SVKM'S NMIMS Deemed to be UNIVERSITY
Nilkamal School of Mathematics, Applied Statistics & Analytics

NAVIGATING WEALTH

UNLEASHING THE POTENTIAL OF PORTFOLIO OPTIMIZATION THROUGH MODERN PORTFOLIO THEORY

INTRODUCTION

- **Mutual funds** offer diversified investment opportunities across stocks and bonds, managed by professional fund managers, facilitating portfolio diversification and risk mitigation.
- **Professional management** of mutual funds streamlines investment decisions, saving investors time and effort, while providing regular performance reports for informed decision-making.
- The research integrates mutual funds, portfolio optimization, and investor objectives to develop a **user-friendly system** grounded in **Modern Portfolio Theory (MPT)**.
- The system employs advanced algorithms to **analyze investor goals and risk tolerance**, r**ecommending optimal mutual fund combinations** tailored to individual preferences.
- Through the utilization of mutual funds and MPT principles, the research aims to **empower investors with personalized investment strategies** aligned with their financial objectives and risk preferences.

MODERN PORTFOLIO THEORY (MPT)

Introduction to MPT:

MPT, pioneered by Harry Markowitz in the 1950s, revolutionized investment theory by emphasizing diversification and risk management.

It provides a framework for constructing portfolios that optimize returns while minimizing risk.

Core Principles of MPT:

Diversification: Spreading investments across a variety of assets to reduce risk.

Efficient Frontier: The set of optimal portfolios that offer the highest expected return for a given level of risk.

Risk-Return Tradeoff: Investors seek to balance the desired level of return with an acceptable level of risk.

MODERN PORTFOLIO THEORY (MPT)

Application of MPT:

Asset Allocation: MPT guides investors in allocating assets across different asset classes, such as stocks, bonds, and cash equivalents.

Portfolio Optimization: MPT helps in constructing portfolios that maximize returns for a given level of risk or minimize risk for a desired level of return.

Risk Management: MPT aids in identifying and managing risks inherent in investment portfolios.

Benefits of MPT:

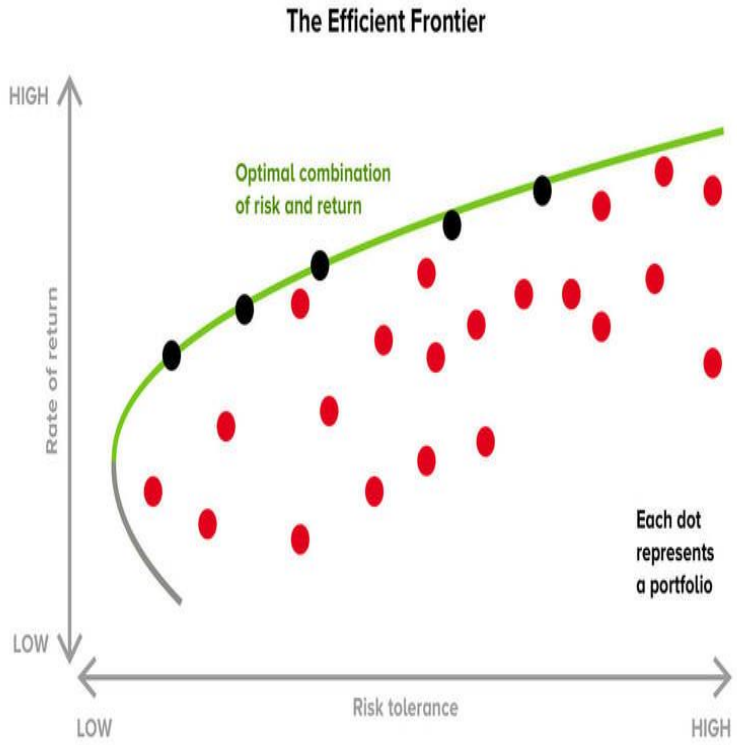
Improved Risk-Adjusted Returns: By diversifying across assets with low correlation, investors can achieve higher returns for a given level of risk.

Rational Decision-Making: MPT provides a systematic approach to investment decision-making, based on quantitative analysis and optimization techniques.

Long-Term Wealth Creation: MPT promotes a disciplined, long-term investment strategy focused on achieving financial goals and preserving capital.

