

Survey on Computational Frontiers

December 20, 2024

1. Introduction

Advancements in computational technology have historically driven significant scientific progress and improved quality of life. Key milestones include the transistor, personal computers, mobile phones, and visual displays (VR, XR). Brain-computer interfaces (BCIs) are emerging as a new frontier, particularly in medicine, and are poised to become integral to consumer products following smart visual displays.

Another frontier involves programming the entire body, potentially starting with sensory organs like eyes and ears, and extending to the nervous system. This could lead to systematic programming of biological systems, enabling interconnected networks and new communication methods. This paper focuses on computational frontiers with significant medical and biological implications, excluding new hardware or programming paradigms.

2. Writing Memories and Thoughts with BCIs

BCIs have demonstrated the ability to decode brain activity and reconstruct visual input, suggesting that visualizations without visual stimuli can also be decoded. Current capabilities include speech reconstruction and basic cursor control. Reading abstract thoughts and visualizations could introduce new input/output modalities for BCIs. To surpass natural abilities, BCIs must develop effective write operations to the brain. Beyond sending signals or audio, a passive memory writing system could enhance mental faculties, enabling the writing of new reasoning abilities and abstract thoughts directly to the brain.

3. Programming Multicellular Organisms

Programming entire organisms represents a significant computational frontier. Due to regulatory and safety concerns, initial efforts will likely focus on existing animals as proof of concept. A programmable interface for genetic programming could enable the design of new organisms and medical advancements, such as in-vivo reprogramming of tissues, organs, and other biological structures.

References

4.1 Types of Tissues – Anatomy & Physiology:

<https://open.oregonstate.education/aandp/chapter/4-1-types-of-tissues/>