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SetDirectory[ParentDirectory[NotebookDirectory[]]];
Needs["SSSiCv100`"];
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SSS (Sessies): This thought-provoking material was put together by Lucas Valenca. Comments welcome!

Sequential Substitution Systems

Professor, this was intended to be a entry for the Sequential Substitution Systems Note but there is a lot of unnecessary information and personal opinion. If you feel that any of the information is appropriate for the Notes online then wonderful, otherwise if you feel the narrative format needs to be modified for more clarity especially in the phrasing then I will do so. I still am unable to edit the Note online so I will defer to your judgment on what to include. Please filter any information that is superfluous. Thank you to my most formidable thinkers.

Edit to your liking! Constructive criticism required.

To begin the conceptualization of sequential substitution systems (SSS; "SESSIES"), designation of a template or framework upon which these "events" occur should be established. The concept of cellular automaton is closely associated (if not synonymous) with SSS, however I am reluctant to elaborate further on the similarities and differences at this time since I am still acclimating to this field of science. Nonetheless, I feel as though cellular automata needs to be mentioned within the context of sequential substitution systems for clarity. I refer to a statement by Prof. Caviness under the NKS notes that "Sessies" are much harder to derive enumeration schemes than elementary cellular automata. It is my understanding that cellular automata precedes SSS's, at least in a historical sense if not procedurally as well. Due to the elusiveness and abstractness of this science and from the influence of Southern University's liberal arts ideology of education, I was forced to briefly explore the history, philosophy and origins of these ideas. While the time scale can extend as far back to 6th century B.C. with the Ancient Greeks like Pythagoras and Parmenides with contemporaries like Aristotle and the Socratics asking, "What is reality?", "What is the explanation of the world?", "Is there one fundamental substance that underlies reality or many?", the direct relevant history originates around the 1940's with John von Neumann (a special note should be made for Gottfried Wilhelm Leibniz who explored principles of continuity and homogeneity in the 1700's, among many other important figures). A brief history will be cited from literature.

[Note: It is quite true that ECAs (elementary cellular automata) can be thought of as a simpler version of sessies, and in fact Stephen Wolfram's ECA enumeration gave me the first impetus towards creating an enumeration for sessie rulesets, although this was a much harder problem. Also note that if sufficiently complex, any of these systems can be represented in terms of the others, as, for example, the well-known theorem that any computational process can be modeled using Turing Machines. --KC]

"Philosophy begins with wonder… At first they wondered about the obvious difficulties and then they gradually progressed to puzzle about the greater ones, for example, the behavior of the moon and sun and stars and the coming to be of the universe"
-Aristotle

To begin, cellular automata refers to an idealized physical system in which spatial and temporal states are discrete, with physical quantities retaining only a finite set of values (Chopard & Droz, 1998). To reiterate, a more in depth analysis of cellular automata will be deferred to Professor Caviness as my knowledge is limited. In the 1940's John von Neumann wanted to create a machine able to emulate complex human brain functioning with enough competence to solve complex problems; implicated in this idealized machine were the aspects of self-control, self-repair, and self-replicating mechanisms, of which Neumann considered necessary for defining the properties of this hypothetical system (Chopard & Droz, 1998). The emphasis of Neumann's inquiry was to establish a logical abstraction of self-reproductive mechanisms, yet not within a context of biological processes (Chopard & Droz, 1998). Neumann postulated a fully discrete universe derived of individual "cells" characterized by intrinsic states whose composition is that of a finite number of information bits (Chopard & Droz, 1998).

Furthermore, these systems of cells evolve in discrete time steps, with changes to the internal states of each cell; the nature of the transitions, and hence the evolution of the system, is dictated by "rules" of which are a function of neighboring cells – the changes in states occurring simultaneously and in synchrony (Chopard & Droz, 1998). The discrete dynamical systems postulated by von Neumann have been elaborated extensively since and have retained the description known as cellular automata. Von Neumann was able to derive an evolution rule for a self-replicating structure made up of elementary cells which attained the "coding" scheme capable of reproducing identical cells – the consequent von Neumann rule possessed the property of universal computation (Chopard & Droz, 1998). The consequences seemed to be that an initial configuration of cellular automata could be programmed by simple rule sets to generate solutions to complex digital algorithms (Chopard & Droz, 1998).

Stephen Wolfram, in the 1980's, recognized the capacity to exhibit complex behaviors, often evident in continuous systems, in terms of a simpler framework using the concept of cellular automata (Chopard & Droz, 1998). As Wolfram considers space and time to be discrete entities, the framework of cellular automata is a possible template on which to model behavior of physical systems in the apparent universe; a limitation that is endured by use of continuous models for describing mechanics, according to Wolfram (Beard, 2012). This is likely the result of quantum mechanical (QM) phenomena evident in physical systems – QM is the theory that describes the physics in the universe in terms of discrete entities (or quanta). Whether this theoretical label of discreteness refers to the (1) states of physical systems (confined or open/unrestricted), (2) nature of any underlying substance (consider the concept of fields), or (3) just to the changes or transitions within the two previously defined contexts, is beyond my knowledge of quantum mechanical theory but can be clarified by our virtuoso Prof. Caviness.

