

Digital Instrumentation and the Measurement of Experience

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Abstract: *A Brief outline of the concept of a Digital Mirror is made. Its proposed use in a High School to College Bridge Infrastructure between high school and college is discussed. Some technical detail regarding a digital mirror is provided.*

Introduction

We briefly outline key elements of a theory advanced as part of proposals designed to end the crisis in American education. The focus is on the crisis's epicenter, which we believe is K-12 mathematics education. The proposals would develop fifty state high school to college transition infrastructures, based in part on entrepreneurial market forces. To justify a public-private project of this nature, we turn to historical traditions and natural science.

Various political concerns are addressed through the use of open markets and state government rather than federal regulation and control. The initial software infrastructure; however, must be developed and then made "ultra-stable" and "provably" secure. This task faces some economic and political barriers.

It is claimed; however, that the technical issues are understood. The infrastructure is to be extended by re-expressing open source software developed to support three-dimensional simulations of avatars, objects and processes.

In addition to stability and security, the technology matches a paradigm found in cognitive science. A linkage is made between cognitive science, social media and a new communication technology. The degree to which these are entangled is remarkable. Underlying this is the notion of coherence and self-identity.

Self-Limitation

We make the observation that self-limitation

is often reflected in private and public decision-making. We regularly limit ourselves. But how does self-limitation come about? Perhaps the feeling of being right is involved.

We suggest that self-limitation, in the math classroom, manifests in the form of an acquired learning disability. The disability is traced to entering freshman students' perception about experiences in math class. A feeling of coherence is seen as part of how self-limitation occurs.

Intellectual consistency found in mathematics should be something sought and appreciated, but is not. Why? Our answer is that a negative perception about "math class" develops due to poor instruction in school. Students accommodate privately experienced failure.

There is a more general condition. Intellectual comfort often hides things from us. We often get it wrong. We sometimes believe something that is not true, and for which there is ample evidence of a false perception. The young mind may develop the sense the math class is a type of social abuse. The perception is both correct and not correct.

Many negative consequences from educational practice might be understood as a psychologically imposed self-limitation consequent from the physical comfort that neural coherence provides. Individuals accommodate poor and incomplete instruction about math by turning off interests and even the capability to see "into" the topic of mathematics. Our

conjecture identifies specific behaviors by society as a whole and within the educational system in particular that creates this disability in almost all of our graduating high school students. The result is that the individual's experience of mathematical concepts is distorted.

In our social system the natural capabilities of our children may be degraded while in school, and by a horrific social media in the form of violent digital games and television. A consistent viewpoint develops so as to cope with this experience. Without understanding that coherence hides information, the individual will not be in a position to overcome the viewpoint.

The Role of Trust in Ending the Crisis

Most students have lost trust in the classroom experience. How is a renewal of trust to be accomplished? The answer we give is that the processing element of cognition, a potential field, must be shifted so that the field is not inhibitory of the student's natural interest. The student must be allowed to develop experience that he or she will trust as beneficial. How the individual perceives mathematical concepts is to be rebuilt even while a strong inhibitory distrust remains deeply seated in the individual consciousness.

As our freshman college students know, they are uncomfortable with arithmetic and set theory. They believe that mathematics cannot be learned, perhaps even that mathematics if learnable, should not be learned. They conform to expectations imposed by social media, schools and peer groups. On the other hand, we have seen democratic practices emerging in current social media use by groups of humans.

The rise of social media involves the notion of trust in real time communicative exchanges, and distrust of traditional media. We propose that real time social media might develop which is dedicated to finding trustworthiness. The architecture we are developing is then suggested as a type of social brain.

Decision Support Systems

We go directly to research on human decision-making^{1 2} and to well-defined concepts about self-intention. What we suggest is a relationship between individual factors, in a cognitive substrate, and models of field potential; such as we see in classical artificial neural network architectures such as ART³ or Harmony Theory⁴. Once a field dynamic is established, creating a type of "trusted" but falsely trusted instrumentation of experience, this field must be set aside as new experience is found that shows the first field to produce false inferences.

Once a neural process adopts/evolves a recognition "field", using negative search, this field is reinforced, using an envelop protecting the field so that an alternative field is difficult to establish. The needed shift of mind is made overly difficult. Decision support systems that evolve into a false field, producing coherent but false predictions, is an example of a good field verses a bad field dynamic.

