The Global Human Social System: A Brain for Gaia

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ABSTRACT

Networks are a key aspect of system organization. All systems can be described as a network of components in which the links between components (nodes) within the system boundary are denser and coupling strengths stronger than between the system and external entities. A special kind of network that is found in all dynamic systems is a flow network in which the links are "channels" and through which flow either materials, energies, or messages (a special form of low-power, modulated energy).

A very important kind of network that processes messages to extract information and construct knowledge is an animal brain. In particular, the human brain and its neocortex constitutes a seemingly infinitely malleable message flow network. Its organization is a hierarchy of functional subnetworks that are arranged in such a way that sensory percepts are constructed in the primary sensory processing areas in the lower-back part of the cortex. Compound percepts are constructed in early association areas just forward of the sensory areas. And increasingly complex concepts are constructed forward of that and into the frontal cortex. From there concepts currently operative in working memory generate motor plans in the posterior frontal lobe and those are forwarded to motor control areas to generate actual outputs.

The brain is recognized as the governance subsystem for an individual. In social animals, the brains of individuals construct concepts of other like-kind individuals and manage interactions between individuals to produce social behaviors. Thus, societies are networks of brains interacting and the individual sends and receives messages to other individuals in the society. Individuals, in this framework, resemble neurons in neural networks. We are led to a conjecture regarding an ideal organization of human societies: if human social organization were along the lines of brain (neocortex) architecture, might the society itself function in a brain-like way to

do the same kind of message processing, with action decisions resulting, that provides a governance subsystem for the planet? It is briefly argued that the planet does need governance as it moves into the future.

This paper describes the brain-like social network being considered, how it functions as an information-extraction, knowledge-constructing, and action-deciding subsystem of the whole planet. And we discuss the needs and benefits to Earth of having a brain – Gaia's brain.

Keywords: Social system design; brain architecture; information processing

INTRODUCTION

Throughout the evolution of living things on this planet there has been an unmistakeable trend in which organisms exposed to increasingly complex environments develop information processing capabilities that provide them with information about what their environments were doing and making decisions on what responses to make. This has been as true for the simplest forms like bacteria and archaea to redwood trees to mammals and birds to human beings. The form that information processing subsystems take is that of a hierarchically organized network of decision nodes that communicate with one another and, under the right conditions, activate responses[1]. In the animal kingdom we recognize these functions in brains, or brain-like precursors, neural networks.

I claim that the evolution of brains, and brain analogues in plants and lower life forms, is a natural and systemic consequence of the increasing complexity of the whole Earth ecosystem, which I call the Ecos. Another, more popular name for this planetary system is Gaia, coined by James Lovelock and developed into a substantial hypothesis by him and Lynn Margulis in the 1970s (Lovelock & Margulis, 1974; Margulis & Sagan, 2000). Since its inception, the Gaia hypothesis first experienced ridicule and disbelief, but as the concept matured and more evidence for the homeostatic properties of Earth's multiple geospheres, especially the biosphere, the concept has gained much scientific support and respectability (c.f., Volk, 1998). What I wish to explore in this paper is the notion that the evolution of Gaia through biological and now through cultural modes is leading inexorably to produce a planet-wide information processing system – a brain – for Gaia Mobus, 2018). Furthermore, I argue that that brain will emerge from the organization of the human social system (HSS), probably after a major material/energy phase transition, into a brain-like network of unitary information processors, individual humans, groups of humans, and a hierarchy of organization of human groups that emulate the organization of the neocortex of the human (and mammal) brain.

[1] While asserting that all life forms utilize these kinds of dataflow/information processing networks, this paper will focus on animal nervous systems (and brains in particular) as representative of the phenomenon.

We human beings are very much like neurons in the neural networks of the brain. There is a functional isomorphic relation to how we communicate with one another and collectively arrive at decisions and take action. This idea is not particularly new, but I have assembled an array of evidence and arguments for why and how this can be the case. In this paper I will only give a broad outline of this work. I have a new book in production that will provide more details about the arguments.

I will start with a brief summary of what we know about brains in terms of functions but also provide a modicum of information about structures that are necessary to execute those functions. I will, then, provide an overview of how a particular kind of human society organization could be expected to provide for the planet the same essential kind of information processing as we see in biological brains and their relation to behaviors. It will be necessary to also establish a reasonable justification for why Gaia needs a brain. I finish with some conjectures about how the HSS can get from its current, highly dysfunctional, structure and state of affairs to this 'ideal' structure. In the background of all of this is the sad state of affairs we are now calling the Anthropocene epoch.

