A Priori Modeling of Information and Intelligence

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Abstract. This paper details *primitive structural traits* in information, and then in intelligence, as a model of 'thinking like nature' (natural/core informatics). It explores the task of designing a general adaptive intelligence from a low-order (non-anthropic) base, to arrive at a scalable, least-ambiguous, and most-general, computational/developmental core.

1 Discussion of Problem: Asking the Right Question . . .

What presents a central conceptual challenge in the advent of human level AI (HLAI) is essentially noted by various individuals, across diverse disciplines, as they each confront their own obstacles:

- 'solving intelligence', Demiss Hassabis, Google Deep Mind [3],
- 'de-risking science', Ed Boyden [2], MIT Media Lab, neurology,
- 'meaning as fundamental', Brian Josephson [17], Cambridge University, physics,
- 'theory of meaning', Shannon and Weaver [34], information theory, and more.

Each individual or discipline has its own framing, but these nominally-diverse logical gaps can be seen as, and reduced to, one main informational failing.

Shannon and Weaver were likely first to see this gap as a missing *theory of meaning* but it has worn many faces since. Further study marks key differences in how we view and treat objective (quantitative) information, and subjective information (qualia, raw sense data) — where basic ideas of 'information' become a confused dualist concept, with neither view fully developed or integrated with the other [34].

For example, mathematics is often seen as being 'purely objective', capable of omitting subjective traits from its arguments as an intellectual ideal (e.g., theoretical mathematics). But mathematics without *subjective elemental facts* is a fact-free science, of little practical use. Only if subjective (S) and objective (O) roles are linked do 'useful results' arise (e.g., applied mathematics). If we look for other firm objective views, the standard model in physics and the periodic table are good candidates. But their recent 'objective success' ignores the fact they arose from a line of *subjective elemental observations*, later normalized via experiment and peer review. Only after enough material regularity ('evidence')

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was *subjectively discerned* and *subjectively named*, by varied individuals, were the models then normalized (agreed upon) as being innately objective.

Practical gains derived from **objectified** *subjective* roles, like the standard model and the periodic table, are so vast that we may forget how objective features first arise as subjective notions. Objective traits cannot even be posited if they are not first *subjectively sensed* or 'discovered' by someone. So, if we now seek to design something 'objectively intelligent', we confront the equal of designing a 'pure subjective' role [35] to sustain later 'objective' aims. The point of *general intelligence* is, after all, to bring new subject matters to our attention, so we can later name new objective gains, in a scalable/serial manner. Continued 'informational (S-O) integration' would presumably lead to a type of HLAI+ or 'super-intelligence'.

But before attempting any such goal, we must ask 'Intelligence about what exactly?', as all intelligences, even human, are unequal due to innate subjectivity [7]. Also, in a manner akin to that seen in the standard model and the periodic table, what *subjective elemental facts* ('data' or base 'information') will we use to initiate that presumably-objective (super) intelligence?

Given that such questions persist, S-O modeling remains **the** core issue for grasping 'knowledge' in western thought. Despite varied framings and opinions on the matter, this all points to an unavoidable subjective aspect in modeling information and intelligent systems — contrary to a presumed 'purely objective' ideal.

2 Current Literature

In the literature, the need for S-O modeling drives a large patchwork of vague, controversial, and competing views [11]. For example, most basic is *scientism*, claiming that if 'a thing' is not objectively named it does not exist, seeking to eliminate subjectivity wholly from consideration [26]. Ironically, this shows the worst of subjective naïveté [27,30]. Philosopher Daniel Dennett [10] is a likely standard-bearer arguing that qualia (raw sense data) are non-existent, ignoring the need for a *functionally differentiating sensorium* in 'evolution by natural selection'. Alternatively, philosopher David Chalmers [5] asserts that qualia are beyond all scientific thought, while often alluding to an 'information theory' solution but with no actual details ever offered. After Chalmers, others support a mystical 'panpsychism', with evolutionary biologist Stuart Kauffman [15,19] and neurologist Christof Koch [21] as recent converts. Lastly, there is 'mysterianism' where some seem to throw their hands up and claim that no solution is ever likely [9]. These and other numerous unnamed views offer seemingly endless debate, but little more.

Conversely, success with Shannon's [33] 'signal entropy' drives an enduring informational pragmatism and decades of information technology leaps — in **objective** roles. Plain objective gains versus endless subjective debate puts most attempts at S-O modeling in a poor light (as per above). Regardless, Shannon and Weaver still saw signal entropy as essentially 'disappointing and bizarre' [34], in part due to a missing *theory of meaning*. Hence, later informational studies convey a 'conceptual labyrinth' of unresolved subjective/semantic issues, even if using a Shannon-based start [12]. Despite that persistent 'labyrinth', gains in unsupervised machine learning point to growing optimism in the possibility of designing an HLAI [22,29]. But those gains include 'catastrophic forgetting' [14] that can obscure the naming of reasons for that recent success. Also, the application of said models is rather limited ('narrow') in focus, despite broader 'general' claims [18]. As such, HLAI(+) efforts currently remain 'fringe projects' [16,24], partly due to the lack of true advances in S-O modeling.

