# Automation of Mutual Funds Analysis and Price Prediction

## About DCB

DCB Bank is a modern emerging new generation private sector bank with 318 branches across 19 states and three union territories. It is a scheduled commercial bank regulated by the Reserve Bank of India. It is professionally managed and governed. DCB Bank has contemporary technology and infrastructure including state of the art internet banking for personal as well as business banking customers.

DCB Bank's business segments are Retail, micro-SME, SME, mid-Corporate, Agriculture, Commodities, Government, Public Sector, Indian Banks, Co-operative Banks and Non-Banking Finance Companies (NBFC). DCB Bank has approximately 450,000 customers.

DCB Bank has deep roots in India since its inception in the 1930s. Its promoter and promoter group the Aga Khan Fund for Economic Development (AKFED) & Platinum Jubilee Investments Ltd. holds over 15.01% stake. AKFED is an international development enterprise. It is dedicated to promoting entrepreneurship and building economically sound companies.

## INTRODUCTION

The project divided into two stages. Firstly, Mutual Funds Data (2006-2018 (present date)) updated daily from AMFI API and this data stored in the Database (HIVE, Local Database) then required data be plotted to observe the behavior of the Time series data. Then data rolling average and the standard deviation is calculated for 22 working days (step size=22) of a month. In this stage, Return and Risk of the mutual funds calculated monthly, Quarterly, Semi-Annual and Annually. Now to compare the mutual funds, past two years data is used to calculate Risk ratios and Return.

**Risk Ratios:** Depending on the benchmark index

- Active Risk
- Volatility

- Beta
- Jensen Alpha
- Sharpe Ratio
- Treynor Ratio
- Information Ratio
- Sortino Ratio

The second stage of the project is to predict the future prices of the Mutual Funds. Here the Machine learning and Deep learning models are used to predict the future prices of the funds. This modeling of data is used to forecast three months prices.

The whole process is automated using python, all the calculated numbers of return, risk, and predicted future prices is updated daily in the database.

## RATIONALE OF THE PROJECT

The project helps to understand different types of Mutual Funds and their characteristics, and also to analyze their risk ratios compared with benchmark index and then rating the Mutual Funds for investment.

This project helps to understand handling the time series data in the platforms and its packages to do various calculations.

Understanding different types of Time series related machine learning and Deep learning algorithms and their implementation. Using those models to forecast future prices of the Mutual Funds.

In this project, automation is implemented to update the return, risk ratios, and forecasted prices in the database on a daily basis.

**Objective**

1. Understanding how mutual funds work
2. Understanding its types
3. Handling and understanding the Time series data

4. Calculating the risk ratios
5. Comparing Mutual funds ratios with benchmark ratios
6. Rating Mutual funds
7. Understanding different modeling techniques

# INTRODUCTION

**Mutual Funds**

A mutual fund is an investment firm that pools money from shareholders and invests in a variety of instruments, such as stocks, bonds, and money market instruments. Most open-end Mutual funds stand ready to buy back (redeem) its shares at their current net asset value, which depends on the total market value of the fund's investment portfolio at the time of redemption. Most open-end Mutual funds continuously offer new shares to investors. Mutual funds invest pooled cash of many investors to meet the fund's stated investment objective. Mutual funds stand ready to sell and redeem their shares at any time at the fund's current net.

*Asset value*: Total fund assets divided by shares outstanding.

In Simple Words, the Mutual fund is a process of pooling the investor's funds by issuing units to the investors and investing those funds in securities.

Investments in securities spread across broad sectors, and thus the risk minimizes. Diversification reduces the risk; all stocks may not move in the same direction in the same proportion at the same time. The investors share the profits or losses in proportion to their investments. The Mutual funds typically come out with some schemes with different investment objectives which are launched from time to time.

The investment manager would invest the money collected from the investor into assets that are permitted by the stated objective of the scheme. For example, an equity fund would invest equity, and equity related instruments and a debt fund would invest in bonds, debentures, gilts.

