Research in the Area of *Neosentience, Biomimetics, and the Insight Engine* 2.0

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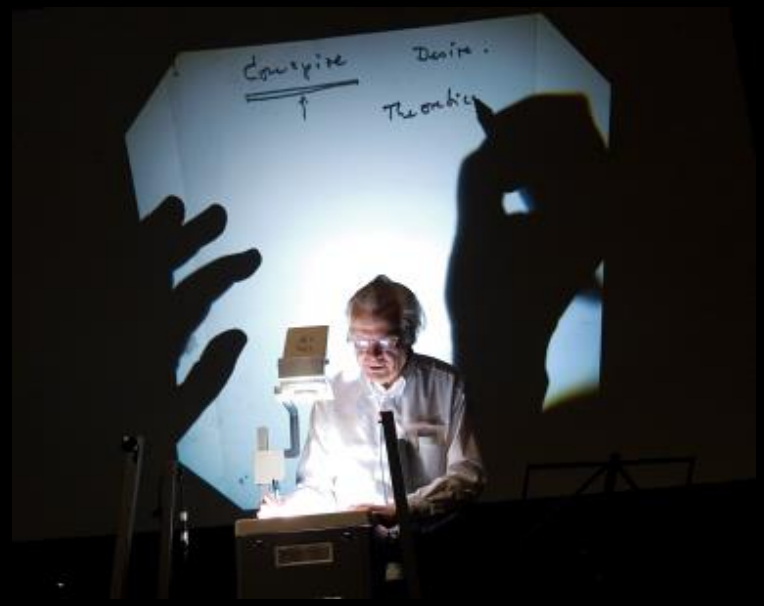
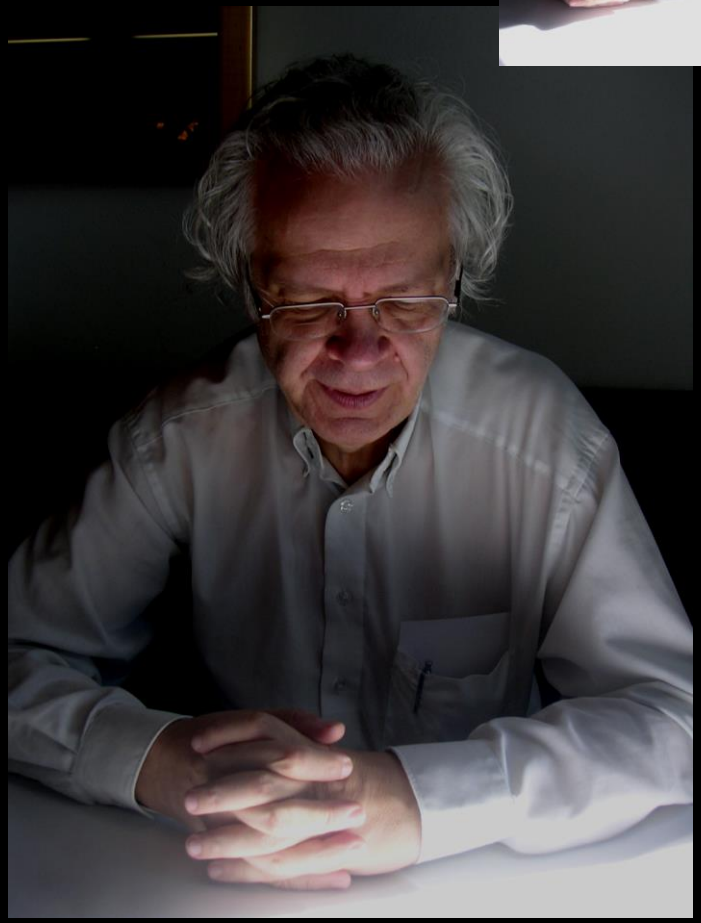
Theoretical and Foundational Problems (TFP) in Information Studies – An Overview:

1) Neosentience — A definition
2) A New Combinatoric N-dimensional Bio-algorithm
2) The 4 Es of Cognition
3) The Insight Engine 2.0
6) Research areas for the Insight Engine 2.0

Neosentience | The Benevolence Engine

Bill Seaman and Otto Rössler 2011





Human “Sentience” is not typically used in the formal languages of either Cognitive Science or Artificial Intelligence, although it is our intention to explore it.