In seeking a practical middle ground, few names appear. Philosopher John Searle [31] calls for 'biological naturalism' as a crucial foundation, framing base ontological and epistemic aspects in subjective and objective roles [32]. But again, no detail on a full model is offered. For example, he argues humans may process qualia, but other biological systems (like a tree) do not, without saying why those biological systems should differ (personal exchange, 30 April 2014). As a small advance, philosopher Luciano Floridi [12] offers a *General Definition of Information* (GDI) that partly differentiates semantic roles. But questions remain on GDI's finality [6]. Later, astrophysicist Sean Carroll [4] attempts a synthesized view by assembling notable intellectuals from diverse disciplines for a focused 'naturalism' discourse, but ends with no meaningful result. In a more-aspiring line, computer scientist Marcus Hutter [23] posits a Universal Artifical Intellgence *top-down* model (AIXI) that seems mostly theoretical and non-computable [37], but points to useful directions. Conversely, mathematician Stephen Wolfram [38] posits a *bottoms-up* 'computational irreducibility', where cosmic 'primitives' drive innate sense-making (interpretative) roles that compute all information. Recent versions of Wolfram Language (symbolic discourse language) mark an early effort at this style of S-O modeling. Still, it is too early to assess this approach's efficacy in (as said) 'mining a computational universe'.

The strongest hint to date of a likely solution comes from neuro-anthropologist Terrence Deacon [8], using a type of 'entropic analysis' as a base synthesis [11]. He references Claude Shannon's signal entropy, Boltzmann's thermodynamic entropy, and Darwinian natural selection as innately complementary views (a Shannon-Boltzmann-Darwin model). But the model's purely thermodynamic bias makes it irreconcilable with wider physics based views (email exchange, January 2017). Also, the work is littered with confusing/unneeded neologisms and nearly impenetrable prose [11,13,25]. The model thus lacks clarity. Beyond Deacon's work no other models are seen, except for the view posited herein — which roughly tracks Deacon's view but in a more-plainly reductive manner. Still, the strength of Deacon's *entropic analysis* is that it stipulates a bottom-up approach, minimizing the chance of later explanatory gaps, and ties directly to Shannon's signal entropy, an already well-established model.

3 Posited Model: Natural/Core Informatics, or 'Thinking Like Nature'

This paper frames a path through the above S-O bind by detailing a naturally scalable core with evolving complexity as we see with nature. It thus marks a growing functionality one also hopes to see in ever-more intelligent informational systems.

The model synthesizes: Shannon *signal entropy*, Bateson's [1] *differentiated differences*, and Darwinian *natural selection* (a Shannon-**Bateson**-Darwin model) for a unified general view. This contrasts to Deacon's Shannon-**Boltzmann**-Darwin model. This S-B-D core furnishes the model's structural fundaments, as briefly developed in the step-wise logic given below. Deeper analysis of those steps is given in three papers (see APPENDIX) that support a larger body of work on Natural/Core Informatics.

The steps that underlie this *naturally scalable core* are as follow:

1. What is *Information*? (an *a priori* dual aspect ...)
   (a) subjective and objective roles are named as distinct-but-interdependent informational precursors, where one affirms the existence of the other. An *a priori* dual-aspect theory [28,36] is thus implied in S-O models of information,
   (b) next, divergent **representational** modes for objective and subjective roles (re *a priori* dualism) are detailed,
   (c) also, divergent **computational** aspects of objective and subjective roles are named (e.g., questions of 'transition and emergence' or 'functional scalability').
   (d) Step 1's 'novelty' lies in: (i) naming an empiric dual-aspect, (ii) from an *a priori* perspective, (iii) therein surpassing prior notions of information.
2. What is *Meaningful* Information? (exploring further S-O links ...)
   (a) varied scientific models (the standard model, periodic table, genomics, and natural selection) are shown as distinct functional 'types' — naming *meaningful* differences in accepted **objectified** *subjective* roles,
   (b) thus, a further '*proximate* dualism', beyond '*a priori* dualism', is shown:
      i. the standard model and periodic table convey a '*proximate* objective' (non-adpative or 'direct') role, and
      ii. genomics and natural selection convey a '*proximate* subjective' (adaptive) role,
   (c) next, the role of metadata in grounding all *functional types* is named,
   (d) thus, to develop an ensuing *general informatics* as 'one logical system', a unifying meta-meta-data perspective is first needed,
   (e) that 'metadata bridge' is shown to entail three types of *meaningful* roles: materially direct (*non-adaptive*), discretely *adaptive* (coded), and temporally *adaptive* (selection), thus grounding a differentiated-but-unified 'general informatics' and general theory of meaning.
   (f) also, this marks a dualist-triune (*non-adaptive*/*adaptive*) topology in ensuing general informatics.