DATAFLOW NETWORKS, INFORMATION, AND BRAINS

A dataflow network is comprised of a set of nodes, **N**, where node $\boldsymbol{n_i}$ is an element of **N**, and a set of directed links, **L**, where **L** is composed of tuples, ($\mathbf{n_i}$, $\mathbf{n_j}$) in which $\mathbf{n_i}$ is a source node and $\mathbf{n_j}$ is a sink node. Nodes are message processors that integrate incoming signals detecting correlations between those signals and extract information regarding the spatiotemporal patterns in their input signals. The whole network receives special messages from external sources (sensors) and outputs special messages to actuators. Generally, embedded within the architecture and dynamics of such a network we find an inherent model of the "meaning" of the relations between input patterns and output responses. Some parts of this model are "built-in" as in genetically prescribed in animal brains. But networks in which the nodes are adaptable, i.e., capable of adjusting their responses as new patterns are encountered and reinforced, can learn new associations between inputs from the environment and responses that result in favorable outcomes (for the decision maker).

The network, **N**, is not an arbitrary or random wiring of connections and nodes. The network has very specific architecture designed to capture meaningful information and when capable of learning, to organize itself to accommodate changes in its input/output relations.

Brains are such networks. Their architecture reflects the way in which they can gather information about their environments and make decisions directing the body to interact with that environment in appropriate manners.

The Generic Brain

The role of a brain can be understood generically to be as a processor that extracts

information from a flow of messages, data streams, and uses that information to make action decisions. Systems that have brains and take actions that will, in turn, affect the environment, are called agents. All sorts of systems from robots to earthworms to human beings have the capacity to process data to detect the spatiotemporal patterns inherent in the dynamics and causal relations among other sibling systems as well as the supra-system within which the agent and its siblings are embedded.

In biology, active agents – animals – have brains that are just complex enough to process the data streams that are inherent in their particular environment, their econiche, providing adequate information flow to allow them to function in that niche (Mobus, 1999).

The evolution of animal life has been a progression of more complex information processing systems in response to the increasingly complex environments that have been, ironically, generated by the continuing evolution of brains (Geary, 2005). That evolution is completely neoDarwinian, descent with variation followed by various forms of selection that result in "improvements" in information processing capacity. That biological evolution led to the advent of the human brain and the emergence of capacities beyond those of any other biological systems previously. Humans evolved a capacity to imagine future scenarios, recognize unique affordances in objects, and, most of all, the capacity to communicate ideas via a symbolic language. The human brain represents another major phase transition from mere responding to changes in the environment to an ability to intentionally obtain a desired future by significant alteration of the environment itself (Deacon, 1997; Tomasello, 2019).

The Human Brain

Evolution of brain structure and functions has been a process of accretion, duplication followed by diversification of functions, and significant expansion of the processing sub-networks (Geary, 2005). There are a number of aspects of the human brain that far exceed the capabilities of lower animals, such as our language processing capacities. But by far, the most significant development in the evolution of the human brain was the nearly explosive expansion of the prefrontal cortex and, in particular, the patch of tissue just behind the eyebrows known as Brodmann area 10 (BA10) which we now recognize as the seat of the unique form of human consciousness (Mobus, 2019). It is possible that the rapid expansion of BA10 actually promoted the expansions of other brain areas such as those involve in speech processing. A great deal of research needs to be done in this area, but it is

factually the case that BA10 evolved as the newest add-on to the prefrontal cortex about the time that humans became their modern selves, about 180k BP.

The advent of brains that could imagine the future, have intentions for how to make that future come to pass, and had the ability to share and communicate their ideas, their intentions, changed everything in the biosphere. Arose a new geosphere, the *noosphere*, a realm in which minds interacted almost purely through the communications of ideas and concepts (de Jardin, 1959; Vernadsky, 1997). And that enabled the advent of a new kind of social group, the human social system (HSS) a 'tribe' of related and semi-related individuals who cooperated intensely for the sake of mutual survival.

The HSS, even when limited to small groups of 50 to 100 individuals operated as a unitary entity. The interactions of the brains in the group became an information processing network. The group succeeded because they could gather information about the environment, process that information collectively, and make decisions about how to behave, as a group, in response.

The Technosphere and the Supra-Brain

The collaboration and information processing capabilities of the collective of these small groups amounted to the advent/emergence of what we can think of as a supra-brain. That is, each human individual in the collective acted as a node in our model of a dataflow network as described above. Each individual received multiple and complex signals from their environment, which mostly comprised other individuals, but also included messages from their general environments. Each extracted the relevant information, the correlations that made 'sense,' and each shared via language with others.