A general model about false sense-making is suggested. False sense-making may hide some aspects of the real world. The student's response to math class is the example that we are highlighting, with the needed shift a shift from shallow learning to deep learning. System coherence is also seen in systems like economic systems. Sometimes something has to act from the "outside" to reset/regulate markets. Markets are like fields in this sense. The mathematical models suggest that they can

¹ Levine, D. S. (2009, July). Executive function, rule selection, and probability judgment. *Proceedings of International Joint Conference on Neural Networks*, 1771-1776.

² Levine, D. S. (2009). Brain pathways for cognitive-emotional decision making in the human animal. *Neural Networks*, 22, 286-293.

³ Carpenter, G.A. & Grossberg, S. (2003), Adaptive Resonance Theory, In Michael A. Arbib (Ed.), *The Handbook of Brain Theory and Neural Networks*, Second Edition (pp. 87-90). Cambridge, MA: MIT Press

⁴ Smolensky, Paul & Legendre, Géraldine. 2006. *The Harmonic Mind: From Neural Computation To Optimality-Theoretic Grammar* Vol. 1: Cognitive Architecture; vol. 2: Linguistic and Philosophical Implications. MIT Press.

get stuck in a local basin of attraction.

In a similar way, general decision support systems such as used in natural intelligence may also get stuck, and not be able to see hidden information. The information may be hidden by the coherence of a dominant viewpoint. The mechanism that hides is coherence itself.

Our model might be written as a stochastic model where the field is a probability field. Such a model might be enhanced with replication and depletion. The model might include gated di-pole mechanisms involved in the initial competition. It might include cross scale substrate part to whole formation, and selective attention. How might a coherent field be established when an absence of trust over some experience “should” challenge that coherent field? With this model in place, the means to shift the formation of a “response field” from a bad field to a good field might be explained.

Computational Stratification

New work on computational stratification makes a contribution to models of decision-making and cognitive processes. Memory and anticipation are involved in creating substance on which decision-making via coherent inference occurs. The methods are similar to what we find in knowledge engineering^{5 6}, where the development of computable ontology may be automated.

In the knowledge engineering discipline’s language, the categories of ontology are “reified” through instantiation of particular examples. However, a mismatch is seen in standard knowledge engineering practices and the mechanisms involved in memory and anticipation in human cognitive systems. This mismatch is resolved using

techniques first seen in the Soviet era applied semiotics⁷. These techniques explicitly recognize the importance of inconsistent and incomplete facts, and the role of inference from false or misleading facts. In the proposed stratified inference system, a shift in underlying calculus is provided. Thus the resources are not directed at a final product, such as is often the case with expert systems or knowledge engineering systems, but rather on resources that generate an emergent rational field on demand.

Stratified inference manifests when field coherence localizes interactions to “only” those processes that share timing information. The means to shift from one inference engine to an entirely different one is built in, and in a way that supports fast computation. In biological systems, interactions are between “complex” systems, having an encapsulated interior. These systems move through modes of behavior⁸ that control how a system is interacting within an environment. Otto Rossler calls this interior an endophysics to the complex system⁹.

Use of Frameworks

The theory may be simplified by linking the neuroscience with a digital framework, one that is stratified. Cognition is seen as emergent phenomena involving the aggregation of memory elements under the constraint of anticipation. Memory is of invariance that exists across multiple instances of examples, and thus is disassociated with particular experience as part of the encoding process. We do not remember “whole” things, but rather we

⁵ Gruber, T. (1995). "Toward Principles for the Design of Ontologies Used for Knowledge Sharing". *International Journal of Human-Computer Studies* 43 (5-6): 907–9

⁶ Natalya F. Noy and Deborah L. McGuinness. *Ontology Development 101: A Guide to Creating Your First Ontology*. Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI-2001-0880, March 2001.

⁷ Prueitt, Paul S. (1996). *Is Computation Something New?*, published in the Proceedings of NIST Conference on Intelligent Systems: A Semiotic Perspective. Session: Memory, Complexity and Control in Biological and Artificial Systems. IEEE October 20-23.

⁸ J. Kowalski; A. Ansari; P. Prueitt; R. Dawes and G. Gross (1988.) *On Synchronization and Phase Locking in Strongly Coupled Systems of Planar Rotators*. *Complex Systems* 2, 441-462.

⁹ Rossler, Otto (1998) *Endophysics: the world as an interface*. World Scientific

bring together categories of disembodied parts¹⁰. The framework creates a cognitive substrate that is then the origin of a subset of elements that combine into a coherent viewpoint.

