Proceeding Paper

Conceptualizing and Designing (Co)Augmented Intelligence(s) Enacting Complex Thinking: Morphological Constraints, Challenges and Implications †

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Abstract: This paper builds upon a recent proposal of a pragmatically-oriented framework for the practice of 'Complex Thinking' to further conceptualize it as a mode of thinking bridging different modes of thinking and types of cognitive activity. It explores the application of this framework for the design of human and computer-guided tools and strategies, or 'Other' Intelligences (OI), including AIs, which, coupled with a given observer/intervenor, would support and augment the enactment of Complex Thinking. This paper raises questions regarding the morphological constraints, challenges, and implications associated with the design of systems of (Co)Augmented Intelligences informed by Complex Thinking which aim to promote it.

Keywords: complex thinking; relational thinking; augmented intelligence; morphological design; computer-assisted tool; enaction; meta-cognitive landscape; modes of thinking; coupling

1. Introduction

The growth of Complexity Sciences has led to calls of attention to the pressing need for the development of new modes of thinking, capable of more fully embracing complexity through the integration of its core organizing principles, and of taking serious consideration of its ontological and epistemological implications [1,2]. The capacity to effectively manage the most complex and pressing 'real-world' challenges and to develop effective and sustainable interventions may depend upon this.

In this paper, we build upon a recent proposal of a pragmatically-oriented framework for the practice of 'Complex Thinking' (CT) [3] to further conceptualize it as a mode of thinking bridging different modes of thinking and types of cognitive activity. CT organizes the coupling of an Observer/Intervenor (ObI) with a target System of Interest (SoI) [4] through processes that are isomorphic to those which underlie both the cognitive activity of the ObI and the organization of many natural, biological and social complex systems [3]. Here, the focus is on the application of this framework to the design of human and computer-guided tools and strategies, or 'Other' Intelligences (OI) including AIs, which coupled with a given observer/intervenor, would support and augment the enactment of CT. Such systems of coupled intelligences should promote rich understandings and facilitate the emergence of novel ideas and hypotheses to guide effective actions.

2. Complex Thinking

The CT framework adopted in this paper is grounded in a relational and constructive worldview (ontology and epistemology) [3] and a perspective of cognition as enactive, embodied, affective, and situated [5,6]. The coupling of an observer with its environment brings forth a particular (micro)world and with it, a landscape of possibilities for action and transformation (of the agent, its environment, and the coupling with it). It is assumed that

cognition may be extended to, and distributed within, that environment [6]. CT is defined as both a mode or process of coupling supported by a set of practices that attend to critical properties organizing complex systems, as well as an enactment of those properties, making specific contributions to the coupling relation, and managing the information generated therein [3]. As an outcome, CT generates a variety of modes of description, explanation, and anticipation, expanding the possibilities for action and informing more effective and eco-systemically fit choices [3]. Under particular conditions CT will lead to emergence in the form of abductive leaps (e.g., new explanatory hypotheses) [3], which may guide the actions of an Ob/I, through 'top-down' effects, under uncertainty, ambiguity, and partial information, playing a critical role in managing 'real-world' change.

The framework [3] enumerates several dimensions and properties for those coupling processes that mimic properties observed in natural, living, and social systems, including structural complexity (variety & dimensionality; relationality; recursiveness); dynamic and process complexity (multiple timescales; dynamic processes; relativity, ambiguity & uncertainty; causal & explanatory complexity (modes and finalities; historicity; complex circularity; emergence); dialogic complexity (dialogical dualities and complementaries; trinities and levels); the observers' complexity (multi-positioning; reflexivity), amongst others [3]. These properties, movements in (a relational) space, compose a coupling dance with a target SoI, bringing forth particular worlds, and creating information as "differences that make a difference" [7] in the ObI, the SoI, and their coupling.

3. Conceptualising Complex Thinking as a Meta-Conversational Pattern or a Meta-Landscape of Know-ing

CT can be further conceptualized as a meta-landscape (or meta-conversational emergent pattern [8]): a complex (differentiated, integrated, recursive, emergent) form of Know-ing (process) that, enacts a set of key organizational principles of complex systems [3], explores and intentionally manipulates the dynamic relationship between an observers' landscape of Be-ing/Know(ing)-how and of Know(ing)-what [8,9], conceived as a complementary pair [10] or a meta-landscape of human cognition [11]. We assume that Know-ing, in the broadest sense, is intrinsic to the experience of Be-ing and that the complexity of more (abstract) Know(ing)-whats [8] is dependent on the (enacted, embodied, situated) complexity of the Be-ing as constituted and as shaped in the coupling with its environment [6]. CT, as a complex form of Know-ing, is sustained in the dynamic interaction between an experiential landscape of Be-ing and Know(ing)-hows and a landscape of Know(ing)-whats which, through abstractions and symbolic meaning–makings, stabilize the patterns of Be-ing, through (embodied and situated) languages and through symbolic constructions and manipulations built upon experiential information. CT can be considered a Star cybernetic complementary [8]: both an emergent product of the dialectic relationship of pair Be-ing-Know(ing)-how~(The ~ (tilde) sign is used to indicate complementarity-see [10]) Know(ing)-what) and the process underlying their interaction.

