

Micro-Swarm & MycoDB

When Data Comes Alive



Emergence from local rules. A biologically inspired Artificial Life System.

Beyond Backpropagation: The 'Glass Box' Philosophy

The Black Box (Neural Networks)

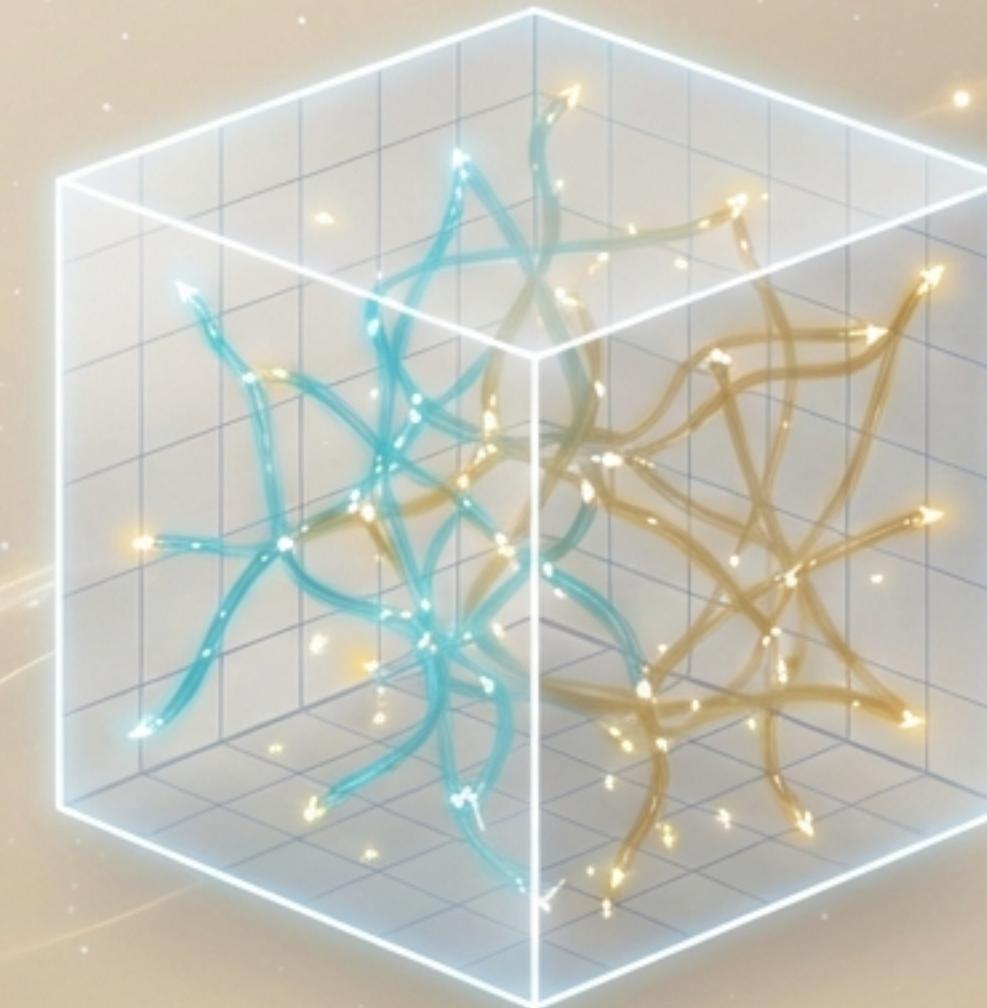


Global Optimization

→ Backpropagation

Opaque Decision Making

The Glass Box (Micro-Swarm)