**Concept Used**

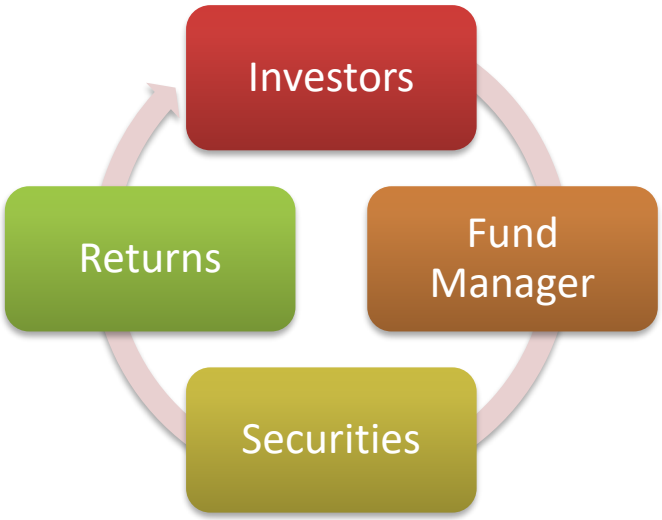
The funds pooled is invested in capital market instruments such as shares, debentures and other securities. Its unitholders share the income earned through these investments and the capital appreciations realized in proportion to the number of units owned by the investors.

### Types of Mutual Funds

1. By structure
   - 1.1. Open – Ended Schemes.
   - 1.2. Close – Ended Schemes.
   - 1.3. Interval Schemes.

2. By investment objective
   - 2.1. Growth Schemes.
   - 2.2. Income Schemes.
   - 2.3. Balanced Schemes.

3. Other schemes
   - 3.1. Tax Saving Schemes.
   - 3.2. Special Schemes.
   - 3.3. Index Schemes.
   - 3.4. Sector Specific Schemes.




### *Open-ended schemes*

The units offered by these schemes are available for sale and repurchase on any business day at NAV based prices. Hence, the unit capital of the schemes keeps changing each day. Such schemes thus offer very high liquidity to investors and are becoming increasingly popular in India. Please note that an open-ended fund is NOT obliged to keep selling/issuing new units at all times, and may stop issuing further subscription to new investors. On the other hand, an open-ended fund rarely denies to its investor the facility to redeem existing units.

### *Closed-ended schemes*

The unit capital of a close-ended product fixed as it makes a one-time sale of a fixed number of units. These schemes launched with an initial public offer (IPO) with a stated maturity period after which the units fully redeemed at NAV linked prices. Unlike open-ended schemes, the unit capital in closed-ended schemes usually remains unchanged. After an initial closed period, the scheme may offer direct repurchase facility to the investors. Closed-ended schemes are usually more illiquid as compared to open-ended schemes and hence trade at a discount to the NAV. This discount tends towards the NAV closer to the maturity date of the scheme.

### *Interval schemes*

These schemes combine the features of open-ended and close-ended schemes. They may be traded on the stock exchange or may be open for sale or redemption during pre-determined intervals at NAV based prices.

### *Growth schemes*

These schemes, also commonly called Equity Schemes, seek to invest a majority of their funds in equities and a small portion of money market instruments. Such schemes have the potential to deliver superior returns over the long term. However, because they invest in equities, these schemes are exposed to fluctuations in value especially in the short term.

### *Income Schemes*

These schemes, also commonly called Debt Schemes, invest in debt securities such as corporate bonds, debentures, and government securities. The prices of these schemes tend to be more stable compared with equity schemes, and most of the returns to the investors generated through dividends or steady capital appreciation. These schemes are ideal for conservative investors or those not in a position to take higher equity risks, such as retired individuals. Compared to the money market schemes they did have a higher price fluctuation risk and compared to a Gilt fund they have higher credit risk.

### *Balanced schemes*

These schemes are commonly known as Hybrid schemes. These schemes invest in equities and as well in debt. By investing in a mix of this nature, balanced schemes seek to attain the objective of income and moderate capital appreciation and are ideal for investors with a conservative, long-term orientation.

### *Tax saving schemes*

Investors are being encouraged to invest in equity markets through Equity Linked Savings Scheme by offering them a tax rebate. Units purchased cannot be assigned/transferred/ pledged/ redeemed/switched – out until completion of 3 years from the date of issue of the Units.