Remember that according to Wolfram, space and time can be viewed as discrete: “There are some aspects of the universe – notably the stricture of space and time – that present-day physics tends to assume are continuous. But over the past century it has at least become universally accepted that all matter is made up of identifiable discrete particles” (Wolfram, 2002). I have not read enough of NKS or studied enough advanced physics to confidently discuss the quantization of fields. The particle vs. field theories are a relevant topic in modern physics. I personally am partial to the quantum field theory explanation of the universe: 6 variations, 4 force fields and 2 mass fields (bosons and fermions). A description or value for quanta of discrete time is of particular interest but will not be discussed at this time.

Shifting back to SSS modeling, I think it is appropriate to consider the internal states of "cells" and the changes that are incurred on the basis of rule sets, as mentioned previously, as simple behavior or transformations, such as "on" -> "off" or "created" -> "destroyed" or "0"-> "1"; the inverse/reciprocal states are also possible, eg. "destroyed"-> "created". It would be reasonable to expect that some features of two identical cells would be different; these variances can be quantified by a scaling and tagging system that Prof. Caviness has outlined in several discourses that will be discussed in subsequent sections. Is it appropriate to say that internal cell states have binary properties – analogous, for example, to the magnetic spin states of electrons? Are there multiple "cell" properties each that have binary components or is it just a cell with only two possible states or behaviors, eg. "created"-> "destroyed"; "on"-> "off"?

It is important to note: a collection of cells can be regarded in several ways (eg. string format, s-format, tagged s-format) and the display of cell sequences +substitutions (evolution of network) can be represented in multiple views through Mathematica software. (?)

So, let's attempt to make more sense of these abstract concepts. Consider a horizontal row of 3 cells which can be represented as alphabetical letters : "AAB". This is an initial condition; the selection of origin cells can be arbitrary. The arrangement of these cells can be defined as a string. Hence, there is an initial string sequence of cells which will be subjected to simple substitution rules with each substitution "event" representing some measure of time interval.

The basis of sequential substitution systems modeling is representing the transitions (substitutions) of the internal cell states, and within the SSS context, the transitions are either "creation" or "destruction". It could perhaps be disputed that a third state of existence exists, as in neither creation or destruction occur. Wolfram seems to imply that it is the signal propagations that are most relevant, an idea that will be elaborated upon later.

The changes, which correlate to the substitution functions, that occur along a string of cells are dictated by simple substitution rules, eg. if a rule states "A"-> "ABA" and a cell "A" is present on an incident string then substitute cell "A" for a series of "ABA" cells. The strings are analyzed from an orientation that begins at origin (0,0) on a Cartesian plane and proceeds in the (+) x-axis (in simplistic terms left-to-right). Is the order of analysis modified at all for higher-order dimensionality? It would be reasonable to expect that left-to-right analysis fails in certain structural scenarios, unless I am misinterpreting the analysis step as it occurs in terms of order of time-steps. If the string analysis identifies a sequence of cell(s) upon which a rule can be applied, it will operate the substitution. After a rule has been applied and a substitution has occurred, the incident string is no longer able to undergo further substitutions. If a string has been analyzed and the assigned rule set cannot be triggered then a second rule set can be employed if applicable. The network will generally "die out" and growth will stop if there are no more applicable rule sets based on the available sequences of cells.

To restate, following a substitution "event", the newly formed output string of cells will then be analyzed for another potential substitution event to take place on the basis of a different rule set. The expression of rule set activation with a consequent substitution event, hence a change in cell sequencing and new string formation, can be defined as "nodes". These nodes are representative of time-steps and correlate to the evolution of a network of strings. It is appropriate to consider nodes as the progression of substitution "events". It is important to note that substitution events can only be designated as "creation" or "destruction" of cells. The network formation propagation, as a result of rule-mediated cell sequence substitutions, should demonstrate causality. Mathematica software can display the evolution of substitution events as a causal network model. The orientation of nodes correspond to the series of substitution operations within the synthetic universal system. The concept of "strings" is modified within the causal network illustration as it no longer corresponds to linear sequencing of cells but rather to the time-steps between nodes in which a substitution has occurred (?) – the details of network layout will have a designated forum section as the critical concepts of dimensionality and pattern recognition will have to be introduced.

This is solely an introduction and several important elements of sequential substitution systems, apart from casual networks, dimensionality, and elementary cellular automata, have not been included. Revisions are necessary. The brilliance of Prof. Caviness' ALL possible enumeration cases was not discussed.

Specific aspects that will be elaborated on with further revisions: emphasize purpose of SSS study, initial conditions, order of rule set implementation, scenarios without valid rule operations, restrictions on applying multiple rules per node, conditions and violations of causality, Caviness' programming of ALL possibilities, illustration of SSS iterations, delegation of measuring all possible cases to Mathematica software, filtering redundant/"boring"/uninteresting cases, mechanisms of deriving network formation from SSS/enumeration indices, substrates of cause and effect within context of SSSs, human analysis and interpretation of network structure/orientations, locality of substitution effects, spatial regions of high node density, exploring more of Amy Beard's paper, Christen Case's work and Prof. Caviness' work, different rule sets producing morphologically similar network layouts, frequency of significant changes: early and late "list" outcomes, philosophy of high complexity derived from simple rules, number of neighbor cells and effects on network evolution, requirement of creation and destruction for evolution of networks, and manipulation of rate of growth through rule set modification.

