BioR5: Biological Reasoning System

A Three-Layer Tool-Calling Architecture

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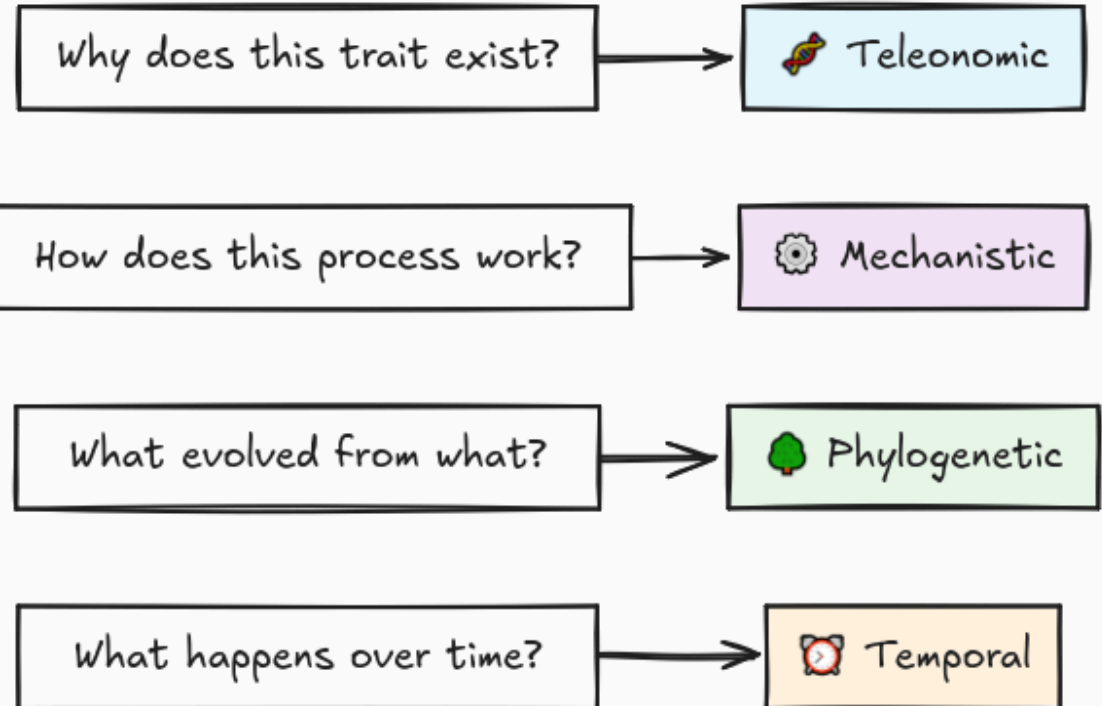University of Chicago

The Problem

The challenge: Biologists use different **reasoning modes**

- **"Why does this trait exist?"** → Teleonomic

- **"How does this work?"** → Mechanistic

Current AI: One model, one approach
Biology: Eleven distinct reasoning modes

| Why does this trait exist? | → | 🧬 Teleonomic |
How does this process work?	→	⚙️ Mechanistic
What evolved from what?	→	🌳 Phylogenetic
What happens over time?	→	⏰ Temporal

Our Solution

BioR5: Different questions → Different approaches

Current AI: "More data + bigger model"

Example: "How does insulin regulate glucose?"