### *Index schemes*

The purpose of an Index is to serve as a measure of the performance of the market on the whole, or a specific sector of the market. An Index serves as a relevant benchmark to evaluate the performance of mutual funds. Some investors are interested in investing in the market in general rather than investing in any specific fund. Such investors are happy to receive the returns posted by the markets. As it is not practical to invest in every stock in the market in proportion to its size, these investors are comfortable investing in a fund that they believe is a good representative of the entire market. Index Funds are launched and managed for such investors.

### *Sector-specific schemes*

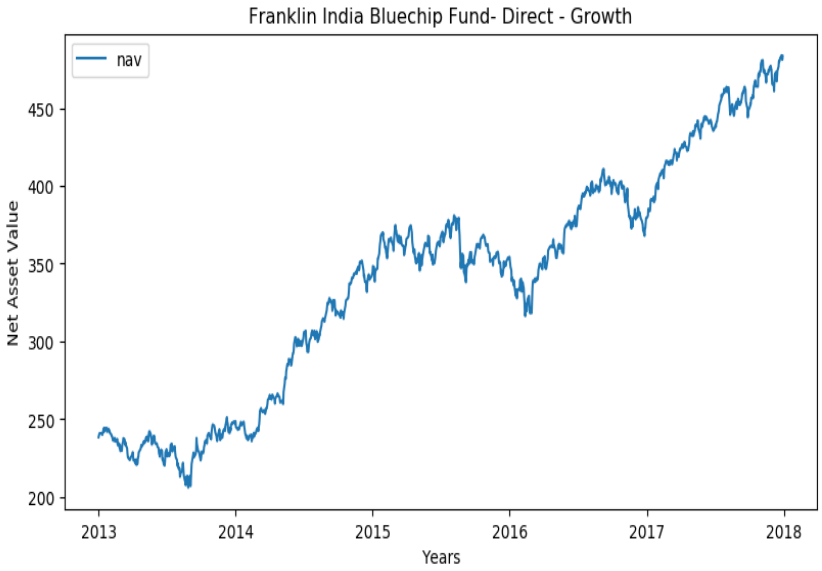
Sector Specific Schemes generally invests money in some specified sectors for example: “Real Estate” Specialized real estate funds would invest in real estates directly, or may fund real estate developers or lend to them directly or buy shares of housing finance companies or may even buy their securitized assets.

## Methodology

# Analysis

**Mutual Fund: Franklin Blue-chip Fund**

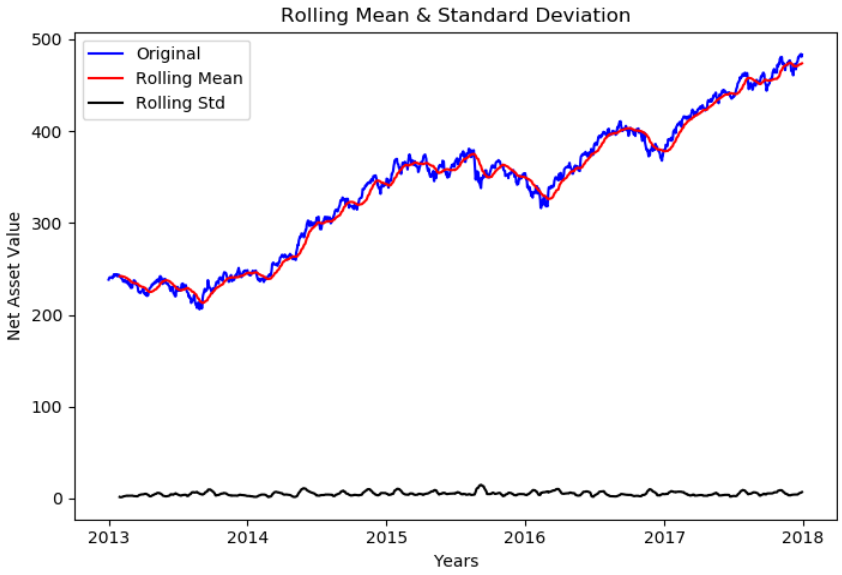
Using the Franklin Blue-chip Net Asset Value, the below figure is plotted using python to observe the behavior of the time series data. From the figure, observation is that the time series data is following a linear trend.




