

Optimal Decision Making Through Scenario Simulations Using Large Language Models

Erfan Tabatabaei

Introduction

Definition

using power of large language models with simulation module and optimization engine for decision making.

Problem

large language models have hallucination and lack of good decision making through
Intricate decision making with llm



Problem

Definition

Deciding whether to buy or lease a car based on parameters needed.

Parameters

1. Buy Price willing to pay
2. monthly lease bill willing to pay
3. down payment
4. duration of lease
5. duration of keeping bought car
6. lease mileage allowance
7. annual mileage
8. maintenance average price



Large Language Models

Pros

- Strong in understanding context
- Understanding language
- Strong in extracting information
- good in generating human like texts

Cons

- Hallucination
- Bias
- weak in optimizing and decision making
- Limited knowledge base

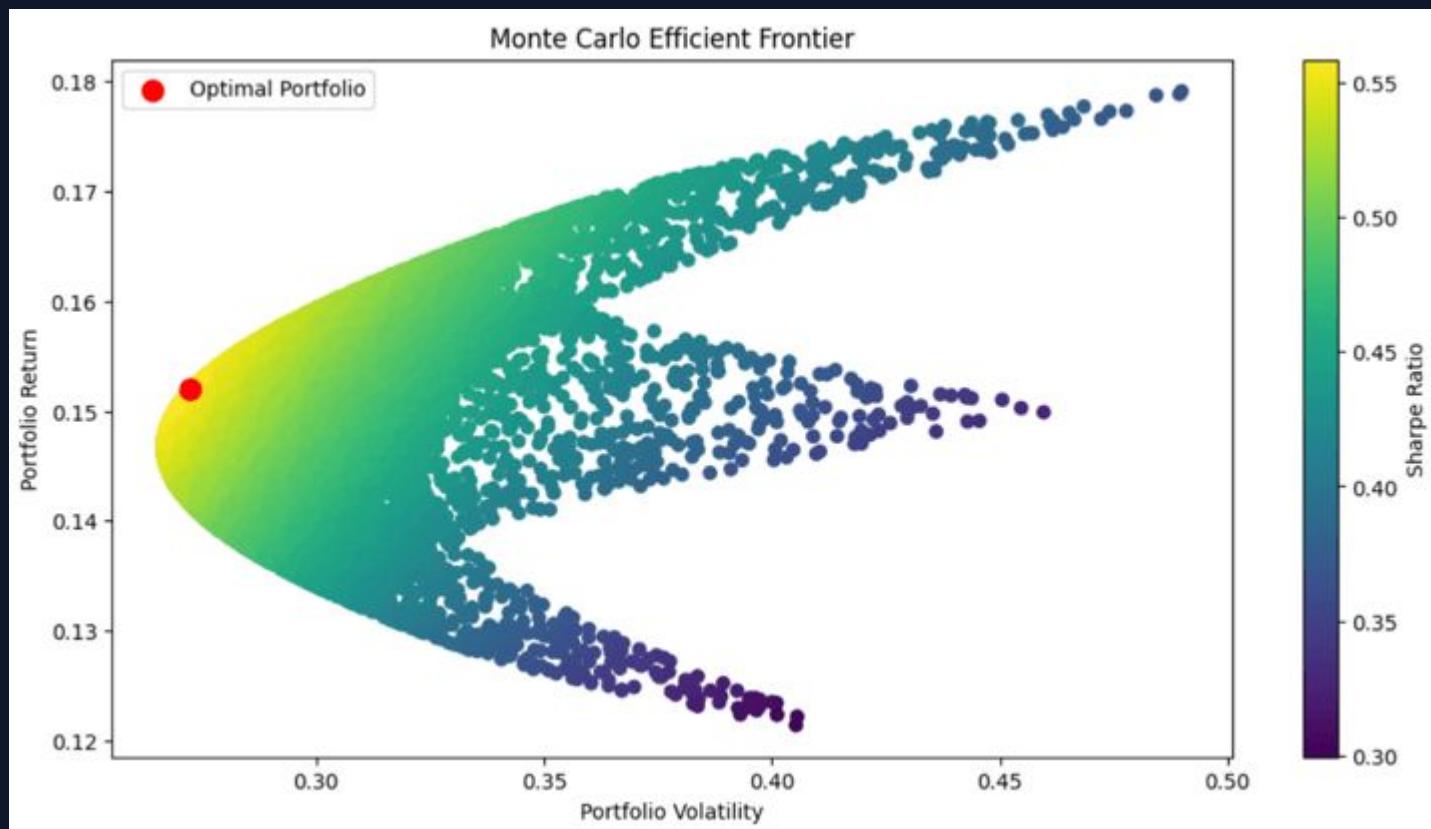
Optimal Decision Making Through Scenario Simulation

