Technical Report

Causal Analysis and Interactive Reasoning over Conversational Data
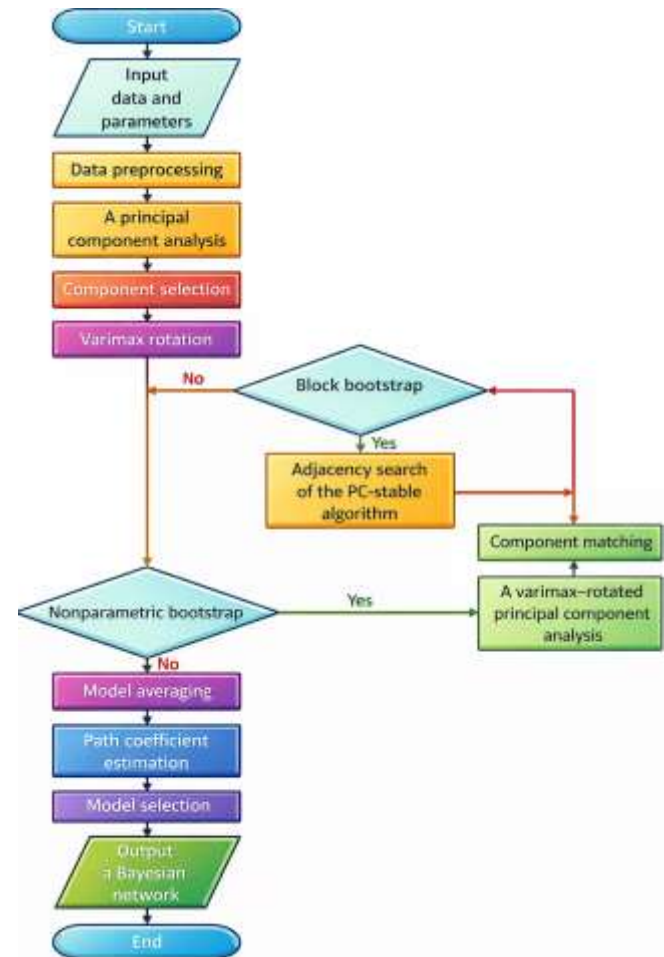
Task 1: Query-Driven Causal Explanation with Evidence

Objective:

Design a system that accepts a single natural-language analytical query related to a predefined outcome event and returns a causal explanation grounded in conversational evidence.

Approach:

- Identify relevant case IDs
- Generate follow-up events if required
- Iterate until no cases remain
- Produce evidence-based causal
- explanation

Task 1:Output

```
RESULT_SUMMARY TABLE
------------------------------------------------------------------------------------
Transcript          Confidence      Causes
------------------------------------------------------------------------------------
7034-5430-2980-54831.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
2801-6816-9124-13550.5              Repeated Failures
3883-8555-9747-57461.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
4967-8141-1813-86581.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
3631-7868-1079-28801.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
5405-1959-8150-26201.0              Repeated Failures, Explicit Escalation Request
6442-9317-2833-52631.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
4471-5440-7427-78351.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
6338-1986-7723-60701.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
2717-1088-7257-73701.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
9319-3940-9382-23871.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
4999-7266-1895-55831.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
3925-2095-7371-79011.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
8584-4627-1759-38461.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
8625-9811-3321-21631.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
3925-3887-6255-81711.0              Repeated Failures, Customer Frustration
3263-1585-8501-27011.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
7111-8235-8458-40311.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
9361-3226-5280-74681.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
3578-4645-2490-57521.0              Repeated Failures, Explicit Escalation Request, Customer Frustration
9036-1648-4300-25221.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
5186-2494-1700-66961.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
7888-5665-2083-76001.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
7552-6299-5982-66541.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
1388-4256-8564-55551.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
7946-2197-7898-40451.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
9295-9855-5231-50460.6              Customer Frustration
3528-5080-2778-77651.0              Customer Frustration, Explicit Escalation Request, Repeated Failures
```

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========== TASK-1 FINAL METRICS ==========

IDRecall (Evidence Accuracy): 95.00%
Faithfulness (Hallucination Control): 95.00%
Relevancy (Query Alignment): 96.77%


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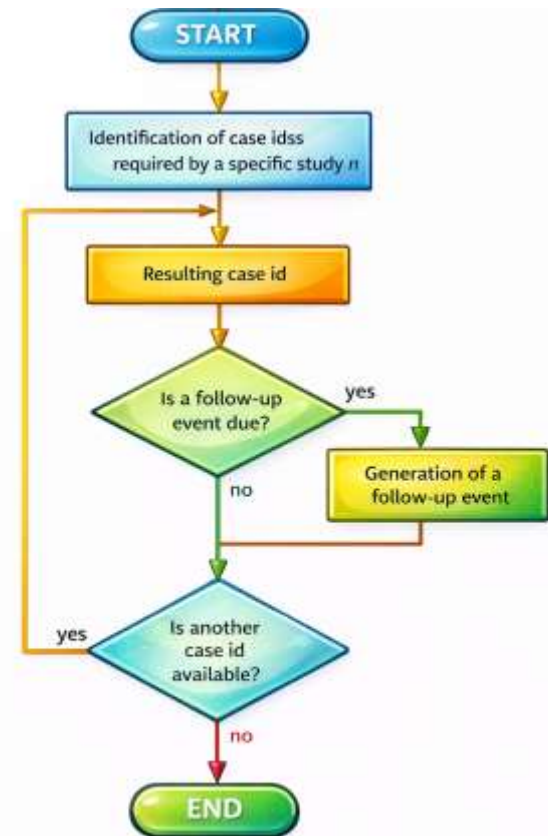
Task 2: Multi-Turn Context-Aware Query Handling

