Computing With Structure

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Context and content

Content:

- A new epistemology for logic.
- On computable functions.
- A unification of logic and geometry and realizable mechanisms for **computing with structure**.

A **work in progress**, the beginnings of a framework for **a new approach** to logic and computation ...

... logic informed by **new data in biophysics**.

The problems I am trying to solve:

1. A method for the mathematical characterization of sense. Describing how sense is formed, modified, and covaries with response potentials in biophysical systems, **the role that sense must play in nature**.

2. The general recognition problem.

3. Decisions across large scale parallel computation.

I will speak about “**sense**” ...

... it is **the various characterizations of our experience**. It is vision, touch etc... it is the characterization of our cognitive experience.

The action of this characterization is what we speak of when we say “I am trying to make sense of this or that” or ask “In what sense?”

It is the characterization of our experience as we act. Indeed, **it covaries with our actions and with actions upon us**.

Slogan: “**Everything is structure, the bit is dead.**”

Consistent with the “mathematics is structure” view.

In logical terms sense is represented by the “satisfied” symbolic expression of the distinction that covaries with a specified result.

The natural laws of logic are laws of nature …

Turing (echoing Peirce): “ I believe that the attempt to make a thinking machine will help us greatly in finding out how we think ourselves.”

“ Precisely how much of the business of thinking a machine could possibly be made to perform, and what part of it must be left for the living mind, is a question not without conceivable practical importance; the study of it can at any rate not fail to throw needed light on the nature of the reasoning process. ... ”

Charles Sanders Peirce. Logical Machines.
The American Journal of Psychology.
November 1887.

It is a surprising and remarkable fact that we can indeed imbue computing machinery with aspects of our intelligence, ...

... but this has not provided an explanation of how sense is characterized nor of the role that it plays in the physical dynamics of the organism.

“ I do not wish to give the impression that I think there is no mystery about consciousness. There is, for instance, something of a paradox connected with any attempt to localise it. But I do not think these mysteries necessarily need to be solved before we can answer the question with which we are concerned in this paper.

Alan Turing. Computing Machinery and Intelligence. (1950)

By definition ... the laws of sense, intuition and reason are laws of biophysics. This is work for logicians.

There is no side to take in the “psychologism debate,” both sides draw a fallacious distinction.

I propose to **reject reductions of analytic “truth”** in favor of structure and it’s transformation ...

.... to **speak about distinction as differentiations on the surface of closed manifolds of sense covariant with response potentials** in the same structure, leading to directed responses.

The greatest (unrecognized) **challenge in biophysics *and logic*** is to explain how sense is characterized, ...

... and the laws by which sense is formed and modified, and how this mechanism leads to directed behavior.

A new epistemology for logic ...

... values of distinction not truth.

Distinctions ...

necessary distinction – a distinction that is forced upon us by the world.

way of speaking – a distinction that we force upon the world.

The epistemological basis of **universals** is that the world is profoundly uniform.

Computation and computability …

Computation

... is that which can be derived mathematically,
i.e., rigorously and systematically

anything that cannot be so derived is said to be “incomputable.”

Humility conjecture: **nothing is, in fact, incomputable** ...

... **the failure is ours**, of our model of computation, it is not a failure of the world ...

Two interpretations of computable functions:

- Transformation of the entire structure (mathematical).
  $f : S \longrightarrow S'$

- Maps from distinguished locations upon S to another on S′(Turing computable).

Other computable functions (universal quantifiers)

... Common properties.

... Maps of one set with common property distinctions to another such set.

... Orders over these.

Epistemic observation:

... conventional points and point sets are conveniences, “ways of speaking” about structures.

... the necessary distinction is the structure itself.

Summary values are metaphysical (traditional points, lengths, areas and volumes) ... are ways of speaking about structures ...

Necessary distinctions:

... “distance” (uncharacterized “length”)

... “intersection” (the bindings of distances)

... “points of intersection” (convergence of intersection)

I propose logic, mathematics and physics have a common subject ...

... structure and its transformation, ...

... requires the unification of logic and geometry.

In which structural transformation is computation, i.e., the inputs and the results are structures and the behavior of structures.

Parallel Computation

Parallel Computation as we understand it today is decomposable, a second order consideration of the Turing model.

Parallelism can be semantically removed from programs with no discernible effect upon the results.

Therefore it **contributes nothing algorithmically**, providing only performance semantics.

Putting aside for a moment the challenges of the recognition problems, well-known **data storage and distribution** issues **limit the engineering of efficient large scale algorithms** on parallel machines.

