Proceeding Paper

Neosentience: Research Areas and Insight Engine 2.0 Foci †

Bill Seaman

Computational Media, Arts and Cultures, Department of Art, Art History and Visual Studies, Duke University, Durham, NC 27708, USA; bill.seaman@duke.edu

† Presented at the Conference on Theoretical and Foundational Problems in Information Studies, IS4SI Summit 2021, online, 12–19 September 2021.

Abstract: This paper will lay out a series of research areas and topics related to Neosentience research and the Insight Engine 2.0. The goal is to create a model for an autonomous robotic system via transdisciplinary information processes and information exchanges. Neosentience is a new approach to AI that is informed by the functionality of the human body through biomimetics and bio-abstraction. The long-term goal of this model is to potentially enable Neosentience to arise via the system's functionality. Transdisciplinary research is explored through the use of a unique intelligent database and AI driven search engine, The Insight Engine 2.0 (I_E) working in conjunction with differing researchers from multiple disciplinary domains. This paper seeks to point toward the breadth of foci that inform the ongoing research and the information-oriented processes involved.

Keywords: Neosentience; artificial intelligence; biomimetics; the Insight Engine 2.0; enacted; embodied; embedded; extended approach

1. Introduction

The special session entitled *Neosentience, Biomimetics, and the Insight Engine 2.0* has been discussed in my initial overview paper in the proceedings, which sets out the operative aspects of this new field. This paper explores the kinds of research that might in part be enfolded to help develop a model for the Neosentient—a new form of AI informed by the workings of the body—as well as the abstraction of those workings in terms of defining a new combinatoric bio-algorithm. This research is multi-perspective in nature and explores information and information processes from a number of differing domains. It has many foci which are born out of differing disciplines and interdisciplinary research, as well as research about new technological methodologies which employ AI for research purposes. In part, its goal seeks to enable the bridging of many intellectual domains to facilitate the exploration of the vast territory of new forms of transdisciplinary research germane to Neosentience.

Neosentience research seeks to be wholistic, enfolding mind/brain/body/environment relationships into a new overarching system of interrelated systems. The Insight Engine 2.0, a transdisciplinary database and visualization system, explores the use of many differing computational technologies that enable focused relationalities to be discovered through the use of system and AI. It focuses on research related to the human to define the entailment structures that lead to sentience arising. One research question relates to the development of potentially new technologies designed to help us to transcend the current limitations inherent to a deep study of the body, and all of its relevant entailment structures. Neosentience research explores biomimetics and bio-abstraction, while also exploring new approaches to knowledge production in the Insight Engine 2.0. It thus seeks to use AI, collaborating with a diverse team of international researchers, to help define a model for a new, higher-order form of AI—Neosentience. This research seeks to employ an information-oriented apparatus to enable the building of intellectual bridges to help answer a series of extremely difficult questions.

The pragmatic benchmarks of Neosentience, as described by Rössler and Seaman in the book *Neosentience/The Benevolence Engine*, are also key foci in the research. Pragmatic

benchmarks are used to define Neosentient robotic entities (differing from the Turing Test). The system can exhibit well-defined functionalities: it learns; it intelligently navigates; it interacts via natural language; it generates simulations of behavior; it metaphorically "thinks" about potential behaviors before acting in physical space; it is creative in some manner; it comes to have a deep situated knowledge of context through multimodal sensing; and it displays mirror competence. Seaman and Rössler have initially entitled this robotic entity *The Benevolence Engine*. Synthetic emotions would also become operative within the system. The System would be benevolent in nature. The concept of Neosentience (coined by Seaman) was articulated in the book *Neosentience/The Benevolence Engine*, by Seaman and Rössler [1].