And as Prof. Caviness has emphasized, particularly intended for other forum Notes: finding significant sequences/patterns in enumeration indices, programming software to only bother human with noteworthy network models, DIMENSIONALITY (fractal and integer), and implications in the real world, that is the world apparent to us as well as beyond.

I wrote this in a narrative format but I can condense it into distinct general points for more clarity. You know how it is easy to get carried away with this…

Conceptual/Philosophy Comments

I have been confused with the "scaling" when the software displays the causal networks in what appears to be empty space. Wolfram suggests time is discrete and when we consider Einstein's relativity and ray optics, shouldn't there be parameters for the geometric evolution of the networks? Otherwise there can be critical violations of causality, right? I think I am misinterpreting the causal network display on Mathematica because, for example, when I see nodes 2 and 4 parallel on a y-axis and node 3 ahead of both on the x-axis I cannot see the causality of events. What kind of dimensionality does TIME introduce? I need to review how time is represented in SSS/network evolution. Also, if time is discrete, how can we quantify the time variables? Planck's time? Are there units that are smaller? It seems like the time-steps are all arbitrary in many network displays. Am I making the mistake of attributing magnitude of time to the linear scale of lengths between nodes?

Chapter 9 of NKS has lead me to believe that signal propagation need limits. Is signal propagation the correlate to the substitution events that occur at nodes, of which the sequence of strings are derived to form the network?

"But if we can observe only the causal network for the universe then our information about space and time must inevitably be deduced indirectly from looking at slices of causal networks" (Wolfram, 2002) pg. 517.

"Such locality is built into the basic structure of systems like cellular automata. For in such systems the underlying rules allow the color of a particular cell to affect only its immediate neighbors at each step. And this has the consequence that effects in such systems can spread only at a LIMITED rate, as manifest for example in a maximum slope for the edges of patterns like those in the pictures below (see page 518). In physics there also seems to be a maximum speed at which the effects of any event can spread: the speed of light… And it is common in spacetime physics to draw "light cones" of the kind shown at the right (see page 519) to indicate the region that will be reached by a light signal emitted from a particular position in space at a particular time. SO WHAT IS THE ANALOG OF THIS IN A CAUSAL NETWORK?" (Wolfram, 2002).

"In the case of substitution systems for strings, locality of underlying replacement rules immediately implies overall locality of effects in the system. For the different elements in the system are always just laid out in a one-dimensional string, with the result that local replacement rules can only ever propagate effects to nearby elements in the string – much like in a one-dimensional cellular automaton." (Wolfram, 2002) pg. 519.

"If one is dealing with an underlying system based on networks, however, then the situation can be somewhat more complicated… there will typically be only an approximate correspondence between the structure of the network and the structure of ordinary space. And so for example… in connection with quantum phenomena – there may sometimes be a kind of thread that connects parts of the network that would not normally be considered nearby in three-dimensional space. And so when clusters of nodes that are nearby with respect to connections on the network get updated, they can potentially propagate effects to what might be considered distant points in space." (Wolfram, 2002) pg. 520.

Response: Is this the location of entangled particles? Existing in dimensions that have no indication of capacity to sustain other "life-forms" or variations of a second-life. Maybe? Nonetheless, what significance is there in high density, highly concentrated areas of nodes? Does this suggest high frequency of substitution events? Isn't frequency synonymous with time, more specifically an important time unit in wave functions – the nature of behavior that seems to describe everything?

"But ultimately the whole point of causal networks in that their connections represent all possible ways that effects propagate. Yet these connections are also what end up defining our notions of space and time in a system… So what about a more complicated causal network? One might imagine that its connections could perhaps represent varying distances in space and varying distances in time. But there is no independent way to work out distance in space or interval in time beyond looking at the connections in the causal network. So the only thing that ultimately makes sense is to measure space and time taking each connection in the causal network to correspond to an identical elementary distance in space and elementary interval in time." (Wolfram, 2002) pg. 520.

Response: So, to revisit the idea of scaling in causal network layouts: is there any defined scaling or coordinate system that influences the propagation of string sequences/network evolution? Are integer values of a metric unit of measurement used? Would modifying the scale to a constant known to be relevant in our physical world make any discernable changes: pi, e, Planck's constant, permittivity of free space, etc.? Or is the scaling completely irrelevant as Wolfram states it's the connections and signal propagation that is most important. Also would designating a coordinate system interfere with Wolfram's vision of representing ALL possible ways that effects propagate – stating that this is the whole point of causal networking? "All possible ways that effects propagate": is this analogous to the "ALL possible cases" Prof. Caviness has generated?