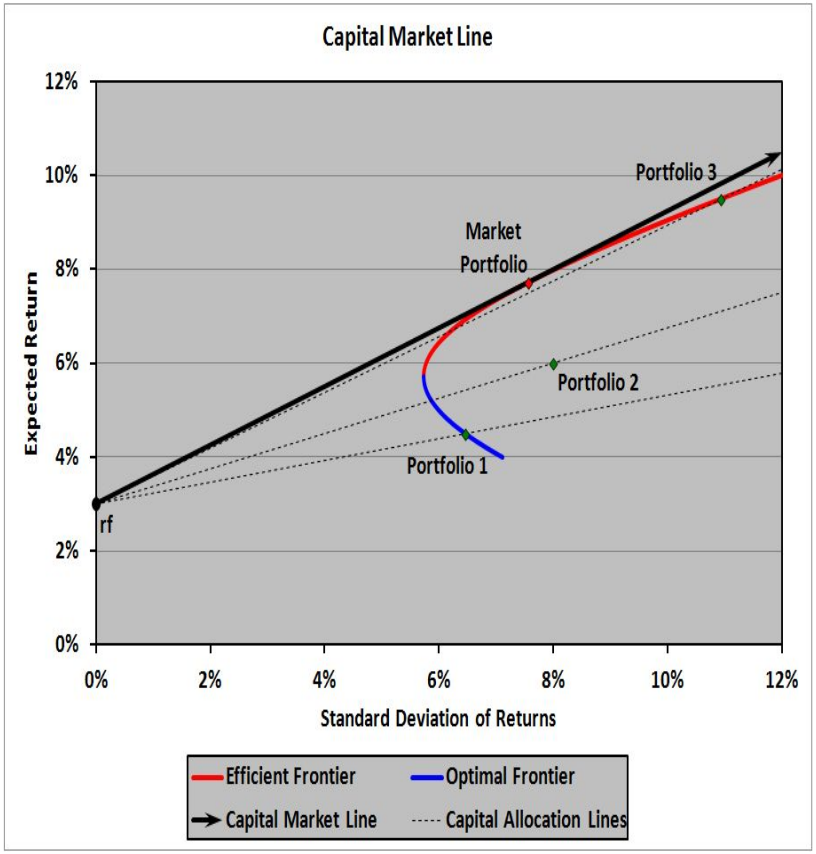
EFFICIENT FRONTIER

- The Efficient Frontier depicts the optimal portfolios offering maximum return for a given risk level in Modern Portfolio Theory (MPT).
- It's a curve plotting expected return against portfolio risk, where efficient portfolios lie on its boundary.
- Concave Shape: Reflects diminishing returns to additional risk.
- Upper Bound: Represents portfolios with the highest achievable return for a given risk level.



CAPITAL MARKET LINE (CML)

- Integral to Modern Portfolio Theory (MPT), the CML extends the Efficient Frontier, integrating the risk-free rate of return.
- Features the risk-free asset and the market portfolio, comprising all available risky assets.
- Efficient portfolios lie on the CML, offering maximum expected return for a given risk level.
- It serves as a benchmark for evaluating portfolio efficiency.
- Guides portfolio construction by optimizing the allocation between the risk-free asset and the market portfolio.
- Assists in capital allocation decisions, aiding investors in achieving optimal risk-return profiles.



OBJECTIVES

- **Showcasing the Accuracy of Internal Rate of Return (IRR)** Calculations by Utilizing Input Data, Ensuring Precision in Investment Evaluation.
- **Delve into Strategic Diversification Strategies**, Balancing Investment Portfolios between Debt and Equity to Optimize Risk-Adjusted Returns.
- **Unlocking Market Potential through Segmentation:** Explore the Benefits of Diversifying Investments across Large, Mid, and Small Cap Securities for Enhanced Portfolio Resilience.
- **Empower Users with Personalized Investment Solutions:** Analyze Data Insights and Craft Tailored Strategies through an Intuitive User Interface, Making Investment Decisions Effortless and Effective.