2. Categories of Research

The growing set of overarching research areas will be developed over time and populate the Insight Engine 2.0. Each research area will have a micropeer (A customizable AI related to each researcher's publications, their interactivity with the system, and the articulation of the micropeers' preferences [discussion with Dev Seth and team]). There will also be a micropeer that is observing the entire system and the corpus populating the database. These different research areas include the following (although new research areas will continuously be added as needed): Neosentience; N-dimensional Combinatoric Bio-algorithm development; Bodily Entailment Structures (and related research technologies); Mindful Awareness–Self-observation; Second-order Cybernetics; Neuroscience and Computational Neuroscience; Neuroscience and the Arts; AI and the Arts–Computational Creativity; Biomimetics; The Connectome; AI; Artificial General Intelligence; AI and Ethics; EI—Extended Intelligence; Embodied Computation; Robotics and situated knowledge production; The Biological Computer Lab; 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.; Computational Intuition; Android Linguistics (Evan Donahue); Related new forms of mathematics; ART-Adaptive Resonance Theory [2]; Autonomous Adaptive Intelligence [2]; Universal Development Code [2]; Attention Schema Theory [3]; and Brain Modules [4].

I invited a series of authors to present at the special session that I felt could contribute to discussions related to Neosentience research, each from their own disciplinary perspective. Not all research areas above were represented in the invited presentations [5].

3. Bisociation and Poly-Association

Central to the Insight Engine is the exploration of processes related to bisociation as discussed in Arthur Koestler's book, *The Act of Creation*: "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 bisociative act connects previously unconnected matrices of experience . . . " [6]. In the Insight Engine, the interactant can choose two different papers and/or textually annotated media objects, the system will facilitate a transdisciplinary search relevant to the selections, and it will visualize links to a series of relevant works as a hierarchy of relationalities. The researcher can also define how many of these works can be called up at a time, and specific 'categories of research' to be searched. I have also coined the term poly-association. This is when an interactant chooses multiple works, the system defines a relevant relationality between them, and then undertakes a search for related items from the database, enabling interesting new forms of transdisciplinary bridging. This facilitates the articulation of new forms of relationality that might not otherwise surface, especially because scientists and researchers from different disciplines often publish in different journals and intellectual domains that do not "naturally" intersect.

4. The Enacted, Embodied, Embedded, Extended Approach, Explored via Biomimetics and Bio-Abstraction

Central to the Neosentience is the research into embodiment and how it relates to knowledge production and language use. Ward & Stapleton, from the School of Philosophy, Psychology, and Language Sciences of the University of Edinburgh, present the following perspective in their paper, entitled *Es are Good: Cognition as enacted, embodied, embedded, affective and extended*: "We present a specific elaboration and partial defense of the claims that cognition is enactive, embodied, embedded, affective and (potentially) extended. According to the view we will defend, the enactivist claim that perception and cognition essentially depend upon the cognizer's interactions with their environment is fundamental. If a particular instance of this kind of dependence pertains, we will argue, then it follows that cognition is essentially embodied and embedded, that the underpinnings of cognition are inextricable from those of affect, that the phenomenon of cognition itself is essentially bound up with affect, and that the possibility of cognitive extension depend upon the instantiation of a specific mode of skillful interrelation between cognizer and environment. Thus, if cognition is enactive then it is also embodied, embedded, affective and potentially extended." [7]. Humans learn from embodied actions in the natural environment and via human interaction with the extended environment of our technological man-made information systems. Language, being historically primarily logocentric, potentially needs to be re-understood in relation to our internet use, pervaded with computational images, sound, and text . . . not to mention visualization and sonification modalities. In many new forms of media environment, fields of meaning of image, sound, and text act upon each other with an ongoing meaning summing, as the associations of the media interactants are enfolded in the production of meaning. Thus, as individuals, we each weave our own understanding of meanings based on the history of our embodied interactions, learning, self-reflection, and creative thought. Interacting with various human, natural and electronic environments is central to this building up of our intelligence and knowledge production over a lifetime. The goal is to research the Embodied, Embedded, Enactive, and Extended approaches to understanding cognition in the human, and then seek to articulate the entailment structures that enable this set of dynamic interrelations to function. Ward and Stapleton (mentioned above) lay out a rich history of seminal texts: "Over the past twenty years several claims about human cognition and its underpinnings have gained currency. Human cognition (henceforth 'cognition') can sometimes be extended–the material vehicles underpinning cognitive states and processes can extend beyond the boundaries of the cognizing organism (Clark & Chalmers 1998; Hurley 1998; Clark 2008). Cognition is enactive–that is, dependent on aspects of the activity of the cognizing organism (Varela, Thompson & Rosch 1991; Hurley 1998; Noë 2004; Thompson 2007). Cognition is embodied–our cognitive properties and performances can crucially depend on facts about our embodiment (Haugeland 1998; Clark 1997). Cognition is embedded–our cognitive properties and performances can crucially depend on facts about our relationship to the surrounding environment (Haugeland 1998; Clark 1997; Hurley 1998). Finally, cognition is affective (Colombetti 2007; Ratcliffe 2009)– that is, intimately dependent upon the value of the object of cognition to the cognizer." [7]. The Insight Engine 2.0 will seek to house and/or provide abstracts and links to these kinds of texts as well as texts and annotated media objects from many other domains related to Neosentience production.

