TechTeam
Vector Research Center
for Enterprise Performance

- Name of Organization(s): **Vector Research Center, division of TTGSI**
- Lead Investigator:
  Dr. Van Parunak, Chief Scientist, VRC/TTGSI
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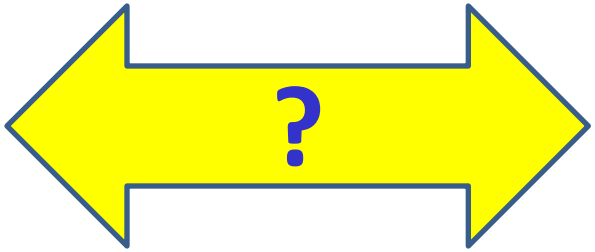
- Current Team Members: **None.**
- Capabilities:
  - **Evolutionary fitting of computational models to observed data to generate dynamic equivalence**
  - **Ability to generate robust, maintainable software**
- Seeking: **Team led by world-class neuroscientists**

The Problem

You know how to measure this

We know how to design and implement a dynamically equivalent algorithm



Human Sensemaking (Carbon)

Cognitive Computation (Silicon)

Attempts at Structural Equivalence

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???

Connectionist

Symbolic

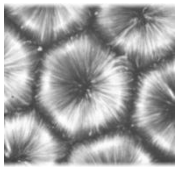
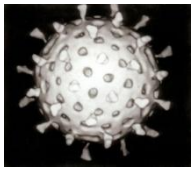
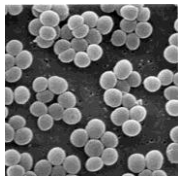
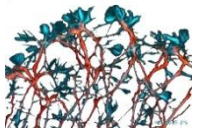
ANN: Neuron, Synapse, Activation

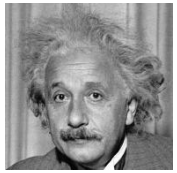
SOM: Localiza-tion in Cerebral Cortex

Soar: LT/ST Memory

ACT-R: Procedural vs. Declarative Knowledge

EAA: Situated BDI




— *physical* energy — *biological* evolution — *psychological* stimulus-response — *gnoseological* cognition & mind — *sociological* cooperation & competition →

Todd Hylton

Ultimately, Organic Chemistry ≠ Digital Logic.
But where do we draw the line?

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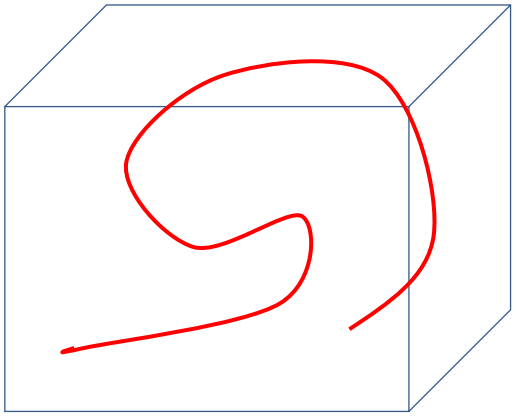

Takens' Theorem and Dynamic Equivalence

Big ideas:

- **State space**
- **Trajectory**
- **Attractor**

Given

- ***any*** **observation function that is twice differentiable and maps each point on the attractor to a real number, then**
- **The topology of the attractor can be reproduced from a *time series* of measurements of this *single* function, *without accessing the underlying state variables***

Idea:

- **Observe biological sensemaking activity at *any* accessible level**
- **Construct a computational system (of *any** structure) that replicates its dynamics**

TT lets us rigorously connect computation to biology at any level of the hierarchy

*with sufficient computational power

Methodology: Evolutionary Fitting

1. Identify an accessible biological observable $\mathbb{O}$ (at level of neuron, circuit, analyst, team, …)
–Here's where we need collaborators
2. Construct a parameterizable representation $\mathbb{R}$ in your favorite cognitive model
–We have EAA model, but are open to collaborate here
3. Use population-based search (GA, PSO) to evolve $\mathbb{R}$ to match observed dynamics of $\mathbb{O}$ while doing sensemaking
–Fitness = (difference between $\mathbb{O}(t)$ and behavior of $\mathbb{R}$)$^{-1}$
–We have extensive experience in this process
4. Execute $\mathbb{R}$ to do computational sensemaking

NB: can continue training $\mathbb{R}$ while running it to track nonstationarity in $\mathbb{O}$ (generated by changes in problem and approach)