Recursive Distinctioning: The 3rd Annual RD Conference, Clayton, Missouri, September 24-27, 2017

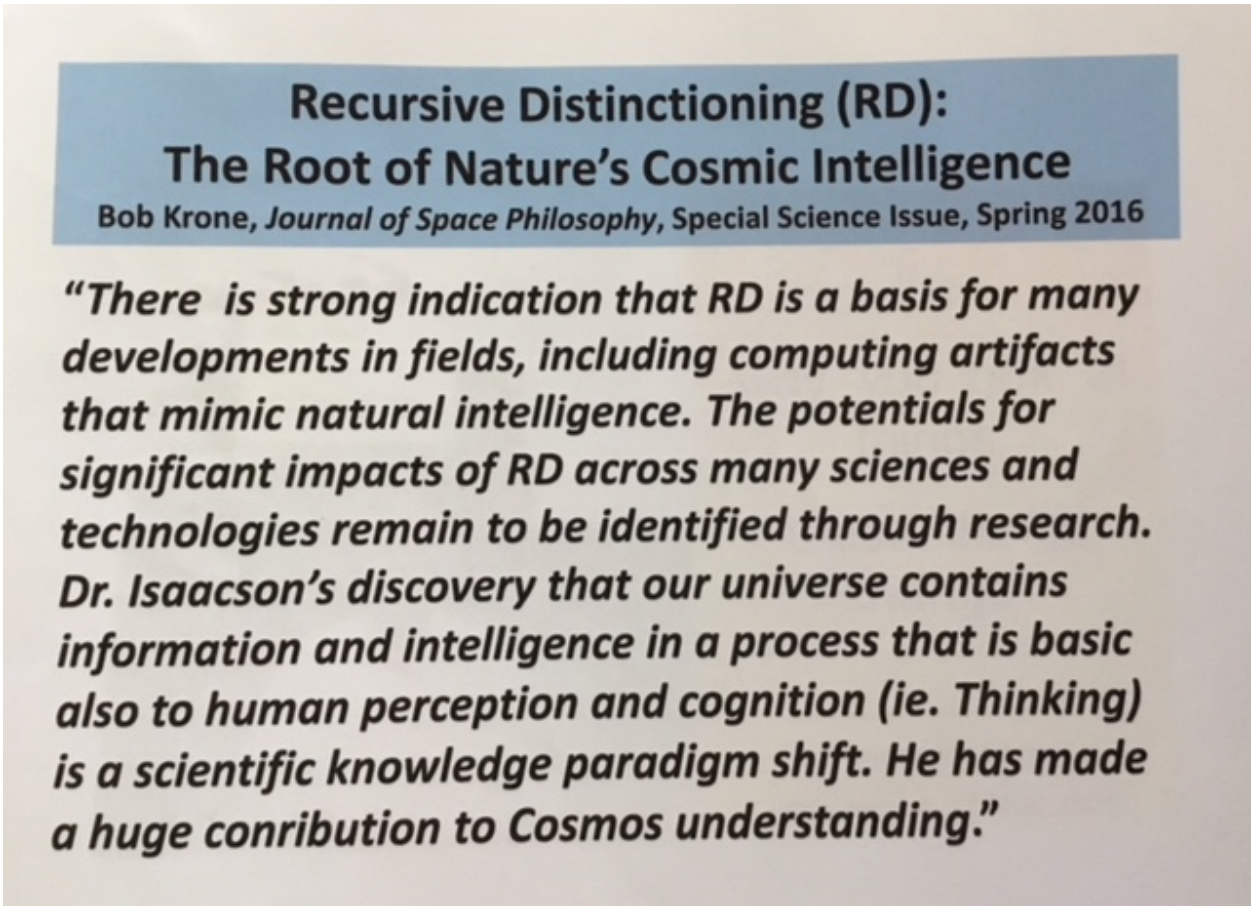
By The Krones: Bob, Salena, and Kat

The *Recursive Distinctioning Team* met for its 2017 Convention at the residence of Dr. and Mrs. Joel Isaacson, 20 Crestwood Drive, Clayton Missouri, 63105, USA, September 24-27, 2017.