- Needs biochemical pathways + causal networks
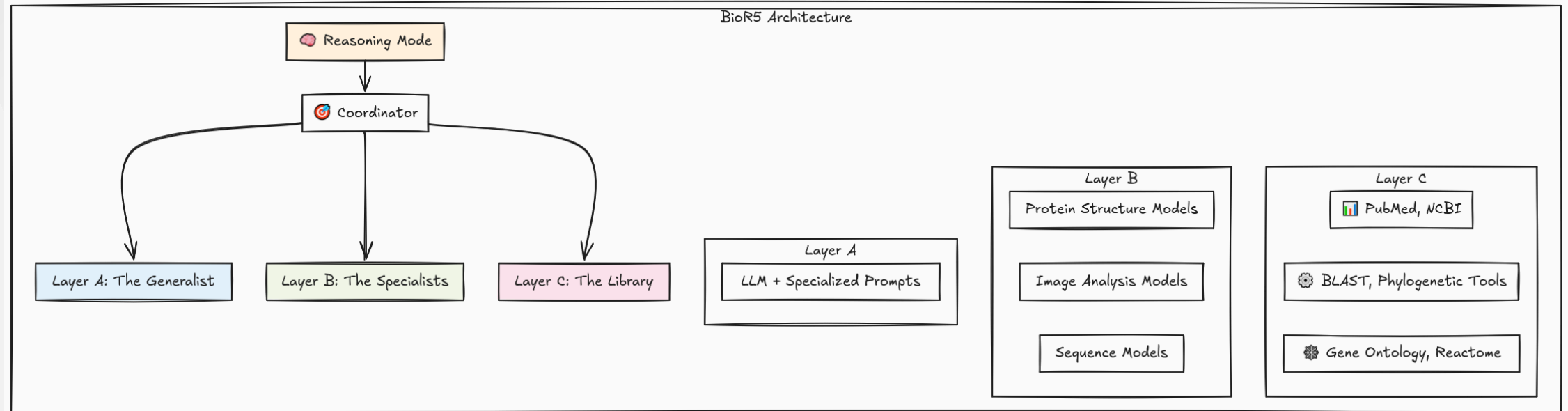- NOT just correlation in expression data
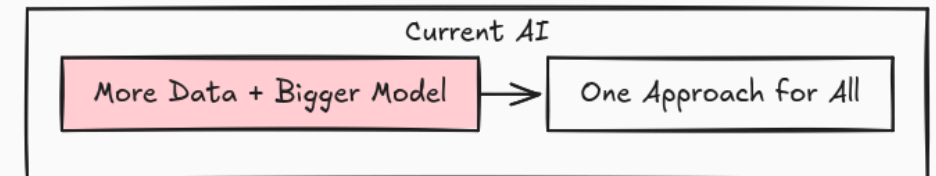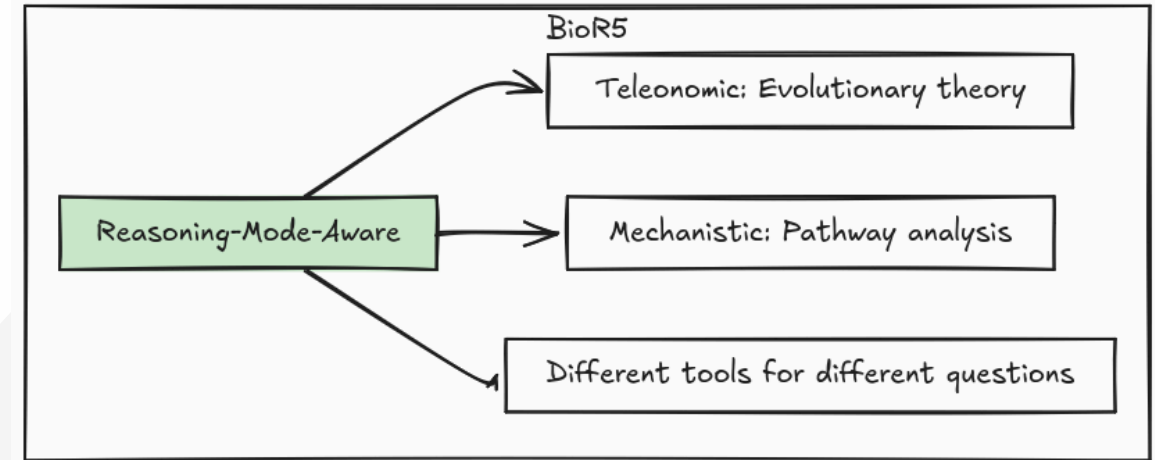
Three-Layer Architecture