"…consider the concept of motion… as we have seen in discussing causal networks, it is in general quite arbitrary how one chooses to match up space at different times. And in fact one can just view different states of motion as corresponding to different such choices: in each case one matches up space so as to treat the point one is at as being the same throughout time."

Maybe?

-Lucas Valenca

Beard, A. J. (2012). Determining the Dimensionality of Causal Networks Based on Growth Derived from Sequential Substitution Systems. Southern Adventist University, Department of Physics. Collegedale: Independent Publisher.

Chopard, B., & Droz, M. (1998). Introduction/Brief History/Self-reproducing systems. In B. Chopard, & M. Drox, Cellular Automata Modeling of Physical Systems (pp. 1-4). Geneva: Cambridge University Press. Retrieved from catdir.loc.gov/catdir/samples/cam031/97028284.pdf

Wolfram, S. (2002). Fundamental Physics. In S. Wolfram, A New Kind of Science (pp. 481-537). Chicago, Illinois: Wolfram Media. Retrieved from www.wolframscience.com/nksonline/

Follow-up musings by Lucas Valenca:

The more I study biochemistry and the most fundamental units of life, I become more convinced of the necessity of applying your causal networks theory//algorithms to any domain of science. I may be mistaken, but one of the essential implications of the causal networks model is the potential to predict behavior in a four-dimensional framework (consistent with the conditions in our physical world). The value of your science in physics//theoretical physics is substantial, but I know there is a role even beyond into biomedical sciences. Just like diagnostic medicine is applying A Einstein's motion equations proposed in the Annus Mirabilis papers//Annalen der Physik journal of 1905 to precisely modify settings using nuclear magnetic resonance imaging techniques to construct a representation of the micro-architecture of neural circuitry specific to the inherent motion properties of a distinct tissue type, I know there is extensive need for your science in generating novel diagnostic and therapeutic approaches in medicine. Imagine when your science will be able to accurately model the pathogenic progression of disease? Physics is the essence of life. Just as causal networks will be able to model the patterns of growth for the fabric of all spacetime - can the theory not then be applied to cellular growth and differentiation?

As usual, I am getting ahead of myself and the intentions of your science. It is a matter that I think of daily regardless of the time since we last had a formal meeting. Have you since discovered the core ‘rulesets’ that confer a basic framework for 4-dimensional growth? Do you think there is a unifying ruleset that creates a single fundamental ‘substance’ from which all other physical existence arises or are there discrete rulesets coding for specific types of physical substance, such as discrete rules for fermions and another for bosons? Can two causal networks interact with each other - or rather can two segments of a causal network interact? Assuming initial conditions (+ruleset) that generate decent, “interesting”, sustainable growth - should the pattern of manifold (network) growth be isotropic in character, as in homogeneous uniformity in all spatial orientations in reference to it’s growth//expansion, would it be meaningful if the trajectory of growth deviated from isotropic-directional preference and assumed an anisotropic proliferation pattern? Would it be meaningful to be able to segregate rulesets that demonstrated ‘anisotropic deviations’ from any sort of uniform, spatially-unbiased core manifold (network) growth? Would this represent a decrease in the entropy measure of the system? Could this be representative of symmetry-breaking phenomena?

In regard to your question last summer: the fate of singleton rulesets; the options were cease to exist or form one-dimensional, repeating networks - is there the option for some variation of behavior as previously described? I need to review the nature of the fluctuations outlined in the last assignment, defined as (pseudo-)repeating, as I am still having trouble conceptualizing this 'SSS' state, should there be an opportunity to continue in the project.

2016-06-20:

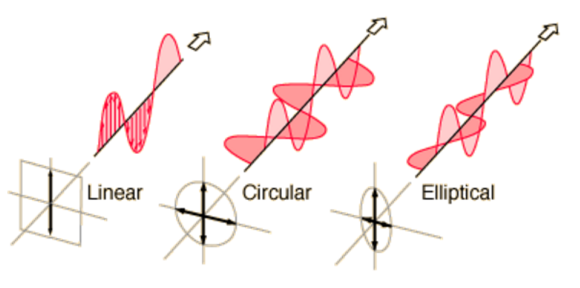
Lucas Valenca's philosophical musings triggered by the construction of n-dimensional networks, for any positive integer n :
[Caution: LV is a little excited here, please take any comparisons he makes between me and great thinkers through the ages with a large pinch of salt! But his excitement is contagious, and he makes us think way outside the box, so here goes:]

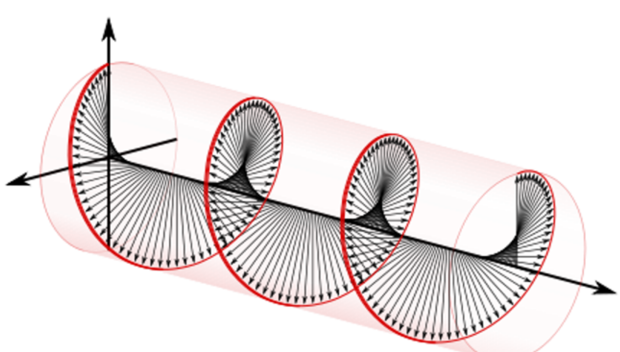
To the most formidable thinkers,
Professor, I appreciate the most recent ‘cc’ as the timing corresponds to completion of MCAT attempt round-one; I briefly looked into the extraordinary progress you all have made and…
ARE YOU SERIOUS?
ABSOLUTELY INCREDIBLE.
As I prime my thinking to the ‘SSS’ frame of reference, I notice that you (+et al.) have exceeded the mental activation barrier of ‘n-dimensionality analysis’ and further derived a more coherent methodology to filter relevant network schemes intent on study. This was always inevitable as Caviness equates to great thinkers, such as James Clerk Maxwell, Niels Bohr, Hendrik Lorentz, Archimedes (of Syracuse),

Immanuel Kant.