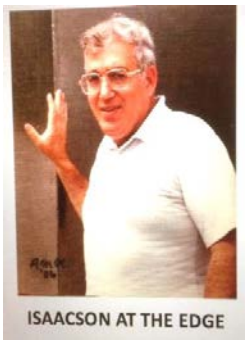
Participating were Dr. Joel D. Isaacson, Mrs. Leora Isaacson, Dr. Louis H. Kauffman, Diane Slaviero, Dr. Robert M. Krone, Mrs. Salena Gregory-Krone, Ms. Kat Krone, and Dr. John Barker. Presenters via Skype were Professors Moshe Klein and Oded Maimon (from Tel Aviv University, Israel), Ben Goertzel (United States) and Stephen King (United States)

The Purpose of the Conference was to identify startup strategies.

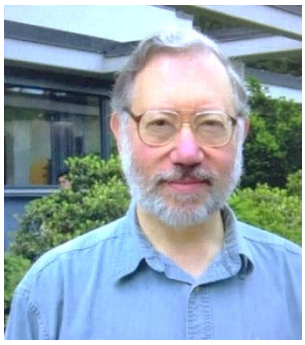
1. **Bob Krone** had distributed a PowerPoint presentation prior to the meeting, that summarized the discovery, history and knowledge about Recursive Distinctioning (RD). A summary statement in that presentation follows:



2. **Joel Isaacson and Louis Kaufmann**



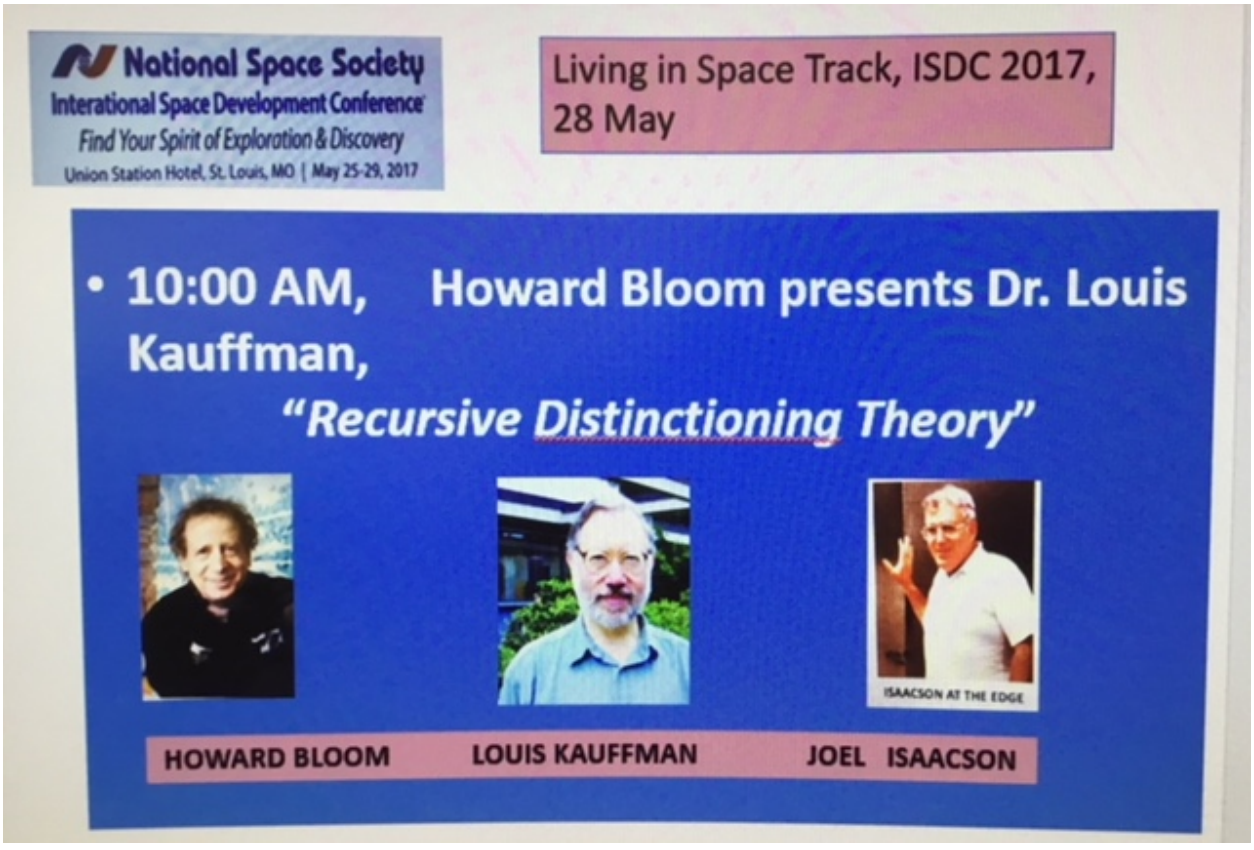
Dr. Joel Isaacson



Dr. Louis Kauffman

Dr Isaacson and Dr. Kauffman opened the conference with welcomes. This 3rd Annual RD Conference occurred following the National Space Society's International Space Development Conference (ISDC–2017), held in St. Louis, May 24-29. The Kepler Space Institute (KSI) was fully involved in that Conference.

Scientist and author Howard Bloom presented at that ISDC-2017 in St. Louis on May 28, 2017 the most recent paper authored by Dr. Louis Kauffman and Dr. Joel Isaacson.



That presentation provided the description and current status of research on RD.

3. **Dr. Louis H. Kauffman's** presentations during the conference included the statement:

> Recursive Distinctioning is a potentially explosive topic whose basic principles apply at all levels of biology, cognition, information science, and computation.
>
> **RD Defined**: Recursive Distinctioning means just what it says. A pattern of distinctions is given in a space based on a graphical structure (such as a line of print, a planar lattice, or a given graph). Each node of the graph is occupied by a letter from some arbitrary alphabet. A specialized alphabet is given that can indicate distinctions about neighbors of a given node. The neighbors of a node are all nodes that are connected to the given node by edges in the graph. The letters in the specialized alphabet (call it SA) are used to describe the states of the letters in the given graph and at each stage in the recursion, letters in SA are written at all nodes in the graph, describing its previous state. The recursive structure that results from the iteration of descriptions is called Recursive Distinctioning. Here is an example. We use a line graph and represent it just as a finite row of letters. The Special Alphabet is SA = { =, [,], O} where "=" means that the letters to the left and to the right are equal to the letter in the middle. Thus, if we had AAA in the line then the middle A would be replaced by =. The symbol "[" means that the letter to the LEFT is different. Thus, in ABB the middle letter would be replaced by [. The symbol "]" means that the letter to the right is different. And finally, the symbol "O" means that the letters both to the left and to the right are different. SA is a tiny language of elementary letter distinctions. Here is an example of this RD in operation where we use the proverbial three dots to indicate a long string of letters in the same pattern. For example,
>
> ... AAAAAAAAAABAAAAAAAAA ...
> is replaced by
> ... =========]O[========= ...
> is replaced by
> ... ========]OOO[======== ...
> is replaced by
> ... =======]O[=]O[======= ....
>
> Note that the element]O[appears and it has replicated itself in a kind of mitosis. Elementary RD patterns are fundamental, and they are found in many structures at all levels. To see a cellular automaton example of this phenomenon, go to Wikipedia.[1] Here we see a replicator in HighLife, a modification of John Horton Conway's automaton Life. The HighLife Replicator follows the same pattern as our RD Replicator! We can begin to understand how the RD Replicator works. This gives a foundation for understanding how the more complex HighLife Replicator behaves in its

[1] en.m.wikipedia.org/wiki/Highlife_(cellular_automaton).