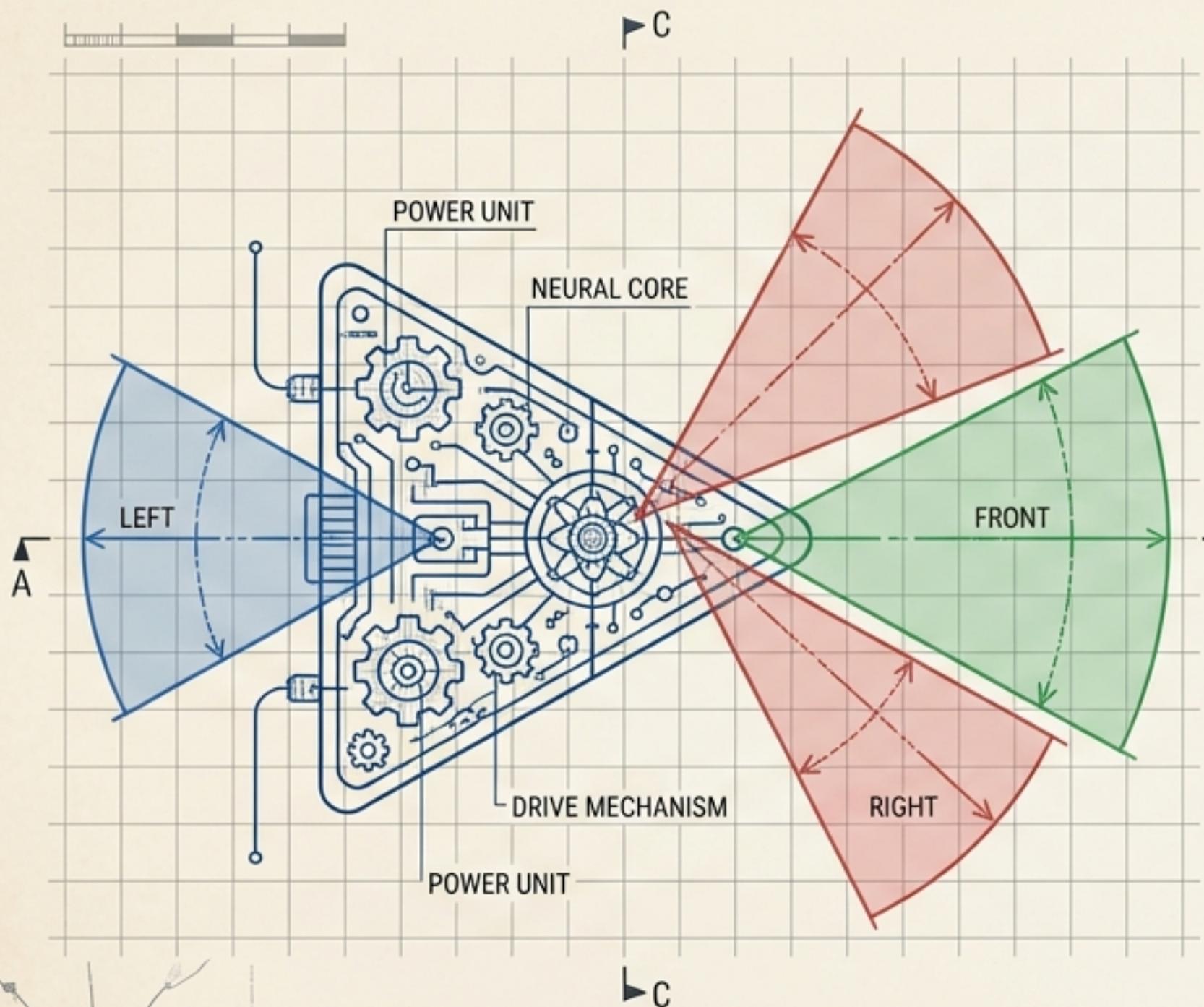
Local Rules

No Global Awareness

Mechanistic Transparency

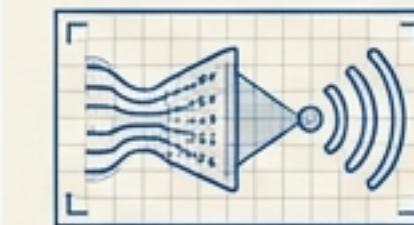
Global order arises from local interactions without a central plan.

The Collective: Local Actors, Global Impact

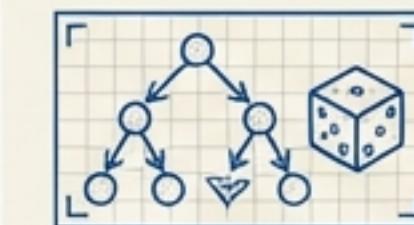


```
STRUCT AGENT_STATE {  
    float position[2];  
    float energy;  
    float genome[128]; // Strategy Parameters  
}
```

Local Loop



Sense: Sample local gradients (L/F/R).



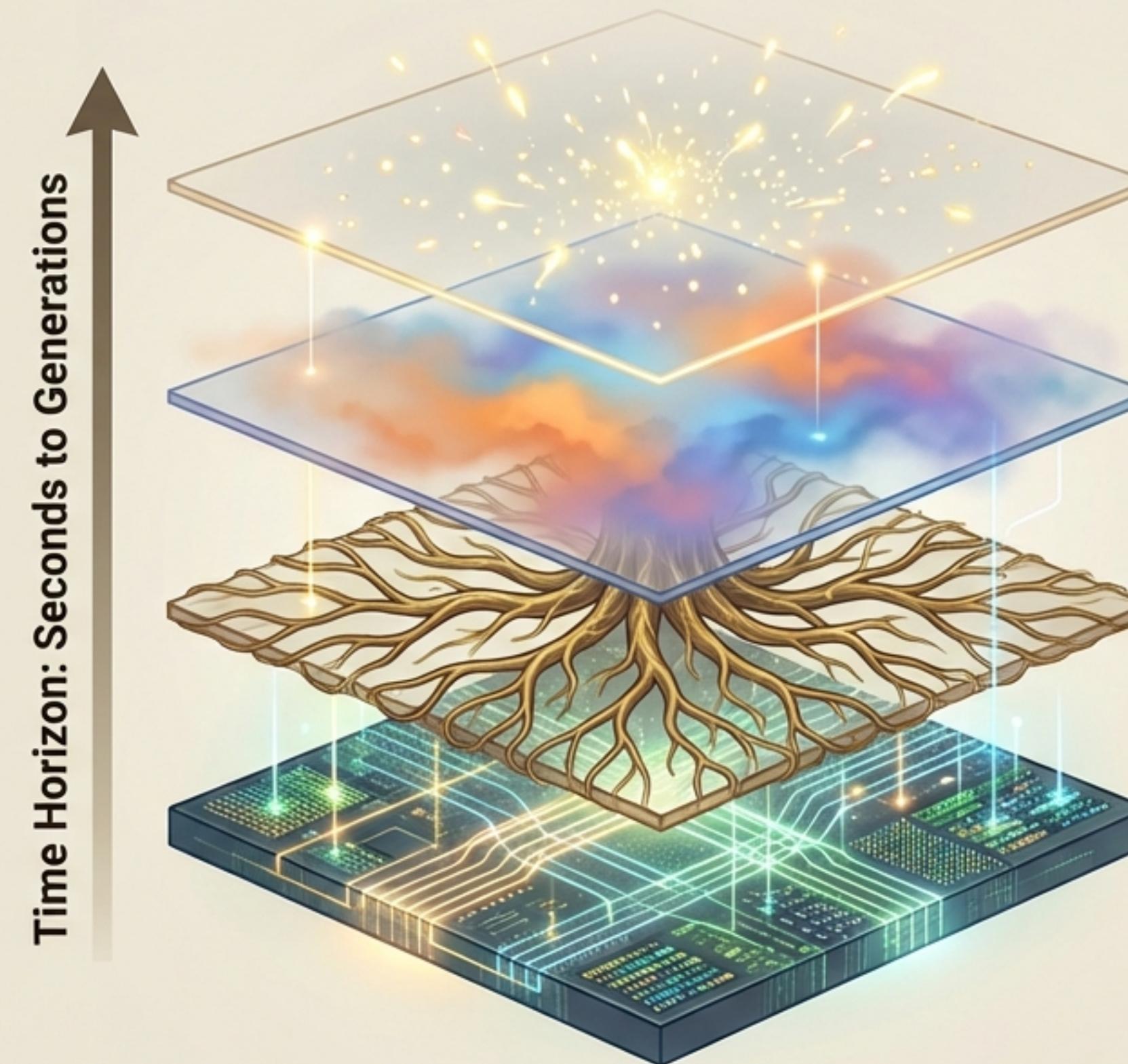
Act: Stochastic choice based on sensor weights.



