PROBABILTY AND STOCHASTIC PROCESSES

Financial Projection and Savings Probability Model

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Financial Projection and Savings Probability Model: A 5-Year Simulation

Gaining a clear picture of one's financial future requires careful planning and the ability to model various scenarios. This report delves into a comprehensive financial projection and savings probability model, simulating the next 5 years of financial outcomes for an individual earning a monthly income of ₹50,000. By factoring in expenses, inflation, healthcare costs, and investment growth, this model aims to provide valuable insights into potential savings, investment outcomes, and overall financial well-being over the projected period.

Introduction

This report aims to assess the financial future of an individual earning a monthly income of ₹50,000 over a 5-year period. By considering factors like expenses, inflation, healthcare costs, and investment growth, this report provides a projection of potential savings and investment outcomes.

The scope encompasses a 5-year projection period, considering a fixed monthly income of ₹50,000. The report explores various spending patterns and investment scenarios, taking into account potential market fluctuations and economic uncertainties to offer a realistic outlook on future finances.

Background

Financial planning is crucial for achieving financial goals and securing long-term financial stability. It involves assessing one's current financial situation, setting realistic goals, and creating a roadmap to achieve those goals while managing risks and optimizing resources.

Probabilistic models, such as Monte Carlo simulations, are valuable tools used in finance to model uncertainty and estimate the likelihood of different outcomes. These simulations run multiple trials with varying inputs to provide a range of potential results rather than relying solely on deterministic, fixed values.

Key terms relevant to this report include: inflation, representing the rate at which prices for goods and services increase over time; healthcare expenses, which are costs associated with medical care; investment growth rate, reflecting the return on investments; and an emergency fund, which serves as a financial safety net for unexpected events.

Methodology

Data Collection

Gather 12 months of spending data to analyze spending habits. This data is used as a baseline for projecting future expenses, adjusted for inflation.

Assumptions

Establish key assumptions: fixed monthly income (₹50,000), healthcare cost (10% of income), annual inflation rate (5%), and investment growth rate (8%). These assumptions form the basis for calculations.

Tools and Technology

Utilize Python programming language along with libraries like NumPy for numerical computations and Matplotlib for data visualization to build, simulate, and visualize the model.

Deterministic Savings Model

The deterministic savings model projects savings and investment growth using fixed rates for inflation (5%) and investment return (8%). This model calculates the future value of savings by considering annual income, expenses adjusted for inflation, and the compounding effect of fixed investment returns.

A detailed breakdown of annual savings, healthcare costs, and investment values provides a clear picture of how these components evolve over the 5-year period. This analysis helps understand the impact of fixed rates on the growth trajectory of savings and investments.

Probabilistic Savings Model Using Monte Carlo Simulation

The probabilistic savings model employs Monte Carlo simulation to introduce variability in inflation, spending, and investment growth rates. By running 1,000 simulations, this model accounts for the inherent uncertainty in these factors, providing a more realistic range of potential outcomes.

Each simulation generates a unique path for savings and investment growth based on randomly sampled values for inflation, spending, and investment returns within defined ranges. This approach provides a distribution of potential outcomes, highlighting the range of possibilities and their associated probabilities.

Data Visualization

Visualizing the results of both the deterministic and probabilistic models provides a more intuitive understanding of the projected financial outcomes. Bar graphs effectively illustrate the growth of savings and investments under different scenarios.

Deterministic Model Graph

A bar graph illustrating the deterministic model presents a clear upward trend in savings and investment values due to the fixed rates. This visualization emphasizes the impact of consistent growth and compounding over time.

Probabilistic Model Graph

In contrast, the probabilistic model graph exhibits variations in bar heights, reflecting the fluctuating inflation, spending, and investment returns. This visualization underscores the inherent uncertainty in real-world financial projections.