> context. Finally, here is an excerpt from a paper by LK about replication in biology and the role of RD.
>
> Recursive Distinctioning (RD) is the study of those systems that use symbolic alphabetic language that can describe the neighborhood of a locus (in a network) occupied by a given icon or letter or element of language. An icon representing the distinctions between the original icon and its neighbors is formed and replaces the original icon. This process continues recursively.
>
> RD processes encompass a very wide class of recursive processes in this context of language, geometry, and logic. These elements are fundamental to cybernetics, and they cross the boundaries between what is traditionally called first- and second-order cybernetics. This is particularly the case when the observer of the RD system is taken to be a serious aspect of that system. Then the elementary and automatic distinctions within the system are integrated with the higher order discriminations of the observer. The very simplest RD processes have dialectical properties, exhibit counting and they exhibit patterns of self-replication. Thus, one has in the first RD a microcosm of cybernetics and perhaps, a microcosm of the world.

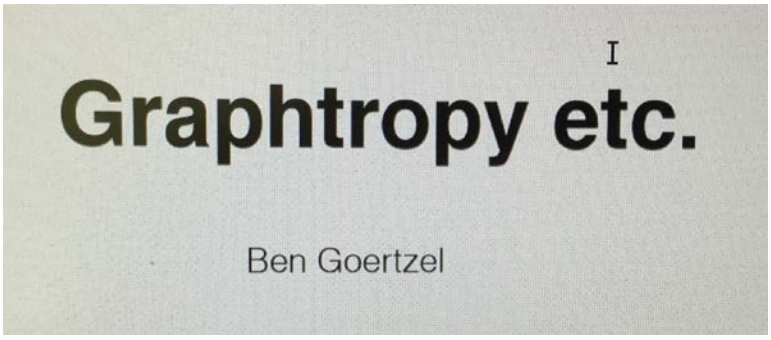
This comes from a Special Issue of JSP, Vol. 5, No. 1, Spring 2016, devoted to RD.

Dr. Louis H. Kauffman Professor of Mathematics, University of Illinois at Chicago, presented on RD via Zoom at the International Space Development Conference – 2016 in San Juan Puerto Rico on May 22, 2016.[2] It will be in the archives maintained by the National Space Society (NSS) and is also available on Researchgate. This presentation, and the formal paper titled “Recursive Distinctioning,” co-authored by Louis H. Kauffman and Joel D. Isaacson, published in the *Journal of Space Philosophy*, Spring 2016, create a major milestone in the Information Sciences, Cybernetics, Cellular Automata and Astro Physics.

Bob Krone, Ph.D., President of Kepler Space Institute (KSI) and Editor-in-Chief of the Journal of Space Philosophy.

[2] See www.dropbox.com/s/p9urkbf87b18l7s/RecursiveDistinctioning.pdf.

4. **Ben Goertzel** (Skype Presentation),



Ben Goertzel gave a presentation on graphtropy. It proposed a new conceptual foundation for the notion of information, based on the concept of a *distinction graph*, in which two nodes are connected if and only if a particular interpreter cannot distinguish them. The graphtropy of a distinction graph is the average connection probability of two nodes. He concluded that graphtropy measures how much complexity there is in the environment relative to an observer.

5. **Stephen Paul King** (Skype Presentation), "Adaptive Networks as the Natural implementation substrate for RD processes."

Abstract

There are a substantial number of examples in nature where networks are the means to implement recursive distinctioning (RD) processes. In this talk, we discuss how an example of an RD process may be occurring in the network of neurons of the brain and how this might be a way to process information in a way that is robust and secure. It can be noted that the usual need for a global clock is ameliorated by the use of "opportunistic" synchronizations in both spatial and temporal orderings. Similarly, networks that can have adaptive neighborhood relations can act to store and use previous RD results in future instances of the RD processing by a variation of topological relations. We hope that this idea is plausible enough for the audience to inspire discussion and comment for the direction of future investigations.

It is believed that the RD process is universal, and it appears in many places, including the brain. Of particular interest is its appearance in the very process of thought and, possibly, consciousness itself. This possibility is mentioned by Joel D. Isaacson and Louis H. Kauffman in a letter to the *Journal of Space Philosophy* 4, no. 1 (Spring 2015).

