2.7.1 Position Traders

Position trading is the longest term trading style amongst the three short term trading. Stocks could be held for a relatively long period of time compared with the other trading styles. Position traders expect to hold on to their stocks for anywhere from 5 days to 3/6 months. Position traders are watching for fundamental changes in value of a stock. This information can be gathered bit by bit from financial reports and industry analyses. Position trading does not require a great deal of time. An examination of daily reports is enough to plan trading strategies. This type of trading is ideal for those who invest in the stock market to supplement their income. The time needed to study the stock market can be as little as 30 minutes a day and can be done after regular work hours.

2.7.2 Swing Traders

Swing traders hold stocks for shorter periods than position traders and it may range from one to five days. The swing trader is looking for changes in the market that are driven more by emotion than fundamental value. This type of trading requires more time than position trading but the payback is often greater. Swing traders usually spend about 2 hours a day analyzing stocks and executing orders. They need to be able to identify trends and pick out trading opportunities. They usually rely on daily and intraday charts to plot stock movements.

2.7.3 Day Traders

Day trading is the most risky way to trade in the stock market. Day trading refers to buying and selling stock in very short periods of time and it is less than a day but often
as short as a few minutes. Day traders rely on information that can influence price moves and have to plot when to get in and out of a position. Day traders need to be rational and analytical. Emotional buyers will quickly lose money in this type of trading. Day trading need to be a full-time profession because of the close attention is required to monitor the market conditions.

2.8 Stock Option Traders

Stock options are contracts to buy or sell a stock at a certain price before a definite time in the future. Buyers of options have the right to buy the stock at the specified price, but they are not obligated to exercise their option. Sellers of options have the obligation to sell the underlying stock if the buyer of the option wishes to exercise it.

2.8.1 Call Option

A contract to buy an option is called a “Call Option”. The buyer of a call option hopes the price of the underlying stock will rise, allowing him to buy it at less than market value. “Strike Price” is the price the stock can be bought / sold. The seller of the call option expects that the price of the stock will not rise, or at least is willing to accept a partial loss of profits made from selling the call option.

For example: An investor buys a call option on IBM with a “Strike Price” of 50 USD. The current price of IBM stocks is 40 USD and the cost of the call is 5 USD. The cost of the call is otherwise known as “Premium”. If the price rises above 55 USD (strike price + cost of call) the buyer could exercise his right to buy and make a profit by reselling in the open market. The seller would still gain from the increase in price from
40 USD to 50 USD plus the 5 USD made by selling the call. If the price remains below 55 USD the call would not be exercised and the seller would profit by 5 USD per share and the buyer would lose 5 USD per share.

Options are traded on specific stocks. They detail the name of the stock, the strike price (the price the stock can be bought or sold at), the expiration date and the premium (the price of the option itself). After the expiration, the option cannot be exercised and is worthless. Otherwise options have a value and are actively traded. For example, an option to buy Microsoft is listed as mentioned below.

**MSFT Jan 06 22.50 Call at $2.00**

This infers that an option to buy 1 share of Microsoft Corporation Inc. at 22.50 USD before the third Friday in January 2006 can be bought for 2.00 USD. Options usually expire on the third Friday of the specified month, and they are usually traded in lots of 100. To buy this particular option you would have to pay 200 USD (plus brokerage fees).

### 2.8.2 Put Option

An option to sell a stock is called a “Put Option”. This gives the holder the right (but not the obligation) to sell a particular stock within a definite time period at a certain price. In this situation the buyer is expecting the price of the stock to fall but does not want to sell outright in case the price rebounds. The seller feels that the price is stable or is willing to acquire the stock at the low price.
• "Buy a Put" - A Buyer thinks price of a stock will decrease. To buy a stock, pay a premium which buyer will never get back, unless it is sold before expiration. The buyer has the right to sell the stock at strike price.

• "Write a put" - Writer receives the premium. If buyer exercises the option, writer will buy the stock at strike price. If buyer does not exercise the option, writer's profit is premium.

For example: “Trader A” (Put Buyer) purchases a put contract to sell 100 shares of Microsoft Corp. to “Trader B” (Put Writer) for 50 USD per share. The current price is 55 USD per share, and “Trader A” pays a premium of 5 USD per share. If the price of Microsoft Corp. stock falls to 40 USD per share right before expiration, then “Trader A” can exercise the put by buying 100 shares for 4,000 USD from the stock market, then selling them to “Trader B” for 5,000 USD.

If, however, the share price never drops below the strike price (in this case, 50 USD), then “Trader A” would not exercise the option. (Why sell a stock to “Trader B” at 50 USD, if it would cost “Trader A” more than that to buy it?). Trader A's option would be worthless and he would have lost the whole investment, the premium fee for the option contract, 500 USD (5 USD per share, 100 shares per contract). Trader A's total loss are limited to the cost of the put premium plus the sales commission to buy it.