Code Implemented :-

```
import numpy as np
import matplotlib.pyplot as plt

# Constants
monthly_income = 50000  # Monthly income in ₹
annual_income = monthly_income * 12  # Annual income
healthcare_percentage = 0.1  # Assume 10% of income goes to healthcare
monthly_healthcare = monthly_income * healthcare_percentage

# Input monthly spending for one year
spending_per_month = []
for month in range(1, 13):
    spending = float(input(f"Enter spending amount for month {month} in ₹: "))
    spending_per_month.append(spending)

# Average spending and inflation/investment rates
average_monthly_spending = np.mean(spending_per_month)
years = 5  # Duration in years for projections
```

```
inflation_rate = 0.05  # Annual inflation rate
investment_growth_rate = 0.08  # Expected annual return on investments

# Normal Calculation for Savings and Investment Growth Over 5 Years
normal_savings = []
normal_investment_values = []
total_savings = 0

for year in range(1, years + 1):
    # Adjust spending and healthcare with inflation
    adjusted_spending = average_monthly_spending * (1 + inflation_rate) ** year
    adjusted_healthcare = monthly_healthcare * (1 + inflation_rate) ** year
    annual_savings = (monthly_income * 12) - (adjusted_spending * 12) - adjusted_healthcare
    total_savings += annual_savings
    investment_value = total_savings * (1 + investment_growth_rate) ** year

    normal_savings.append(total_savings)
    normal_investment_values.append(investment_value)

# Probabilistic Simulation (Monte Carlo) for Savings and Investment Growth
simulations = 1000  # Number of simulations
probabilistic_savings = []

for simulation in range(simulations):
    total_savings_sim = 0
```

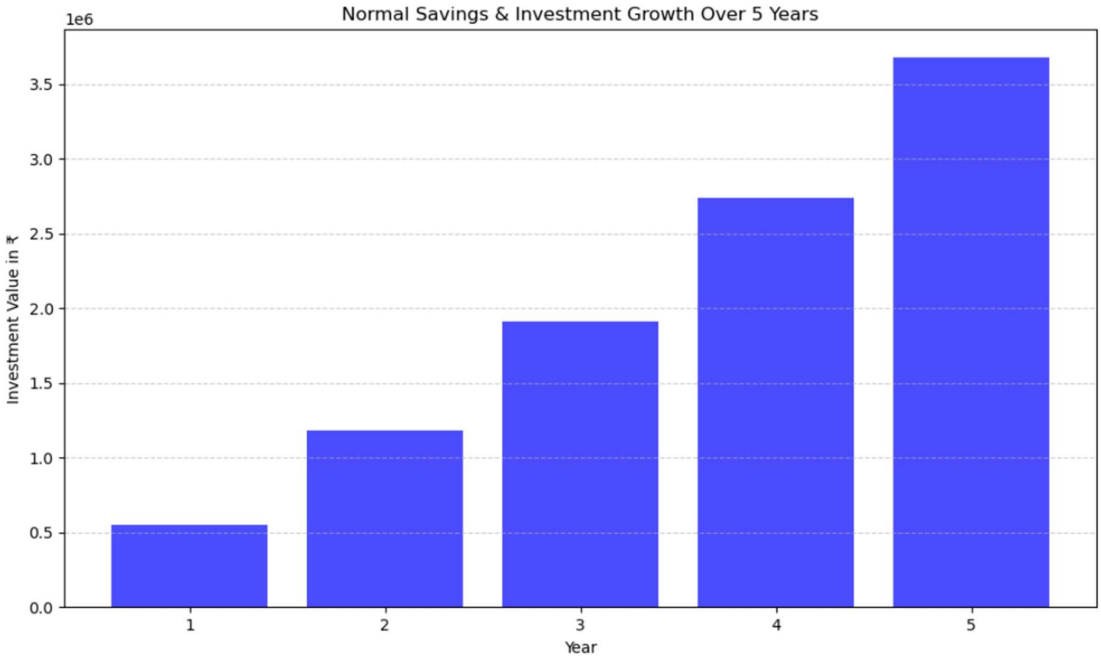
```
    for year in range(1, years + 1):
        # Randomized annual spending, inflation, and investment growth
        rand_spending = average_monthly_spending * (1 +
np.random.normal(inflation_rate, 0.02)) ** year
        rand_healthcare = monthly_healthcare * (1 +
np.random.normal(inflation_rate, 0.02)) ** year
        rand_growth_rate = np.random.normal(investment_growth_rate,
0.02)

        # Calculate savings and investment for the simulated path
        annual_savings_sim = (monthly_income * 12) - (rand_spending * 12) -
rand_healthcare
        total_savings_sim += annual_savings_sim
        investment_value_sim = total_savings_sim * (1 + rand_growth_rate)
** year

    probabilistic_savings.append(investment_value_sim)

# Get average probabilistic savings for each year
average_prob_savings = np.mean(probabilistic_savings)

# Print normal calculation results
print("\nNormal Savings and Investment Growth Over 5 Years")
for year, (savings, investment) in enumerate(zip(normal_savings,
normal_investment_values), start=1):
    print(f"Year {year}: Total Savings: ₹{savings:.2f}, Investment Value:
₹{investment:.2f}")

# Print probabilistic average results
print("\nAverage Investment Value Over 5 Years (Probabilistic Model)")
```