Data

We sourced our data from Bombay Stock Exchange (BSE) and Yahoo Finance. For the purpose of our project, we took in consideration past returns of 40 years of various investments (31st March 1981- 31st March 2021)

Valuation Date	Inflation WPI e-based on 100	%Change (YoY)	Gold Value er 10 gms.) (Rs	%Change (YoY)	Silver Value er 1 kg.) (Rs	%Change (YoY)	F.D. Value Value (Rs.	BANK F.D. Rate(%)	PPF Value Value (Rs.)	PPF Rate(%)	BSE-Sensex Index Value	%Change (YoY)
31/03/81	1000		1522		2618		1085	8.50%	1080	8.00%	173	
31/03/82	1000	0.00%	1719	12.92%	2636	0.70%	1177	8.50%	1172	8.50%	218	26.00%
31/03/83	1049	4.90%	1723	0.20%	2798	6.16%	1277	8.50%	1271	8.50%	212	-3.00%
31/03/84	1128	7.53%	1858	7.89%	3506	25.28%	1386	8.50%	1386	9.00%	245	16.00%
31/03/85	1201	6.47%	1984	6.75%	3594	2.50%	1497	8.00%	1517	9.50%	354	44.00%
31/03/86	1254	4.41%	2125	7.13%	3918	9.04%	1628	8.75%	1669	10.00%	574	62.00%
31/03/87	1327	5.82%	2323	9.32%	4247	8.39%	1770	8.75%	1870	12.00%	510	-11.00%
31/03/88	1435	8.14%	3082	32.66%	5539	30.41%	1938	9.50%	2094	12.00%	398	-22.00%
31/03/89	1542	7.46%	3175	3.01%	6367	14.95%	2122	9.50%	2345	12.00%	714	79.00%
31/03/90	1657	7.46%	3229	1.70%	6842	7.46%	2324	9.50%	2627	12.00%	781	9.00%
31/03/91	1827	10.26%	3452	6.88%	6761	-1.19%	2545	9.50%	2942	12.00%	1168	50.00%
31/03/92	2078	13.74%	4298	24.51%	7332	8.45%	2850	12.00%	3295	12.00%	4285	267.00%
31/03/93	2287	10.06%	4104	-4,51%	7078	-3.46%	3164	11.00%	3690	12.00%	2281	-47.00%
31/03/94	2478	8.35%	4532	10.43%	6348	-10.32%	3480	10.00%	4133	12.00%	3779	66.00%
31/03/95	2790	12.60%	4667	2.99%	6692	5.42%	3863	11.00%	4629	12.00%	3261	-14.00%
31/03/96	3013	7.99%	4958	6.22%	7221	7.89%	4326	12.00%	5184	12.00%	3367	3.00%
31/03/97	3152	4.61%	5071	2.28%	7165	-0.77%	4824	11.50%	5807	12.00%	3361	0.00%
31/03/98	3291	4.40%	4347	-14.27%	7352	2.61%	5343	10.75%	6503	12.00%	3893	16.00%
31/03/99	3487	5.95%	4268	-1.82%	7855	6.84%	5877	10.00%	7284	12.00%	3740	-4.00%

The NAVs for the funds are given every month from October'05 to May'23. The second data set is for the diversification of the equity mutual funds data into the following types of funds

Time	Large cap	Small cap	Mid cap
Oct-05	2412.56	4952.50	3478.65
Nov-05	2696.92	5567.17	3832.50
Dec-05	2872.90	5943.11	4030.45
Jan-06	3030.48	6225.35	4308.15
Feb-06	3145.15	6144.48	4395.95
Mar-06	3424.42	6591.66	4787.15
Apr-06	3625.81	7206.31	5021.25
May-06	3123.42	6364.29	4399.60
Jun-06	3121.62	5357.04	3944.65
Jul-06	3144.99	5131.48	3877.80
Aug-06	3441.59	5778.99	4307.15
Sep-06	3670.43	6161.73	4691.65
Oct-06	3830.09	6392.59	4834.70
Nov-06	4020.01	6647.08	5069.00
Dec-06	4049.88	6892.32	5199.75
Jan-07	4144.63	7503.50	5279.55
Feb-07	3785.73	6705.91	4877.35
Mar-07	3820.58	6470.51	4850.05
Apr-07	4079.10	6993.84	5245.70
May-07	4331.85	7413.03	5644.15