Professor, I may be mistaken, but didn't you predict this approach to inducing dimensionality years ago – the single-cell-addition method? You once added a character to introduce rule-sets coding wave-like behavior by fluctuating the string-length to represent oscillatory features in node propagation. I believe it was met with scrutiny on the basis of deliberately altering the course of network growth; early on, the experimental standard was total deferment to the software in running iterations without bias. To run 'all possible cases' was the underlying tenet and with it the culprit for most programming and computational deficits. So the idea was largely dismissed – not necessarily by you –, though I find it referenced frequently in my notes as I found conviction for its validity for in it was the only unequivocal representation of SSS-modeled physical action permitted so early in the project. Velocity correlated to the angle of oscillations whose composition was node evolution determined by ruleset. A maximum 'height' associated to speed of light. Suddenly there existed some INVARIANCE.

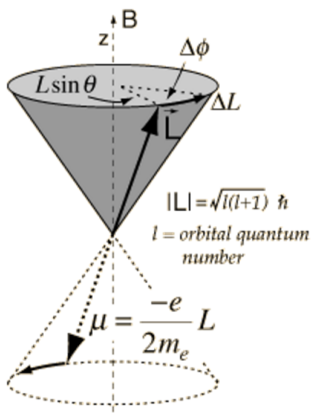
Does not the 4-D network example (OneNote 13.6.16) invoke resemblance to plane-polarized light propagating along a transverse axis but also rotating about the polarizer axis (perpendicular?). As my mathematics is essentially non-contributory, I find myself struggling to reduce the physical world to a 4-D actuality when considering, for example, nuclear gyromagnetic resonance spectroscopy, for cases undergoing external-field precession of the atomic magnetic moment. The addition of 'motion' into the conceptual frame, whether rotational, vibrational or translational, is confusing as the thermodynamic-quantum interface is so unclear: was not Einstein bothered by the congruity of thermodynamic equilibrium in an environment of continuous quantum-photon spectroscopic exchange. Did this intellect not translate into conception of light-amplification by stimulated emissive radiation (LASER)?

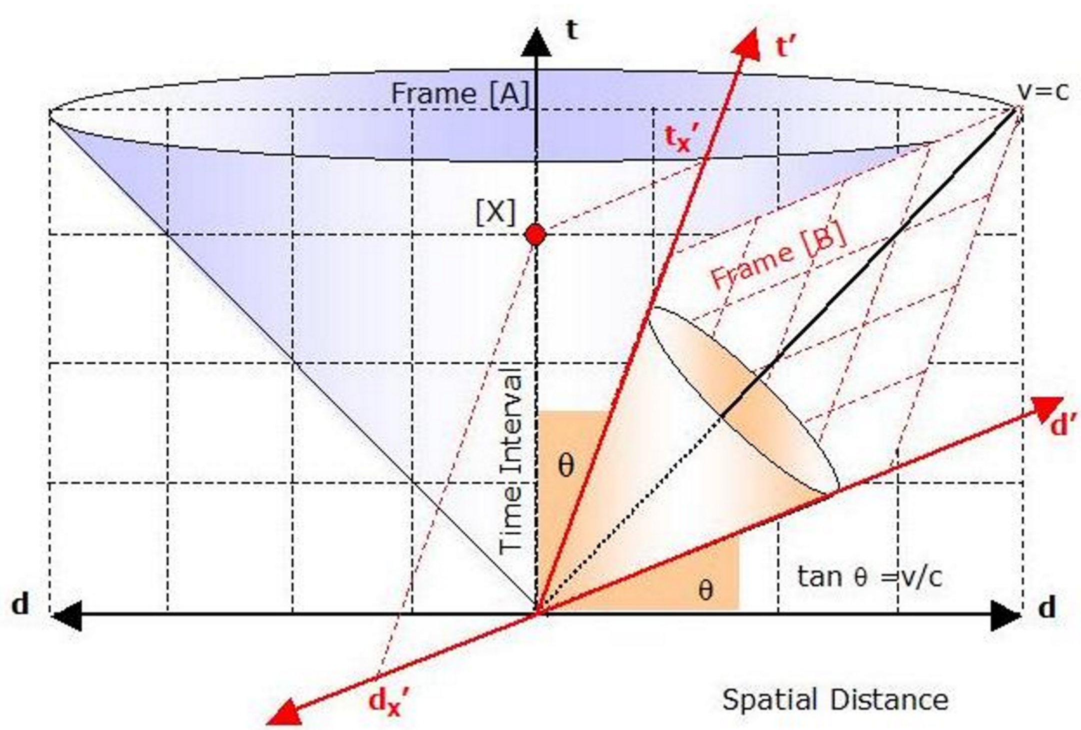




Is oscillatory or periodic behavior relevant in the SSS template – whether in appearance-frequency of dimensionality-factors (addition of characters) or in the enumeration sequence or in the actual net-