Without transparent data movement expressing these algorithms for execution upon these machines may be intractable at the scales we now consider.

New data available from biophysics ...

After two decades of detailed investigation with new technologies the evidence shows there is **no storage architecture independent of symbolic processing in biophysical systems**.

Biophysical behavior is broadly cooperative and concurrent. But there is no load/store architecture and **recognition operations are low cost.**

Overall **energy requirements are**, in effect, **independent** of processing utilization.

Contrary to the view of earlier paradigms, **the electrical behavior seen in neurons** is best considered for its non-isolated **participation in the dynamics of neurological and broader cell structure**.

These structural dynamics are closely bound to action potentials in complex electrochemical behavior.

Computation in biophysical systems

In biophysics then it is **structure and the concurrency of action** that **are first-order considerations**.

It is **the shape** of single cells and multicellular membranes (“closed manifolds” in mathematical terms) that characterize sense and **modify action potentials that produce behavior**.

A generalization of the existing evidence suggests that **symbols form directly upon the surface of these manifolds** in cell and membrane architectures, the **processing of which constrains biophysical action potentials associated with the structure.**

This close binding of symbol processing and action potential is naturally formed by the evolutionary process.

In biophysical systems **structural parallelism is not decomposable without impact upon the results.**

It **plays a role algorithmically, providing the mechanisms of recognition and memory in the surface conformations** of the processing architecture.

Large scale differentiation appears in the dynamics of these closed manifolds and result in measurable characteristic behavior **suggesting new architectures for identification and prediction.**

Symbolic processing in the biophysical system is profoundly efficient. **Storage is free and the capacity for symbol representation is combinatorial across dynamic sensory manifolds.**

This simple efficiency **suggests general engineering principles** that offer significantly greater symbolic processing capability in biophysical architectures than previously considered.

Realizable mechanisms

Geometry/Construction

The **first distinction** is the **sense** of distinction,

... ways of speaking about this distinction:

“**distance**,” “separation,” “difference”

A change in this base distinction is a change in the character of sense, e.g., we may say of it “larger,” “further apart,” “different” ...

Aggregates of these dynamic distinctions characterize our experience and give us a particular **“sense**.”

In the following I will adopt the nomenclature of “distance” when speaking about distinctions in general.

How the geometry is constructed

- **measure** designates an act of apprehension.
- **length** designates a record of such measure.
- **intersection** is construction of lengths.

Constructive method ...

... to apprehend/**discover necessary distinctions** constructively **from the basis** distinction (that I will call “distance,” *a sense thereof*).

Distinctions of our geometric construction

a. Length (measure of a unit distance without further character).

b. Derive a closed manifold (a sphere of *base length* radius).
c. Derive the surface and planes as the intersection of two such spheres *centered upon the extremes of a common base length*.
d. Derive points as a further intersect of three such spheres.
The third centered upon the intersection of the other two.

e. Characterize the dynamic shaping of surface and behavior as covariant continuous functions of length.

Rejected metaphysics (conveniences of reason)

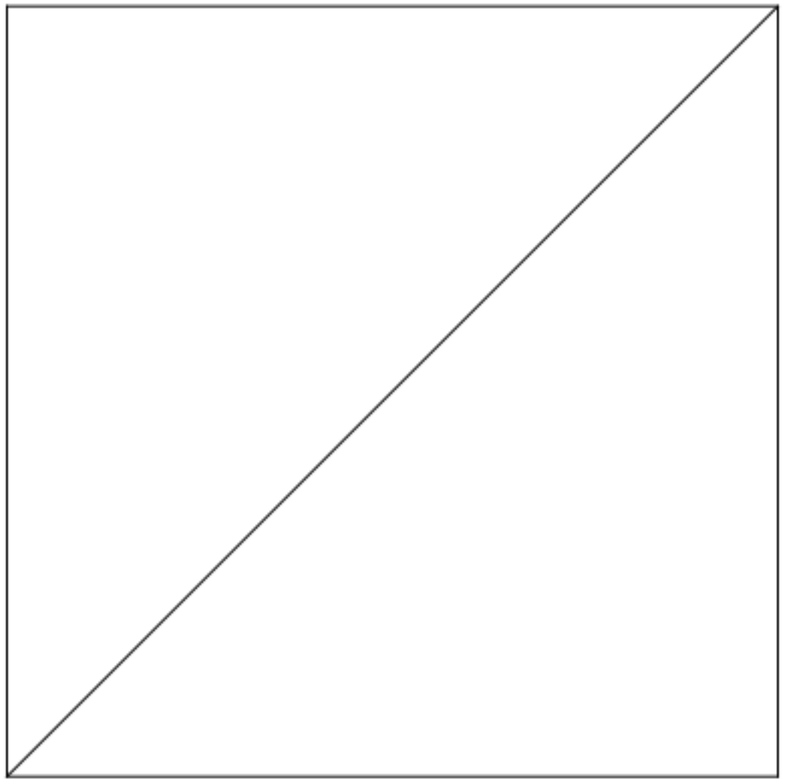
a. No Infinite dimensions - points are terminal distinctions.
b. No space and time - there is a natural “tension” in the geometry that allows us to reason about the “force” of structural transformation.