The landscape of Be-ing is a landscape of action- supporting the cognitive agent's Direct Know-ing and Know(ing)-how [8] of themselves and their world brought forth through their becoming [5,9]. It takes a pre-reflective, pre-discursive, experiential, direct, immediate-embodied, iconic, intuitive form, that could be associated with a System 1, fast, automated, and intuitive type of thinking [12]. The symbolic meaning of Know-whats encompasses more abstracted constructions of knowledge, in a landscape of consciousness where they can be discursive, narrative [11,13] or take more or less propositional, descriptive or explanatory, and nomological forms [5]. It is in this landscape that System 2 operates more strongly characterized by a slower and more effortful process [12].

In attempting to engage in more effective actions in complex situations, an ObI needs to be able to manage their contributions to the coupling relationship with an SoI both at the level of the emergent experiences of Be-ing as well as at the emergent 'higher-order' level of abstractions of Know-what. We assume that the latter constructions, as they are abstracted and externalized (e.g., through language) become a constitutive part of

the environment of the cognitive agent, not only participating in the interactions with other entities but also creating perturbations and posing constraints to their Be-ing. On the other hand, different movements in the landscape of Be-ing will generate different types of experiences and information that will be subject to different types of symbolic constructions, further stabilizing or introducing more fluctuations in the Be-ing. Different models of transformational learning and change have been proposed that build upon this relationship [14] which could be further enriched/extended to managing complex interventions.

The management of complex situations will depend on the nature of the coupling between an ObI, an SoI, and their environments [15]. Moreover, the complexity of this coupling relationship and its potential to generate information capable of guiding the ObI towards effective actions will depend on their capacity to manage their contributions to that coupling, namely by managing their movements in the landscapes of Be-ing/Know-how and Know-whats so they might perturb each other, expanding possibilities for action.

By enacting key properties of CT as contributions to the coupling relationship while managing, in that enactment, the dynamic relationship between their Landscape of Be-ing/Know-how and Know-whats, so they perturb each other, the ObI can nurture the production of emergent information, to guide their actions, in the absence of a full mapping of their system of interest and its associated territories. Those perturbations may lead to variations, innovations, and (even deeper) transformations [16] underlying creative [17] and abductive outcomes [18]. Perturbations in the landscape of Be-ing may result in the emergence of 'complex (experiential) intuitions' and manipulative forms of abduction [19] which can then be further elaborated on the coupled landscape of Know(ing)-what, where the perturbations may result in or be further elaborated through different types of theoretical abduction [19]. Their outcomes will further inform and shape the interventions. The management of the coupling between landscapes of Know-ing is, therefore, necessary for effective management of the interventions and (the ongoing) change processes, bringing forth new versions of the world. We postulate that CT will promote the emergence of information leading to more ecologically and systematically fit actions.

4. Scaffolding Complex Thinking through Systems of (Co)Augmented Intelligences

The contributions of the observer to the complexity of the coupling relationship with a target system of interest are constrained by their structural determination [20]. It should be possible to scaffold [21] the complexity of an ObI, and their contributions to the coupling relationship, through the practice of CT, in a frame of Augmented Intelligence(s), involving both human-to-ObI and human-to-ObI-to-AI/Computer Tool (AI/CT) interactions. This system of coupled Intelligences would have to guide the enactment of key properties of CT by the target human ObI in their coupling with an SoI. It should guide the observer in generating as many perspectives as possible, supporting recursive movements and the re-entry, management, and integration of the rich information generated in the dynamic interaction between the different landscapes of Know-ing, in that coupling. The author has been developing analogical tools aimed at promoting CT [15,22,23] (structural and dynamical complexity) by supporting an observer to layout information and to perform thinking movements that are both abstracted from and performed upon an embodied dimension. An AI-Computer-assisted CT tool could support the observer and a human-to-ObI pair (e.g., mentor/reflexive partner) in better managing the information, offloading some of the cognitive processing tasks that burden the human mind (retaining information; mapping relations). However, such a tool should not just store and retrieve information but support the relational manipulation and exploration of information, through the different properties of CT. It could, for example, invite the observer to perform random walks and explore unusual relations, integrate higher and lower levels, and perform recursive loops. It should prompt exploration from multiple perspectives, and promote the interplay of both concrete (direct, embodied, intuitive) and abstract (e.g., symbolic, conceptual) modes of knowing. The visual feedback from the tools should both prompt and reflect the observer's