BioR5: Map reasoning modes to computational layers

Layer A: LLM + specialized prompts

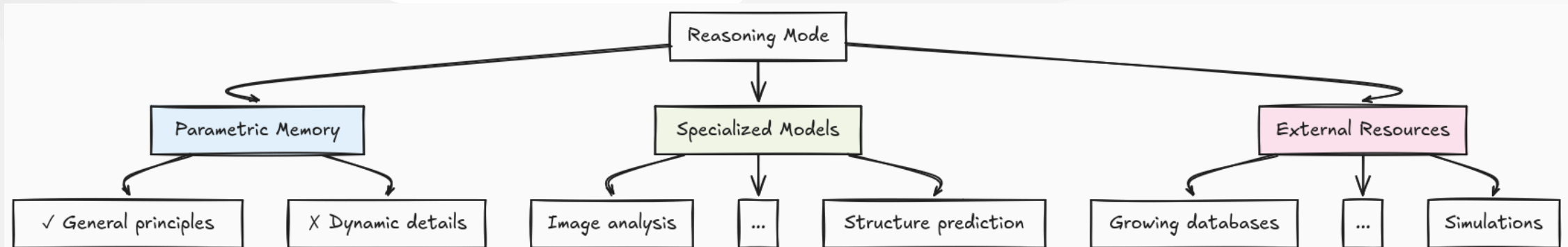**Layer B**: Specialized models (proteins, images)

Layer C: External resources (databases, tools)

Reasoning Mode Details - A Receipe

Key Insight: Each reasoning mode needs different resources:

1. **Model weights**: Principles ✓, Details ✗

2. **Specialized models**: Images, structures, etc.

3. **External**: Databases, simulations, etc.

Layer Details - ToolRegistries

Layer A: `parametric_memory` = LLM + specialized prompts

- Same LLM, different prompts → Different knowledge distillation
- Status: 11 reasoning modes implemented

Layer B: Specialized models as tools

- Structure prediction, image analysis
- Packaged as callable tools

Layer C: External resources

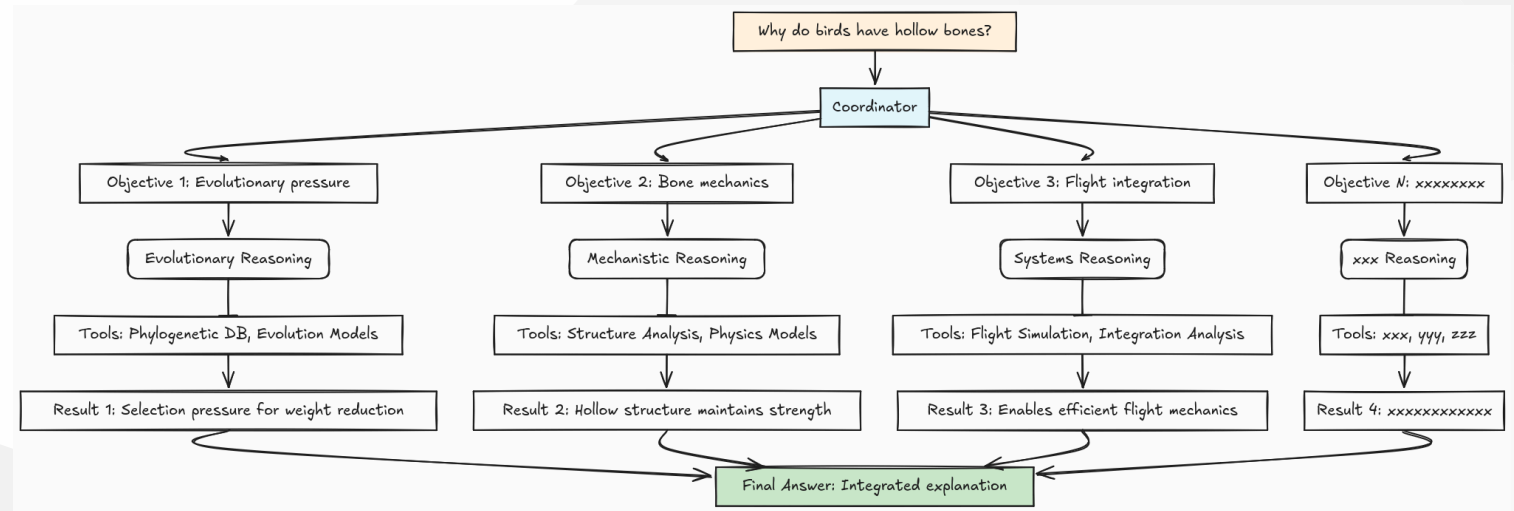- Databases, computational tools, knowledge graphs