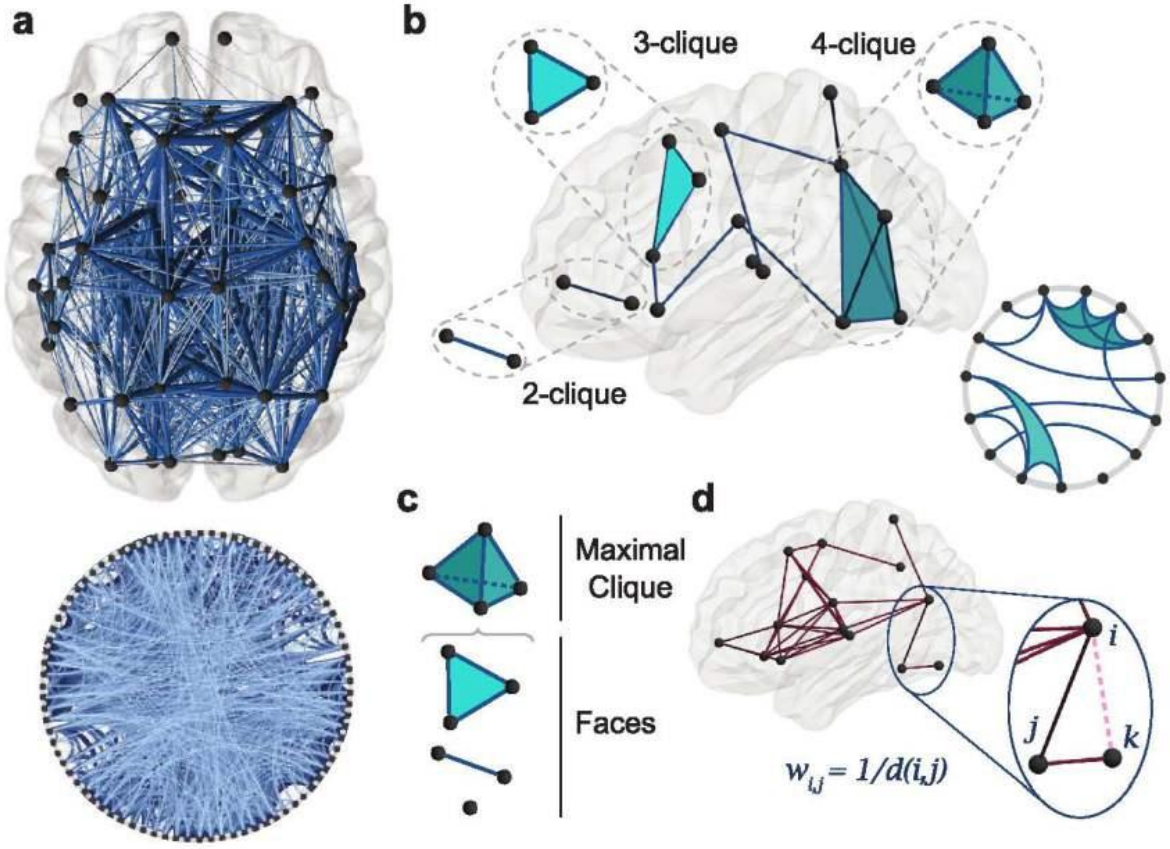
> This recursive process depends, at its base, on the most elementary distinctions possible for character strings. No mathematical calculations are performed. We should mention that distinction-making without mathematical computation is ubiquitous in natural neuronal processing.

Let us look at the patterns….