d. No universal metric - a rational number can always be found to replace the irrational.

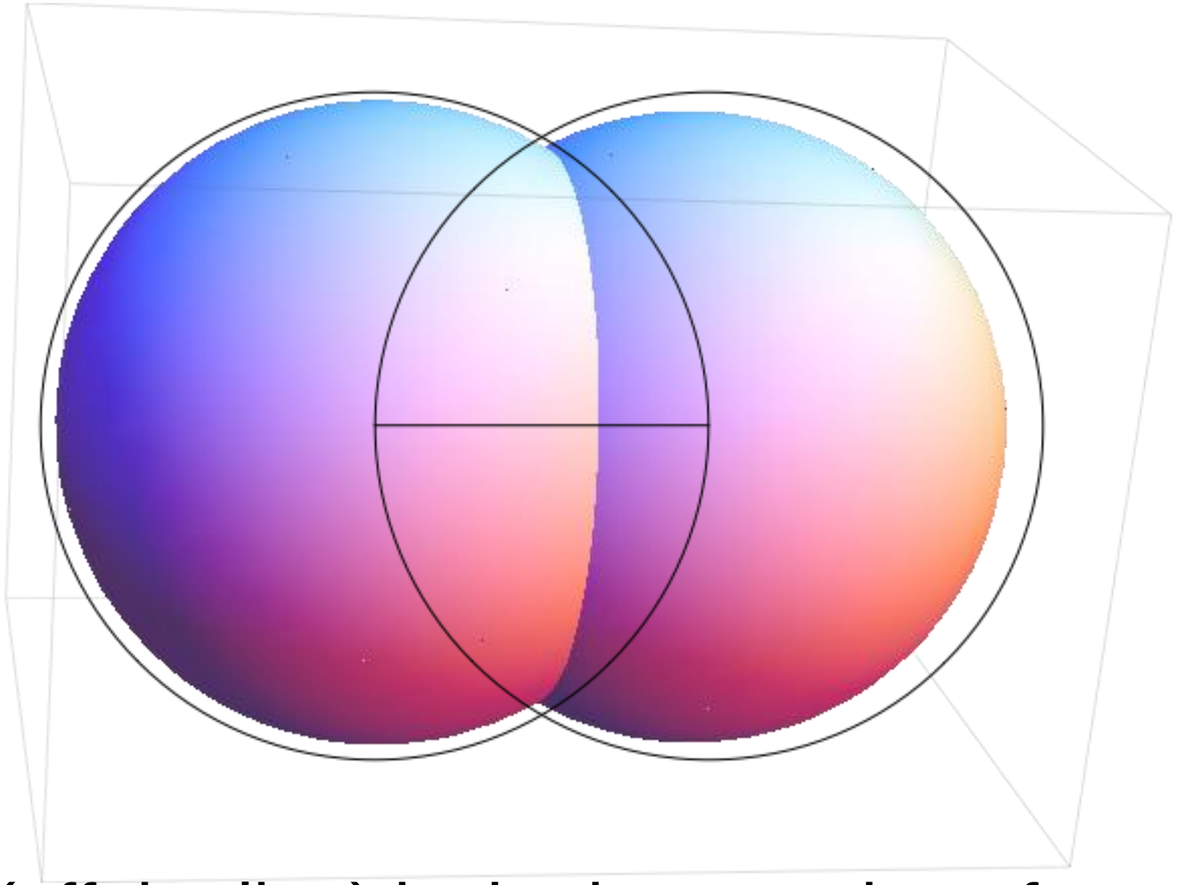
By contradiction the unit square provides prima facia evidence for rejection of the universal metric.

A given length cannot be both rational (terminating) and irrational (non-terminating).

The metric is a choice. The sides or the diagonal?



