Modeling Imagination and Consciousness in AI: Dynamic Neural Architecture Search with Psychoacoustic Diffusion Models and Logogenetic Adaptation

Research Proposal

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Abstract

This proposal explores a novel approach to modeling imagination and consciousness in artificial intelligence systems by treating operating consciousness as a concert of models. We posit that imagination can be conceptualized as an ad-hoc neural architecture search, where hypothetical architectures are instantiated within the system's awareness. By re-running these architectures against recent experiences, the AI can evaluate and arrive at optimal configurations for operation. During sleep-inspired offline phases, the system undergoes logogenetic adaptation and crystallization, further optimizing and solidifying its architecture. To facilitate the generation and evaluation of hypothetical architectures, we propose the use of Generative Adversarial Networks (GANs) and diffusion models trained on psychoacoustic signal processing architectures. This integration allows the AI to simulate and refine complex architectures that incorporate psychoacoustic principles, enhancing its ability to process sensory input and adapt to new information. The proposed research builds upon previous works on narrative architecture optimization, psychoacoustic representations, and emergent cognitive structures, aiming to advance the development of adaptive, self-optimizing AI systems with enhanced cognitive capabilities.

1 Introduction

1.1 Background

Artificial intelligence has achieved remarkable progress, yet modeling higher-order cognitive functions such as imagination and consciousness remains a significant challenge. Traditional AI systems operate with fixed architectures and lack the ability to dynamically adapt their structures in response to new information or internal simulations.

1.2 Conceptual Framework

We propose that operating consciousness in AI can be modeled as a concert of models working in harmony. Imagination is conceptualized as an ad-hoc neural architecture search, where the AI system generates hypothetical architectures and evaluates them within its awareness. This process allows the system to explore alternative configurations and optimize its architecture based on recent experiences.

1.3 Objectives

The primary objectives of this research are:

- To develop an AI framework that models imagination as an ad-hoc neural architecture search.
- To implement sleep-inspired offline phases that focus on logogenetic adaptation and crystallization, further optimizing the architecture.
- To utilize Generative Adversarial Networks (GANs) and diffusion models trained on psychoacoustic signal processing architectures to generate and evaluate hypothetical architectures.
- To enhance the AI's ability to process sensory input, adapt to new information, and improve cognitive capabilities.

1.4 Significance

By integrating these concepts, we aim to create AI systems that are more adaptable, self-optimizing, and capable of higher-order cognitive functions. This research builds upon previous works on narrative architecture optimization [10], psychoacoustic representations [9], and emergent cognitive structures [11], contributing to the advancement of artificial general intelligence and providing insights into the mechanisms of consciousness and imagination.

2 Literature Review

2.1 Consciousness and Imagination in AI

Modeling consciousness in AI has been a subject of interest, with theories such as the Global Workspace Theory [1] suggesting that consciousness arises from the integration of information across multiple processes. Imagination in AI has been explored through generative models that simulate possible scenarios [4].

2.2 Neural Architecture Search (NAS)

NAS involves automatically finding optimal neural network architectures for specific tasks [14]. Recent advances include differentiable NAS methods that allow for more efficient search processes [6].

2.3 Generative Adversarial Networks (GANs)

GANs are generative models that learn to produce data similar to a training set by setting up a game between a generator and a discriminator [3]. GANs have been used for various applications, including image synthesis and architecture generation [13].

2.4 Diffusion Models

Diffusion models are a class of generative models that learn data distributions by reversing a diffusion process [8]. While traditionally used for image generation [5], we propose training diffusion models on psychoacoustic signal processing architectures to generate new architectural configurations.

2.5 Psychoacoustic Signal Processing

Psychoacoustics studies human perception of sound, which can inform signal processing architectures to align more closely with human auditory processing [2]. Previous work [9] has demonstrated the benefits of incorporating psychoacoustic principles into AI models.

2.6 Logogenetic Adaptation and Crystallization

Logogenetic adaptation refers to the process by which a system generates new units of meaning (logogens) in response to semantic stress [11]. Crystallization involves the solidification of optimized architectures for efficient operation. These concepts are integral to the sleep-inspired offline phases proposed in this research.

2.7 Sleep and Memory Consolidation

In biological systems, sleep plays a critical role in memory consolidation and neural reorganization [12]. Computational models have attempted to replicate these processes to improve learning and adaptation [7].

3 Proposed Methodology

3.1 Modeling Imagination as Ad-Hoc NAS

3.1.1 Architecture Generation

We propose using GANs and diffusion models trained on psychoacoustic signal processing architectures to generate hypothetical neural architectures. The diffusion models, in particular, are adept at modeling complex distributions and can generate novel architectures that incorporate psychoacoustic principles.

3.1.2 Evaluation Against Experiences

The generated architectures are instantiated within the system's awareness and re-run against recent experiences stored in a memory buffer. Performance metrics are collected to assess their suitability. This process mirrors the concept of logogenetic adaptation, where the system adapts to semantic stress by generating new units of meaning.