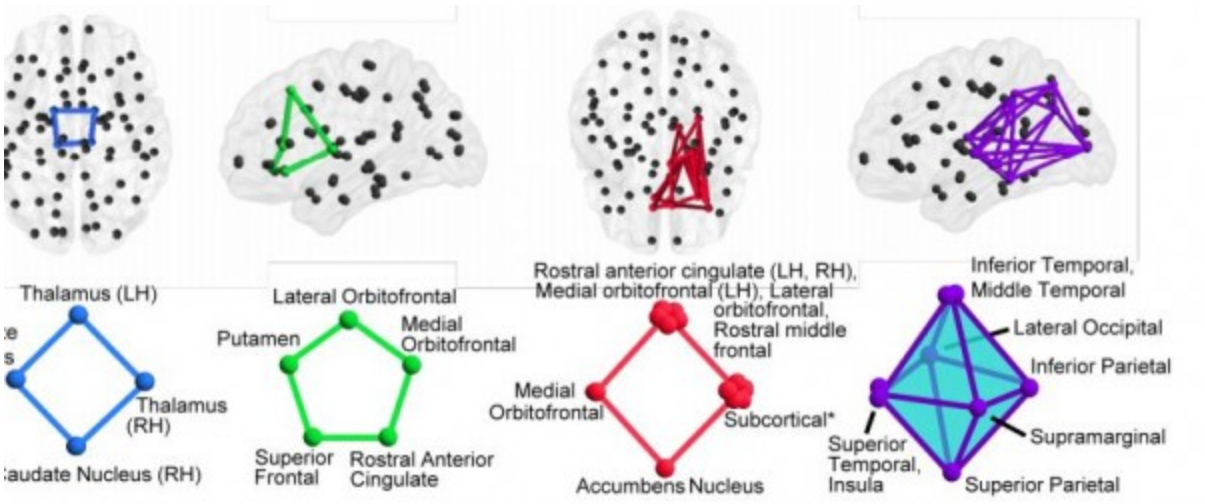
Looking at the flow of signals in the brain, we note the patterns of synchronization across many cortical columns.

Videos of Brain Synaptic firing patterns.
https://www.youtube.com/watch?v=yy994HpFudc
https://www.youtube.com/watch?v=toJX5LfFDQA
https://www.youtube.com/watch?v=ZQTqvv6HHHY

Topological view:



From anthonybonato.com/2016/08/31/algebraic-topology-and-the-brain/



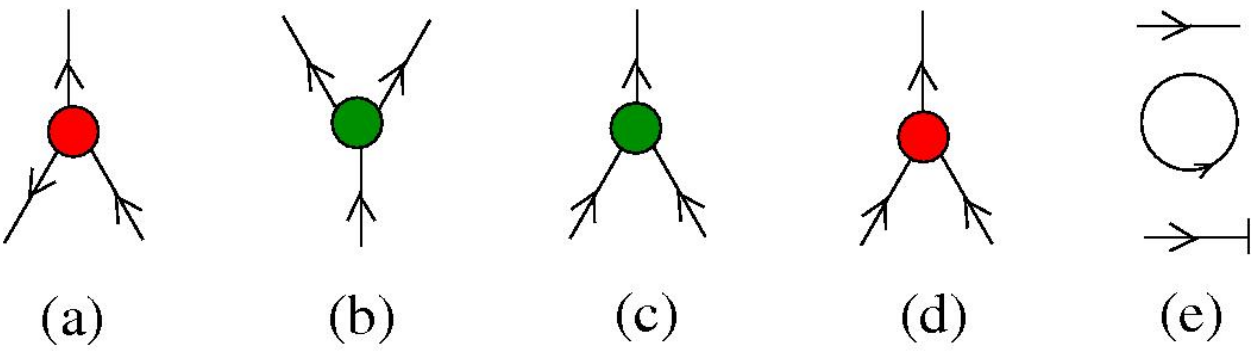
From www.technologyreview.com/s/602234/how-the-mathematics-of-algebraic-topology-is-revolutionizing-brain-science/

GLC discussion: clips of GLC animations
www.youtube.com/watch?v=UDi_eWa_Z4Q
www.youtube.com/watch?v=Zzsp5TWcAvQ
https://www.youtube.com/watch?v=lMH8I-woAiU

