

# Exploring the Cognitive Bio-plausibility of Computational Neuroscience Models:

## *A Review of Bio-circuit and Machine Learning Computational Neuroscience Models Compared to the Human Brain*

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### Abstract

Despite advances in neuroscience, the exact relationship between the brain and cognition remains unknown. Researchers use bio-circuit and machine learning models to understand pieces of cognition, but each type of model possesses limitations. This project reviews the benefits and limitations of both model types and aims to answer the question of how they compare in capturing human cognition. The end-goal is to create an accurate model of human cognition that is bio-plausible, accounts for cellular and synaptic activity, contributes to a specific neurological or psychological function, and is not in violation of any substantiated principles.

### Introduction

Though we have made theoretical and technological advances in neuroscience, the exact relationship between the biological hardware of the brain and conscious cognition has yet to be discovered. We understand the brain's hardware is at a biophysical level and how neurons communicate, but each of the individual complexities of how those pieces interact to give rise to a cognitive experience remains unknown.

So far, researchers have developed modern bio-circuit models that capture and record different aspects of the human brain, such as the spiking in individual neurons, and more complicated models that capture navigational processes such as ring attractor networks. These models predict lab measurements well, but they are often less useful for performing cognitive tasks than current machine learning approaches are. However, machine learning approaches are often missing a human element or understanding which may make them act in unpredictable or inhuman ways despite their high performance.

To understand cognition, it is important to understand these two types of models (bio-circuit and machine learning) and their capabilities. This project reviews the benefits and limitations of bio-circuit models and machine learning models, and how their functions relate to human cognition. To do so, we must understand and familiarize ourselves with the types of models, their primary functions, and their limitations.