Interact: Consume resources, emit pheromones.

Constraint: Agents possess ZERO global awareness.
They only see their immediate grid neighborhood.

Intelligence as Layered Memory



Molecules (Reaction)
Short-term. Highly volatile.

Pheromones (Communication)
Mid-term. Diffusive fields.

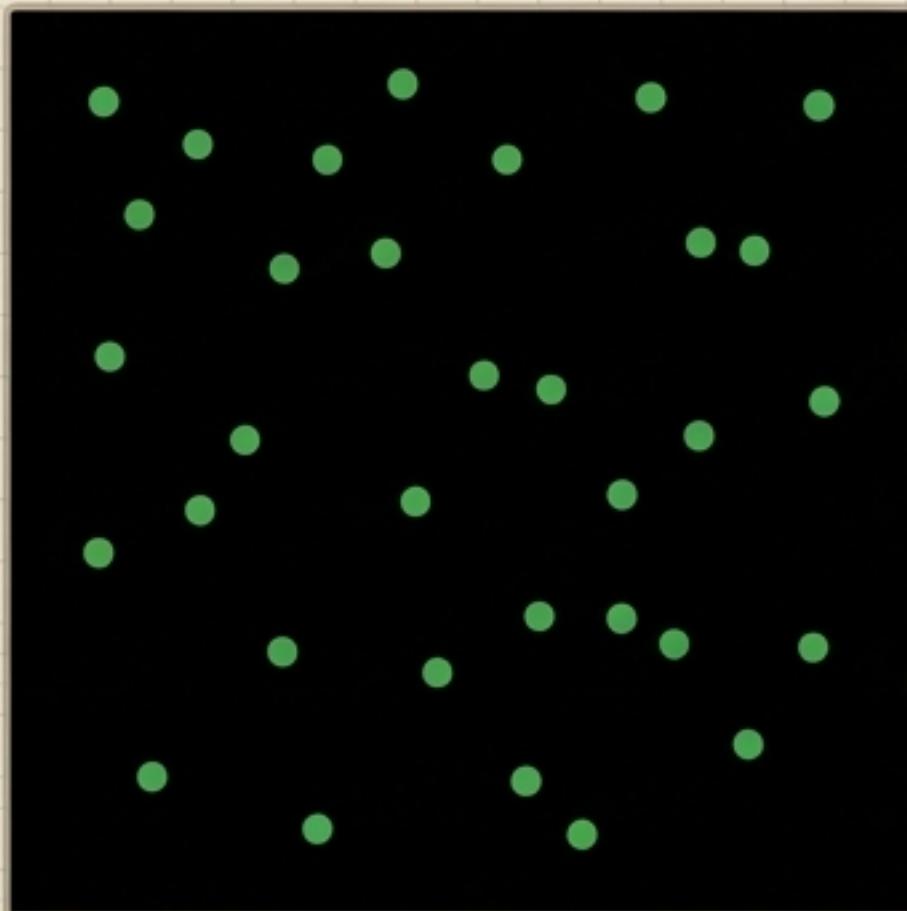
Mycelium (Structure)
Long-term. Structural memory
of sustained activity.

DNA (Strategy)
Persistent. Evolutionary
parameter vectors.