Neosentient Model:
Although related to artificial intelligence the long term goal of this research (using the Insight Engine 2.0 discussed later) is the creation of an entity exhibiting a new form of machinic sentience.

The Neosentient – Pragmatic Benchmarks

- The neosentient entity can learn
- It can intelligently navigate
- It can interact via natural language
- It can generate simulations of behaviour (it can ‘think’ about potential behaviours) before acting in physical space
- It can function in a creative manner
- It can come to have a deep situated knowledge of context through multimodal sensing
- It can display mirror competence
- It can function in a benevolent manner

Neosentient - Speculations

It will be brought up (brought to life) in a social and cultural sphere of reciprocal interactions contributing to language and knowledge acquisition.

This is achieved thought embodied robotic relations to the environment, self and others. The development of synthetic emotions would also be explored in the neosentient.

Neosentience - Seaman’s approach

The creation of such a machine via the embodiment of a series of specific algorithms on a parallel computing platform (or new form of algorithm) working in conjunction with a specific situated multimodal machinic sensing environment and situated robot.

Seaman has provisionally named this computational approach - Combinatoric N-dimensional bio-algorithm. This may also be implemented via a new hardware paradigm.

How do we best abstract human abilities related to thought and embodied learning and re-embody them in an anthropocentric machinic system?

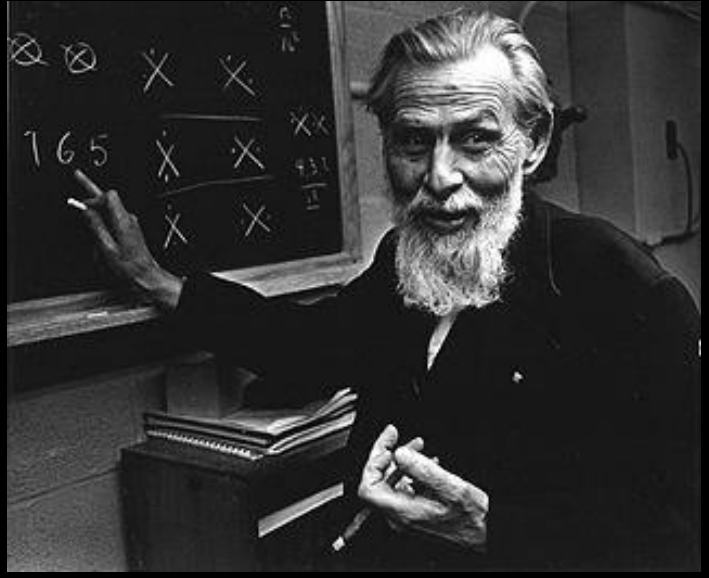
Ross Ashby's "cybernetics is the study of all possible abstract machines" comes to mind.

Perhaps the beginning of the biomimetics and bio-abstraction…

A Pre-precursor…
N. Rashevsky (Walter Pitts teacher) in 1933 foreshadowed many of the ideas that are discussed in the McCulloch and Pitts paper related to neural nets. Rachevsky's paper was entitled: "Outline of a Physico-mathematical Theory of Excitation and Inhibition."

Rashevsky:

"The aim of this present paper is to present a phenomenological theory, which however is susceptible of a simple physical interpretation. It is not an attempt to merely add another possible expression to the great number of already existing ones, but to introduce what seems to us to be an essentially new point of view. This new point of view appears to give a rather simple explanation of many important phenomena of excitation and inhibition."



The paper by McCulloch and Pitts (1943) is properly titled “A logical calculus of the ideas immanent in nervous activity”

After stating a careful and well-argued selection of simplifications of the behavior of real neurons, they develop a logical apparatus to define: the concept of the solution of a net and of the realisability of a logical predicate by a net.

McCulloch W. and Pitts W. (1943) A logical calculus of the ideas immanent in nervous activity. Bulletin of Mathematical Biophysics, 7 (115-133)

von Neumann

In the words of von Neumann: “[…] it is a fundamental requirement of the scientific viewpoint the so-called principle of the psycho-physical parallelism – that it must be possible so to describe the extra-physical process of the subjective perception as if it were in reality in the physical world – i.e., to assign to its parts equivalent physical processes in the objective environment, in ordinary space.”47

John von Neumann “The General and Logical Theory of Automata” 1948

Beyond the Turing limit
Author: Hava T. Siegelmann

The theoretical foundations of Neural Networks and Analog Computation conceptualize neural networks as a particular type of computer consisting of multiple assemblies of basic processors interconnected in an intricate structure…

On a mathematical level, the treatment of neural computations enriches the theory of computation but also explicates the computational complexity associated with biological networks, adaptive engineering tools, and related models from the fields of control theory and nonlinear dynamics .