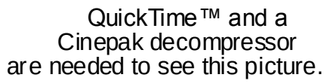
Pythagorean Theorem a convenience to convert between metrics.



2nd order length (off the line) is the intersection of two spheres, distinguishing **a circle** that in turn distinguishes a plane.

... the intersection establishes a unit metric for the distinguished plane, the diameter of the circle.

Providing full characterization of the plane by lengths from the base length.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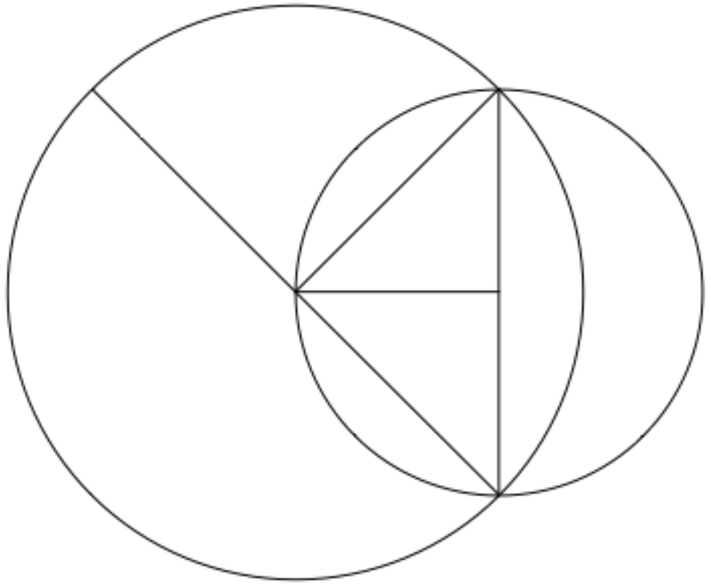
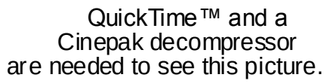


A new length, w[0, 2] in the base metric, fully characterizes the surface of the unit sphere |1| by w[0, 2] and distinguishes the orthogonal planes.

$$|1||w[\ 0,\ 2\ ]|$$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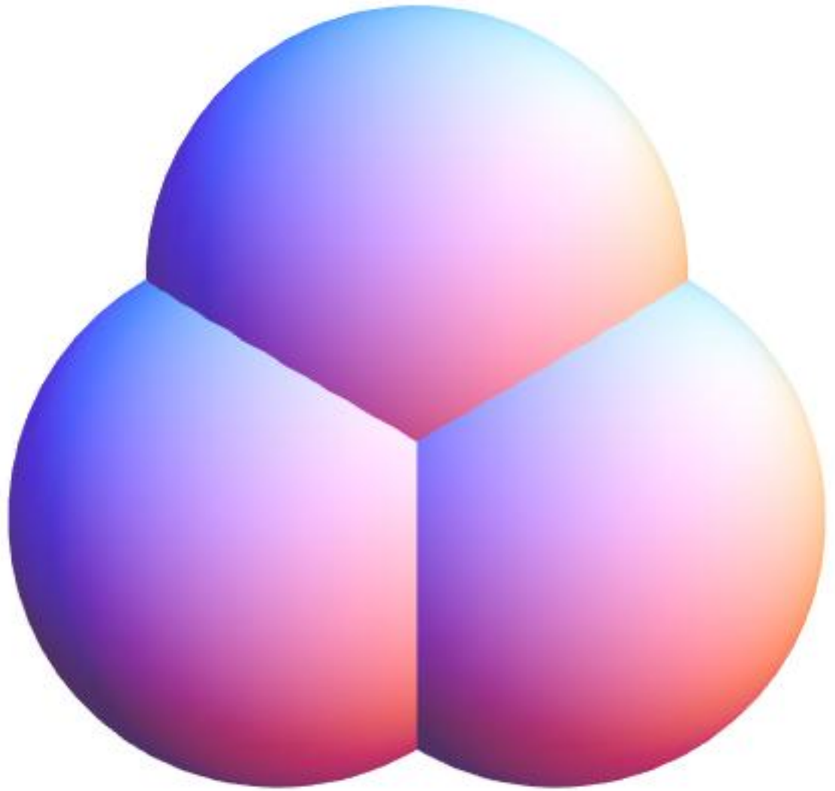
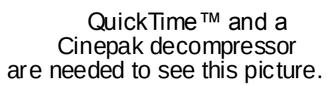