work morphology? Does not everything on earth condense into its most simple, harmonic oscillatory elements? Even heat can be reduced to its quantum essence – vibrational-operator phonons (?).
Does the helical trajectory of plane-polarized photons contribute any dimensionality to an otherwise purely circular, static origin? Einstein's light-mirror "clock" in the Special Relativity model is purely one-dimensional (up-down), yet upon acquiring translational motion the pathway of light is undeniably two-dimensional for the inertial-frame observer, as such, is it the motion that confers the dimensional modification? Does the Lorentz-factor transformations for relativistic effects impose any incongruity in spatial dimensionality? Restated: is modeling oscillatory patterns relevant in the SSS 'toy'-world? Conical topology (as the 3D example illustrates on OneNote) can represent oscillatory phenomena, ex. dampening in circuits, or aperiodic in Einstein's famous light-cones.

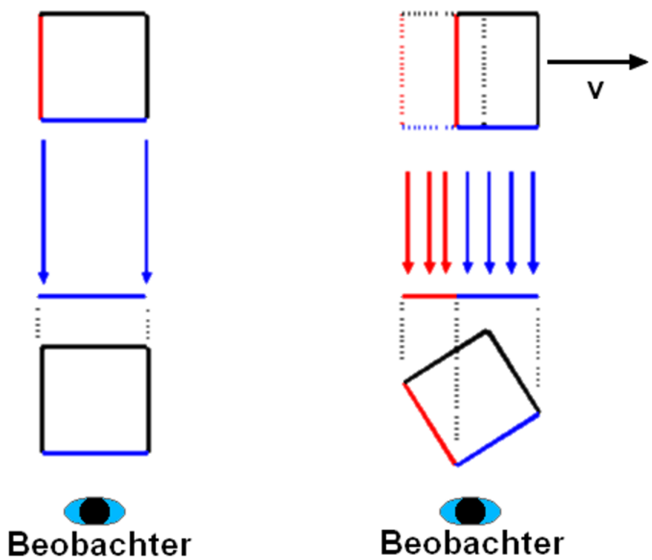




The dimensionality of time – does time oscillate?

Will Prof. Caviness find rulesets corresponding to the symmetries of motion or the fundamental forces, such like proportions of an electromagnetic radiative nature?

What is the relationship between dimensionality and motion?



***Lorentz-factor transformation image distortion at relativistic speeds.

An informatics literature piece discussed "neighborhood-effects" in the SSS template – universality vs localized network schemata. Professor Caviness has previously discussed "edge"-effects or network regions with unique interactive node-pattern features, such as connectivity ratios or some distinctive configurational trait.

What are the laws for overlapping in the SSS domain? As Caviness avoids Einstein-causality violations in temporal context, how will the logical network respond to a ruleset ordering a creation event in the precise spatial vicinity where prior node activity has established residence of upstream string-elements? The enumeration 'view' is restricted in linear progression, but for an unrestricted network oriented in an open-ended coordinate system, theoretically are there not incompatible scenarios or contradictory growth orientations – assume a highly-evolved network-state with a magnitude of iterations (node events) in tera-scale order exhibiting extensive growth symmetry. Can linear sequences be coded in ruleset to transition towards a growth-trajectory that would 'back-track' to the site of the original, incident string or rather an earlier creation event? The rudimentary twofold-event condition requisite for generating a causal connection – if early creation events are only destroyed significantly late or distant in the enumeration sequence, a hypothetical linear structure would require a 'bend' or distortive shift to achieve the destruction event without imposing upon the orientation planes of previously arranged nodes.

What are the determinants of network (node-) mechanics?

Is it possible to localize a high-density region with causal (node-) connections? Analogous: second thermodynamic law permits energy-concentration against the intrinsic entropic motive for dispersal bias.

As explicit n-dimensionality can be differentiated, what is the defining feature of a 3- vs 4- dimensional manifold; as consistent with our physical world would require defining one specific dimensional component as equivalent to some expression of time – what is the SSS-time correlate in a perceived static network template? Or have I overlooked the big picture and disregarded the reality of rule-set evolution as the basic time unit?

Professor, are you holding meetings for the rest of the summer? Is it permissible to attend if so?

