Quantifying Experience through Causal Emergence

Paper Review

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Hoel, Erik P. "Agent Above, Atom Below." *Uberty*, 2017. Accessed June 9, 2017. http://uberty.org/items/resource/erikhoel-agent-above-atom-below-how-agents-causally-emerge-from-their-underlying-microphysics/.

In his paper "Agent Above, Atom Below", Erik P.Hoel attempts to understand how agency occurs at macroscale in (certain kinds of) complex systems and cannot be causally reduced to the microscale of (sum of) their constituents. That such a property belongs to the macroscale is indicated by the presence of extra information in the latter- quantity of information higher than the summation of information in constituents of microscale. This property could be life in a cell, intentionality/goal-oriented behaviour in case of other kinds of complex systems like human beings[1]. Picking from (E. Hoel 2017), "higher-scale relationships can have more information because they are performing error-correction"[2]. As higher amount of information is transferred through error-correcting codes to avoid interference from noise, macro scales also "reduce noise and uncertainty in a system's causal structure, strengthening causal relationships and making the system's behaviour more deterministic" (Wolchover 2017). In Hoel's system, the measure of causation is in bits based on the fundamental Shannon theorem 1948 and carried through Judea Pearl's causal calculus. More specifically, effective information is the currency for measuring causal power. Effective information shows the extent to which the current state of a system is necessary to predict future state of the system (E. P. Hoel, Albantakis, and Tononi 2013). To show how effective information from a micro-vs-macro scale is relevant to the question of agency (and goal-directedness), consider the following excerpt:

"A real-world example cements the point. "Our life is very noisy," Hoel said. "If you just give me your atomic state, it may be totally impossible to guess where your future [atomic] state will be in 12 hours. Try running that forward; there's going to be so much noise, you'd have no idea. Now give a psychological description, or a physiological one: Where are you going to be in 12 hours?" he said (it was mid-day). "You're going to be asleep — easy. So these higher-level relationships are the things that seem reliable. That would be a super simple example of causal emergence.""(E. P. Hoel, Albantakis, and Tononi 2013; Wolchover 2017)

My review focuses on the philosophical implication of Hoel's position. I do not focus on the technicalities of working of causal calculus, whose credibility and correct technical application is not my area of specialization.

That there is information embedded in the world around us whose nature allows us access to understanding objects and their relationship to one another has gained major weight through development of information theory over the past few years.

Integrated Information Theory has been one of the first ingenious initiatives to provide a quantification-oriented systematic approach to consciousness, while retaining the autonomy of the latter. We encounter higher amount of information in the macroscales, than in the microscales and causally structuring one's behaviour at the macroscale is channel coding, allowing systems to be stable and teleological by reducing the chances of error due to noise/disturbances (from the external environment or internal changes as well). Causal emergence, thus, becomes the process by which the causal structure of a system develops at the macroscale, performing error-correction (reducing noise and degeneracy) in constant interaction with its environment. This provides a fresh look at how information at macroscales can be measured, why we encounter higher information at macroscale and how this information caters to causal power of the system. Apart from refreshing development in quantifying consciousness, causal emergence validates the space for phenomenology and literature- a space which had been marginalized to the corner of studies on consciousness and mind over the centuries.

It is evident that the starting point for Hoel's position is ensuring that the subjective experience is unreduced in the course of explaining it. Such starting points are rare in history of philosophy of mind and must be duly acknowledged. However, over the course of reading the paper, one can sense a certain detachment (not *departure*) from the subjectivity of understanding an experience. The paper begins with an observation which can be mildly classed as phenomenological (what we encounter in our experience of the world: agents with goal-oriented behaviour and intentions) and move to mathematical modelling (the causal calculus)- however, the paper never comes back to it: predictions of the behaviour of an agent must be carried out at the macroscale, through a methodology that takes into account the subject, as a whole (which is what, as Hoel mentions, psychology, phenomenology[3] intend to do). While causal emergence provides a sturdy basis for the presence of a macroscale in the form of higher information carrying out error-correction, our experience with the world occurs at the level of belief, desires, intentions, thoughts- my actions in the future are not a product of my actions in the past *alone*. No lack of coherence or validity is encountered within the apparatus that Hoel has set up: the causal calculus provides one of the best ways to measure the causal power of a scale. However, for a reader with phenomenological inclinations, the paper seemed to have provided high hopes initially and taken a backseat later. The issue of micro-macro causal structure is not an issue of descriptions but of confronting causal power at macroscale which is non-existent at the microscale. In observing a subject *x*, say a human being, at the level of atoms, there is no *x*, there is an organization of atoms interacting with one another but the object of my study is not *x* anymore, which is characterised by the causal power of intentionality, goals. The micro-macro causal structure is a way of delineating the limits of certain sciences. What kind of prediction can physics/phenomenology come up with, based on the information we gather?

My concern with the idea of causal emergence and its relation to intentionality can be posed in the following question: “What kind of information do we encounter at the microscales? Are they same or different in kind from the ones we observe in microscales?”.