Scenario Simulation

Monte Carlo Simulation to create scenarios

Optimization Engine

Analyze scenarios generated by Monte Carlo Simulation



Core Modules

LLM Agent

1. Knowledge and Parameter Extraction
2. Question Answering And Guidance
3. Analyzing Result of Optimization

Simulation Module

- Use Parameters Extracted From LLM To Generate Scenarios

Optimization Engine

- Use Scenarios Generated In Simulation Module And Do Optimization

Core Modules (continue)

User Interface

1. Streamlit Interface for user and agent interaction
2. handling history for parameter extraction

Context-Aware Data warehouse

- Real-World Data for the task
- Parameters Needed for simulation
- validate simulation module outputs

Result Interface

- Text Generated result deciding whether to buy or lease
- Distribution plotting of buy and lease overall cost

Method

User Interface

LLM Agent

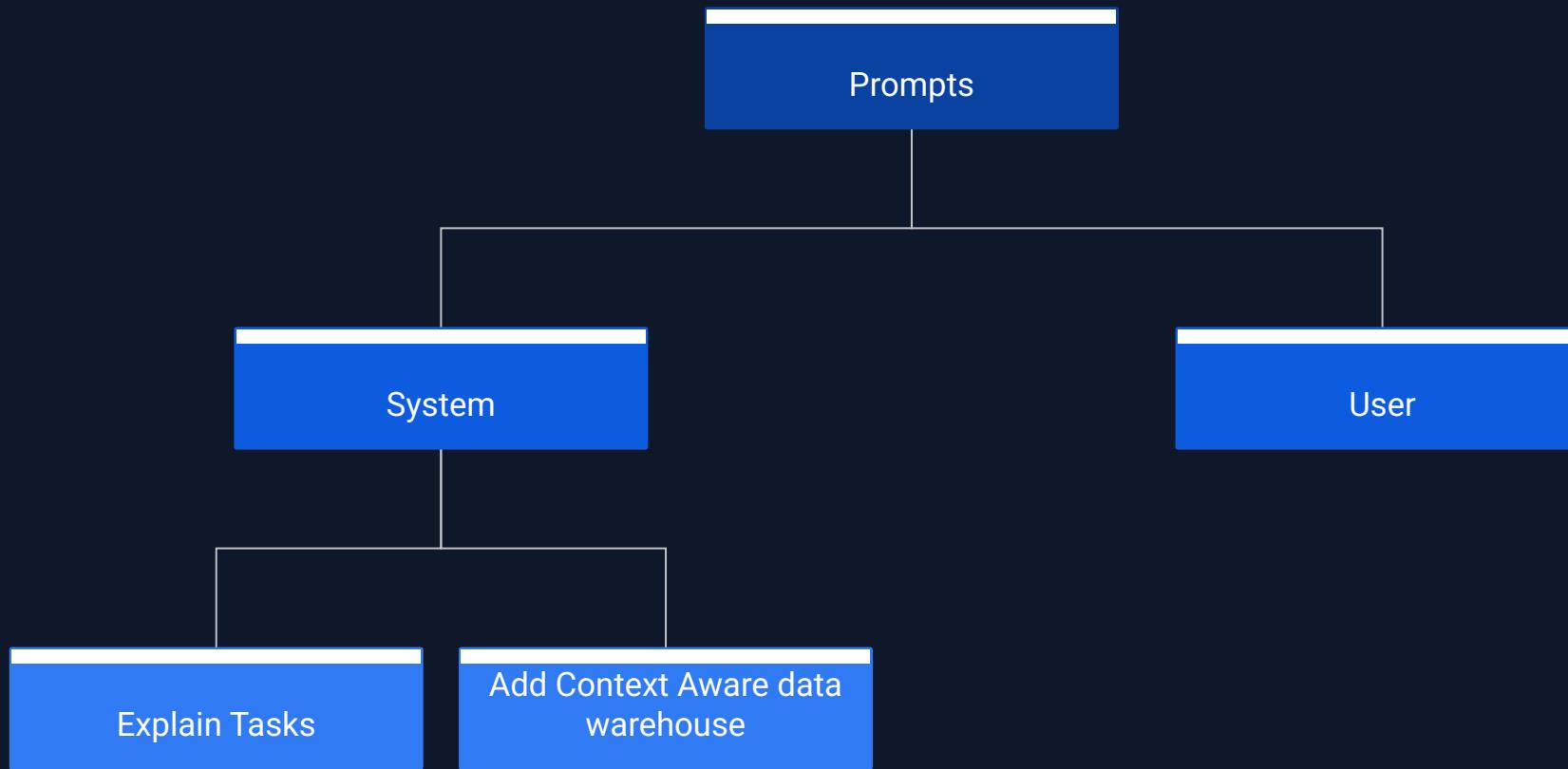
Simulation and Optimization

Context-Aware Data Warehouse

Result

- | | | | | |
|--|--|---|---|--|
| <ul style="list-style-type: none">• Interaction interface for user and llm• Showing Parameters Extracted• Showing Results• Gemma3 with Ollama | <ul style="list-style-type: none">• Extract Parameters based on the data warehouse• Answer questions• Analyze result | <ul style="list-style-type: none">• simulate different scenarios based on the data warehouse and validate them• output distribution and best option for user | <ul style="list-style-type: none">• Provide Parameters needed• Provide real world data | <ul style="list-style-type: none">• Text generated result for choosing between lease and buy and full analysis |
|--|--|---|---|--|

Agent



Context Aware Data Warehouse

```
    data_complete: bool
    purchase_price: float
    down_payment: float
    monthly_lease: float
    lease_mileage_allowance: int
    duration_buy_months: int
    duration_lease_months: int
    annual_mileage: int
estimated_maintenance_avg: float = 100.0