Large cap	Small cap	Mid cap
11.14%	11.70%	9.69%
6.32%	6.53%	5.04%
5.34%	4.64%	6.66%
3.71%	-1.31%	2.02%
8.51%	7.03%	8.53%
5.71%	8.92%	4.77%
-14.91%	-12.43%	-13.22%
-0.06%	-17.23%	-10.92%
0.75%	-4.30%	-1.71%
9.01%	11.88%	10.50%
6.44%	6.41%	8.55%
4.26%	3.68%	3.00%
4.84%	3.90%	4.73%
0.74%	3.62%	2.55%
2.31%	8.50%	1.52%
-9.06%	-11.24%	-7.92%
0.92%	-3.57%	-0.56%
6.55%	7.78%	7.84%
6.01%	5.82%	7.32%

The concept of the risk-free rate in finance refers to the theoretical return on an investment with no risk of financial loss. In practice, the closest approximation to this risk-free rate is often the yield on short-term government securities, such as the 91-day T-bill rate

Government Securities Market	
7.10% GS 2034	: 7.0831% #
7.18% GS 2033	: 7.1165% #
7.37% GS 2028	: 7.0919% #
7.06% GS 2028	: 7.0914% #
7.33% GS 2026	: 7.0556% #
6.99% GS 2026	: 7.0455% #
91 day T-bills	: 6.8702%*
182 day T-bills	: 7.0297%*
364 day T-bills	: 7.0490%*

LITERATURE REVIEW

Application of Portfolio Optimization Techniques on Indian Mutual Funds : A Primer	Review on Modern Portfolio Theory and Optimization Models	The Modern Portfolio Theory in Optimising Risky-Asset Portfolio
Suraj Rajani	**Zehan Hou, Zeyu Li, and Yang Zhou**	**Mossad A. Abaikhail**
The document explores the Markowitz Model for optimizing fund portfolios via efficient frontier analysis. It utilizes historical data from equity funds of Canara Robeco, Franklin Templeton, Reliance, L&T and ICICI Prudential. Techniques for calculating portfolio return, variability, and covariance are discussed in the paper as well, including the standard deviation using Markowitz's formula. It showcases the efficient frontier for L&T with allocation adjustments based on risk-return tradeoff. Additionally, it provides details on Franklin Templeton Mutual Funds, including AUM, returns, beta and Sharpe ratio.	Modern Portfolio Theory (MPT) has evolved to incorporate new findings like behavioral finance and advanced strategies such as Genetic Algorithms and Monte Carlo simulation for dynamic portfolio development. While portfolio optimization aims to improve the Sharpe ratio and balance risk and return, the assumption of constant risk attitudes contrasts with reality, making MPT implementation complex despite its straightforward theory. Efficient risk management remains crucial in modern financial planning.	This paper examines whether a fund or portfolio based on a market index of risky assets is an optimal choice. It created a hypothetical optimal portfolio for four sectors in the US Stock market and compared it with Vanguard and SPDR sector-index funds. The paper also discusses the Modern Portfolio Theory, the efficient frontier, and how to determine an optimal portfolio value.

METHODOLOGY

- **Data Collection & Preparation:** Gather financial data including performance metrics and market segmentation.
- **IRR Calculation:** Use established formulas and software for precise Internal Rate of Return analysis.
- **Diversification:** Apply Modern Portfolio Theory for strategic allocation between debt and equity.
- **Market Analysis:** Conduct comprehensive research on large, mid, and small-cap sectors.
- **Strategy Formulation**: Utilize quantitative analysis to craft personalized investment strategies.
- **UI Design & Testing**: Develop user-friendly interface, ensuring seamless user experience.

Formulas Used

Net Present Value:

$$\mathrm{NPV} = \frac{R_t}{(1+i)^t}$$

Future Value

$$FV = PV(1+r)^n$$

Internal rate of return

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n}$$

Expected Returns

$$E[R] = \sum_{i=1}^{n} R_i P_i$$

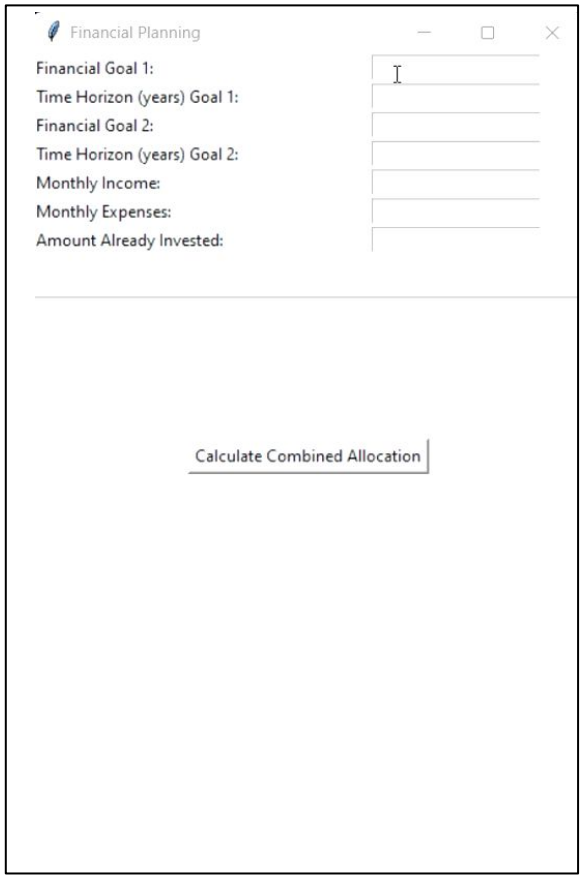
Covariance

$$cov_{x,y} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{N-1}$$

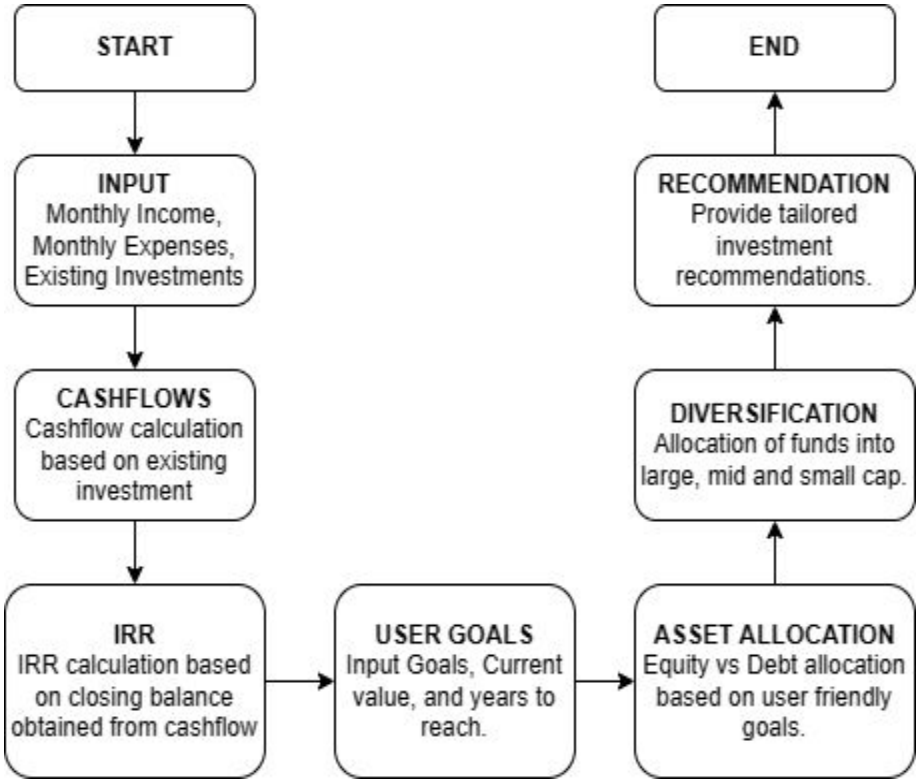
USER INTERFACE OVERVIEW

- **User Interface Design**: Incorporates user's monthly expenses, income, and existing investments to compute cash flows.
- **IRR Calculation:** Utilizes computed cash flows to determine Internal Rate of Return (IRR), enhancing accuracy in investment evaluation.
- **Goal-Based Planning:** Considers user-defined financial goals, current goal values, and time horizon to personalize investment strategies.
- **Asset Allocation:** Determines optimal allocation between equity and debt based on user's risk profile and financial objectives.
- **Market Segmentation:** Further diversifies investments into large-cap, mid-cap, and small-cap securities for enhanced portfolio resilience and potential returns.
- **Tailored Recommendations**: Provides customized investment recommendations aligned with user's goals, risk tolerance, and investment horizon, fostering a holistic approach to wealth management.

