Brain-CA Technologies

Casting off the Old Guard

Achieving Superior A.I. Performance through Simplification







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What if we could cut A.I. Energy costs by 99%?

Basic learning task using 99% fewer transistors. Savings: Energy, Size, Cost.



Agenda

- Current LLM and GNN challenges and the inherent limitations of Von Neumann architecture.
- BRAIN-CA Physical Architecture
 using Cellular Automata for simplicity, scalability and
 lower power requirements.
- BRAIN-CA Logical Architecture using simple bit manipulations and no CPU.



The Legacy of Von Neumann Architecture







Cellular Automata (CA)

Grid of cells, with

- State (memory)
- Rules (logic)

Rules for State Management



Classic example Conway's Game of Life



The BRAIN-CA[™] Physical Architecture



Let's look at seven of them.



The BRAIN-CA™ Physical Architecture

Cells' inputs align with neighbors' outputs.



Primary paths route through cell.



The BRAIN-CA™ Physical Architecture

Logic facilitates passing values at oblique angles.



Cells consist of six identical equilateral triangles.



The BRAIN-CA[™] Physical Architecture

Designed for Simplicity and Massive Parallelism.



The BRAIN-CA[™] Logical Architecture





Dashboard







BRAIN-CA in action





Inputs initiate communication waves





Communication System



Recurring observations solidify relationship





Communication System & Memory System









Pie Chart Using Counters

Gray

Input





Using Counters Showing Powers of Two





Cincinnati Algorithm & BRAIN-CA[™] Estimator





Cincinnati Algorithm & BRAIN-CA[™] Estimator





Fast connections for strong relationships





Connection System



Prediction from relationships & connections





Memory System



Offset pulses are accommodated – Training





Memory System



Offset pulses are accommodated – Inference





Memory System



Multi-Bit finds complex relationships



Multi-Bit Technology

addresses complex relationships without the need for hidden layers.





Tried and Tested	Bold and Innovative
Von Neumann architecture: separate memory and compute	BRAIN-CA [™] Cellular Automata architecture: embedded memory with very simple compute (logic)
Neural networks: weight and bias calculations, back propagation	Binary decomposition: simple correlation table lookups, The Cincinnati Algorithm
Highly complex, hot systems: focus on maximizing FLOPS	Simple systems with lower energy costs: focus on minimizing CA System complexity
Learning through complex calculus	Learning by associating observations
Absolute memory addressing	Relative cell addressing
Rigid node connections	Wave propagation and dynamic connections
Floating point representation	Bit, integer, and BRAIN-CA™ Estimator representation
Floating point math operations (add, subtract, multiply, divide, exponentiate, log, square root, trigonometric, etc.)	Logic only (compare, invert, And, Or, Not, increment, decrement)

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Arrange a meeting with us during ISCA! brain-ca.com/ISCA