Siegelmann, H. (2007), Neural Networks and Analog Computation: Beyond the Turing Limit, http://www.cs.umass.edu/~hava/advertisement.html, Accessed 1 December 2009. See also Siegelmann, H (1999), Neural Networks and Analogue Computation, Beyond the Turing Limit, Boston, MA: Birkh.user.

Today, some of the most powerful artificial intelligence systems employ a type of machine learning called deep learning. Their algorithms learn by processing massive amounts of data through hidden layers of interconnected nodes, referred to as deep neural networks. As their name suggests, deep neural networks were inspired by the real neural networks in the brain, with the nodes modeled after real neurons — or, at least, after what neuroscientists knew about neurons back in the 1950s, when an influential neuron model called the perceptron was articulated first by Frank Rosenblatt.

Additionally the book ***Perceptrons: an introduction to computational geometry,*** a book written by Marvin Minsky and Seymour Papert was published in 1969.

Since then, our understanding of the computational complexity of single neurons has dramatically expanded, so biological neurons are known to be more complex than artificial ones. But by how much?

Rosenblatt, Frank (January 1957). "The Perceptron: A Perceiving and Recognizing Automaton (Project PARA)"

To find out, David Beniaguev, Idan Segev and Michael London, all at the Hebrew University of Jerusalem, trained an artificial deep neural network to mimic the computations of a simulated biological neuron. They showed that a deep neural network requires between five and eight layers of interconnected “neurons” to represent the complexity of one single biological neuron.

Thus, we just begin to touch on the complexity of such a future system!

Abstracting Abstraction
The axiomatic procedure – von Neumann

Axiomatizing the behavior of the elements means this: We assume that the elements have certain well-defined, outside, functional characteristics; that is, they are to be treated as “black boxes.” They are viewed as automatisms, the inner structure of which need not be disclosed, but which are assumed to react to certain unambiguously defined stimuli, by certain unambiguously defined responses.

von Neumann, J. (1995), The Neumann Compendium, vol. 1, F. Bródy and T. Vámos (eds), Singapore: World Scientific Publishing, pp. 526–28.

We are
Electrochemical Computers of
a highly complex variety.

Seaman:
Thus we can study entailment structures and make “analogous” functional substitutions in machinic systems. Sentience is an emergent phenomena that has not yet been fully entailed. As black boxes are replaced with the knowledge of articulated functionality then “emergence” is replaced with “entailment structures”.

The future of computing is perhaps of a mixed analogue and digital nature… or the emulation of the analogue via a new form of “high-resolution” digital formulation of the analogue. (Conversation with Rössler).

I am thinking that in the future we will explore the interrelation of multiple computational forms…

The body is an ultra-complex biomachine, with a complexity greater than all ‘human-made’ systems. Robert Rosen early on saw the limitations of the machine metaphor in relation to biological research. In a book published in 2000, *Essays on Life Itself,* Rosen points to a particular form of limit:

I have attempted to introduce, and to motivate, a concept of complexity. A system is called complex if it has a nonsimulable model. The science of such complex systems is very different from the science we have become used to over the past three centuries. Above all, complex systems cannot be completely characterized in terms of any reductionistic scheme based on simple systems. Since the science is different, so too are technologies based on it, as well as any craft pertaining to the systems with which that science deals. (Rosen, 1999, p. 307)

Perhaps we can devise an ultra-complex simulable model given the potentials of new computational systems --- or we can work toward building a system to explore complex mathematics and logic that enable new forms of modeling ultra-complex systems? Perhaps this is one of the highest goals of our project. Rosen, in the 1999 text suggests:

It is too early to tell how such ideas will develop in the future. My purpose here has been to introduce some of the flavors of the concept of complexity, how it pertains to basic biological issues, and how it may force a complete reevaluation, not only of our science, but of our concepts of art and of craft as well. Indeed, it may turn out, as it has before, that the pursuit of craft may provide the best kind of probe to guide our science itself. (Rosen, 1999, p. 307)

A New Combinatoric
N-dimensional Bio-algorithm

Cognitive Behavior is approached through a series of information-oriented processes. Central is to define all of the entailment structures that inform the emergent arising of sentience in the human (new incomplete territory), and seek to abstract those into an autonomous robotic system.