Deriving points (“locations”, conceptual terminals) from three-sphere. Symmetry.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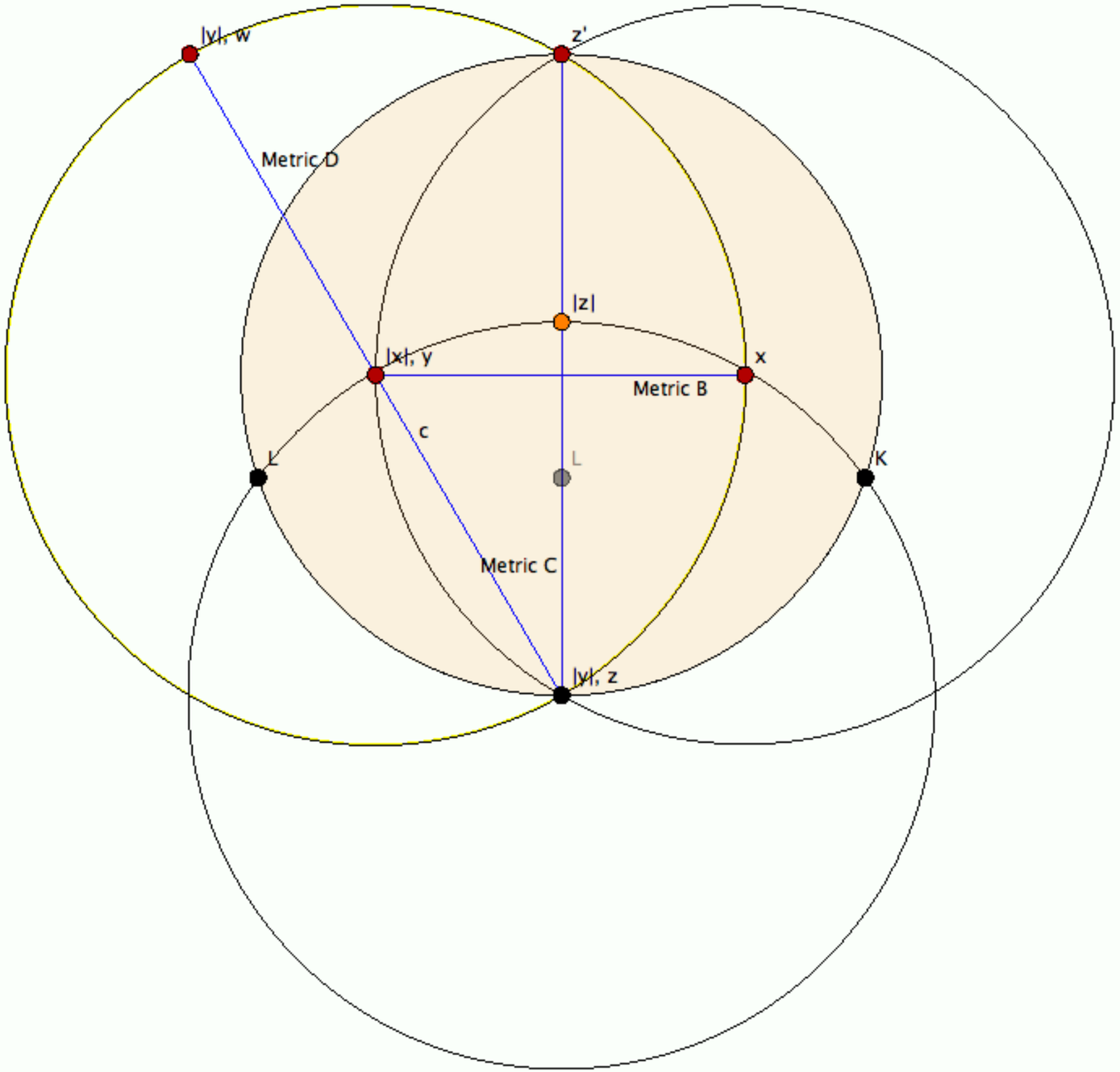
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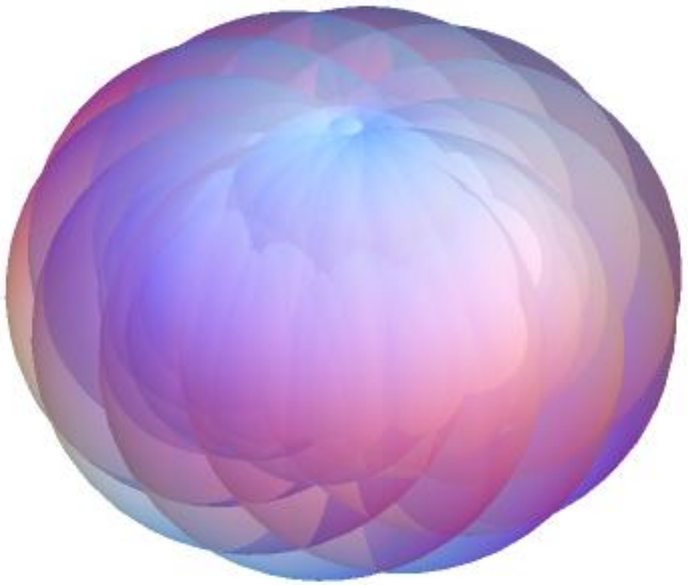

