

“All my relations” Contributing to a fabric of belonging

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AGI 2024
2024 August 15

Outline

1 Introduction

- All my relations
- Toward collective sensemaking

2 Abstracting computers

3 Dynamic interaction

4 Outlook

All my relations

—Lakota Sioux

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- I think we are under-developed in our ability to track *care*.
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No need to commit to excitement or doom about AGI.

- Both of these are rooted in care.
- So we need an open-ended investigation into care itself.

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- Care words: *matters, useful, important, worry, problem, want, value*.
- Pirsig: what shows up externally as quality occurs internally as care.
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- This baby, this genius kid from India, this algorithm, this experience.
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- The actual is what is here. Actions speak louder than words.
- Self actualization, becoming all you can be, reaching your potential.

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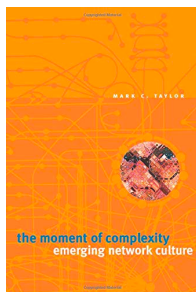
To tend:

- Empirically, how do we *tend* to accomplish stuff? We care.
- Care works by tending, as to a garden. Stay with it, concern yourself.
- To care is to attend, to pay attention.

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Here's the problem I've cared about, which has led me to be here with you.

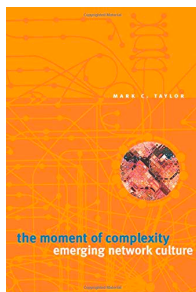
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 - "In ~1993 the world's brain came online."
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 - Maybe it could help us navigate the complexity.
- I've spent the last 17 years working on this.

Driving question: *how can CT help humanity make better collective sense?*

Collective sensemaking

“All intelligence is collective intelligence” –Mike Levin.

- Humans communicate, make sense together, learn from each other.
- But each human is itself a collection of cells acting collectively.
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- Videos, blogs, etc. explaining the world's situation in real time.
- Let's call this activity *cultural processing*.
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We need something to help us take care of ourselves.

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- Where can we turn to help us organize and balance the coll'tive sense?

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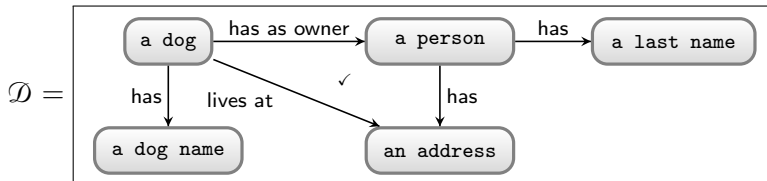
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Math helps organize thinking; can it be of use?

Maybe it's all stored in our heads

How can we imagine the problem of collective sensemaking? A first stab:

- The most important thing is communication, understanding each other.
- Imagine everyone has a database in their head, organizing everything:
- ...a schematic layout of how things fit together, and tons of examples.



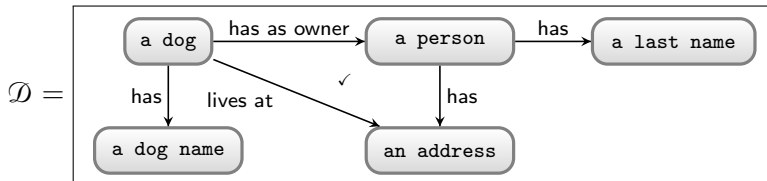
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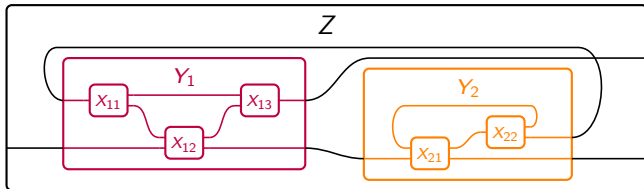
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- Our brains are very different and organize the world differently.
- Let's make math about that: how different databases can communicate.

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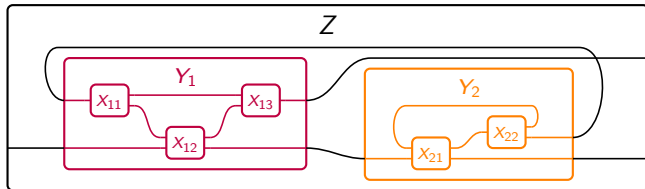
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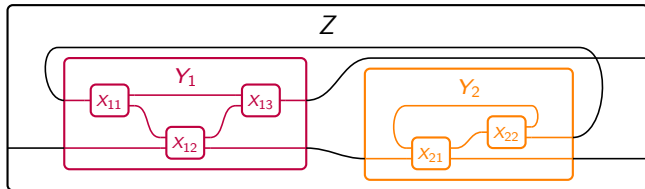
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- Perhaps the flowing information causes the wiring diagram to change?

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There's beautiful math for all this. But it's still missing some'ng *important*.