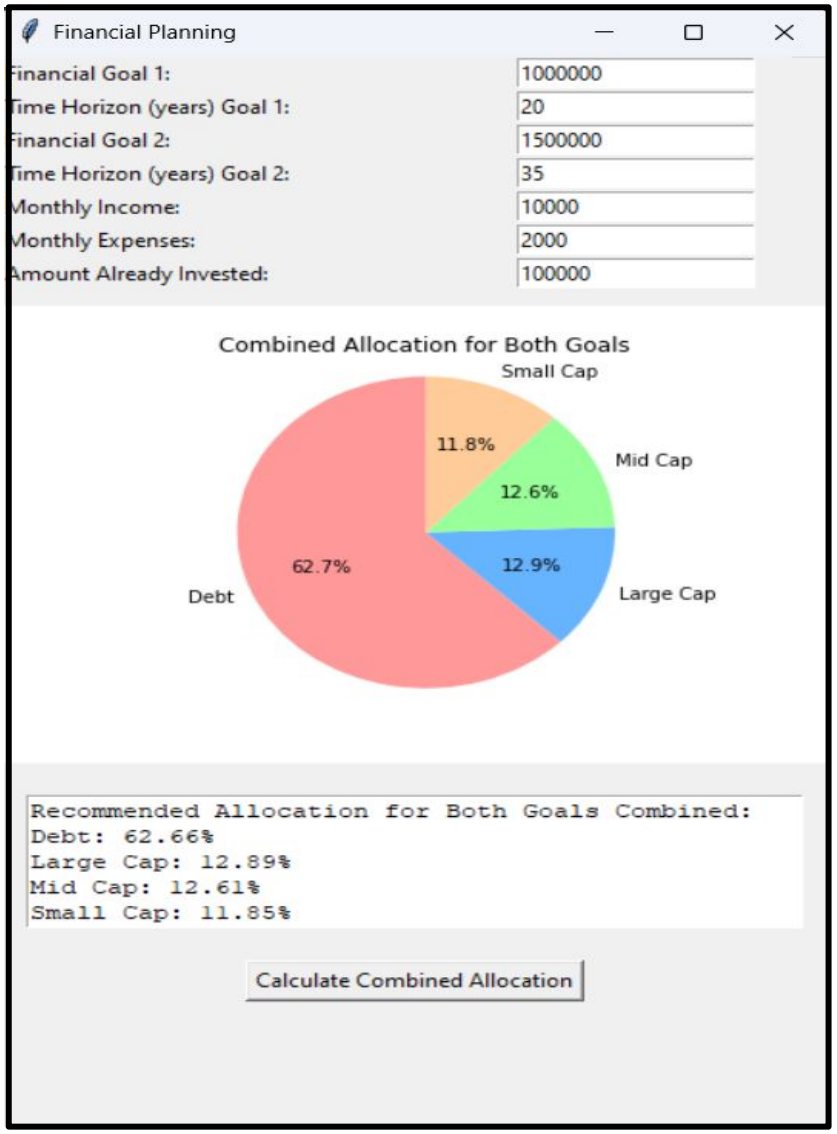
USER INTERFACE OVERVIEW

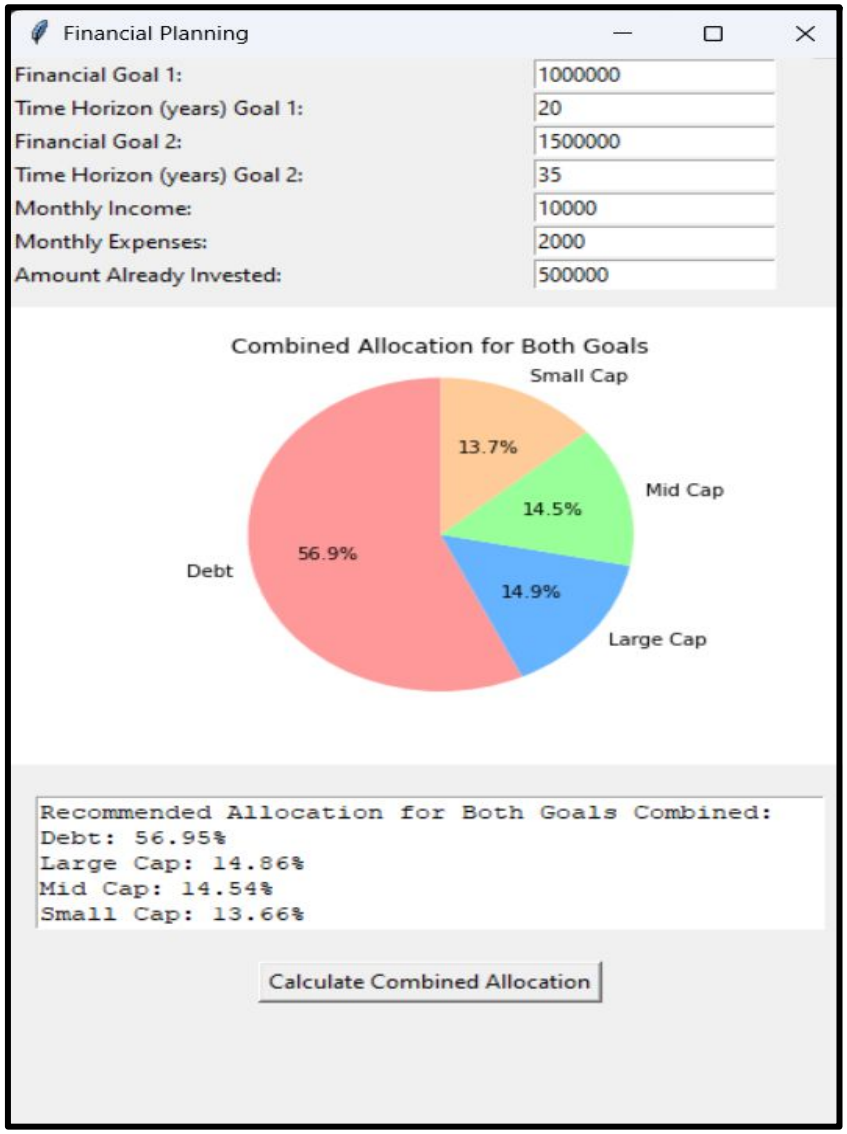


SNAPSHOT



FLOWCHART


Financial Planning
Financial Goal 1: 1000000
Time Horizon (years) Goal 1: 20
Financial Goal 2: 1500000
Time Horizon (years) Goal 2: 35
Monthly Income: 10000
Monthly Expenses: 2000
Amount Already Invested: 100000
Combined Allocation for Both Goals
Small Cap
11.8%
Mid Cap
12.6%
62.7%
12.9%
Debt
Large Cap
Recommended Allocation for Both Goals Combined:
Debt: 62.66%
Large Cap: 12.89%
Mid Cap: 12.61%
Small Cap: 11.85%
Calculate Combined Allocation


Financial Planning
Financial Goal 1: 1000000
Time Horizon (years) Goal 1: 20
Financial Goal 2: 1500000
Time Horizon (years) Goal 2: 35
Monthly Income: 10000
Monthly Expenses: 2000
Amount Already Invested: 500000
Combined Allocation for Both Goals
Small Cap
13.7%
Mid Cap
14.5%
56.9%
14.9%
Debt
Large Cap
Recommended Allocation for Both Goals Combined:
Debt: 56.95%
Large Cap: 14.86%
Mid Cap: 14.54%
Small Cap: 13.66%