From Chaos to Order: Emergence in Action

Step 0

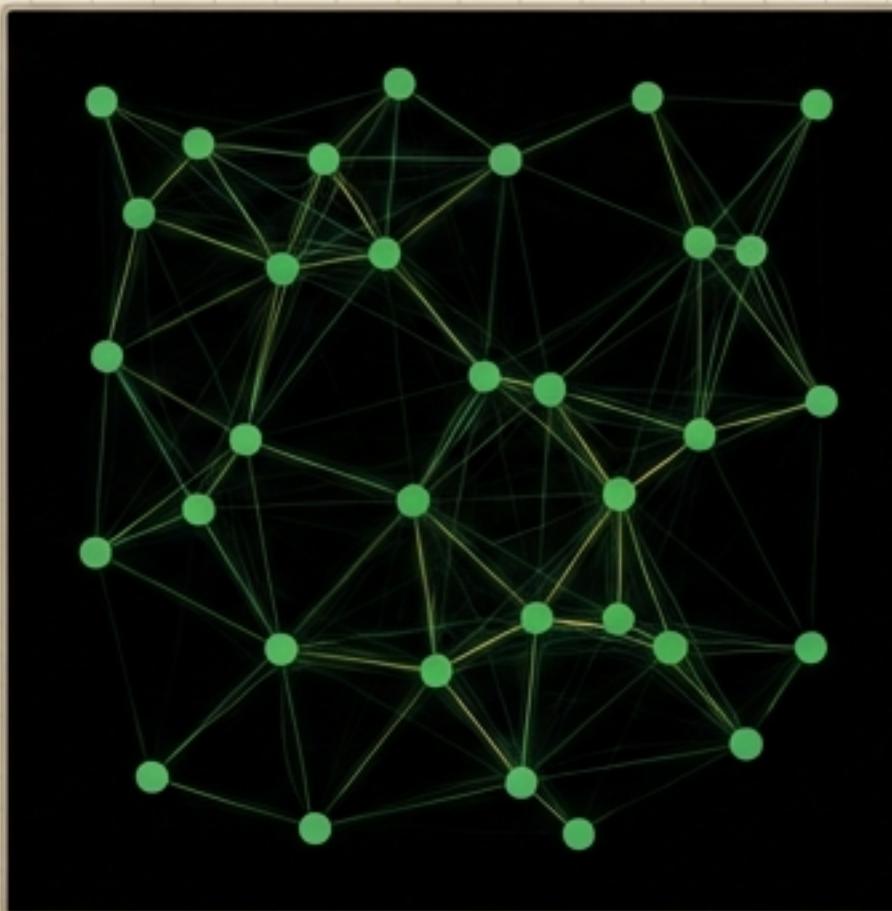
Random Distribution



mycel_nonzero_ratio: 0.0000

Step 50

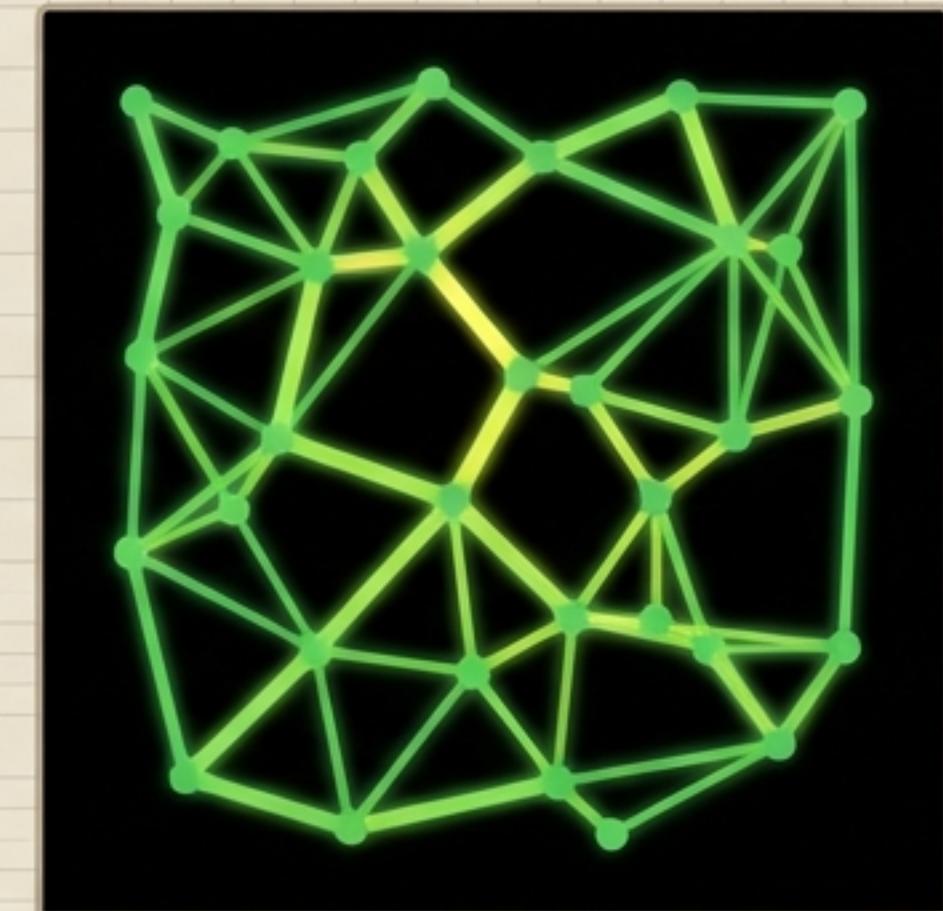
Early Connections