A New Combinatoric
N-dimensional Bio-algorithm

The system will bring together a series of technologies from the research of diverse scientists, artists, designers, and cyberneticists, and the study of complex systems, to help map this time-based set of relationalities that bridge mind / brain / body — multi-modal sensing systems, and environment.

A New Combinatoric
N-dimensional Bio-algorithm

No single discipline of science, the humanities and/or the arts can tackle such a difficult information-related problem set. A special transdisciplinary team of teams would need to arise out of the use of the Insight Engine 2.0. This overarching research team (or set of teams) would potentially consist of groups of specialists from a series of fields that would also learn enough about the other member fields to be able to talk across disciplines.

Researcher conversation would be central to the ongoing development of this new form of research into this variable Bio-algorithmic network contributing to Neosentience. Perhaps an earlier version of this kind of thinking was witnessed in the Biological Computer Lab headed by Heinz von Foerster, 1958-1976. Historical items related to the topic areas would also be included in the database.
i.e. the study of Bionics etc.

See: An Unfinished Revolution / The Biological Computer Laboratory, Müller and Müller, 2007 Echoraum

The Insight Engine 2.0

The initial goal is to make the Insight Engine function in such a way as to “point” ” after Wittgenstein (Philosophical investigations) to potential new research data across disciplinary boundaries by using advanced information processing, computational linguistics, a Natural language API, and additional forms of AI acting as Micropeers (AI collaborators) to enable intelligent bridging of research questions, and the development of new information paradigms through bisociation (after Arthur Koestler) and poly-association (Seaman).

The Insight Engine 2.0

These I_E information systems support researchers, empowering them to access relevant transdisciplinary information from the database, to contribute to the higher order goal over time of articulating a functional Neosentient Model. Such a model is informed from many intellectual perspectives and transdisciplinary conversations facilitated by the I_E system, a listserv, and future information oriented conferences.

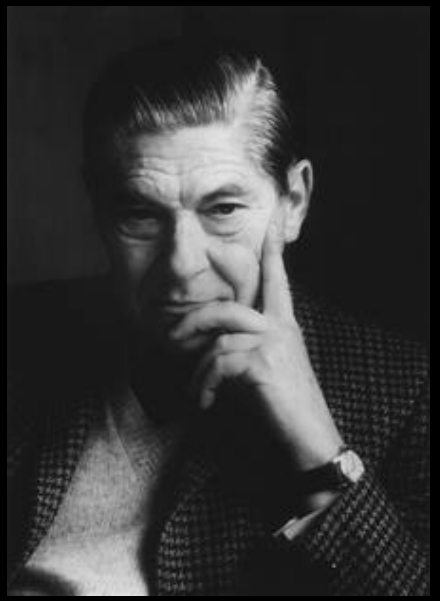
The Insight Engine embodies a series of intelligent processing structures, visualization systems, the mapping of relationalities related to the corpus of papers, books, media objects, key words, abstracts, diagrams, etc. (initially textually structured with pattern recognition, visual and sonic systems will soon be integrated that will help build and navigate the database) and help outline the articulation of a very new variety of Combinatoric N-dimensional Bio-algorithm – informed by the deep study of human bio-functionality .

Bio-informatic processing structures

Bio-informatic processing structures are to be abstracted and then re-articulated in a biomimetic manner (or though bio-abstraction) in the Neosentient model. This dynamic combinatoric, self-organizing system seeks to be resilient and interactive with the environment, building new knowledge up somewhat like humans do, through pattern-flows of multi-modal sense perturbations, as well as incorporating a layering of other potential learning systems and access to distributed computational learning systems. Meta-levels of self-observation and the development of language to articulate such contextual learning is central for the embodiment of the system.

Bisociation… Made Operational in the Insight Engine

“I have coined the term ‘bisociation’ in order to make a distinction between the routine skills of thinking on a single ‘plane’, as it were, and the creative act, which, as I shall try to show, always operates on more than one plane. The former may be called singled-minded, the latter a double-minded, transitory state of unstable equilibrium.”