Deep Learning and Skills-based Testing

Deep learning of curriculum might allow a new emergent field potential to develop without the weight of the bad field. This possibility opens a pathway to practical change in mathematics learning support programs at colleges. Shallow learning is seen to be evocative of the “bad” field acquired due to high school experiences and the direct re-enforcement of an existing acquired learning disability.

Deep learning is defined to involve an internalization of the elements and principles of a curriculum, as opposed to skill based learning. So deep learning involves substructure; e, g. memory of parts, and composition of substructural elements into a whole expression.

Logical Stratification

For stratification to occur the interactions must treat substrate elements as elements of categories. For example, molecules treat atoms as categories. One hydrogen atom is just as good as another. Clearly whatever the processes that formed the atomic level of organization, this took a long time. Stratification theory suggests that at least computationally, a “synthetic” development process may occur over a far shorter period of time. Logical stratification is reflected in Prueitt’s interpretations^{11 12} of the Soviet era quasi-axiomatic theories¹³.

Once stratification develops there are important features, such as are discussed in the context of a computing backplate to virtual private networks. The computing backplate is an invention of Prueitt’s, and yet is independently illustrated in several computing innovations. In essence, the backplate propagates an encryption/compression dictionary. A dictionary is associated with a framework, making data passage far easier and far more secure.

The process of making a decision is seen by Valeria and Maturana to involve multiple autopoietic envelopes¹⁴ (each being, in essence, an individual “self”) and a reinforcement mechanism. This regime may be understood in the light of organizational coherence, and the underlying physical coherence found in field mechanics. Coherence occurs as a function of processes existing within the same time scale. Thus the relationship between coherence and the sense of self is found to involve an encapsulation of elements of a substrate into categories.

The Sense of Self

As knowledge management tools are integrated within social media, we find an interesting possibility. Is it with replication mechanisms that we find a place in which to instrument the experience of the individual? Might we more fully instrument a measurement of the elements of experience so that we might more clearly see the nature of personal knowledge? The answer is yes. The maintenance of self is seen to occur via a replication regime, involving various types of gene and gene like expressions.

These tools connect computational architecture¹⁵ with neuroscience. Our model, in the simplest form, suggests that

¹⁰ Schacter, Daniel & Tulving, Endel (Eds) (1995). *Memory Systems* 1994, The MIT Press, Cambridge Mass.

¹¹ Prueitt, P. (1997). *Quasi Axiomatic Theory*, represented in the simplest form as a Voting Procedure. Presented in Moscow at a conference held at VINTI, and published in *All Russian Workshop in Applied Semiotics*, Moscow, Russia. (Translated into Russian and published in *VINITI Conference Proceedings*.)

¹² Prueitt, P. (1997). *Grounding Applied Semiotics in Neuropsychology and Open Logic*, in *IEEE Systems Man and Cybernetics* Oct. 1997.

¹³ Finn, Victor (1991). *Plausible Inferences and Reliable*

Reasoning. *Journal of Soviet Mathematics*, Plenum Publ. Cor. Vol. 56, N1 pp. 2201-2248

¹⁴ Maturana H and Valeria F (1989) *The Tree of Knowledge, the biological roots to intelligence*.

¹⁵ Prueitt, Paul (2009) - "The Service Engine: Structured Communication using Modern Service Technologies" *SOA Magazine*, <http://www.soamag.com/I30/0709-1.asp>

neuro-field processing holds the sense of self and that this sense of sense might be evoked by sign systems; e.g., computational ontology. So the digital mirror is hold up as a means to evoke a remembrance.

This instrumentation is to be made available to the individual hoping to transition from high school to college. A new sense of self is required and for this to develop the old field has to be broken down and replaced. Unfortunately, the new field is built only in the presence of the old one. A competition between fields is necessary. For this to be successful, we need novel experiences and surprises. We must look deeper into science.

Grounding in Natural Science

Our theory suggests that an inability to learn is due to a specific type of habituated response to poor and incomplete experiences in math class. The response creates a specific type of neural field potential that should be measurable using EEG.

Stratification suggests that the mechanisms that associate experience with field processing are those involved in an assembly of substrate elements into the causative elements selecting and supporting specific field processing.

We observe that not only in biology but also in physics we have models of how a class of mechanisms supports the sense of self. Many types of rewards and suppressions cause mechanisms to form. A general model of “reward” and “suppression” then emerges and may be discussed along with a generalized notion of replication mechanism. So our task reduces to an instrumented control of replication. Replication necessarily involves the emergence of structure under the constraints of environmentally driven function. Both individual learning and mechanisms that support locally oriented governance is seen in this light.