mycel_nonzero_ratio: 0.5417

Step 450

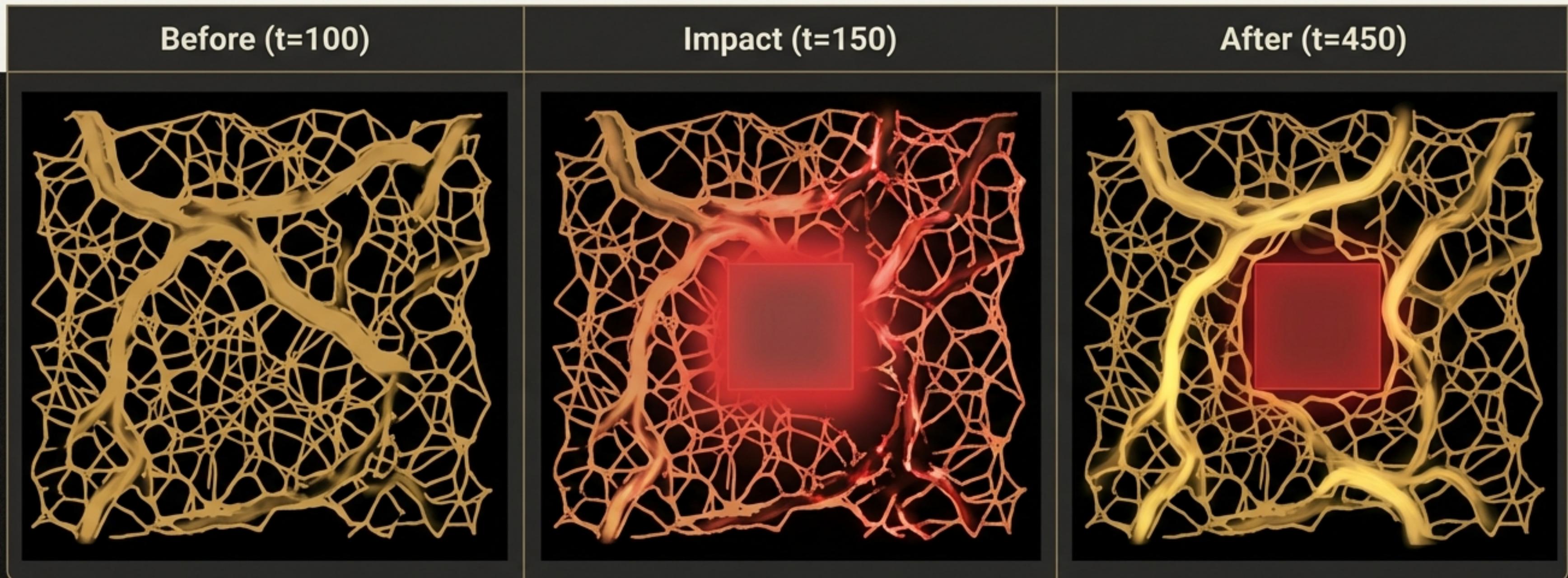
Stable Supply Network



mycel_nonzero_ratio: 1.0000

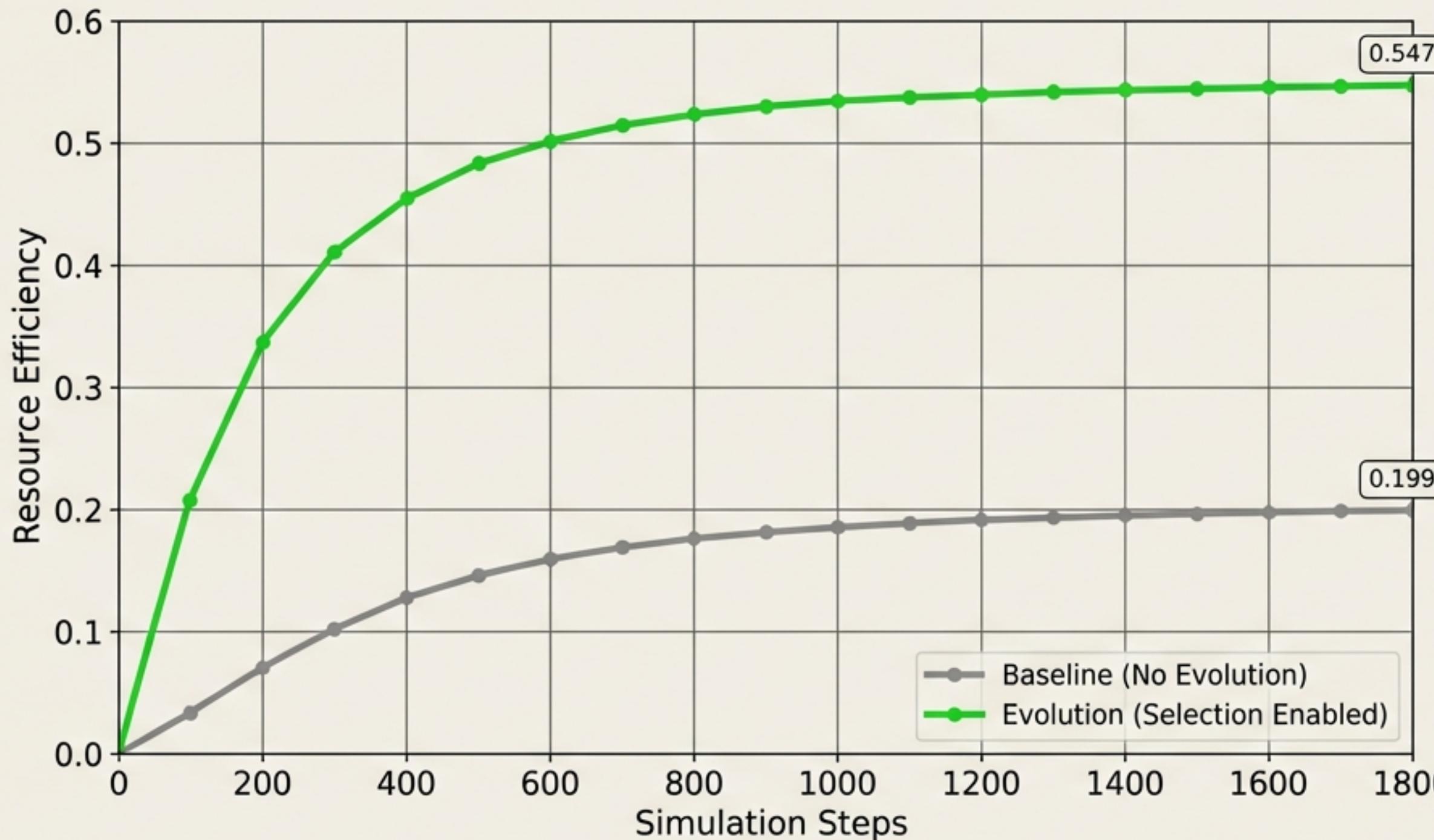
Metric: mycel_nonzero_ratio rises from 0.0 to 1.0