Calculate Combined Allocation

DATA ANALYSIS

Data Input:

Our interface simplifies financial data analysis by capturing critical metrics such as monthly income, expenses, and current investments. This comprehensive overview allows users to gain valuable insights into their financial standing and available resources. Furthermore, users can set investment horizons and define specific financial goals, providing clarity and direction for their investment strategies.

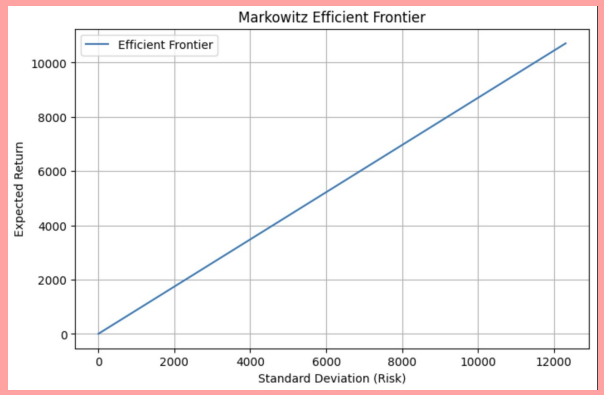
Internal Rate of Return (IRR) Calculation:

Utilizing advanced Python algorithms, our system facilitates precise Internal Rate of Return (IRR) calculations. By meticulously synthesizing cash flow dynamics, including individual investments, income streams, and expenses, our algorithm iteratively computes the IRR. This iterative process ensures accurate and reliable results, empowering users to make informed decisions about their investment opportunities and financial planning strategies.

