Survey on Computational Frontiers

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 (XR). Brain-computer interfaces (BCIs) are emerging as a new frontier, particularly in medicine, and are poised to become integral to consumer products. Another frontier involves executing discrete programs within the body. This could allow for systematic programming of biological systems, enabling interconnected networks and new communication methods. This paper focuses on computational technologies with significant medical and biological implications, excluding new hardware or programming paradigms.

Writing Memories and Thoughts with BCIs

Given that BCIs have demonstrated the ability to decode brain activity and reconstruct visual input [2-4], then perhaps visualizations without visual stimuli can also be decoded. Current capabilities include speech reconstruction [1] and basic cursor control [5-7]. 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.

Programming Within Multicellular Organisms

Programming within organisms represents a significant computational frontier, but there are regulatory and safety concerns. A programmable interface for cellular programming could enable scientific advancements, such as in vivo programming of tissues, organs, and other biological structures.

References:

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