Resilience: The ‘Wound Healing’ Stress Test



The system dynamically routes around damage without retraining.

Evolution: Optimization through Selection



Mechanism

High-energy agents contribute genomes to a global pool.

Low-energy agents are re-initialized from this pool.

Sustainable strategies emerge over generations.

MycoDB: Organic Spatial Storage



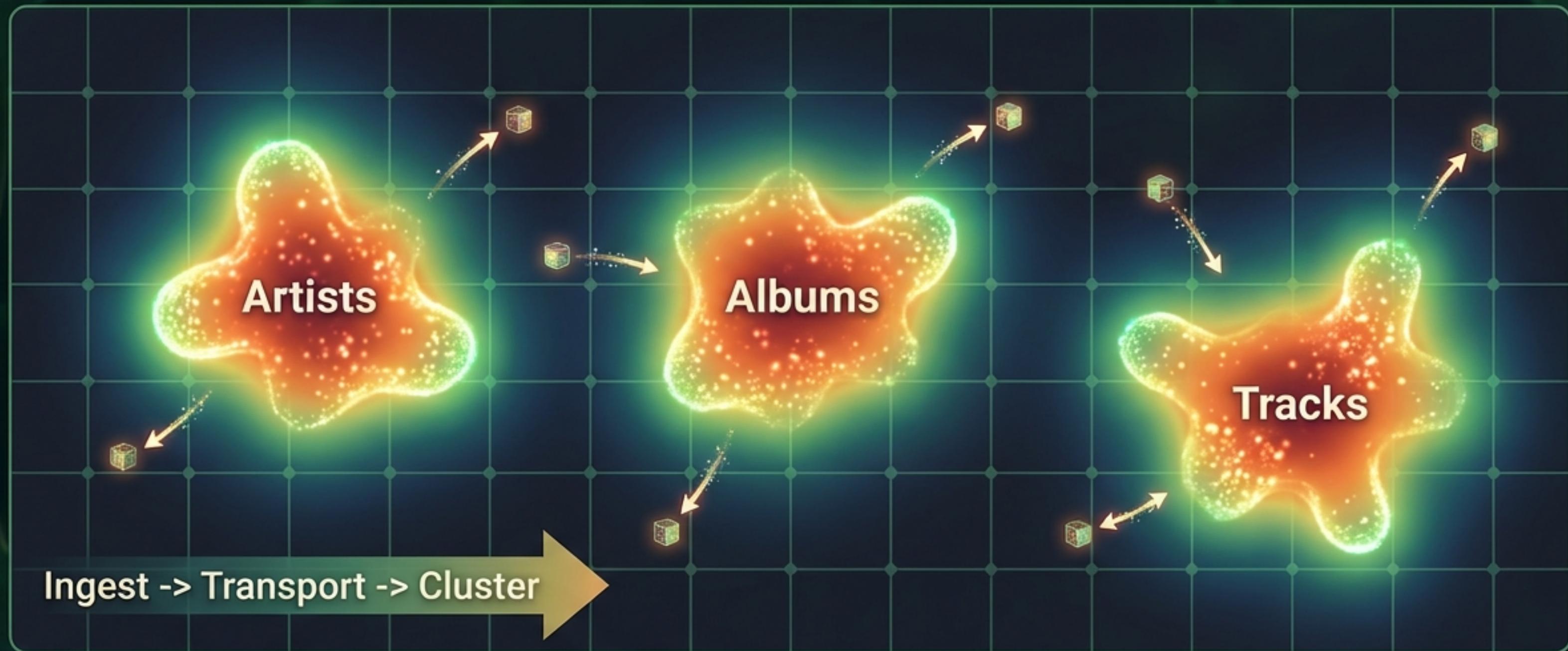
Rigid SQL Structure

Fluid Data Organism

Metaphor Shift

- SQL Row → Physical Payload (Object in 2D Space)
- Table ID → Pheromone Signature (Unique Scent)
- Foreign Key → Gravitational Attraction (Biological Imperative)