One of the main outcomes of this new kind of information processing, that included, incidentally the storage of memories, both explicit and tacit, and the capacity to reason about the significance of patterns for the life of the group and self, was an ability to grasp the ways of acting on the world to produce things that did not previously exist that would, in turn, allow the individual and the group to do things more efficiently and faster. It started with chipping stones to form cutting tools and intentionally setting fires. That would eventually grow to realizing that we could manage to grow foods in a way that reduced much of the uncertainty in keeping alive. And it would ultimately result in larger groups producing new technologies, tools and procedures, that lead us up to the world of today.

We now live in a world in which a supra-brain-like network generates an abundance of technology. Some individual lives are enhanced, so far as convenience and speed are concerned, but many lives are not because the blessings of the technosphere are not really as they first appear. The whole global human social system is functioning as a controlling agent over the future of the planet. But it is a completely unconscious process. It is not a brain-like system. And, indeed, it is currently driving the planet to destruction. Brains evolved in animals to provide a stable, reliable governance system for the individual and ensure the properness of its interactions with a dynamic, sometimes dangerous, world. The HSS is currently directing the behavior of the world but it is a blind, unconscious kind of direction. The emergence of the supra-brain capacities of small tribal groups points us in the direction of a more brain-like function that the HSS might fulfil. We just need to understand better how brains work to govern their host systems.

THE BRAIN AS A GOVERNANCE SUBSYSTEM

All animal brains govern the animals' bodies. This means coordinating internal functions (managing the physiology), coordinating the animal's behavior with the situations it encounters in the environment, and, to some degree, at least in mammals and birds, considering alternative strategies to more effectively interact with future environments.

I have developed a model of governance, called the hierarchical cybernetic governance system or HCGS (Mobus, 2015, 2017) that relegates decision types in a hierarchy differentiated by kinds of processes and time domains of dynamics. These are: operational decisions, real-time, generally based on error feedback; logistical coordination decisions, ensuring that local work processes (operations) are interacting smoothly and solving optimization problems, giving directions to operational units as needed to maintain balance of flows through the system; tactical decisions, in which operational processes involved with obtaining resource inputs and expelling product/waste outputs are coordinated with associated sources and sinks are managed so as to coordinate properly with those sources and sinks.

I have shown that this governance architecture is requisite for the proper functioning of complex, adaptive, and evolvable systems.

The Governance of Complex, Adaptive, and Evolvable Systems

Living systems such as individual organisms are complex and adaptive, CASs. Supra-living systems such as species/populations, ecosystems, and societies are complex, adaptive, and capable of undergoing evolutionary change (CAES). The latter capability is necessary in order that the system may be long-term sustainable in the face of non-homogeneous non-stationary environments. It has to be capable of changing itself physically and/or behaviorally when its environment changes in

unpredictable ways. I have demonstrated that such a system can only succeed if it is governed by a HCGS that includes a capacity to make strategic decisions (Mobus, 2017 and *in press*).

The HSS is a CAES, at least in principle. It has all of the aspects of a CAES except for a unified HCGS that would govern it and its interactions with its environment. For example, it is struggling to find a way to manage its carbon output to the atmosphere. There is no real governance structure that can implement and enforce a plan to reduce emissions. It only has a vague intention to do so but no way to actually come up with a strategic plan and manage its implementation.

Gaia is a CAES in Need of a Brain

The human brain is a CAES governing a body of an individual in a complex, dynamic, and often unpredictable environment that is, itself, a CAES (i.e., a CAES subsystem inside a larger CAES operating in a still larger CAES!) If we take this logic to its full conclusion regarding the planet as a whole then Gaia, clearly a CAES, needs a subsystem CAES to function as a HCGS to bring long-term viability to the whole.

Here is the basic argument. At present the Ecos is a special kind of CAES, a system managed by a set of interrelated mutual constraints, call it an ecoCAES. Ecosystems have all of the attributes of a complex, adaptive, and evolvable system when in a state known as climax state, but they do not evince a sense of purpose or intentionality. They simply exist. And they are at the mercy of larger forces. Ecosystems may enjoy a modicum of balance and stability in the climax state, but, invariably, they are susceptible to disruptions from invasive species or climate change.