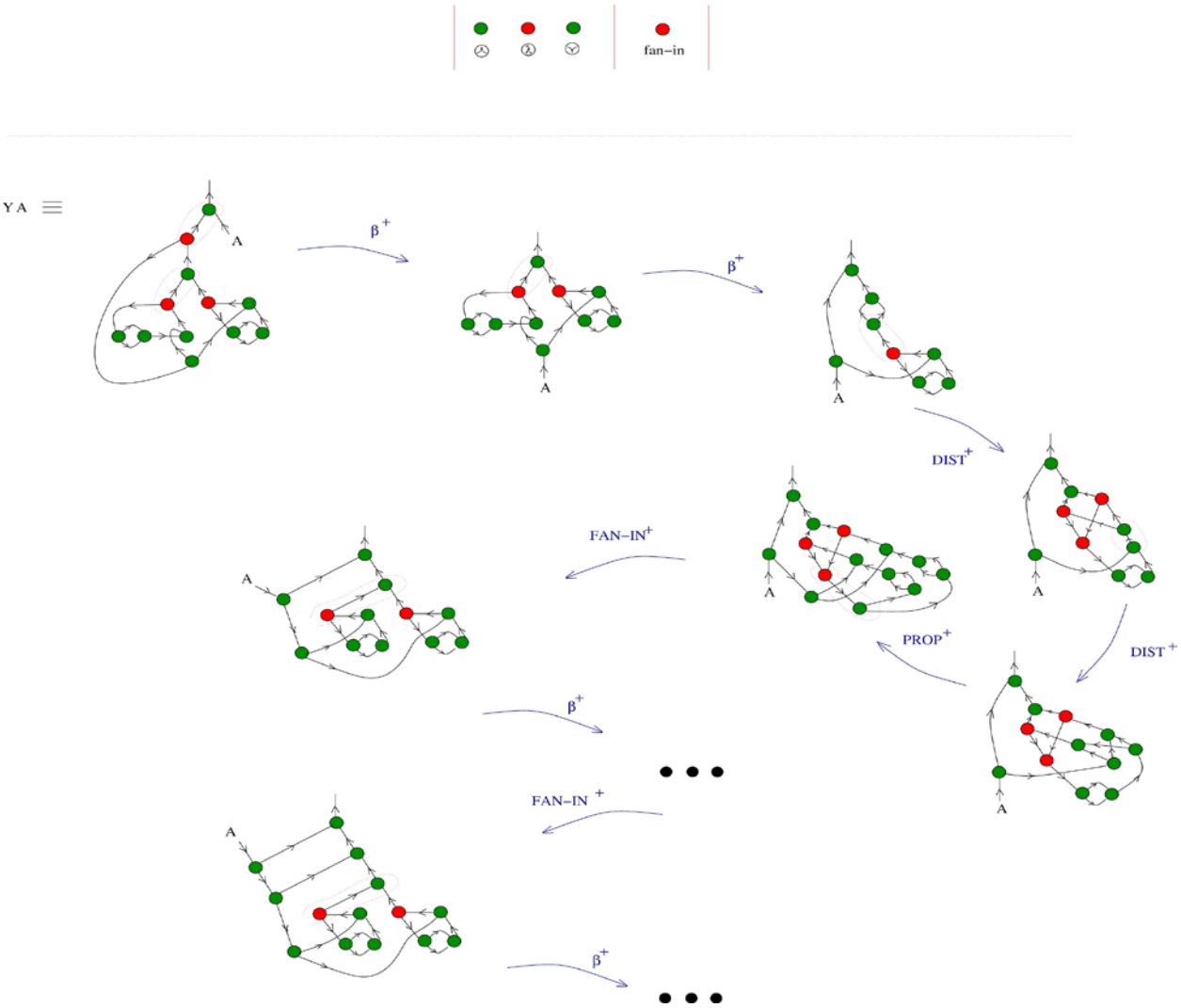
It occurred to me, when I first found Marius Buliga's work, that the Graphic Lambda Calculus was remarkably similar to what we see in the patterns of synchronized neuron firings. Could it be that this is a way that the brain is processing an RD based computation? I went on to investigate whether it possible to implement GLC in networks of devices but the details of that is outside the scope of this talk. 😊

What is GLC?
Graphic lambda calculus is a computational formalism that uses a set GRAPH of oriented, locally planar, trivalent graphs, with nodes decorated with functions (and also connectives, loops, and a termination node) that can represent any lambda calculus expression. Lambda expressions are instances of mathematical logic and computer science for expressing computation by way of variable binding and substitution.

chorasimilarity.wordpress.com/graphic-lambda-calculus/



To understand how GLC processing occurs, we need to introduce the concept of graph rewriting.