Working in Progress

Next: Divide-and-conquer scheduling

Example: 'bird bone evolution' →

- Evolutionary pressure
- Bone mechanics
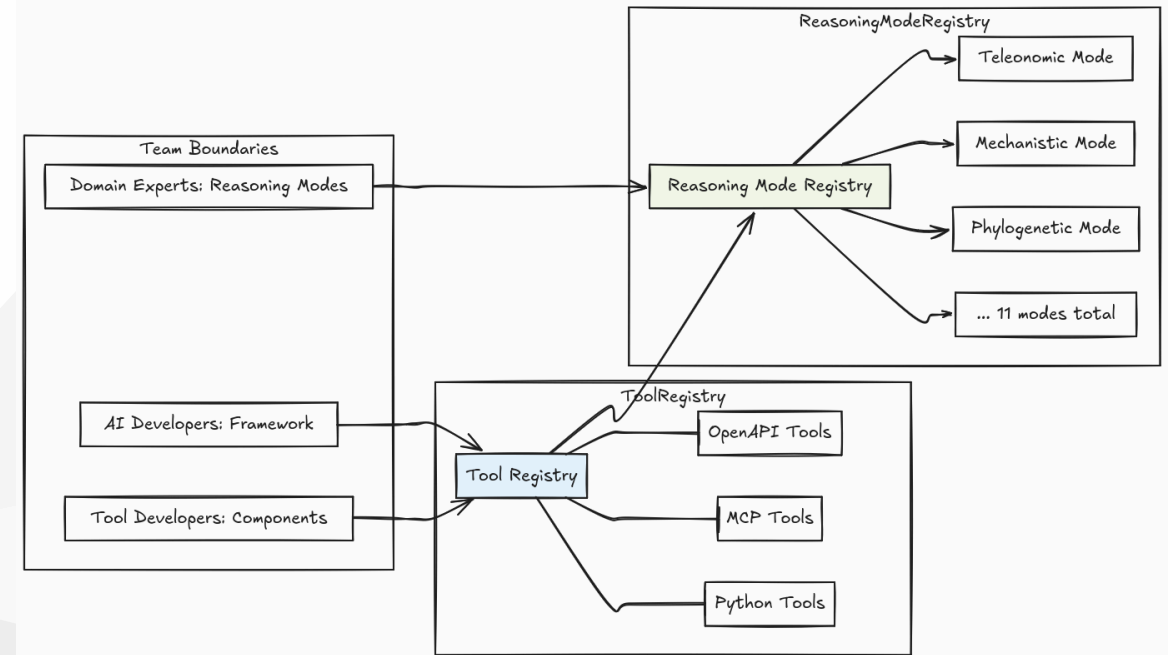- Flight integration

Results merge into final answer

Why This Matters

Scalability:

- ToolRegistry: Any OpenAPI/MCP/Python function becomes a tool

- ReasoningModeRegistry: Recipes for reasoning

Team boundaries:

- AI developers: Framework

- Domain experts: Reasoning modes

- Tool developers: Components

Thank You

Questions?