At present, the Ecos along with the HSS as a subsidiary system, is more like an ecoCAES than an intentional CAES (like an individual human or a group of humans). It just depends on luck to keep going undisturbed. And, given all the evidence of the effects of anthropogenic bumbling in the technosphere, it looks like its luck has run out. Very similar to when that asteroid or comet hit the planet 65 million years ago.

But suppose Gaia had a brain, an information processing network that could sense conditions, both internal and external, and manage, i.e., coordinate responses that would stabilize the planet's behavior and internal physiology such that it would enjoy a really long-term sustainable future. Why not?

We human beings are already information extractors and sharers. We already live in a complex, but poorly organized, network that processes higher-order information (patterns in space-time). If we were organized in a society that had a purpose in processing information for the governance of the planet, not as "rulers," but as caretakers the way our brains take care of us, might not Gaia as a whole, meaning including us, become a long-term viable system?

It turns out that if we adopt a hardnosed systems examination of these kinds of questions, we begin to see a viable purpose to the existence of a human society, not as a destructor of a planet, but as its mental functions, its management of resources and wastes such that the planet will thrive for a very long time. Just as in our brains, no single neuron has any conception of the whole of cognition, so too in a society of individuals no one person needs to have a conception of an overall governance process for the planet, but only if the society is organized in a brain-like architecture that produces cognitive results.

The structure in the human brain that produces cognition and consciousness in us is the neocortex. The way it is organized results in a flow of data from neural modules to other modules that results in the encoding of concepts or models of what exists in the world and of using those concepts to generate new concepts of what 'might' exist in the world. The organization and functioning of the neocortex are a model of how a social system might emulate the information processing and decision-making capabilities of a sentient entity, in this case Gaia.

HUMAN SOCIETY ORGANIZED AS A NEOCORTEX

Suppose we asked what an 'ideal' human society would look like, in light of criteria such as long-term sustainability, viability, and thrivability not just for our HSS but for the planet as a whole. How would society be organized such that each and every individual member of society would be able to self-actualize and achieve their full potentials as human beings? In part we might employ an evolutionary argument that asks: How were humans organized socially during the period of their emergence as a species? The justification for asking this question is based on the relevance of genetics to individual human development. We humans evolved as animals to pursue our lives and existence, how we made a living, in a certain way that presumably made us fit for survival and to thrive. That this way was successful is evidenced by our apparent success as a species in achieving the dominant place in the pecking order of life.

Human social groups, during the late Pleistocene epoch, were small, mostly based on a few extended families. It was during this time, roughly ~180k BP (before the present) that *Homo sapiens* emerged and developed the species' modern form and, importantly, language. These groups were already acting as a processing module, extracting information from their environments and making decisions about what to do next. And they had to interact, occasionally with other groups. They had to process intergroup information through verbal exchanges, trade, and mate acquisitions to consider larger concerns than just for the tribe itself.

Human social groups, in fact, resembled a neocortical structure called a 'cortical column.' The cortex is a sheet of neural tissues organized into small 'cellular' structures or columns that is the basis for a wide variety of neural tasks such as feature recognition in the hind-most regions of the sensory cortex. Remarkably, these column structures are repeated across all regions of the cortex. They seem to function similarly throughout the cortex, but as we go from those hind-most regions that are busy extracting sensory information to more forward regions we see that the same basic functional processes of the columns deal with more complex feature processing (Hawkins & Blakeslee, 2004). In fact, we can see that as messages are propagated toward the most forward parts of the cortex, these columns are integrating more and more complex patterns – concepts, in fact. At last, we come to the prefrontal cortex where our most elaborate concepts are processed. They are elaborate in the sense that they combine simpler concepts and relations between concepts (e.g., causal relations) and may be the seat of what has come to be called 'working memory.'

The prefrontal cortex is also referred to as handling the 'executive functions.' This is still a catchall for the idea that this region of the brain is controlling the rest of the brain's functions, such as memory recall and working memory focus. What is very interesting about this region of the brain is that it is a very recent accretion to brains in evolution. It correlates quite well with the increase in animal intelligence (say from reptiles to mammals).

The overall organization of the brain's neocortex, then, is a hierarchy of complexity of concept encoding (and working with) from back to front and an increase in governance function at the same time. In other words, the neocortex assembles and forwards upward sets of patterns that correspond with what is being sensed and temporally correlated. Remarkably, the more complex correlations are accomplished with the same 'amount' of processing hardware as the simpler ones, the cortical

columns are essentially the same 'size' as one proceeds from the sensory areas to the frontal areas. This is because the representation of complexity is distributed back through the whole cortex. The sensory modules contribute to the activation of conceptual modules but the latter do not need to hold another representation of the former. They work together to produce a global representation of the whole. The forward (prefrontal cortex columns, for example) are not, strictly speaking, "grandmother" neurons. But they are the roots of a representation tree, splaying back into the earlier cortices, and hence, if themselves activated (by mental processes beyond the scope of this paper) will subsequently activate the earlier association and sensory modules that contribute to the memory of grandmother.