(thinking) movements in space, given the importance of physical movement in giving rise to, supporting, and shaping the thinking [23], as well as supporting the manipulative processes underlying certain forms of abduction [19]. This AI/CT should promote the particular properties of CT that need to be practiced, proposing strategies. It needs to support:

(i) mapping of the initial Know-Hows, Know-Whats, and Not-Knowns;

(ii) prompting of the observer to play with multiple positions/modes of Be-ing in their coupling with the SoI and their environment(s) [15], generating different experiences;

(iii) mobilization of information generated by the Be-ing, to add variety (e.g perspectives) and depth but also to revise and reconstruct and develop the Know-Whats;

(iv) relational and recursive exploration of the Know-Whats, exploring different trajectories through the information and promoting a variety of perspectives;

(v) integration relations of relations and of emergent information and how it may recursively lead to new modes of Be-ing and Know-Whats, and transferred it to action;

(vi) construction of complex narratives and use of metaphors as tools for ensuring narrative complexity and communicating effectively.

5. Morphological Constraints, Challenges and Possibilities of Systems of (Co)-Augmented Intelligences Organized through Complex Thinking

To support the enactment of CT, the system would have to be organized using the same principles that organize complex systems. Recursively, the OI will need to be tightly coupled to the target observer and use it as a source of perturbation to their landscapes to extend and amplify their cognitive capacities. Some properties of CT will likely require the intervention of another human to add particular dimensions (e.g, ethical and aesthetical complexity). Given the dependence of thinking on the action and movement [23] and the importance of relational movements in CT, the physical coupling would likely be fundamental. Such systems could potentially evolve to systems of Co-Augmented Intelligence(s) generating coupled complex meta-conversational patterns of Know-ing from where new possibilities for action could emerge, in jointly enacted worlds. Additionally, within a recursive organization, one would expect that the capacities of the scaffolder could be equally enhanced, both in Humans and Artificial Intelligences, under the conditions that they are organized as open-ended processes [16]. This raises interesting issues about the social and distributed nature of cognition and opens new discussions concerning the design of Co-evolving, Co-Augmenting Intelligence Systems, where both humans and computers distribute and expand each other's cognitive capacities, across their landscapes of existence, exploring the relationship between the Be-ing/Know-How and Know-Whats. More importantly, it opens key questions about the morphological requirements of these systems for (Co)Augmenting Intelligence(s) in terms of the configurations and constraints of the Computer/AI-assisted tool (AI/CT) and its couplings:

- Could the human be physically supported by an AI/CT to explore new spaces and modes (e.g., sensorial, kinesthetic, imagetic) of exploring, manipulating, and relating information emerging from the landscapes of Be-ing and Know-What, prompting their mutual perturbation, in unusual ways, while enacting properties of CT (e.g., exploring relationality and recursiveness; physically navigating relations between concepts; exploring different trajectories; "sensing" abstract information)? What form should the interfaces with AI/CT adopt?
- Does the AI/CT require special means for 'sensing' the target ObI and coupling directly with their embodied movements? Does it require its own "physical body" or could its cognition be extended through the coupling with the human body?
- To what extent can the feedback from the ObI to the AI/CT be limited to digital/symbolic information or does it require a landscape of embodied Be-ing? What kind of interfaces could support such analogic, non-verbal feedback?

- Could the coupling be set up so that it opens space for variation or innovation in the landscapes of Be-ing of the OI (AI/CT and human) and could they feedback and increase the structural variety of the thinking of the target ObI?
- Does the coupling between the human OI need to be of the same nature as between the AI/CT -ObI and of what shape? Taking biological systems as examples, what would be the model (e.g., coupling with one, the other, both, and how)?

6. Discussion

With this paper, we open and invite others to engage in new interdisciplinary dialogues and projects to explore the theoretical, methodological, pragmatic challenges and implications of conceptualizing and designing the tools, strategies, and morphological constraints of systems for (Co)Augmenting Intelligences, through scaffolding the enactment of Complex Thinking (CT), by an observer, in relation to a target complex system of interest. There are many challenges to address particularly in terms of the morphological dimensions of their design, considering the coupling between the computer tools or AIs and the human components. We propose that the properties of CT need to be considered not just as targets but in the design of such systems of (Co)Augmented Intelligences as they might determine their potentialities and capacity to co-evolve the possibilities for the action of both the Human and Artificial Intelligences.

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