A typical put option might read like this.

```
1 IBM Oct 110 put
```
This option grants its owner the right to sell 100 shares of IBM common stock at 110 per share until third Friday of next October. Let’s examine each part of the description.

- **1 IBM Oct 110 put** — The “1” indicates that this is one put that conveys the right to sell 100 shares of stock. Every put option carries the right to sell 100 shares of stock. Three puts would permit the sale of 300 shares, and 15 puts would cover 1,500 shares.

- **1 IBM Oct 110 put** — IBM is the underlying stock, the stock that the put holder has the right to sell.

- **1 IBM Oct 110 put** — This option expires in third Friday of October. There may be other outstanding IBM 110 puts expiring in other months.

- **1 IBM Oct 110 put** — The strike price, or exercise price, is 110. There may be other Oct IBM puts outstanding with higher and lower strike prices like 100, 105, 115, 120 and so on.

- **1 IBM Oct 110 put** — This is the type of option, which gives its owner the right to sell stock. (A call permits its owner to buy stock.)

As can be seen, stock options can be used to protect against loss or as an investment opportunity in their own right. They are generally used as part of a trading strategy which combines the purchase of stock with the purchase of options.
In a bullish (rising) market stocks and call options may be bought. Also put options can be sold. This facilitates to obtain full advantage of rising stock prices. The call option allows buying a stock at price less than the market prices when the value of the stocks rises. If the market dips and the buyer of the put option exercise it, additional stocks at low prices can be picked up. If the buyer does not exercise the option, money can be made from the sale of the option.

Conversely, in a bearish market, one can sell stocks, sell calls, and buy puts to limit losses and generate profits. Unstable markets can use a mixture of puts and calls to maximize profit potential.

2.9 The Predictive Approaches

Technical Predictive Approach includes Time Series Quantitative Analysis, Stochastic Analysis and Heuristics. Time series quantitative analysis is used in this research work to predict the financial stock market. The time series quantitative analysis is dealt throughout this thesis. The fundamental theory of Stochastic Analysis and Heuristics are briefed below.

2.9.1 Stochastic Analysis

Stochastic Analysis is a branch of mathematics that operates on stochastic processes. The best-known stochastic process to which stochastic analysis may be applied is the Wiener process (named in honor of Norbert Wiener), which is used for modeling Brownian motion as described by Albert Einstein and other physical diffusion processes in space of particles subject to random forces. Since the 1970's, the Wiener process has
been widely applied in “Financial Mathematics” to model the evolution in time of stock and bond prices [64]. It allows a consistent theory of integration to be defined for integrals of stochastic processes with respect to stochastic processes [93].

Mathematical finance is the branches of applied mathematics concerned with the financial markets. The subject has a close relationship with the discipline of financial economics, which is concerned with much of the underlying theory. Generally, mathematical finance will derive, and extend, the mathematical or numerical models suggested by financial economics. Thus, for example, while a financial economist might study the structural reasons why a company may have a certain share price, a financial mathematician may take the share price as a given, and attempt to use stochastic calculus to obtain the fair value of derivatives of the stock.

In terms of practice, mathematical finance also overlaps heavily with the field of computational finance, which is also known as financial engineering. Perhaps, these are largely synonymous, although the latter focuses on application, while the former focuses on modeling and derivation. The fundamental theorem of arbitrage-free pricing is one of the key theorems in mathematical finance.

2.9.2 The Heuristics

Heuristics are typically used when there is no known method to find an optimal solution, under the given constraints (of time, space etc.) or at all. In computer science, a “Heuristic Algorithm”, or simply a “Heuristic”, is an algorithm that is able to produce an acceptable solution to a problem in many practical scenarios, but for which there is no
formal proof of its correctness [73]. Alternatively, it may be correct, but may not be proven to produce an optimal solution, or to use reasonable resources.

Two fundamental goals in computer science are finding algorithms with provably good run times and with provably good or optimal solution quality. A heuristic is an algorithm that abandons one or both of these goals; for example, it usually finds pretty good solutions, but there is no proof the solutions could not get arbitrarily bad; or it usually runs reasonably quickly, but there is no argument that this will always be the case.

For instance, say you are packing odd-shaped items into a box. Finding a perfect solution is a hard problem: there is no known way to do it that is significantly faster than trying every possible way of packing them. What most people do, then, is "put the largest items in first, then fit the smaller items into the spaces left around them." This will not necessarily be perfect packing, but it will usually give a packing that is pretty good. It is an example of a heuristic solution.