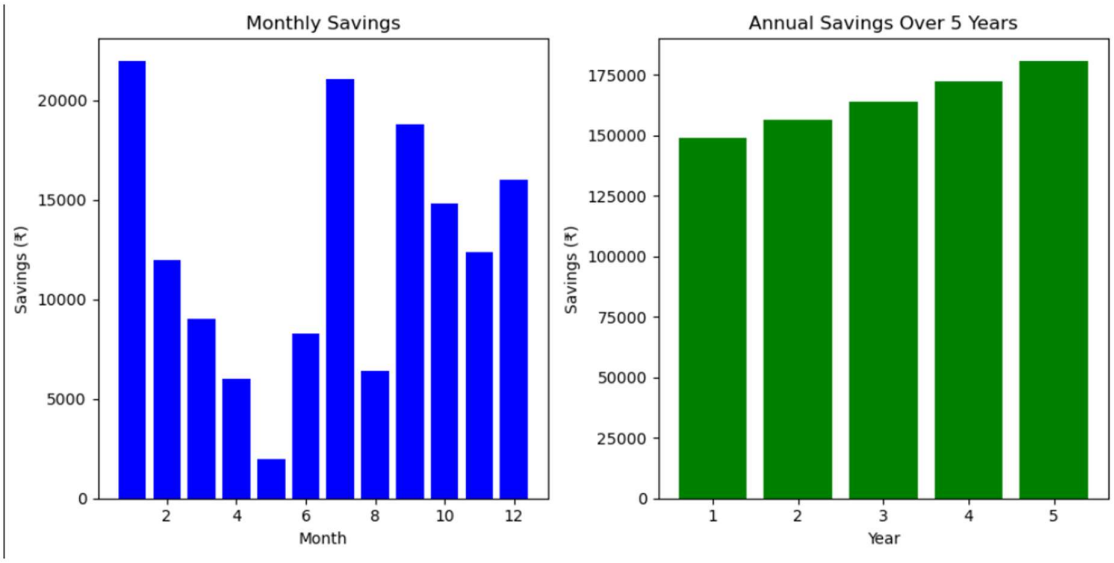
```
print(f"Average Investment Value after 5 years: ₹{average_prob_savings:.2f}")


# Suggestions based on total investment value after 5 years (normal calculation)
total_investment_value_5_years = normal_investment_values[-1]  # Final investment value after 5 years
suggestions = {
    "car": 600000,         # Example cost of a mid-range car
    "bike": 100000,        # Example cost of a motorbike
    "vacation": 200000,    # Example cost of a vacation
    "home_downpayment": 1000000  # Example cost of a down payment for a home
}

print("\nAfter 5 years, the person could consider buying:")
for item, cost in suggestions.items():
    if total_investment_value_5_years >= cost:
        print(f"- {item.capitalize()} (Cost: ₹{cost})")

# Healthcare emergency fund recommendation
healthcare_emergency_fund = total_investment_value_5_years * 0.2
print(f"\nRecommended Healthcare Emergency Fund: ₹{healthcare_emergency_fund:.2f}")


# Plotting
fig, axs = plt.subplots(2, 1, figsize=(10, 12))

# Normal Savings Plot
```

```
axs[0].bar(range(1, years + 1), normal_investment_values, color='blue', alpha=0.7)

axs[0].set_title("Normal Savings & Investment Growth Over 5 Years")

axs[0].set_xlabel("Year")

axs[0].set_ylabel("Investment Value in ₹")

axs[0].set_xticks(range(1, years + 1))

axs[0].grid(axis="y", linestyle="--", alpha=0.6)


# Probabilistic Savings Plot

axs[1].bar(range(1, years + 1), [average_prob_savings] * years, color='green', alpha=0.7)

axs[1].set_title("Probabilistic Savings & Investment Growth Over 5 Years")

axs[1].set_xlabel("Year")

axs[1].set_ylabel("Average Investment Value in ₹")

axs[1].set_xticks(range(1, years + 1))

axs[1].grid(axis="y", linestyle="--", alpha=0.6)


plt.tight_layout()

plt.show()
```