***Note*:** This Fund is taken as the reference to calculate return and risk. Later the same process is automated for the rest of the funds in the database.

**Calculating Rolling Mean & Standard Deviation**

Mean of the data is not constant it varies according to the time. So, the stochastic mean and standard deviation, i.e. the rolling mean and standard deviation calculated with a step size (window) of 22.



**Return & Risk Calculations**

## Return

The return of the fund calculated on day to day basis. Here percentage change formula is used to calculate the percentage change in the return.

$$\boldsymbol{Return} = \frac{Nav_{n+1} - Nav_n}{Nav_n}$$

## Risk

The risk is calculated, using past two years data of mutual funds and benchmark.

- Past two years return is calculated taking present NAV of the fund and exactly two years back fund value.
- Return is calculates using percentage change formula

$$Return(\%) = \frac{Nav_{n+1} - Nav_n}{Nav_n} \times 100$$

$$Nav - Net\ Asset\ Value$$

- Two years return converted into one year effective return.

$$\boldsymbol{Effective\ Return}(\%) = (((1 + Return)^{\frac{1}{2}}) - 1) \times 100$$

## Volatility

Standard deviation (SD) measures the volatility of the fund returns about its average returns. It explains how a fund return can deviate from the historical mean return of scheme.

$$\boldsymbol{Variance} = \frac{Sum\ of\ squared\ Differences:\ daily\ return\ and\ mean\ of\ fund}{Number\ of\ daily\ return\ data\ points}$$

Note: If data is less than three years

$$Variance = \frac{Sum\ of\ squared\ Differences: daily\ return\ and\ mean\ of\ fund}{Number\ of\ daily\ return\ data\ points - 1}$$

$$\boldsymbol{Standard\ Deviation\ (SD)} = \sqrt[2]{Variance}$$

Note: If data is more than three years

***Study*:** Higher the Standard deviation more volatile is the funds return.

## R Square

It measures the relationship between a portfolio and its benchmark. The value will be in percentages between 1% to 100%

$$Correlation\ Coefficient = \frac{Cov(Mutual\ Fund, Benchmark)}{SD_{MF} \times\ SD_B}$$

$$SD_{MF}: Standard\ Deviation\ of\ Mutual\ Funds\ Return$$
$$SD_B: Standard\ Deviation\ of\ Benchmark\ Return$$

$$\boldsymbol{R\ Square} = (Correlation\ Coefficient)^2$$

***Study***: Higher R Square value indicates the fund's performance pattern has been in line with index and low indicates that fund does not match with index

## Beta

Beta measures the fund's volatility compared to that of the benchmark index. It explains, how much a funds performance would move upside down compared to its benchmark.

$$\boldsymbol{Beta} = \frac{SD_{MF}}{SD_B} \times\ RSquare$$
$$SD_{MF}: Standard\ Deviation\ of\ Mutual\ Funds\ Return$$
$$SD_B: Standard\ Deviation\ of\ Benchmark\ Return$$

Study: A fund with beta more than one would be more volatile than the market. If beta lower than one, then the fund is less volatile than the benchmark.

## Jensen Alpha

Alpha is performance ratio to measure the risk-adjusted performance of a portfolio. It measures the difference between an actual fund return and its expected performance, given its level of risk.

$$\boldsymbol{Alpha} = \{(Fund\ Return - R_f) - Beta\ \times\ (Benchmark\ Return - R_f)\}$$

$$R_f: Risk\ free\ return$$

**Note:** Risk-free return is the return that would be obtained if invested in a government bond for the same duration as mutual funds.

Study: Alpha represented by percentage indicates underperformance or outperformance of a portfolio

- Positive Alpha represents outperformed its benchmark index vice versa.
- Fund return and risk both contribute to its alpha, two funds with same return could have different alphas

## Active Risk

Active risk is the difference between a portfolio's returns and the benchmark.

