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# Pragmatic phenomenological types

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ABSTRACT

We approach a well-known problem: how to relate component physical processes in biological systems to governing imperatives in multiple system levels. The intent is to further practical tools that can be used in the clinical context. An example proposes a formal type system that would support this kind of reasoning, including in machines. Our example is based on a model of the connection between a quality of mind associated with creativity and neuropsychiatric dynamics: constructing narrative as a form of conscious introspection, which allows the manipulation of one's own driving imperatives.

In this context, general creativity is indicated by an ability to manage multiple heterogeneous worldviews simultaneously in a developing narrative. 'Narrative' in this context is framed as the organizing concept behind rational linearization that can be applied to metaphysics as well as modeling perceptive dynamics. Introspection is framed as the phenomenological 'tip' that allows a perceiver to be within experience or outside it, reflecting on and modifying it.

What distinguishes the approach is the rooting in well founded but disparate disciplines: phenomenology, ontic virtuality, two-sorted geometric logics, functional reactive programming, multi-level ontologies and narrative cognition.

This paper advances the work by proposing a type strategy within a two-sorted reasoning system that supports cross-ontology structure. The paper describes influences on this approach, and presents an example that involves phenotype classes and monitored creativity enhanced by both soft methods and transcranial direct-current stimulation.

The proposed solution integrates pragmatic phenomenology, situation theory, narratology and functional programming in one framework.



## 1. Introduction

### 1.1. Background

Our intent in this paper is to explore the metatools required for a formal, coherent approach to the multilevel problem in biology, described below. In particular, the focus is on a *type system* that serves our needs. A companion paper (Goranson and Cardier, 2013) describes the theoretical foundations and accompanying methods of a system that models and reasons over the open world and across ontologically discrete system levels. This paper focuses on the metaphysics of the system and implications for the types therein.

A key notion is *narrative*. We use it in its simplest embodiment: the way humans organize what we perceive in order to comprehend and remember. This notion is extended in two directions. We use it to advise a metaphysics based on the assumption that the most *elegant* elegance comes from how we automatically structure the world. We also use the observed dynamics of complex narrative to tease out the hidden agents that co-construct situations within the phenomena of interest.

A key technique is use of a two-sorted reasoning system. One sort is able to maintain current methods in all disciplines and system levels, as inherited from existing research and projects. We add a second sort of reasoning system that is not logic-based, does not have Newtonian legacy and is tailor-made for the phenomena of interest. It operates on the first and reasons at multiple levels about cross-situational dynamics. This second sort is informed by solid theoretical influences, many of which are noted here.

Our research group specializes in using these two approaches to build workable systems capable of doings things previously undoable.

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This paper is aimed at a multidisciplinary audience and care has been taken to avoid the use of jargon and domain-specific notation; more references have been included than otherwise would be the case. Also, in some cases, simple reductions of complex issues have been made to allow the presentation to be more concise as a synthesis of several ideas. We apologize in advance to specialists who feel their domain should have been more fully described.

### *1.2. The problem*

Complex systems operate at numerous levels, and are understood using diverse disciplines – for example, the mind is modeled using chemistry, neurology, biology and psychology. Each level has its own driving imperatives which are recorded in an array of different modes and notations. Modeling the interaction among these systems is a long-standing problem, both for humans and machines.

We follow others in describing coherent aspects of the world as *situations* in which elements are structured so they can be viewed as a whole (Cardier, 2013). In the above example of the mind, each level can be characterized as a situation, and the components within it also be modeled as situations. We frame the driving imperative that is both within, and responsible for, the assembly of these situations as *causal agency. Causal agency* is any imperative that can alter a situation.

The problem is anchored in cross-situational modeling in formal systems. Perception and representation are limited and subjective, and as a result, the ontological reification of any system omits critical aspects of the process. This is especially true of causal agents, which in the open world, facilitate the transformation among heterogeneous states. Formal systems thus struggle to account for causal transformation using logic.

The problem of perceptual limit is a manifest concrete problem for ontology design in knowledge systems. It should be noted that we use the term *ontology* exclusively as computer scientists use it, and not as philosophers (including phenomenologists) would. As noted below, an ontology is a formal characterization of a domain of interest (Gruber, 1993) used in computable reasoning systems.

