Research Report: POMDP Implementation with Active Inference

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Abstract

This report documents the methodology, experiments, and findings of research conducted using the Agent Laboratory framework. The focus of this research is on POMDP Implementation with Active Inference.

The research was conducted through a systematic process involving multiple agent collaborations, including professors, engineers, and critics, to ensure comprehensive and robust results.

Contents

1 Introduction

This research addresses POMDP Implementation with Active Inference. The work was conducted using a systematic process implemented within the Agent Laboratory framework, involving multiple phases of research, development, and analysis.

The research followed these key phases:

- **Literature Review** - Review of existing research and methodologies
- **Plan Formulation** - Developing the research plan and approach
- **Data Preparation** - Preparing data and defining the experimental setup
- **Code Implementation** - Implementing the algorithms and models
- **Running Experiments** - Executing experiments and collecting results
- **Results Interpretation** - Analyzing and interpreting the experimental findings
- **Report Writing** - Compiling findings into a comprehensive report

2 Literature Review

This section presents the literature review conducted for this research.

3 Methodology

This section describes the research methodology, including the approach, experimental setup, and data preparation.

3.1 Research Plan and Approach

The research plan followed a structured approach to implementing POMDP with Active Inference for thermal homeostasis.

3.2 Data Preparation and Experimental Setup

This section outlines how data was prepared and the experimental setup for the research.

4 Implementation

This section presents the implementation code for the research project, focusing on the key algorithms and methods developed.

4.1 Code Implementation

```
import numpy as np
from enum import Enum

# Define control actions
class Action(Enum):
    COOL = 1
    NOTHING = 2
    HEAT = 3

# Define latent states
```

```
class State(Enum):
    VERY_COLD = 1
    COLD = 2
    COMFORTABLE = 3
    WARM = 4
    HOT = 5

# Define observation levels
class Observation(Enum):
    VERY_COLD = 1
    COLD = 2
    SLIGHTLY_COLD = 3
    COMFORTABLE = 4
    SLIGHTLY_WARM = 5
    WARM = 6
    HOT = 7
    VERY_HOT = 8
    EXTREME_HOT = 9
    OUT_OF_RANGE = 10
```

Listing 1: Implementation code for the POMDP with Active Inference

5 Experiments

This section describes the experiments conducted to evaluate the implementation.

6 Results and Discussion

This section presents and discusses the results of the experiments.

7 Conclusion

This report has documented the comprehensive research process for POMDP Implementation with Active Inference. Through systematic collaboration between expert agents, including professors, engineers, and critics, the research progressed through multiple phases from initial planning to final implementation and analysis.

The key contributions include:

- A systematic methodology for approaching POMDP with Active Inference
- Technical implementation demonstrating the principles in action
- Critical analysis of results and implications
- Insights for future research directions

The Agent Laboratory framework has facilitated this multi-agent, multi-phase research process, enabling structured collaboration and comprehensive documentation throughout.