Two ways to measure Active risk

- Subtract benchmark cumulative return from the portfolio return.

$$\boldsymbol{Active\ Risk} = Fund\ Return - Index\ Return$$

- Calculating the standard deviation of the difference in the fund and benchmark returns over time.

$$\boldsymbol{Active\ Risk\ (TE)} = \sqrt{\sum_{i=1}^{n} \frac{(R_{MFi} - R_{Bi})^2}{N-1}}$$

$$TE: Tracking\ Error$$

$$R_{MFi}: Fund\ Returns$$

$$R_{Bi}: Benchmark\ Returns$$

$$N: Number\ of\ Return\ Periods$$

*Study*: Lower Active risk means Fund closely follows its benchmark. High active risk means the opposite. Active Risk gives a sense of how a Mutual fund is around the benchmark or how volatile the portfolio is relative to its benchmark.

### Sharpe Ratio

Sharpe ratio helps to know if a mutual fund delivers the return concerning the risk is taken by it comparing a fund with a risk-free rate of return

$$\boldsymbol{Sharpe\ Ratio} = \frac{(R_{MF} - R_f)}{SD_{MF}}$$

$$R_{MF}: Fund\ Returns$$
$$R_f: Risk\ free\ return$$
$$SD_{MF}: Standard\ Deviation\ of\ Mutual\ Funds\ Return$$

Study: Higher the value better the fund. If Sharpe ratio is negative, then Fund underperforms when compared to the risk-free rate of return.

### Treynor ratio

Treynor ratio is also known as a reward to volatility ratio; it is the excess return generated by a fund over and above the risk-free rate. Like Sharpe ratio, but uses beta as a measure of volatility.

$$\boldsymbol{Treynor\ Ratio} = \frac{R_{MF} - R_f}{Beta}$$

$$R_{MF}: Fund\ Returns$$
$$R_f: Risk\ free\ return$$

Study:  Higher the ratio implies that the fund has better risk-adjusted return than that of another fund with a lower Treynor ratio.

## Information Ratio

A measure of risk-adjusted return of Mutual Funds. It is also known as Appraisal Ratio. It is the advanced version of Sharpe ratio. The information ratio is the active return to the relevant benchmark divided by standard deviation of the active return or tracking error.

$$\boldsymbol{Information\ Ratio} = \frac{Annualized\ R_{MF} - Annualized\ R_B}{(SD_{MF} - SD_B) \times \sqrt{252}}$$

Study: The information ratio is used to gauge the skill of managers of mutual funds. It measures the active return of managers portfolio divided by the amount of risk that the manager takes relative to the benchmark. Higher the Information ratio, better the performance of the fund manager

## Sortino Ratio

Sortino ratio measures the performance of the investment relative to the downward deviation.

- It uses the downward deviation for denominator instead of standard deviation.
- Sortino ratio gives a more realistic picture of downward risk ingrained in the fund

$$\boldsymbol{Sortino\ Ratio} = \frac{Expected\ R_{MF} - R_f}{SD_{MF-d}}$$

$$Expected\ R_{MF}: Expected\ Fund\ Returns$$

$$R_f: Risk\ free\ return$$

$$SD_{MF-d}: Standard\ Deviation\ of\ Negative\ Asset\ Returns$$

Study: Large Sortino ratio indicates a low probability of a large loss

*Comparision for (Franklin Bluechip India growth Direct)*

| S.no | Statistic | Calculated | Fundoo | Deviation |
|---|---|---|---|---|
| **1** | Return | 15.4056 | 15.42 | 0.0144 |
| **2** | Jensen Alpha | -0.0557 | -0.2 | -0.1443 |
| **3** | Active Risk | 0.3248 | 0.81 | 0.4852 |
| **4** | Volatility | 11.042 | 10.56 | -0.482 |
| **5** | Beta | 0.9911 | 0.9 | -0.0911 |
| **6** | Sharpe Ratio | 0.7703 | 0.96 | 0.1897 |
| **7** | Treynor Ratio | 8.5822 | 10.21 | 1.6278 |
| **8** | Information Ratio | -0.0007 | 0 | 0.0007 |
| **9** | Sortino Ratio | 1.1162 | 1.32 | 0.2038 |