DATA ANALYSIS

Equity and Debt Diversification:

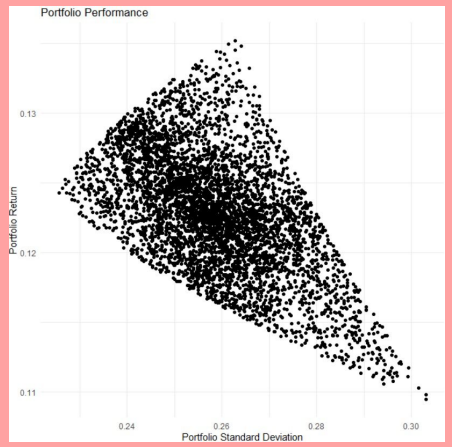
Portfolio optimization is a cornerstone of effective investment management. Our platform employs a sophisticated approach to diversification by balancing risk-bearing assets (Equity) and risk-averse assets (Debt) along an efficient frontier. This strategic allocation not only enhances portfolio resilience against market volatility but also maximizes potential returns by leveraging the unique characteristics of each asset class.



DATA ANALYSIS

Equity Diversification by Cap Size:

Delving deeper into equity diversification, our system considers the nuances of different market segments, including large, mid, and small-cap equities. Through a meticulous analysis of required rates of return and asset class fontiers, our platform determines the optimal allocation across these segments. This tailored approach ensures that portfolios are aligned with individual risk profiles and investment objectives, ultimately enhancing long-term portfolio performance and stability.




```
Optimal Point for Desired Return of 0.08
Portfolio Standard Deviation: 0.29874627356931455
Portfolio Return: 0.10418712464231

Weights of the Optimal Portfolio:
Large Cap Ln Return: 34.14%
Mid Cap Ln Return: 33.39%
Small Cap Ln Return: 32.46%
```

CONCLUSION

In conclusion, we've embarked on a journey exploring the intersection of mutual funds, portfolio optimization, and individual financial aspirations. Through our efforts, we've developed an intuitive framework grounded in Modern Portfolio Theory (MPT), bridging theoretical concepts with practical solutions. By integrating MPT principles into a user-friendly interface, we empower investors to input their unique preferences and goals, receiving personalized strategies in return. This endeavor highlights the importance of marrying theory with real-world applications, with the ultimate goal of enhancing investor outcomes and guiding them towards financial success.

FUTURE SCOPE

1. **Real-Time Portfolio Monitoring:** The UI could integrate with financial data feeds for real-time portfolio monitoring and dynamic management, adjusting allocations to optimize performance and minimize risk in response to market movements.
2. **Tax Optimization:** The interface can integrate tax strategies, such as tax-loss harvesting and tax-efficient fund selection, to enhance portfolio optimization by mitigating the impact of taxes on investment returns.
3. **User Experience Optimization:** Iterate on the user interface based on investor feedback to maintain usability, clarity, and ease of use, employing usability tests and user feedback to address any areas for improvement.
4. **Personalised Risk Management:** Implement advanced risk management techniques, including downside risk, volatility, and drawdown analysis, to customize portfolio recommendations based on individual investor risk preferences and constraints, ensuring alignment with financial goals.
5. **Machine Learning Integration:** Machine learning algorithms can analyse myriad amounts of data to identify patterns and trends.

LIMITATIONS

1. **Data Dependence-** MPT's use of historical data for predicting future market outcomes is problematic due to the stock market's inherent unpredictability, where past success doesn't ensure future performance.
2. **Rational Investor Assumptions-** MPT assumes rationality, but investors' biases and emotions, unaccounted for in UI, can significantly impact decision-making.
3. **Risk Measurement-** MPT's reliance on standard deviation overlooks downside risk, a crucial measure of potential investment loss.
4. **Financial Illiteracy-** Users should receive comprehensive education on alternative options, associated risks, and a clear understanding of their personal risk tolerance and investment objectives alongside recommendations.
5. **Fees and Taxes-** MPT neglects to consider fees and taxes related to mutual fund transactions, potentially diminishing returns, particularly for smaller investments.

Thank You!