Biological Indexing: The Carrier Agents



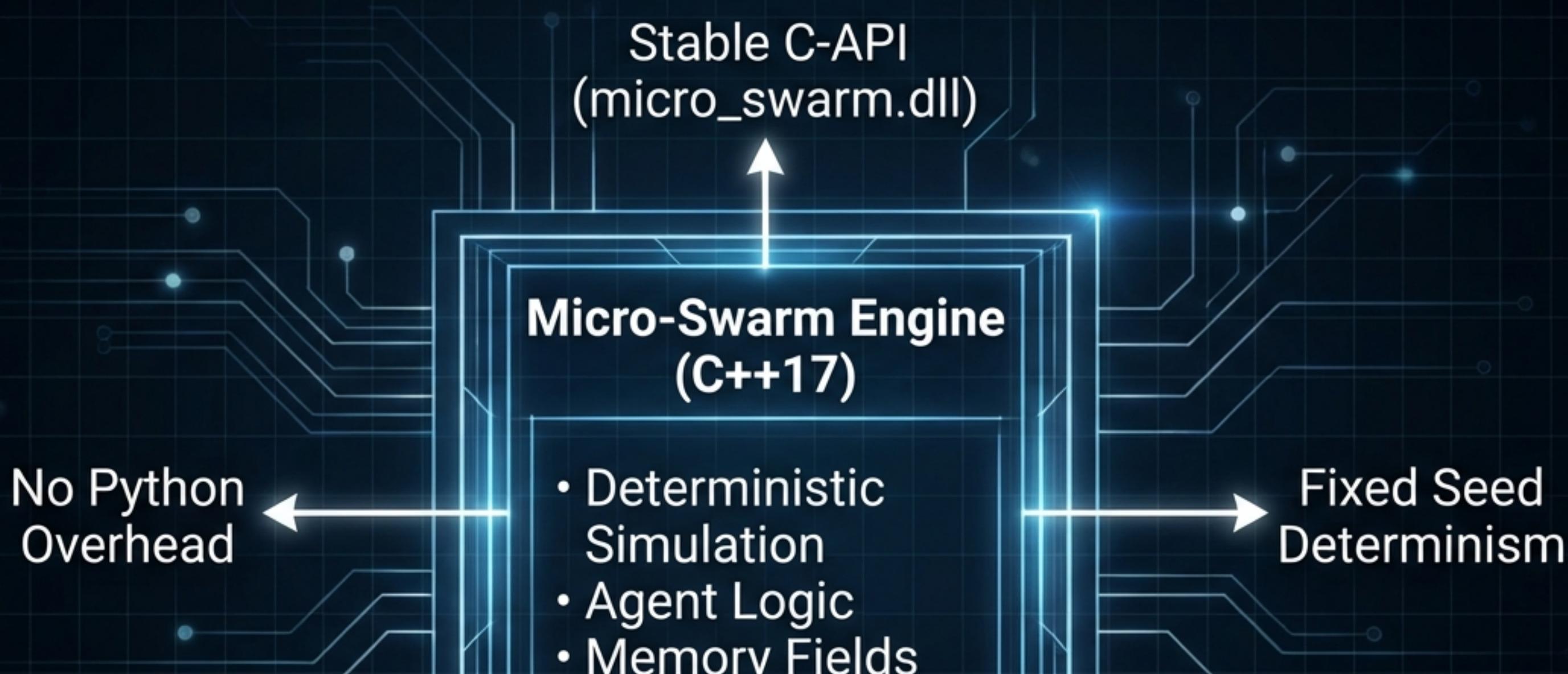
Emergent Clustering: Related data physically congregates without manual indexing.