5. Embodied Computational Research

There are a number of labs undertaking Embodied Computational research. One exists in the MIT Department of Architecture [8]. Another example is the *Embodied Computation Lab* at Princeton University, also an architecture lab. The lab building is described as follows: "This is a facility for interdisciplinary research on robotics, sensors, and everywhere that computers meet the physical world and become 'embodied computation'." [9]. Seaman's early paper *(Re) Thinking–The Body, Generative Tools and Computational Articulation* (and others at billseaman.com) explore embodiment [10]. Additionally, Seaman has been actively

recouping aspects of historical research in terms of the initial study of biological computers related to the work of Heinz von Foerster, described in the book: *An Unfinished Revolution? Heinz von Foerster and the Biological Computer Laboratory | BCL 1958-1976* [11] and in Seaman's paper *Towards A Dynamical Heterarchical Ecology Of Conversations* [12].

6. Some Visualization Strategies in the Insight Engine 2.0

The interactant can choose from a series of visualization systems with different functional qualities to explore relevant data. This also enables participants to explore particular categories of interest as well as different visualization systems that they might be leaning toward. The basic visualization interfaces are the following: The Micropeer system will potentially be active under the surface in all of the visualization systems. This will include an interactive interface where researchers can set levels for different kinds of AI activities as an active collaborator functioning in all of the differing visualization environments.

One interface explores A mathematical system based on point-cloud data of a high dimensional search space, initially developed by Ashley Kwon and Dev Seth (in discussion with the team), with additional approaches developed by John Herr. The visualization makes a set of superimpositions, where overlapping points represent differing forms of relationality between the papers (or textually annotated media-objects) that have been called up based on an intelligent search mechanism. The central search avenue in the point cloud system are research papers. In terms of bisociation, the three axes in the space represent the alignment among papers (x-axis), author relationalities (y-axis), and publication date (z-axis). Each point in the 3D space is a research paper, while in a visualization system where differing sets of point cloud data are overlaid each set of intersecting points represent associations among papers, authors, or concepts discussed in the papers. On each point, along with the general information about it, represented with the three axes, other information that the paper represents, such as its keywords, is potentially overlaid as multidimensional vectors. Depending on how much information about the paper we want to represent with the point, the number of dimensions of the vectors can vary. Users will be able to search for specific papers using these numerical intersection points related to a high-dimensional numerical intersection of the content, such as cosine distance. This introduces a different way of visualizing intersections among research papers from the other methods discussed in this text.

Along with the 3D point cloud visualization, a knowledge tree can be a way to represent associations among authors. Each author can be represented as a tree-like visualization with their individual papers and/or research papers that the author searched for and collected. There are different ways of using this part of the system, perhaps relevant to researchers from differing research domains. Users will be able to search for specific authors and papers or multiple authors and papers to visualize associations among them, zoom in and out and move through the trees, and make new bisociations and poly-associations (research sub-group headed initially by Ashley Kwon, including Kelsey Brod and Mingyong Cheng).