In computer science, *graph transformation*, or *graph rewriting*, concerns the technique of creating a new graph out of an original graph algorithmically. It has numerous applications, ranging from software engineering (software construction and also software verification) to layout algorithms and picture generation.

Graph transformations can be used as a computation abstraction. The basic idea is that the state of a computation can be represented as a graph, further steps in that computation can then be represented as transformation rules on that graph. Such rules consist of an original graph, which is to be matched to a subgraph in the complete state, and a replacing graph, which will replace the matched subgraph.

This rewriting process can occur asynchronously and concurrently to overcome the problem of the nonexistence of perpetual global clocking. For more detail on this, we note how when we have a network of mutating connections with a variable signal delay, there is a possibility that spontaneous correlations can occur that are almost simultaneous in time. We call this opportunistic synchronization.

This takes us to the concept of Asynchronous Cellular Automata (ACA)
en.wikipedia.org/wiki/Asynchronous_cellular_automaton
A guided tour of asynchronous cellular automata

In the case of ACAs, there is a possibility that patterns will emerge that happen to be synchronized in time. If additional layers of RD processing can act on these as they occur, we obtain instances of opportunistic synchronization. This may be a temporal form of RD process that we might want to look into further, as it would connect directly to the GLC.

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Bridge to Recursive Distinctioning and Bisimulation

Philosophical Concepts

Entities are the products of processes. We can model a process as a stream that, like a current of water – the very thing that inspired Heraclitus – can merge and diverge and most importantly, can form whirlpools, cycles or recursions of interactions.

All interactions between entities can be represented as concurrent processes and, as such, can be seen as organized into orderings to *simultaneous givens* or *sequential givens*, as per Kant's idea.

Lou states the basic idea of RD as "a recursive process that writes the distinctions at time *t* into a new pattern of distinctions at time *t* + 1."

This act of taking distinctions recursively leads us to an alternative way of thinking of information.

Following Bateson's idea, we define a bit as the minimal distinction between two entities that makes a difference to a third entity. A distinction could be quantified as a failure to match a pair of bits in any interaction process; we see this in the case of pattern recognition. Computation is the processing of bits and functional relations between bits. Marius Buliga has shown that GLC is Turing universal. Has it been shown that RD automata are Turing universal? This is an open problem in my research so far, but given the large number of examples of CA that are Turing universal, it seems likely.

There is a way to tie RD directly to computation by considering how one can relate pairs of computational processes to each other. This is the concept of bisimilarity and bisimulation. The relations between computations can be captured in the concept of bisimulation. If a pair of computational processes are such that one can exactly simulate the other in the sense that the simulations of the transformation of input bits (and

functions) and output bits (and functions) match up, we have an equality relation between computers: bisimilarity.

6. **Moshe Klein and Professor Oded Maimon** (Skype Presentation from Tel Aviv University), "*Axioms of Soft Logic*".

Readers can contact Moshe Klein to request the current version of the Axioms of Soft Logic Presentation at: mosheklein@mail.tau.ac.il

7. **Two Future Projects**

a. Recursive Distinctioning Book Planning. The following Motion was approved:

   That this RD Team agrees to launch the first RD book project with the World Scientific Publishers.

   Drs. Isaacson and Kauffman will draft the design and contents. Dr. Bob Krone and Dr. Gordon Arthur offered their services as editors.

b. An IBM Watson AI project be investigated to be a foundation for Recursive Distinctioning knowledge and references for future research.