Plan for the talk

In the remainder of the talk, I'll discuss:

- Motivation for sensemaking
- Actual math with potential to help
- Where I think we need to go from here.

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1 Introduction

2 **Abstracting computers**

- Turing's extraction
- How abstraction works

3 Dynamic interaction

4 Outlook

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What made the women do such a good job? Care.

- They needed care to do the high-quality work.
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Since then we've scaled up the uncaring mechanism by ~ 20 OOMs.

- But it's still the living who care. CPUs and LLMs don't *care*.
- This essential piece—the interest, the drive—is going un-tracked.

We've lost track of what matters most. Let's consider how it works.

What is sense?

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- Let's think of *intelligence* as current: how much flows per unit time.
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Care tends to actualize potential by making sense of things.

- By *sense*, I don't mean raw perception.
- A spidey sense, a sense of danger or belonging, a sense of direction.
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Consider a snapshot of two math students, both wanting to succeed:

- Student A is faithfully copies down what the teacher says.
- Student B seems to be doing the opposite: ...
- ...clearly frustrated, arguing with the teacher, "but then why XYZ??"
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Making sense of things takes work, but it produces sense!

Tracking what we care about

What do we mean by *tracking*?

- Tracking criminals, tracking bears: we care about finding them.
- Tracking trains, keeping them on rails. Traction of tires on road.
- Tracking someone's logic, not getting distracted, getting back on track.
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I believe that sensemaking may come down to accounting.

- Student B was trying to figure out how to account for XYZ.
- We seek an abstraction with which to overlay our experience.
- Once we find it, we can “put things in their proper place”.

Sensemaking may be finding systematic ways of accounting for experience.

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- We will use this in two ways: to motivate CT and to discuss **Poly**.
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 - **Poly** is a part of CT that holds many of the ideas we're discussing.
- Goal: to see how well the abstraction applies to what we care about.

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To actualize our own potential, we need to be clearer about all our relations

Category theory $\approx$ relational math

Category theory is math about structures and how they relate.

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Next up, I’ll give you a taste.

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2 Abstracting computers

3 Dynamic interaction

- Polynomial functors
- Interfaces and delegation
- Dynamics and arrangements
- Application
- Story

4 Outlook

Miracles

In mathematics, there are a few *miracles*.

- The complex numbers are a miracle. You adjoin $\sqrt{-1}$ to $\mathbb{R}$.
- The result is not only that all polynomials factor completely, ...
- ...but that if a function has one derivative, it has infinitely many.
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What goal do they serve, especially in terms of this talk?

- Polynomial functors are the simplest framework I've found...
- ...in which we can talk about agents, interactions, dynamics,...
- ...and aim to understand ourselves: what's inside and how we relate.
- **Poly** is a good language with which to ask very basic questions.

Interfaces for tasks and outcomes

Let's talk about “agents” in terms of their *interfaces*.

- Let's hold off on awareness, preferences, etc.
- The interface of an agent is what you can give it and receive from it.
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Let's imagine it like this: you give it a *task*, and it returns an *outcome*.

- Different agents have different sets of tasks they can do.
- And each task has its own set of possible outcomes.
- The task “flip coin” has two possible outcomes: {Heads, Tails}.
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Let's move into the math. What is the interface for an agent?

- An interface consists of a set T of tasks and,...
- ...for each task $t : T$, a set O_t of possible outcomes for it.

Delegation: mapping between interfaces

Delegation has a lot in common with what we called abstraction.

- Suppose we have two agent interfaces.
- To specify a way that agent 1 *delegates* to agent 2:
 - for each agent-1 task $t_1 : T_1$, specify an agent-2 task $t_2 : T_2$
 - for each agent-2 outcome $o_2 : O_{t_2}$, specify an agent-1 outcome $o_1 : O_{t_1}$
- For abstraction, we went from concrete to abstract.
 - Starting with an experience, we *extract* some concept, and...
 - ...given an conceptual action, we *apply* it to the experience.
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You can encode all this in “polynomial functor” form. Here’s an interface:

$$p := \sum_{t:T} y^{O_t}.$$

- This actually specifies a *functor*, in the sense of category theory.
- Above “delegation” is precisely a *natural transformation* $p_1 \rightarrow p_2$.
- So this back-and-forth mapping is *natural* in the mathematical sense.

The algebra of interfaces

Polynomials let us do algebra with interfaces. Suppose given poly's p, q .

- Each is considered as interface: tasks and their possible outcomes.
- We can combine them in many ways to get new interfaces

$$p + q, \quad p \times q, \quad p \otimes q, \quad p \triangleleft q, \quad [p, q]$$

What are the tasks and outcomes of each of these new interfaces?