Judea Pearl states that heuristic methods are based upon intelligent search strategies for computer problem solving, using several alternative approaches [74]. Often, one can find specially crafted problem instances where the heuristic will in fact produce very bad results or run very slowly; however, such pathological instances might never occur in practice because of their special structure. Therefore, the use of heuristics is very common in real world implementations. For many practical problems, a heuristic algorithm may be the only way to get good solutions in a reasonable amount of time. There is a class of general heuristic strategies called metaheuristics, which often use randomized search for example. They can be applied to a wide range of problems, but
good performance is never guaranteed and hence this technique of solving financial time series is adopted in this thesis.

2.10 Time Series

Time series are temporal sequences of measures that can be mined for information [65]. Time series data is a sequence of data points, measured typically at successive times, spaced at (often) uniform time intervals. Time series analysis comprises methods that attempt to understand such time series, or to understand the underlying context of the data points like, where did they come from? And what generated them? or to make forecasts or predictions. The analysis of evolving time series data lead to the discovery of many interesting financial market predictive patterns [82]. Evolving time series data analysis maximizes the profit-loss value prediction of financial stock using time series quantitative analysis.

2.10.1 Financial Time Series Data

The stock market data are stored in bar format, which is a time series data. A typical time series historic data for IBM stock in bar format for the period from 01-12-2008 to 15-12-2008, downloaded from yahoo finance web site is shown in Table 2.2. The Bar has six fields and they are open, low, high and close prices, volume, and starting time stamp. Open is the open price of the stock in the given time period. Low is the lowest price of the stock, high is the highest price of the stock and close is the closing price of the stock. Volume represents the total number of stocks traded during the period.
Adjusted Close provides the closing price for the requested day, week, or month, adjusted for all applicable splits and dividend distributions. Data is adjusted using appropriate split and dividend multipliers, adhering to “Center for Research in Security Prices” (CRSP) standards. Split multipliers are determined by the split ratio. For instance, in a 2 for 1 split, the pre-split data is multiplied by 0.5. Dividend multipliers are calculated based on dividend as a percentage of prices, primarily to avoid negative historical pricing.

Table 2.2 A typical Financial Times Series Historic Data of IBM Stock

<table>
<thead>
<tr>
<th>Date</th>
<th>Open</th>
<th>High</th>
<th>Low</th>
<th>Close</th>
<th>Volume</th>
<th>Adj. Close</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/1/2008</td>
<td>80.95</td>
<td>81.36</td>
<td>76.79</td>
<td>76.9</td>
<td>10265000</td>
<td>76.48</td>
</tr>
<tr>
<td>12/2/2008</td>
<td>77.8</td>
<td>80</td>
<td>76.14</td>
<td>79.84</td>
<td>9305200</td>
<td>79.41</td>
</tr>
<tr>
<td>12/3/2008</td>
<td>78.62</td>
<td>81</td>
<td>76.99</td>
<td>80.67</td>
<td>9757800</td>
<td>80.23</td>
</tr>
<tr>
<td>12/4/2008</td>
<td>80.03</td>
<td>80.83</td>
<td>76.18</td>
<td>77.44</td>
<td>10914000</td>
<td>77.02</td>
</tr>
<tr>
<td>12/5/2008</td>
<td>76.78</td>
<td>81.5</td>
<td>75.31</td>
<td>80.59</td>
<td>11212000</td>
<td>80.15</td>
</tr>
<tr>
<td>12/8/2008</td>
<td>82.57</td>
<td>85.88</td>
<td>81.73</td>
<td>84.86</td>
<td>11177600</td>
<td>84.4</td>
</tr>
<tr>
<td>12/9/2008</td>
<td>83.82</td>
<td>85.43</td>
<td>82.2</td>
<td>82.69</td>
<td>9356400</td>
<td>82.24</td>
</tr>
<tr>
<td>12/10/2008</td>
<td>83.95</td>
<td>84.99</td>
<td>81.83</td>
<td>82.86</td>
<td>8187000</td>
<td>82.41</td>
</tr>
<tr>
<td>12/11/2008</td>
<td>81.5</td>
<td>82.86</td>
<td>79.77</td>
<td>80.58</td>
<td>10682400</td>
<td>80.14</td>
</tr>
<tr>
<td>12/12/2008</td>
<td>78.68</td>
<td>82.94</td>
<td>78.06</td>
<td>82.2</td>
<td>10381700</td>
<td>81.76</td>
</tr>
<tr>
<td>12/15/2008</td>
<td>82.51</td>
<td>83.54</td>
<td>80</td>
<td>82.77</td>
<td>8848200</td>
<td>82.32</td>
</tr>
</tbody>
</table>
2.10.1.1 Adjusted Close Calculations

For example, when a 0.08 USD cash dividend is distributed for some stock “x” on Feb 19 (ex-date), and the Feb 18 closing price was 24.96, the pre-dividend data is multiplied by (1-0.08/24.96) = 0.9968. This is elaborated in distinguished steps below.