A reading of macroscales as operating through error-correction codes gives the impression that the noise we are reducing at macroscale is still the noise that the microscales encounter. That is, as we move up the scales (*focusing the camera*, in Hoel’s terms), would the nature of noise remain the same? Owing to my lack of specialization in mathematics, it is possible that such a direct application of a structure that fits into the microscale to the macroscale seems a bit odd. This is not to deny that the principles which seem to govern behaviour of integrated wholes (complex systems which exhibit stability, coherence and cohesion) at different scales are the same: some such principles being non-linearity, self-organization, Bateson’s “the difference that makes a difference”.

My specific worry is that while Hoel’s work takes into account, impressively, the ultimate (though not the intended) goal of stable equilibrium that systems are oriented towards, it seems to have left behind the nature of organization as we move up the scales: integrity of the whole at a macroscale is different in kind from integrity of the whole in the microscales, owing to the novel properties we encounter (which are causally emergent). The explanatory model set up by Hoel is an unprecedented way of understanding *how* the macroscales are operating their causal power: they have more information, error-correcting codes which can be quantified. However, at a macroscale, the noise I am intending to reduce is not the noise which microscales encounter. What is more basic to my experience of the world is the framework I have set up to make sense of the world around me- this framework constitutes of beliefs, desires (axiomatic, secondary). The kind of information I will need to make sense of intentionality (the kind of intentional stance I will embody towards an other in a certain situation) will be intertwined with the information we encounter within the global structure of the scale to which I belong as a whole (over biology and below economics, as pointed out by Hoel). That there is extra information constituting this macroscale state than the sum of information at a microscale is helpful to understand not that the macro is *greater* than the micro but that it is *other* than the micro. (This is not to deny that this identity as a whole arises from the interaction of processes that occur between the micro-elements: “global structure that arises from the local interactions”(Goss, Gatteschi, and Bogani 2014)) Causal calculus is an optimal method for measuring the kind of causal power that a macroscale exhibits, in form of causal relationships- however, this does not take us closer to understanding intentionality or qualia.

The principles explicated by Hoel, those of causal emergence, error-correcting, reduction of noise, integrated information and effective information are exactly the floating rocks which might fill up the fluid explanatory gap that has plagued philosophy of mind for decades. However, the only way in which such floating rocks

could glue together to form a bridge or in a stronger way, to show that there is no gap, is to take into account sources of information which talk about causal emergence in the most genuine way: the works of phenomenology, existentialism and as Hoel also admits, literature ("The novel is, of all the tools of the intellect, the one that brings us closest to another's consciousness. It does this through its exploration of mind space: the realm of possible conscious experiences and their relationships to external, physical, and social contexts."(E. Hoel 2016)).

In my opinion, Hoel deals with causal emergence as a larger phenomenon, with uncomparable sincerity. Placing his paper within the larger framework of Integrated Information Theory allowed me to gain more insight into his treatment of subjectivity: that experience is a conceptual structure whose intrinsic irreducibility reflects the amount of consciousness there is (that is, the quantity of experience) (Tononi et al. 2016). However, the jump that irreducibility reflects the quantity is yet again a sign of not having taken into account the change in nature of the information we encounter at macroscale. There can be structure without measurement through quantity: this is precisely what qualitative accounts of experience in literature attempt to show. Our ability to set up the structure that delineates the nature of experience provides us with a spectrum of probabilities about the future behaviour of our subject but not a quantity of the experience. The qualitative character of an experience is untouchable, though we can reach it- we can stand and look at how it works but never contain it as a quantity. While Integrated Information Theory attempts, almost triumphantly, to preserve the autonomy and irreducibility of experience, it is given up when experience in itself is quantified. The scope of Integrated Information Theory along with causal emergence is vast and by studying it in a detailed and thorough manner, it is my hope that the question: "Is the *kind* of information we encounter at macroscales, the *kind* we observe at the microscales?" will be answered adequately.

ENDNOTES

1. These are considered to be novel properties within the study of complex systems. Those properties of a complex system which are not shared by any of their constituents.
2. Error refers to the situation when the output information in a system does not match the input information. During the transfer of information, noise interferes with the digital signals which introduces errors in binary bits which are traveling from one system to the other. This means that 0 bit may change to 1 and 1 bit may change to 0. The basic idea of error-correcting codes is that they add redundant bits to allow transfer of information in the presence of noise in a complex system. The Shannon Limit 1948 mentions the maximum information that can be transferred in a channel theoretically. According to Shannon theorem, “Given a noisy channel with channel capacity C and information transmitted with a rate R, then if R < C there exist codes that allow the probability of error at the receiver to be made arbitrarily small”.
3. Hoel does not mention ‘phenomenology’ or ‘literature’ in his paper, though reference to it can be found in other papers: http://www.thedailybeast.com/how-to-mathematically-measure-consciousness,

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