- $p + q$: pick a task from p or q ; return an outcome of it.
- $p \times q$: pick a task from p and q ; return an outcome of either.
- $p \otimes q$: pick a task from p and q ; return an outcome of both.
- $p \triangleleft q$: pick a task from p and, for each outcome, pick a task from q ;...
- ...return an outcome of each.
- $[p, q]$: pick a delegation from p to q ; return a task from p ...
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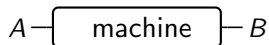
What's the point?

- We can combine agent interfaces in all sorts of controlled, lawful ways.

Machines

Moore machines and Mealy machines are used throughout the sciences.

- Each requires a set A of poss. inputs and a set B of poss. outputs.
- Also a set S of “internal states”, updated by A 's & reading out B s.

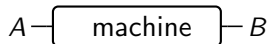


- Moore: update $u: A \times S \rightarrow S$, readout $r: S \rightarrow B$.
- Mealy: combined $f: A \times S \rightarrow B \times S$.
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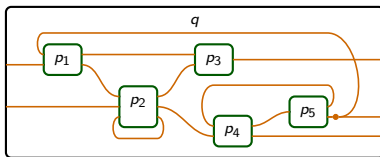
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We can think of both Moore and Mealy machines in terms of delegations.

- Moore: it's exactly a natural transformation $Sy^S \rightarrow By^A$.
- Mealy: it's exactly a natural transformation $Sy^S \rightarrow [Ay, By]$.
- In each case, Sy^S is an interface with S as tasks and outcomes.
- A simple agent is in a state $s: S$ and wants a new state $s': S$.
- It delegates this problem to the Moore interface By^A .
- Moore reveals its task $b: B$ and waits for an outcome $a: A$.

Dynamic arrangements

You can interconnect machines, and the result is another machine.

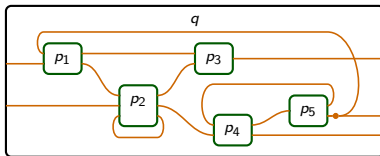


One can even make the interaction pattern *dynamic*:

- Data flowing on the wires can cause the interaction pattern to change.
- This happens in deep learning: the loss changes the weights.
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One can also define hierarchical agents that call on others.

- One agent delegates tasks to a host of subagents.
- Define arbitrary flowcharts for how subagents pass data around.
- After finite time, an outcome is returned to the original agent.
- Finally, the flowchart itself is updated in response to the outcome.
- All this is easy to specify (low K-complexity) in the poly. formalism.

Application

Now that we've looked at all this abstraction, how do we apply it?

- We can bring anything from this math back into our experience.
- To do so, someone builds it. Much has already been built (ANNs).
- Other stuff is being built along these lines as we speak.

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- What is this meeting? What makes a body hang together?
- What is eating, reproducing, sensing, healing?
- Where do care and intention come from?

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I think we can ground philosophical questions in mathematics like this.

- In fact, doing so *creates* new math.
- And that math will apply by helping us make sense of our lives.

Story time

Let's try to do what Turing did, but trying to take care into account.

- He found a memetically-fit abstraction for the *mechanism* of computers
- It's harder but more *important* to understand how the care part works.
- Let's try to tell the story of how we got here and where we're going.
- And let's do so in a way that is plausibly mathematizable.

A story of care

Actualizing potential is already part of physics.

- A hurricane, a lightning bolt: these actualize a potential difference.
- Metabolism-first origins: life as the simplest chemistry lab.
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- Being at the place where potential is actualized, you're *swirled* by it.
- Maybe this swirl organizes the local area, "storing information."
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Carers—from neurons to humans and beyond—collab. to actualize potential

- The ability to care is the precious thing that's passed down.

Outline

- 1 Introduction
- 2 Abstracting computers
- 3 Dynamic interaction
- 4 **Outlook**
 - What holds care?
 - Fabric of belonging

What holds care?

We are now playing with our own lives. “Gain of function” research.

- The math/CS that we create will take us through the phase transition.
- We'll process and make sense of the world much more powerfully.
- It may cause bizarre hiccups of miscommunication and “fake news”.
- I believe that the more elegant our abstractions, the fewer the hiccups.

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The most important thing—by definition—is what we care about.

- Tending to it well may not be easy, but it's our job.
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Purpose of this talk: I’m worried that we’re not properly *tracking* our care.

- Money is the closest thing, and it’s very poor as a tracker of care.
- If we’re going to have a “good” future, we need to remember care.

Contributing to a fabric of belonging

Imagine a fabric, threads knotted together billions of times.

- We're the knots, connected by the threads of which we're made.
- *Belonging* means going together; this is what shapes the fabric.
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We're knitting this fabric as we speak. Tying knots. Entangling ourselves.

- Evolution and learning change the consistency of this fabric.
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The most important thing we can possibly put into it is care.

Thank you for attending. Comments and questions welcome...