In computer science, if an ontological conceptualization is closely modeled on a domain, it will likely be conceptually *heterogeneous*: a tight perspective that makes it less compatible with other systems (Acampora et al., 2012; Wigner, 1960; Berners-Lee, 2008). A number of approaches have been developed to address this incompatibility between systems, most of which standardize knowledge so there are no inconsistencies.

The inability of heterogeneous ontologies to communicate with each other is crystallized in our target biological phenomenon. When modeling the multiple-level emergence and transformation of living systems, the usual solution of standardizing or generalizing away inconsistent, conflicting or diverse information is too costly, as it can omit critical aspects of causal agency. As evidenced by narrative processes, such tensions and diversity are needed to propel emergence and transformative imperatives in the first place (Cardier, 2013). (The relationship between narrative and multilevel impetus is described in a moment.)

The difficultly in modeling multi-level dynamics can be found in numerous fields, as one would expect. One statement of the problem relates to formal studies of information flow. *Situations* are similar to a *context*, in that a shift between *situations* alters the effect of facts (Devlin, 1995). Many situations cannot be reduced to facts or reached by logic (Devlin, 1996). Dynamics at the system level have imperatives not evidenced in individual components.

Another statement of the problem is motivated by quantum physics; though it is one of the most successful theories devised, there is no satisfactory proposal for a metaphysics. Some category theorists (Bohm and Hiley, 1993) have an attractive proposal, and (Siek and Phillip) presents a model from first principles. But these are not amenable to engineering of models. The general principle of extractable concepts is addressed in the section addressing Rosen (Santilli).

A third expression of the problem concerns how to reason over multiple system dynamics in living systems; the problem is well stated in previous volumes of this Journal (Bard et al., 2013). Roughly speaking, we have extraordinary tools to model biology at the level of physics, physics as expressed in chemistry and chemistry (and associated physical metrics) as a basis for biology at the molecular level. But we lack models and methods with semantic weight that can subsume these at higher levels and systems and yet give us useful mechanics and associated imperatives of living systems. It is this latter definition of the problem that we use here, though we leverage tools from those working the parallel challenges in quantum physics and ontology design.

The paper outlines the metaformalisms as *types* behind our approach. In computable systems design, types specify the fundamental units of meaning, and underlie the functions of computational comprehension. Due to our focus on multi-level systems, our types must be fundamental both in the context of their sources, as well as in the context of our developing system. In accordance with the notion that *information* is a common organizing parameter across all levels of natural phenomena, the types are chosen to underpin notions of assembling information – those discernable in any framework governed by ordered perception.

We draw upon several bodies of research to devise these types, and the paper is organized to outline these areas in general terms. It forms a survey of the philosophical foundations: phenomenology, symmetry and situation theory in the first sections.

In the body of this paper, we turn to the implementation frameworks leveraged: quantum interaction, calculus and computable two-sorts. Finally, we indicate an experiment and future directions.

## 2. Phenomenology

### *2.1. About types*

This work requires us to act as both radical scientists and reliable engineers.

On one hand, we have to invent new theoretical tools. By definition, we are approaching problems that are unsolvable by current methods; some of these are extremely high payoff areas. A reliable engineer would work within existing theoretical frameworks, but we need some radical advances. So we work at two levels, in both theory and tool development.

As engineers, we are constructing useful tools, borrowing fabric and methods from others. As this paper outlines, our sources are unusual and are put together in ways that many of the source researchers did not anticipate. On the track from research to utility, only the most trusted and salient components are used. Engineering a type system from scratch is daunting, but necessary given the unique modeling of the problem.

As scientists, we realize invention is required. We don't need to *rethink* science per se, but we agree with the many others cited in this volume that new fundamentals need to be applied. We seek deeper abstractions and abstraction frameworks: abstractions that satisfy at the philosophical level, and related abstractions that have computational affordances to support modeling and practical analysis. We need to understand processes beyond the cellular level, beyond the structural model and across systems to individual and group cognition. The work requires new primitives.

Similarly, the abstraction problem needs both a radical advance