Arthur Koestler, ‘The Act of Creation’ 1969

Arthur Koestler,
The Act of Creation
1969

The bisociative act connects previously unconnected matrices of experience; it makes us ‘understand what it is to be awake, to be living on several planes at once’ (to quote T.S. Eliot, somewhat out of context).

Poly-association processes brought about through AI in the I_E.

Seaman coined the term Poly-association – drawing from multiple computational sources to define a research arena.

The problem is, no one knows exactly what contributes and what can be left out… yet this is no reason not to research in this direction.

The 4 Es of Cognition
Embodied, Embedded, Enactive and Extended approaches to Cognition

The study of the operation of human multi-modal sensing systems could be used to help define a computational “pattern language” that future robotic systems could make operative. This represents a set of processes that contribute to the development of a Model for Neosentience arrived at through biomimetics and biological abstraction…

The goal is to enfold the Embodied, Embedded, Enactive and Extended approaches to understanding cognition in the human, and then seek to articulate the processes and entailment structures that enable this set of dynamic interrelations to function.

We seek to articulate a transdisciplinary holistic approach which will enable the examination of dynamic, time-based Mind/Brain/Body/Sensing/ Environment relationalities. The Insight Engine 2.0 will seek to contain as many relevant papers and research embodiments (diagrams, documents, images, videos etc. that are textually annotated) and/or pointers to papers via the exploration of relevant abstracts, keywords and author’s names and dates of publication.

We have a current set of overarching research categories in the system. Each research area will have a Micropeer, these include the following (although new research areas will be added as needed):

Initial Research Categories in the Insight Engine 2.0

Neosentience; N-dimentional Combinatoric Bio-algorithm development; Bodily entailment structures; Mindful Awareness – self-observation; 2nd-order Cybernetics; Neuroscience; Neuroscience and the arts; AI and the arts – Computational Creativity; Biomimetics; The Connectome; AI; AI and Ethics; EI; The Biological Computer Lab (Cybernetics and 2nd Order Cybernetics, Bionics); Science Fiction; The History of AI; Bridge Building between disciplines; Transdisciplinarity – A Multi-perspective Approach to Knowledge Production; Information – new approaches; Approaches to Learning - Conversation Theory etc.; Robotics and situated knowledge; Computational Intuition; Android Linguistics (Donahue); related new forms of mathematics; synthetic emotions; embodied computation.

The Research team consists of Professor Bill Seaman, PhD, Computational Media, Arts and Cultures, Duke University; John Herr, Duke Office of Information Technology; Dev Seth, Computer Science student, Duke University; Ashley Kwon, Computer Science student Duke University, Quran Karriem, PhD student, CMAC, Duke University; Kelsey Brod, PhD student CMAC, Duke; and Mingyong Chen, PhD student, UC San Diego.

The Goal

Once the Insight Engine is up and running (we are currently still in the development mode so researchers will be providing papers on work in progress) is to search for active participants that would contribute links (abstracts, key words, date of publication, active link to distributer), or entire papers or books (if they are the legal copyright owners), as well as textually annotated images, video, 3d models, etc.

Another class of participant will just be perusing the data.

We are very much interested in ethics, and the paradox of bias in terms of AI authorship and use.

Visualization Modalities

A series of differing visualization modes will be explored from within the Unity Game Engine 3d Environment, each exploring different interface metaphors exploring relational information gleaned by the natural language API and micropeers and participants interaction with the system.

Visualization Modalities Include
1) Trees and Forests of Information
2) Molecule-like visualizations of Information
3) A point cloud computational system of relational research papers, their author, key words, abstracts and on-line links
4) A key word sentence generator suggesting new forms of research
5) A virtual world generating system enabling researchers to define their own relationalities in space – defining neighboring relationalities in a world designed in real time by themselves. And or via high-level commands that bring sorted data into the world related to an individual researcher's needs fallin inconjunction with what the micropeers have gleaned though observation of the choices of the interactant.

In each case the researcher, while navigating in the 3d World and it’s different navigational modalities of search and discovery, and/or entering more traditional textual search queries, will be able to select different bodies of information to navigate or save to their individual research repository or active group domain.

Please be in touch with me if you want to be included in future information emails about Neosentience and/or The Insight Engine 2.0, or related future conferences.

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