Exploring the Space of Substitution Systems.
http://www.complex-systems.com/pdf/22-1-1.pdf
-lv

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2019.02.14

Happy Valentine's Day to all my fellow formidable thinkers,

Much of the epistemological value I can offer is of the philosophical nature as my mathematical &physics prowess is quite weak. My motivations are mostly for preservation of living systems, and by that I also mean efforts in reducing human suffering. The involvement in Dr./Maestro Caviness' project has expanded my thinking and cognitive flexibility to think about science in very nuanced ways. For ex., the acknowledgement that quantum behavior plays a critical role in human physiology has forced me to re-evaluate classical conventions in disease theory. Like, for ex., the processes that give rise to 'heat' and thermal motion in the setting of the central nervous system (human brain) should be expanded to include quantum-mediated operations, like spectroscopic-exchange operations and molecular (i) vibrational /(ii) valence electronic-transition /(iii) rotational excitation, instead of defaulting to a classical thermodynamic model that emphasizes translational motion operators in the etiology of heat/thermal dynamics. Neuron cell bodies (central nervous) are quite restricted in their translational motion freedom (despite processes of neuroplasticity/Hebbian synaptic plasticity), thus in regard to thermodynamic exchange mechanisms we should expect a major reliance on radiative modes of thermal dissipation, although I do not ignore the role of convective/conductive interactions between the aqueous interstitial compartments that suspend(?) the cellular constituents of the parenchyma.. My point is that we need to appreciate all possible contributors to the thermal environment in the brain. My goal in life is to construct a 'magnetic brain cooling' device that will reduce the massive pathogenic severity in traumatic brain injury (TBI), because currently medicine only offers supportive measures in the care modalities for TBI. My premise is based on the logic that conventional cooling methods AND a magnetic-based approach can inhibit/reduce the molecular decoherence that may be a predominant contributor to disease progression. So, yes, I would like to 'freeze' the pathology of TBI enough so that it becomes manageable, because otherwise the synaptic architecture will breakdown and the neuronal networks will dissolve and then patients transition into vegetative (coma) states or wake-up with massive functional and cognitive disability.. So, it is a case of maximal human suffering.

These ideas have origins in Caviness challenging our intellectual potential with things like network analysis and the construction of complex, intelligent systems based on simple, rudimentary conditions (ex., substitution 'rule-sets'). We become forced to appreciate the most fundamental constructs of a system, thus I became compelled to consider that even seemingly-negligible physical action, like vibrational excitation of covalent bonds in a molecule, could be meaningful, even in the context of disease that plays out in the MAXIMALLY-thermodynamically-stochastic, "noisy", "wet" environment of human biology. Wait, but life is supposed to be a situation of avoiding the decay to equilibrium? Thus, it is the order amidst constant thermodynamic perturbation that captures the elegance of LIFE. I was on the verge of full-blown atheism before I took Caviness' Physics II lecture and I've slowly, but surely, moved into a case of unrelenting conviction for God's existence and His absolutely amazing design.

I apologize, I should be discussing causal network modeling (CNM) and sequential substitution systems (SSS) and I will. I just wanted to illustrate how Caviness' science can be a force for serving humanity and reducing human suffering through maximal-intellectual rigor. We are all privileged to be involved in the work of Professor Caviness.

A few themes that I have been thinking about in the context of CNM/SSS are that of causal inference in network analysis. The role of causality in the SSS regime should be an important topic.

"Causality is fundamental to artificial intelligence. Intelligent systems must choose actions that are likely to bring about their goals, must monitor situations to detect when plans are going awry, and must modify their plans in appropriate ways in response to unexpected occurrences. Intelligent systems must also learn about causal relationships from interacting with and observing their environments. These capabilities require reasoning about, drawing inferences about, and acting appropriately with respect to, cause and effect relationships in the world.

Causality has been a contentious topic in philosophy and the sciences. The intuitive notion that manipulating causes produces changes in effects has been difficult to formalize as a scientifically rigorous, non-circular theory of causation (cf., Woodward, 2001). Another challenge has been the development of learning methods that can distinguish spurious correlation from genuine causation. In recent years, the artificial intelligence and statistics communities have converged on graphical models as a formal language for expressing cause and effect relationships. Causal graphical models augment graphical probability models with assumptions about the effects of external interventions on the probabilities encoded by the model."

This was taken from a paper I read on Quantum Causal Networks and I happened to run into quite a nuanced perspective on quantum mechanics posed by the mathematical/physicist/intellectual wizard - John von Neumann - whom, let us remind ourselves, was referenced earlier in this thread as the original author credited for the concept of Elementary Cellular Automata..

"This paper interprets the von Neumann formalization of quantum theory as an interventionist theory of causality, describes its relationship to interventionist theories popular in the artificial intelligence literature, and presents a new family of graphical models that extends causal Bayesian networks to quantum systems."

I found it quite humorous also that the paper discussed a way to address the ontological grievance concerning quantum-state reductions ("wave-function collapse") through this interventionist-causality theory.