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Calculation</th>
<th>Adjusted Close</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/13/03</td>
<td>Close</td>
<td></td>
<td>46.99</td>
</tr>
<tr>
<td>2/14/03</td>
<td>Close</td>
<td></td>
<td>48.30</td>
</tr>
<tr>
<td>2/18/03</td>
<td>Split</td>
<td></td>
<td>2:1</td>
</tr>
<tr>
<td>2/18/03</td>
<td>Close</td>
<td></td>
<td>24.96</td>
</tr>
<tr>
<td>2/19/03</td>
<td>Cash Dividend</td>
<td></td>
<td>0.08 (ex-date)</td>
</tr>
<tr>
<td>2/19/03</td>
<td>Close</td>
<td></td>
<td>24.53</td>
</tr>
<tr>
<td>Split Multiplier</td>
<td>= 2:1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dividend Multiplier</td>
<td>= 1 - (0.08/24.96)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/13/03 Adj. Close</td>
<td>= 0.5 * 0.9968 * 46.99</td>
<td></td>
<td>23.42</td>
</tr>
<tr>
<td>2/14/03 Adj. Close</td>
<td>= 0.5 * 0.9968 * 48.30</td>
<td></td>
<td>24.07</td>
</tr>
<tr>
<td>2/18/03 Adj. Close</td>
<td>= 0.9968 * 24.96</td>
<td></td>
<td>24.88</td>
</tr>
<tr>
<td>2/19/03 Adj. Close</td>
<td>= 24.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A bar data represents an abstract sample of trades that have taken place during the given period. Bar data can be formulated using different time intervals in minutes, hours, days, weeks or months. The bar data formulated on day interval is used in this study.
2.10.2 Bar Charts

Technical analysis relies heavily on charts for tracking the market movements. Bar charts are the most commonly used. They consist of vertical bars representing a particular time period, weekly, daily, hourly, or even by the minute. The top of each bar shows the highest price for the period, the bottom is the lowest price, and the small bar or dot to the right is the closing price. A bar chart for the IBM stock data presented in Table 2.1 is shown in figure 2.2. A small bar or dot to the left may be included for the opening price and it is not included in figure 2.2 for improving the clarity of the picture.

![Figure 2.2 A bar chart for the IBM stock data shown in Table 2.1](image)

The bar chart overlapped on the volume of stock traded on a particular business day is shown in figure 2.3. A great deal of information can be seen in glancing at bar charts. Long bars indicate a large price spread and the position of the side bars or dots shows whether the price rose or dropped and also the spread between opening and closing prices.
Figure 2.3 A bar chart for the IBM stock data shown in Table 2.1 overlapped on the volume of stock traded

2.10.3 Candlestick Chart

A variation on the bar chart is the candlestick chart. These charts use solid bodies to indicate the variation between opening and closing prices. The lines that extend above and below the body indicate the highest and lowest prices respectively of the stock during the particular business day. They are also called as “Candle wicks” on both sides.

The Candlestick bodies are colored black or red if the closing price was lower than the previous period’s closing price. The Candlestick bodies are colored white or green if the closing price was higher than the previous period’s closing price. Candlesticks form various shapes that can indicate market movement.
A typical Candlestick chart for the IBM data is shown in figure 2.4 and the Candlestick chart overlapped on the volume of stock traded on a particular business day is shown in figure 2.5. A green or white Candlestick body with short "Candle wick" is bullish market. This infers that the stock is opened with a price near its low and closed near its high. Conversely, a red or black Candlestick body with short "Candle wick" is bearish market. This infers that the stock is opened with a price near the high and closed near the low. These are only two of the more than 20 patterns that can be formed by candlesticks.

When glancing at charts the untrained eye may simply see random movements from one day to the next. Trained analysts, however, see patterns that are used to predict future movements of stock prices. There are hundreds of different indicators and patterns that can be applied. There is no one single reliable indicator, but when taken into consideration with others, investors can be quite successful in predicting price movements.
The technical quantitative analytical methods are used to discover previously undetected patterns present in the historic data to determine the buying and selling points of equities [86].

There are well documented time series quantitative algorithms or financial indicators available, which are used to perform technical study of stocks. As these analytics are done upon the same data, there is a possibility of having high correlation between multiple analytics [29]. There is a need to study combinations of uncorrelated analytics in order to improve the predictive power. In this research, a combinatorial quantitative analytical study was undertaken to find out the best combinational patterns that have the predictive power of high probability of profitable trades and high percentage returns.