Another method of visualization involves a 3D World Generator 2.0 space (programming by Quran Karriem), abstracting Seaman's historical interface with the same name. This environment explores a rolodex/shelving-like wheel structure. The wheel is divided into different sections, each representing an academic discipline and/or one of the research topic areas discussed above, as well as potential textually annotated 3D models, still images, videos, media-objects, and sound. Each section will be composed in part of research papers (and/or other media elements) that are relevant to the topic they represent. Users will be able to change the selection of papers loaded into each section based on their interests, or have the visualization world-space auto-loaded based on particular menu choices. All of these systems are currently under development for the Unity Game Engine environment.

7. Ethics and Redefining Notions of AI Bias

The large area of our research process in constructing the Insight Engine 2.0 is concerned with research related to selection biases and the limits of intelligent systems to instantiate ethical solutions while operating within the constraints of an imperfect world [conversation with Quran Karriem]. Our position is that a system that meaningfully "avoids biases" will still always have a bias. Trying to transcend this problem is a paradox and an impossibility; nevertheless, one we must continually strive toward circumnavigating inappropriate biases. We have to work in the world as it exists, with an ideal computational set of systems in mind for the one we want to build. Humans and human societies are unavoidably biased, and our machines inevitably produce abstractions and reproductions of those biases. Our goal is to instantiate shifts in our biases: to re-direct them toward explicitly and universally pro-human ends. Some part of that is being overt about inclusion and consent, as well as openness to the notion of drawing on potential alternate social histories as authors of the system.

8. Conclusions

I have discussed a set of categories relevant to Neosentience research, and a series of related topics that focus, in particular, on research methodologies germane to the Insight Engine 2.0.

References

1. Rössler, O.; Seaman, W. *Neosentience/The Benevolence Engine*; Intellect Press: London, UK, 2011.
2. Grossberg, S. *Conscious MIND Resonant BRAIN*; Oxford University Press: New York, NY, USA, 2021.
3. Graziano, M.S.A. The Attention Schema Theory: A Foundation for Engineering Artificial Consciousness. *Front. Robot. AI* **2017**, *4*, 60. [CrossRef]
4. Bertolero, M.A.; Yeo, B.T.; D'Esposito, M. The modular and integrative functional architecture of the human brain. *Proc. Natl. Acad. Sci. USA* **2015**, *112*, E6798–E6807. [CrossRef] [PubMed]
5. Special Session. Neosentience, Biomimetics, and the Insight Engine 2.0, Session Organizer: Bill Seaman. Available online: https://tfpiscom.files.wordpress.com/2021/09/neosentiencevideolinks.pdf (accessed on 1 February 2022).
6. Koestler, A. *The Act of Creation*; Macmillan Co.: New York, NY, USA, 1964.
7. Es Are Good, Cognition as Enacted, Embodied, Embedded, Affective and Extended. Available online: https://www.researchgate.net/publication/258832836_Es_are_good_Cognition_as_enacted_embodied_embedded_affective_and_extended (accessed on 14 May 2021).
8. Architectural Robotics–Embodied Computation. Available online: https://architecture.mit.edu/building-technology/lecture/architectural-robotics-embodied-computation (accessed on 20 May 2021).
9. Embodied Computation Lab. Available online: https://architizer.com/projects/embodied-computation-lab/ (accessed on 16 May 2021).
10. (Re) Thinking—The Body, Generative Tools and Computational Articulation. Available online: https://billseaman.com/Papers/TA%207.3%20(Re)Thinking%20copy.pdf (accessed on 16 May 2021).
11. Müller, A.; Müller, K. *An Unfinished Revolution? Heinz von Foerster and the Biological Computer Laboratory | BCL 1958-1976*; Echoraum Press: Vienna, Austria, 2007.
12. Bill, S. Towards A Dynamic Heterarchical Ecology of Conversations. *Cybern. Hum. Knowing J. Second Order Cybern. Autopoiesis Cyber Semiot.* **2018**, *25*, 91–108.