maintenance_std_dev: float = 3.0
overage_charge_per_mile: float = 1.5
```

Simulation Module and Optimization Engine

- **Stochastic Modeling:** Uses normal distributions to simulate variability in annual mileage and maintenance costs across 10,000 iterations.
- **Cost Calculation:** Computes total buying costs (price + maintenance) and leasing costs (payments + mileage overage fees) for each iteration.
- **Probability Analysis:** Returns average costs and the statistical probability that leasing is cheaper than buying based on the simulated distributions.

Interface and Result

The screenshot shows a dark-themed conversational interface. The user asks about buying or leasing, and the AI responds with a simulation based on specific parameters. The parameters are displayed as a JSON object, followed by a recommendation and a breakdown of why.

whats your answer buy or lease?

Okay, I've completed the simulation based on the following parameters:

```
{  
    "data_complete": true,  
    "purchase_price": 12000,  
    "down_payment": 2000,  
    "monthly_lease": 400,  
    "lease_mileage_allowance": 12000,  
    "duration_buy_months": 36,  
    "duration_lease_months": 36,  
    "annual_mileage": 12000,  
    "estimated_maintenance_avg": 100.0,  
    "maintenance_std_dev": 3.0,  
    "overage_charge_per_mile": 1.5  
}
```

Recommendation:

Based on these figures, I recommend you **lease** the vehicle.

Here's the breakdown of why:

- **Total Cost of Ownership (Buying):**
 - Purchase Price: \$12,000
 - Down Payment: \$2,000
 - Cost over 36 months (estimated maintenance): 4,320 (calculated based on 100/month overage charge)

Criticism and Problem

- Decision accuracy is highly correlated with a context-aware data warehouse.
- High prompt tuning is required to ensure proper output and answers at each step.
- Output format may sometimes be corrupted due to hallucinations.

**Thank you
for your
attention**