Objective:

Extend the Task 1 system to support multi-turn analytical interaction while preserving contextual consistency.

Approach:

- Data preprocessing and PCA
- Varimax rotation and component selection
- Bootstrap-based causal discovery
- Generate Bayesian network output

Task 2:Output

```
Turn 1
Query: customer reported fraud alert and card was cancelled
Retrieved Call ID: 3577-9057-2601-2106
Output: good afternoon, securebank customer service. how can i help you today? hi, i'm calling because i noticed some charges on my

Turn 2
Query: what was the amount of the fraudulent charge
Retrieved Call ID: 3577-9057-2601-2106
Output: how can i help you today? hi, i'm calling because i noticed some charges on my credit card that i didn't make. which charge

Turn 3
Query: where did the fraudulent transaction occur
Retrieved Call ID: 3577-9057-2601-2106
Output: how can i help you today? hi, i'm calling because i noticed some charges on my credit card that i didn't make. which charge

Turn 4
Query: did the customer say they have ever been to that location
Retrieved Call ID: 3577-9057-2601-2106
Output: good afternoon, securebank customer service. how can i help you today? hi, i'm calling because i noticed some charges on my

Turn 5
Query: what did the agent do immediately after confirming fraud
Retrieved Call ID: 3577-9057-2601-2106
Output: good afternoon, securebank customer service. how can i help you today? hi, i'm calling because i noticed some charges on my

Turn 6
Query: how long will the charge reversal take
Retrieved Call ID: 3577-9057-2601-2106
Output: how can i help you today? hi, i'm calling because i noticed some charges on my credit card that i didn't make. let's take a
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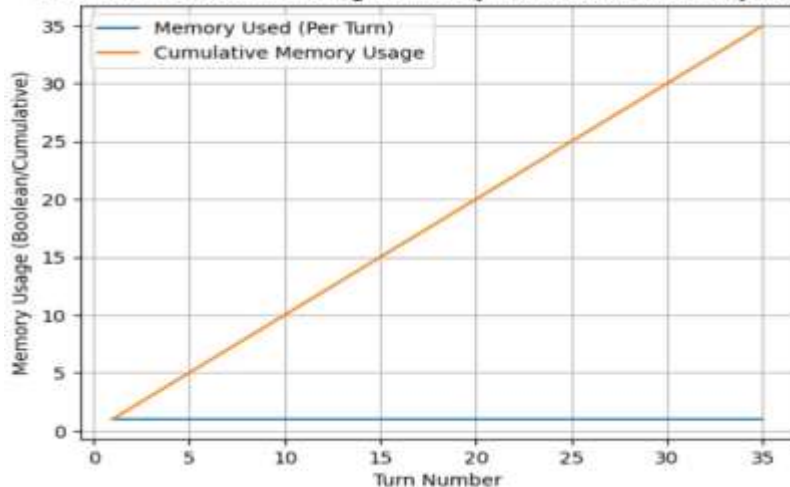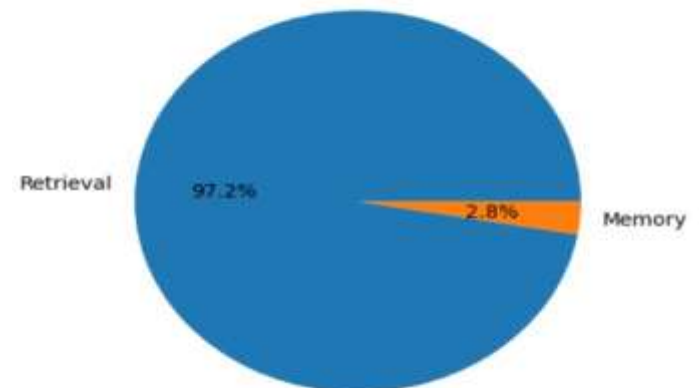

Multi-Turn Context Handling Summary (Retrieval vs Memory Reuse)

Proportion of Retrieval vs Memory Usage

Technical Outputs & Reproducibility

Outputs:

- Accuracy and evaluation summaries
- Causal explanation and Bayesian network
- IDRecall (Evidence Accuracy): 95.00%
- Faithfulness (Hallucination Control): 95.00%
- Relevancy (Query Alignment): 96.77%

Reproducibility:

- Deterministic execution
- requirements.txt for dependencies
- CODE.ipynb as source code