The reason this level of understanding of how the brain functions is needed is that it provides clues as to how an HSS might be organized to produce 'thoughts' of the state of the planet, not unlike our internal images of our own bodily states (Damasio, 1994, 2000).

Moreover, if the HSS were organized along the lines of the neocortex, with a prefrontal cortex based on the principles of the HCGS, it is conceivable that the HSS as a whole might provide Gaia with a new kind of consciousness – beyond what we individual humans experience as consciousness. I cannot speculate further without risks. But is it unreasonable to assume that if our planet is to achieve a very long-term sustainable condition, that is not to be subject to the whims of a nonergodic Universe, that the development of an actual planetary brain is the next step? If the patterns of evolution of the past are prelude to the future, this is a feasible scenario. Moreover, we humans have achieved a capacity for intentional direction of evolution itself. We can orchestrate our own organization of society. We can serve a purpose for the planet.

CONCLUSION

Evolution has produced a consistent pattern of brain-like information processing, dataflow networks that have assumed the role of hierarchical cybernetic governance systems in their embedding supra-systems. There are good reasons to believe that the evolution of the human social system has been moving in the direction of such an information processing system. But its current state of affairs is far afield of the basic model we have of an HCGS. I propose that a more elaborated knowledge of systems emergence and evolution may provide us with what we need to intentionally direct the future structure of the HSS to become Gaia's brain.

REFERENCES

Damasio, AR (1994). *Descartes' Error: Emotion, Reason, and the Human Brain*, G.P. Putnum's Sons, New York

Damasio, A (2000) *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*, Mariner Books, New York.

de Chardin, PT (1959) *The Phenomenon of Man*, Harper Perennial

Deacon, TW. (1997) *The Symbolic Species: The Co-evolution of Language and the Brain*, W. W. Norton & Co., New York

Geary, DC (2005) *The Origin of Mind: Evolution of Brain, Cognition, and General Intelligence*, American Psychological Association, Washington, DC

Hawkins, J with Blakeslee, S. (2004) *On Intelligence*, Times Books/Henry Holt and Company, New York

Lovelock, J.E.& Margulis, L. (1974). "Atmospheric homeostasis by and for the biosphere: the Gaia hypothesis". *Tellus. Series A.* Stockholm: International Meteorological Institute. **26** (1–2): 2–10.

Margulis L, Sagan D (2000) *What is Life?*, University of California Press, Los Angeles CA

Mobus, GE (1999) "Foraging Search: Prototypical Intelligence", *The Third International Conference on Computing Anticipatory Systems*, Liege, Belgium, August, 1999. Available on-line: http://faculty.washington.edu/gmobus/ForagingSearch/Foraging.html

_____ (2015) "A Systems Science Framework for Understanding the Nature of Governance", Conference: *Governing the Anthropocene*, International Society for the Systems Sciences, Berlin, Germany, August 2 - 7

_____ (2017). "A Framework for Understanding and Achieving Sustainability of Complex Systems", *Systems Research and Behavioral Science*, **34**:5, John Wiley & Sons, Ltd, doi: 10.1002/sres.2482.

_____ (2018) "A Systems-Based Architecture/Design for the Human Social System", *Systems Analysis in Economy*, Moscow Finance and Economics University, Moscow, ORCID: https://orcid.org/0000-0001-8145-0908

_____ (2019) *A Theory of Sapience: Using Systems Science to Understand the Nature of Wisdom and the Human Mind*, Currently available online, hosted by The Millennium Alliance for Humanity and the Biosphere at Stanford University, https://mahb.stanford.edu/library-item/theory-sapience-using-systems-science-understand-nature-wisdom-human-mind/ . Accessed 10/7/2019. In preparation for print edition.

Tomasello, M (2019), *Becoming Human: A Theory of Ontology*, Harvard University Press, Cambridge MA

Vernadsky, VI (1997) "Scientific Thought as a Planetary Phenomenon", *Nongovernmental Ecological V.I.Vernadsky Foundation*, Moscow

Volk, T (1998) *Gaia's Body: Toward a Physiology of Earth*, Springer-Verlag, New York