Spatial SQL: A New Query Paradigm

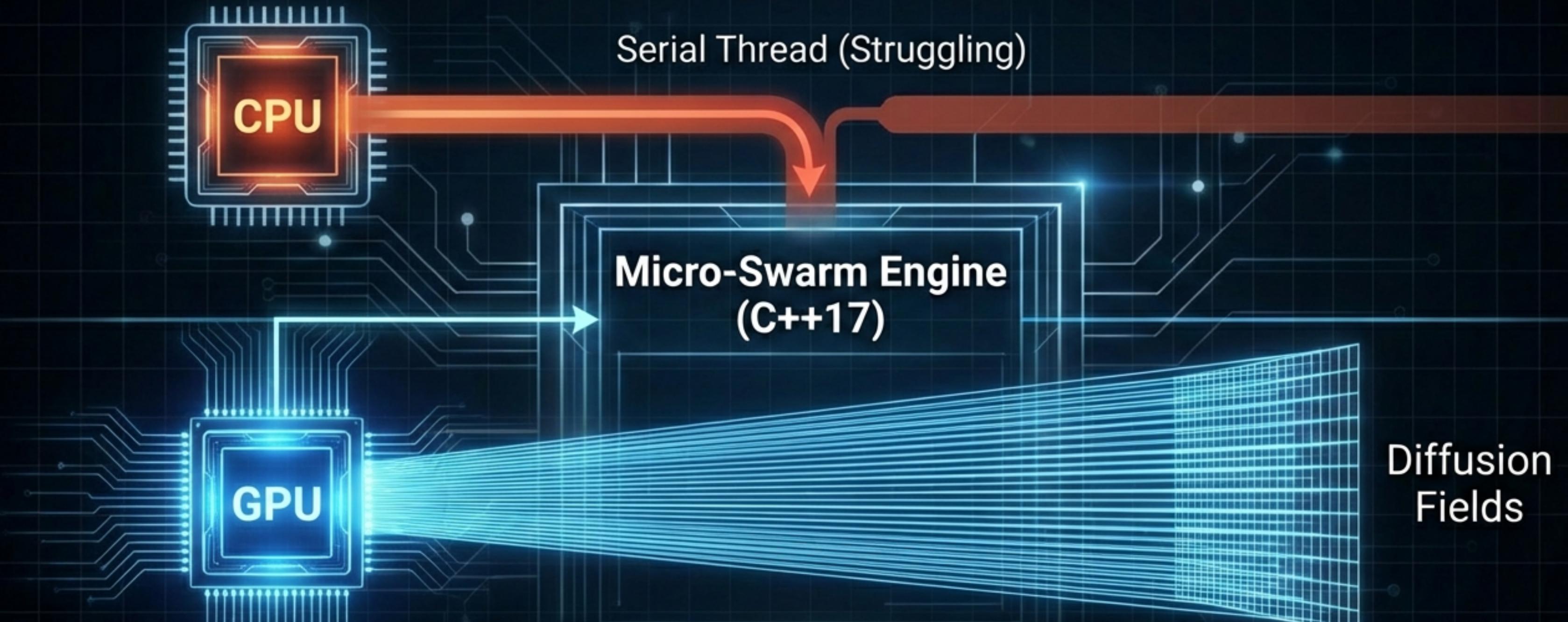


$O(1)$ complexity for related data. Instead of scanning the whole table, the query head jumps to a physical location and scans the neighborhood.

The Architecture: High-Performance C++ Core



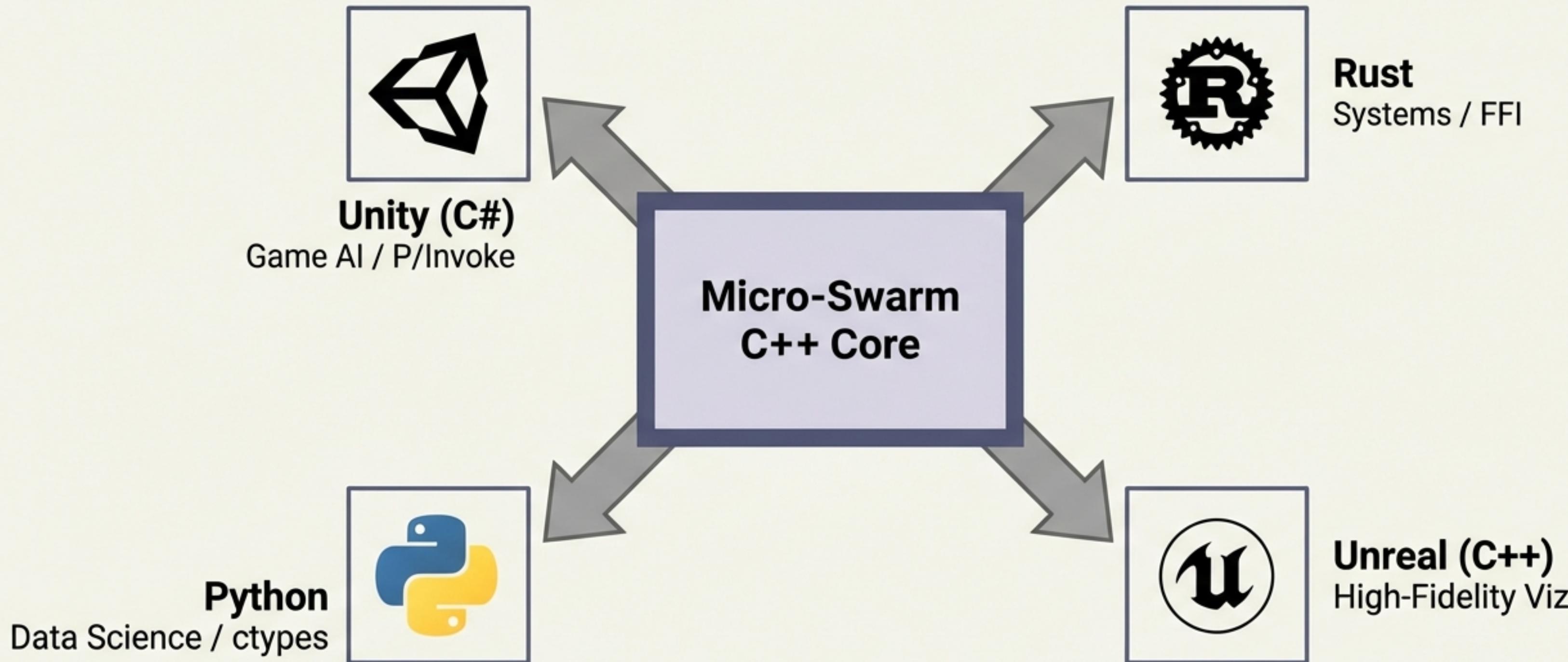
Massively Parallelism via OpenCL



GPU Offloading for Diffusion Fields

Pheromones, Molecules, and Mycelium updates run on the GPU.
Thousands of diffusion steps per second.

The Integration Ecosystem



An Engine for Experimentation. Embeddable anywhere via C-API.

Applications Beyond Storage

Game AI



Simulation



Visualization



A Database You Can Watch Thinking



Emergence replaces rigid optimization.

Glass Box transparency replaces Black Box opacity.

Data organizes itself organically.