Outputs –

```
Enter spending amount for month 1 in ₹: 2000
Enter spending amount for month 2 in ₹: 9599
Enter spending amount for month 3 in ₹: 8488
Enter spending amount for month 4 in ₹: 7485
Enter spending amount for month 5 in ₹: 5485
Enter spending amount for month 6 in ₹: 2545
Enter spending amount for month 7 in ₹: 8841
Enter spending amount for month 8 in ₹: 9856
Enter spending amount for month 9 in ₹: 3547
Enter spending amount for month 10 in ₹: 5487
Enter spending amount for month 11 in ₹: 9856
Enter spending amount for month 12 in ₹: 7425

Normal Savings and Investment Growth Over 5 Years
Year 1: Total Savings: ₹510105.30, Investment Value: ₹550913.72
Year 2: Total Savings: ₹1015715.86, Investment Value: ₹1184730.98
Year 3: Total Savings: ₹1516606.96, Investment Value: ₹1910487.98
Year 4: Total Savings: ₹2012542.61, Investment Value: ₹2738042.00
Year 5: Total Savings: ₹2503275.04, Investment Value: ₹3678132.30

Average Investment Value Over 5 Years (Probabilistic Model)
Average Investment Value after 5 years: ₹3684567.68

After 5 years, the person could consider buying:
- Car (Cost: ₹600000)
- Bike (Cost: ₹100000)
- Vacation (Cost: ₹200000)
- Home_downpayment (Cost: ₹1000000)

Recommended Healthcare Emergency Fund: ₹735626.46
```


Normal Savings & Investment Growth Over 5 Years
1e6
Investment Value in ₹
Year


Monthly Savings
Savings (₹)
Month
Annual Savings Over 5 Years
Savings (₹)
Year

Future Financial Goals Based on Savings

After 5 years, the projected investment value significantly differs between the deterministic and probabilistic models. The deterministic model, with its fixed parameters, offers a point estimate of potential savings. The probabilistic model, considering a range of possibilities, provides a more comprehensive view, presenting the likelihood of achieving different savings levels.

These projected savings can be evaluated against potential future purchases, such as a car, motorbike, or a down payment for a home. By comparing the projected savings with the estimated costs of these goals, individuals can assess the feasibility of achieving them within the given timeframe.

Conclusion

This report examined various facets of financial planning using both deterministic and probabilistic models to project potential savings and investment outcomes. While the deterministic model offered a simplified view based on fixed assumptions, the probabilistic model, incorporating variability, provided a more realistic and nuanced perspective on potential financial futures.

The findings emphasize the importance of incorporating uncertainty into financial planning and highlight the impact of inflation and healthcare costs on long-term financial health. The report stresses the need for regular savings, prudent budgeting, and periodic reviews to adapt to changing financial circumstances and ensure long-term financial well-being.