Points on the mid-plane

Take from this that the geometry naturally deals with biophysical like structures and behaviors, e.g., mitosis, a basic function of biophysics.

Note that I distinguish between limits of length and points.

Algebra

Let |x|, |y|, |z| be lengths bound by a unit metric |1|,

... a distinct plane is identified by each intersection (x, y), (y, z), and (x, z), each establishes a new metric, the diameter of the circle.

... a distinct symmetric point pair (+-) is distinguished by the intersection (x, y, z) (laws of intersection constrain relative values).

Intersection distinction

let x and x’ be the limits of a length
i = intersection(|x|, |x’|) : |x| + |x’| ≥1_x.

Point distinction

let |z| be the length distinguished by i, and z’ a limit point (i, |z’|[0, 1_z])

1_x *and* 1_z *designate distinct metrics.* |x| *is to be read “length originating from* x”*.*

The surface of the unit sphere |1| and the planes passing through it are distinguished by the intersecting second order length |x’|[0,2],

... in general, the location of the planes are defined by the ratio between the two lengths involved. So if the two lengths are equal it is always the mid-plane.

The locations in our coordinate system are not equally spaced and exhibit a natural “tension” of curvature.

We are looking for a structural “tension” that reflects the laws of physics. In this unified geometry we do not want to impose external concepts to include mass/energy and gravitation.

Validating task : rewrite the Einstein field equations.

Conjecture

It is the construction and conformation of closed manifolds upon this basis that characterizes sense and associated response potentials.

By this means we may formally characterize sense.

A logic of distinctions and behaviors

Our notation and methods are preliminary, a logical algebra.

Terms designate distinctions (distinct conformations of structure, characterizations of sense).

Logical operators describe the composition of terms and composite structures.

Conventional “properties” are unique aggregations of distinctions.

Inference is the behavior (transformation) of such compositions and directed response potential, all by the same mechanics ...

... a covariant characterization of sense and behavior.

Composition (AND / Presence)

Let a, b, c be distinctions then the expression

$$a + b + c$$

is the composition of symbols upon the manifold and the manifold determines the laws of such composition.

In particular, the associative and distribution laws are determined by the properties of the manifold, so whilst

$$a + b = b + a$$

may be valid (a + b indistinguishable from b + a because the manifold is orientation indifferent) but

$$a + b + c \neq b + c + a$$

The laws are not dyadic reductions.

Proximity parenthesis

$$a + (b + c) = (b + c) + a$$

$$a + (b + c) \neq b + (c + a)$$

Anticipation (NOT / Absence / Guard)

$$\bar{a} + (\bar{b} + \bar{c})$$

An unsatisfied distinction, a structure awaiting fulfillment by interaction with its environment.

Similarity / Forcing (Carnap's basis)

$$a + b \cong (a + b) + \bar{c}$$

$$a + b \cong (a + \bar{c}) + b$$

Inference (transformation / directed response potential), like guarded alternatives in process algebra.

Let P (S) be a process, a transform of the manifold S

$$\bar{a} + (\bar{b} + \bar{c}) \Rightarrow a + (b + c) : P (S)$$

$$\overline{\text{Tiger}} \Rightarrow \text{Tiger} : P (\text{Run})$$

$$\overline{\text{Sugar}} \Rightarrow \text{Sugar} : P (\text{Yum})$$

Anticipate Distinction ⇒ Satisfaction : Action

in place of the analytic

Premise ⇒ Conclusion

Covariant continuous functions, given structure S defined in the foregoing geometry.

Let functions s and f be the covariant sense (symbol) characterization and response potential, then

$$Ss = Sf$$

The formation of sense informs the structure, the structure informs the character of sense. Similar to Einstein's GR characterization of gravitation.