In our proposal, the instrumentation of learning mechanisms is turned over to the

individual, where it is most useful in terms of individual self-fulfillment. How this is done is described in technical documents, but in essence the free will of the individual becomes actively involved in the reification of elements of ontological modeling. This modeling might be highly personalized and invocative of skills, such as those involved in college level mathematics testing.

Testing using Focus Topic Metrics

Learning may be measured by testing directed not by an institution of higher learning but by the individual. Necessary institutional guidance is given to the individual in the form of lists of topics. In the college mathematics class, a model is composed of focus topics and connections between focus topics. The individual is asked to replicate a curriculum fully, rather than being tested on short-term skills.

A focus topic framework is a device measuring structural knowledge of elements of an institutionally specified curriculum. The individual, under the guidance of the institution, then brings the replication of elements of experience under control. Replication involves the use of parts of the brain, with different parts involved in a replication of letters using a computer when compared with replication involving free form handwriting. Mathematical notation is not in standard letters. Handwritten composition is required.

Testing via handwritten composition allows the student to select elements and illustrations that are most interesting to the individual. This compositional activity means that the student is reproducing concepts without being tightly directed by exam test questions. The curriculum becomes far more internalized than with traditional testing, and with this internalization we find that the individual develops a new capacity to compose.

The Technical Innovation, a Computing Backplate

The technical specification of the backplate requires some background¹⁶. A metaphoric analogy for this concept is that the backplate is to a computable reality as quantum reality is to the reality of chemical compounds.

Compounds are formed within localized reaction environments that produce an encapsulation of creation-destruction mechanisms involving several organizational scales. Metabolic-repair and action perception cycles are built up at higher levels of organization. Elementary particle physics often is framed in a way that is similar to the periodic table's relationship to chemistry. Thus the periodic table is the best example of a framework.

The envelopes, "over" individual self-identity, may be seen each as a physical field having non-locality similar to a quantum potential field. Field non-locality has a technical parallel in the now several decades old computing technology surrounding super distribution¹⁷.

Super-Distribution and the Backplate

Super distribution is created due to an everywhere present set of data templates. So data is not moved, a set of instructions are sent which then causes the data to be "uncompressed" at the new location.

The stratification between backplate and service layer follows the well-understood use of encryption/compression methods. There is a fractal nature to this, both in the non-locality of self-similarity and in the framework nature of some basic patterns that are repeated through iteration and composition.

Data grows from the backplate like a seed grows in a fertile ground. Templates create a structural base; in the form of a substructural set of atoms, from which any data propagation is achieved. Local interactions occur and are contextualized, within the conditions established by potential fields. These local interactions create structure locally from the set of atoms.

The parallel to neuro-processing is remarkable. A neurological field may emerge in the fashion described by Pribram's neurowave equation¹⁸. However, the exact nature of interactions between fields supporting cognition and cognitive inferences is still a subject of active research. We do not wish to claim to be providing any kind of final science, of course.

So what about our concern regarding privacy over individual information within the backplate? Complex systems theory asserts that if field interactions are of a certain type, they will not "see" each other. Moreover, if a complex reality is present in real space, the interior of that reality will not be visible when the reality is "viewed" at the organizational scale of the reality. For example, the inner thoughts of an individual are not visible at the social level.

Similar phenomena occur in optics and sound. There will be no interactions between interactions where interactions are occurring in different organizational layers. One of the terms used to talk about this are various "tunneling environments"¹⁹, also see author's 1987 work on planar rotator models²⁰.

¹⁶ Prueitt, Paul Stephen (published on the web – February 2011) Notational Paper in Five Parts, at www.reverseTwitter.com

¹⁷ Ryoichi Mori, Masaji Kawahara, "Superdistribution: The Concept and the Architecture". *Transactions of The Institute of Electronics, Information, and Communication Engineers*, vol. E73 #7, July 1990, pp.1133–1146.

¹⁸ Pribram, K. H. (1991). *Brain and Perception: Holonomy and Structure in Figural Processing*. Hillsdale, NJ: Lawrence Erlbaum Associates.

¹⁹ See, for example, <http://www.omicon.de/>: Formation of Iron Oxide Nanoparticles and Thin Films on Au. 05/2007)

²⁰ J. Kowalski; A. Ansari; P. Prueitt; R. Dawes and G. Gross (1988.) On Synchronization and Phase Locking in Strongly Coupled Systems of Planar Rotators. *Complex Systems* 2, 441-462.