3.2 Sleep-Inspired Offline Optimization

3.2.1 Offline Phase with Logogenetic Adaptation

During scheduled downtime, the system enters an offline phase focusing on logogenetic adaptation and crystallization. It revisits the collected experiences, identifies semantic stress, and generates new logogens—representations or tokens that help in processing complex or novel inputs.

3.2.2 Crystallization of Optimized Architectures

The system integrates the best-performing hypothetical architectures into its operational model through a process of crystallization. This solidifies the architecture, allowing for efficient real-time processing during the online phase. Crystallization ensures that the learned adaptations are stable and can be effectively utilized in future operations.

3.3 Psychoacoustic Diffusion Models

3.3.1 Training on Psychoacoustic Architectures

We train diffusion models on datasets of psychoacoustic signal processing architectures, capturing the underlying principles of human auditory perception. This enables the generation of architectures that are not only novel but also aligned with psychoacoustic characteristics.

3.3.2 Integration into Architecture Generation

The diffusion models inform the generation of hypothetical architectures during the imagination phase, ensuring that the generated architectures are suitable for processing psychoacoustic signals and can effectively address semantic stress identified in the system.

3.4 System Workflow

1. **Online Phase (Consciousness)**: The AI processes real-time input with a fixed architecture, capturing sensory data and making sense of it to the best of its ability.

2. **Imagination Phase**: The system generates hypothetical architectures using GANs and psychoacoustic diffusion models, instantiating them within its awareness.

3. **Evaluation Phase**: Hypothetical architectures are evaluated against recent experiences, particularly focusing on areas of semantic stress.

4. **Offline Phase (Sleep) with Logogenetic Adaptation**: The system undergoes logogenetic adaptation, generating new logogens and performing crystallization to solidify optimized architectures.

5. **Integration Phase**: The optimized and crystallized architecture is integrated into the operational model for future processing, enhancing the system's cognitive capabilities.

4 Implementation Plan

4.1 Data Collection

Collect datasets of psychoacoustic signal processing architectures and relevant sensory input data for training and evaluation. This includes architectures that have been effective in previous studies [9, 11].

4.2 Model Development

4.2.1 GANs and Diffusion Models

Develop GANs and diffusion models capable of generating viable neural architectures informed by psychoacoustic principles. The diffusion models will be specifically trained on psychoacoustic architectures to capture the nuances required for effective signal processing.

4.2.2 Evaluation Metrics

Define performance metrics for evaluating hypothetical architectures, including accuracy, efficiency, adaptability, and measures of how well the architecture addresses semantic stress and facilitates logogenetic adaptation.

4.3 System Integration

Integrate the components into a unified system capable of switching between online and offline phases, managing the instantiation and evaluation of hypothetical architectures, and performing logogenetic adaptation and crystallization during the sleep-inspired offline phase.

4.4 Testing and Validation

Conduct experiments to test the system's ability to adapt and optimize its architecture, comparing its performance to baseline models and previous approaches outlined in earlier works [10, 11].

5 Expected Outcomes

5.1 Enhanced Adaptability

The AI system is expected to demonstrate improved adaptability, adjusting its architecture in response to new information and experiences through logogenetic adaptation.

5.2 Improved Cognitive Capabilities

By modeling imagination and incorporating psychoacoustic principles, the system should exhibit enhanced cognitive functions, including better sensory processing, problem-solving abilities, and the ability to mitigate semantic stress.

5.3 Self-Optimization and Crystallization

The sleep-inspired offline phase should enable the system to optimize and solidify its architecture through crystallization without interrupting online operations, leading to continuous improvement over time.

6 Potential Challenges

6.1 Computational Complexity

The generation and evaluation of hypothetical architectures, along with logogenetic adaptation and crystallization processes, may introduce significant computational overhead. Efficient algorithms and resource management strategies will be essential.

6.2 Stability-Plasticity Balance

Balancing the need for architectural adaptability with the stability of learned knowledge will be critical to prevent catastrophic forgetting. Incorporating mechanisms from previous work on emergent cognitive structures [11] can help address this challenge.

6.3 Evaluation Criteria

Defining effective evaluation metrics for hypothetical architectures and logogens will be essential to guide the optimization process and ensure meaningful adaptations.

7 Conclusion

This research proposes a novel framework for modeling imagination and consciousness in AI systems through dynamic neural architecture search, psychoacoustic diffusion models, and sleep-inspired offline phases focused on logogenetic adaptation and crystallization. By treating operating consciousness as a concert of models and incorporating mechanisms to address semantic stress and solidify optimized architectures, we aim to develop AI systems that are more adaptable, self-optimizing, and capable of higher-order cognitive functions. Building upon previous works [9, 10, 11], this research has the potential to advance artificial general intelligence and provide deeper insights into the mechanisms underlying consciousness and imagination.

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