R-DKE v2.0 — Physarum-Inspired Recursive Deep Knowledge Engine
A biologically-inspired architecture for continuous self-evolving AI knowledge systems

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1. Abstract

Modern AI systems remain primarily **reactive** — they generate answers when asked. R-DKE (Recursive Deep Knowledge Engine) introduced a forward-learning concept where AI continuously compresses knowledge, builds a truth graph, questions uncertainty, and synthesizes verified answers.

This v2.0 extension draws inspiration from *Physarum polycephalum* (slime mold), an organism capable of distributed computation, optimal path-finding, and dynamic resource allocation without centralized control.

We propose a **Physarum-Inspired Reasoning Loop** inside R-DKE, where:

- Uncertainty = "nutrient"
- Competing reasoning paths grow/decay like slime-mold veins
- Strongest/verified paths reinforce knowledge graph edges
- Incorrect/unproductive paths are pruned naturally

This allows knowledge to self-organize toward truth-seeking efficiency — a living, adaptive cognitive substrate.

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2. Background: R-DKE Core Loop (v1)

Stage	Description
Information Intake	World → structured knowledge
Semantic Compression	Convert data → knowledge atoms
Truth Graph	Verified, weighted relationships
Self-Questioning	Uncertainty triggers recursive inquiry
Instant Verified Answers	Answers + evidence trace

R-DKE reframes AI from **search → think** to **think continuously → answer instantly**.

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3. Why Physarum?

Physarum polycephalum demonstrates:

- Distributed problem solving
- Emergent optimal routing
- Memory without neurons
- Adaptive network reconfiguration
- Efficient exploration/exploitation balance

It has solved:

- Shortest path problems
- Network optimization
- Spanning tree formation

We borrow its **nutrient-driven reinforcement model**.

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4. R-DKE v2.0 — Physarum Loop

Key Idea

Knowledge edges "pulse" like slime-mold veins.

- Higher confidence edges thicken
- Low-evidence edges shrink
- Uncertainty flows toward unresolved nodes
- System "grows" explanations

AI no longer selects answers. It *grows* them.

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5. Algorithmic Sketch

```
for each knowledge_node:
    uncertainty = measure_uncertainty(node)

    if uncertainty > threshold:
        inject("nutrient") into node  // triggers expansion
```

```
for each connected path:
    propagate_signal(path, strength = truth_weight)

    if path solves contradiction or explains uncertainty:
        reinforce(path)
    else:
        decay(path)
```

Emergent behavior:
Truth pathways strengthen → hallucinations decay.

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6. Expected Capabilities

Capability	Description
Self-stabilizing truth networks	Reduces hallucination risk
Distributed reasoning	No single failure point
Adaptive curiosity	System asks "where do I grow next?"
Evidence-driven learning	Strong ideas survive, weak ones fade
Long-term emergent intelligence	Memory-like graph evolution

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7. Testing & Validation

To validate this concept, future experiments can simulate:

- Graph-based nutrient flow on knowledge graphs
- Reinforcement based on truth score
- Path suppression for hallucination tendencies
- Energy-budget-based reasoning (like slime mold)

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8. Conclusion

R-DKE v2.0 proposes a new research direction:
AI that organizes knowledge like biology — efficient, distributed, self-improving.

Instead of *querying knowledge*, the system **evolves it**.

This may serve as a stepping stone toward autonomous reasoning architectures beyond transformers and classical search.

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9. Citations / Inspirations

- Nakagaki T. et al. — *Maze solving by slime mold*
- Tero A. et al. — *Rules for biologically inspired network design*
- Friston K. — Free-energy principle (adaptive systems)
- Early AGI architectures & R-DKE v1 (Gherasim, 2025)

Gherasim, M. (2025). *R-DKE v2.0: Physarum-Inspired Recursive Deep Knowledge Engine.*