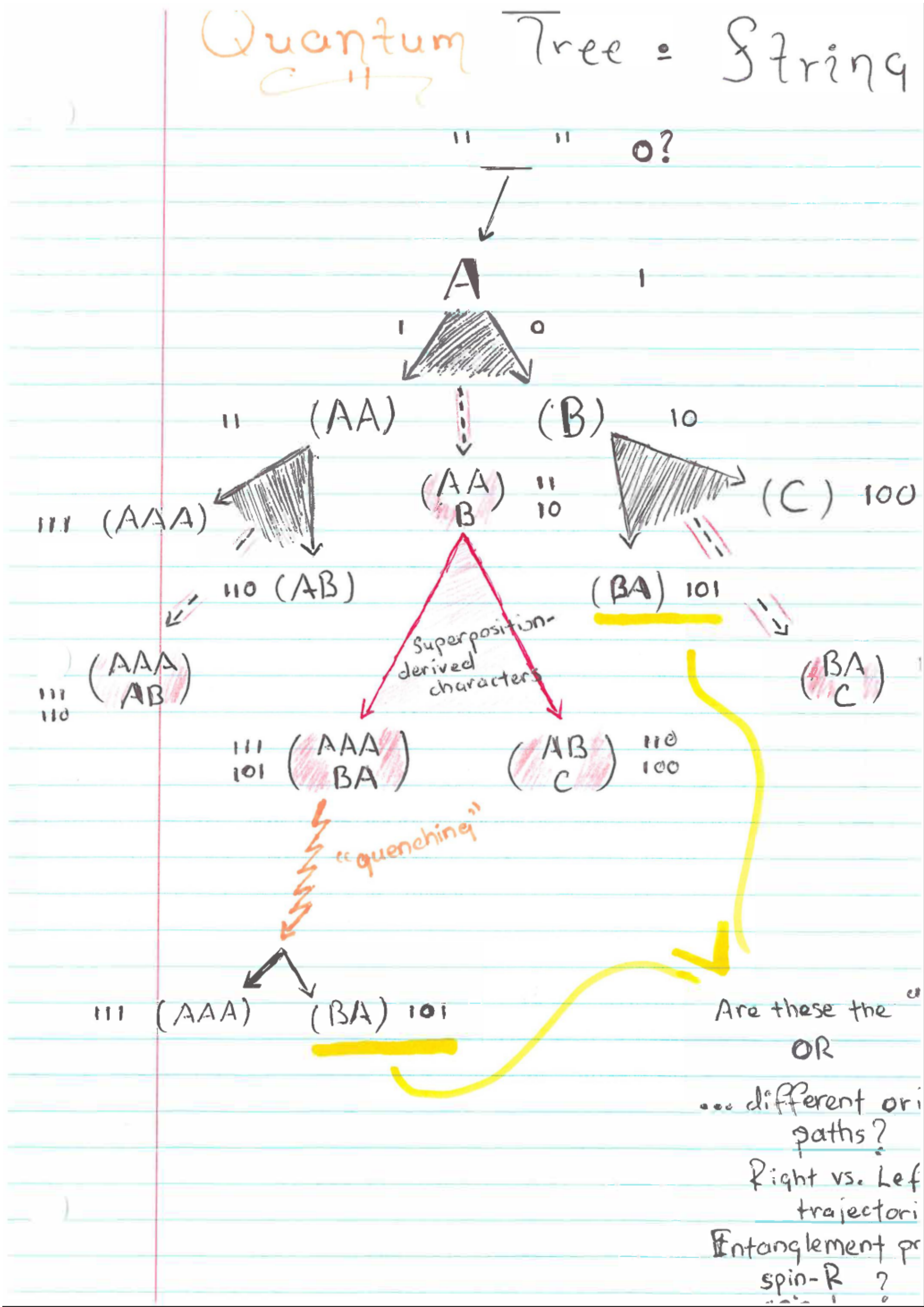
Thus, is causality preservation a desired requisite/condition in the isolation of the most-meaningful SSS-derived networks? What exactly are meaningful causality signatures in the SSS landscape or enumeration construct? The statements aforementioned discussed the role of the environment in causal inference - so, what is the analogue of environment in a (SSS-derived) causal network structure? Is the network evolution generating the environment (whatever that means..) or does the network confront other environmental elements as it grows? Wait.. We are supposed to assume a network growing in some… umm Euclidean/Hilbert space that we would expect to be absolutely VOID of everything except for the existence of the network,…right? So, perhaps a ridiculous question… but, does the actual network create changes in the void environment/empty space around it as it evolves? :S… Ok, it's time to stop.. :)

I would like to mention also, the issue of dimensionality seems to have been addressed extensively in the previous work by Caviness (and students) in recent years and I have yet to catch up with the outstanding progress, but I will.

Thank you for your willingness to read/engage and open-mindedness. Also, I've included an article on Learning Causal Bayesian Network Structures from Experimental Data that was also incredibly interesting.

Quantum Causal Networks: https://arxiv.org/pdf/0710.1200.pdf

Learning Causal Bayesian Network Structures from Experimental Data: https://web.stanford.edu/-group/wonglab/doc/EllisWong-061025.pdf


Quantum Tree : String
" " 0?
A 1
1 0
11 (AA)
(B) 10
(AA B) 11 10
111 (AAA)
(C) 100
110 (AB)
(BA) 101
Superposition-derived characters
111 110 (AAA AB)
(BA C)
111 101 (AAA BA)
(AB C) 110 100
"quenching"
111 (AAA)
(BA) 101
Are these the
OR
... different ori
paths?
Right vs. Lef
trajectori
Entanglement pr
spin-R ?