(g) Step 2's novelty is in (i) differentiating meaningful 'types', (ii) reframing *metadata* as 'data about **meaning**' versus common 'data about **data**', and (iii) identifying an empiric '2–3' topology for general informatics.

3. How is *Adaptive Logic* Generated? (focusing on adaptive 'intelligence' ...)
   (a) a general 'adaptive key' with *material* and *behavioral* facets is identified in 'levers'. Thus, *levers* afford a basis for further logical analysis (i.e., a *subjectively grounded* 'computational trope'),
   (b) this *adaptive key* is next deconstructed to mark three lever classes and three key computational roles, that naturally afford/generate **numerous** adaptive options,
   (c) those computational roles are then mapped in relation to Shannon signal entropy, to mark natural 'entropic types' that join to initiate a sense-making interpretive ('entropically generative' or *creative*) system,
   (d) a natural scalable example of this interpretive system is then given in the advent of lever-based 'simple machines and beyond'.
   (e) Step 3's novelty lies in: (i) the joint modeling of diverse levered roles, (ii) to derive a continuous *general adaptive logic*, (iii) that naturally bridges to signal entropy.
4. How is Adaptivity *Selectively Optimized*? (given many adaptive outputs ...)
   (a) myriad adaptive options thus exist (per above), that are now reduced by the *happenstance* of 'evolution by natural selection' (e.g., problem of 'uncontrolled variables'),
   (b) only *functional reduction* can optimize those options, driven by natural selection,
   (c) to frame that 'evolutionary landscape' classic threefold selection pressure and agent responses are shown as entangled functional roles,
   (d) as such, *happenstance* is also reframed as a general 'agent+force = result' (2–3) logic, for a basic *reducing model*, or an 'interpretive process' that reduces 'many *subjectives*' into 'the **objective**',
   (e) *reductive logic* is then shown to hold a 2–3 topology of ... 3232 ... as an extensible 'fractal key', for a naturally scalable adaptive continuum,
   (f) next, that *fractal key* is explored in relation to chaos theory as a way to structurally/computationally model happenstance and logical reduction,
   (g) lastly, that *reductive process* is framed as a 'base cognitive psychology' that conveys nominal intelligence.
   (h) Step 4's novelty is in: (i) the joint modeling of selection dynamics and agent responses, (ii) to detail a continuous dualist-triune topology, that also (iii) frames a *base adaptive psychology* as 'adaptive intelligence'.

The implication of this analysis is that designing an HLAI(+) likely requires a sequence of computational roles, rather than a one-step (top-down) algorithmic model. Also, using this step-wise view implies a range of 'interpretive tendencies', *adjacent possibilities* [20], or *stepping-stones* [35] typical to chaos theory, rather than firm predictive results. Such a model can still aid human inventiveness, but more likely in a non-autonomous HLAI+ role. Also, this computational view implies that an HLAI would not 'consciously experience' worldly events, unless specifically programmed to model existential risks to a 'Self', as with actual living agents. This analysis covers *general adaptive logic*, but does not address existential risk modeling. Finally, this study focuses on defining a *simple adaptive logic* (SAL), rather than targeting 'complex (higher-order) adaptive systems' (CAS). More detail is available in the video and papers linked below.

A Appendix: Supplementary Material

The video and papers listed here provided added detail on the above step-wise analysis.

Title: *THE 'HARD PROBLEM' OF CONSCIOUSNESS* — names flaws in one of the more popular/well-known philosophical views, from among the many philosophical views noted in the first paragraph of Sect. 2.

Link: https://issuu.com/mabundis/docs/hardproblem.

Abstract: To frame any *meaningful* model of information, intelligence, 'consciousness', or the like, one must address a claimed Hard Problem (Chalmers, 1996) — the idea that such phenomenal roles fall beyond scientific views. While the Hard Problem's veracity is often debated, basic analogues to this claim still appear elsewhere in the literature as a 'symbol grounding problem' (Harnad, 1990), 'solving intelligence' (Burton-Hill, 2016), Shannon and Weaver's (1949) 'theory of meaning', etc. As such, the 'issue of phenomena' or *innate subjectivity* continues to hold sway in many circles as being unresolved. Also, direct analysis of the Hard Problem seems rare, where researchers instead typically offer related-claims asserting that: (1) it is a patently absurd view unworthy of study, or (2) it presents a fully intractable issue defying clear exploration, but with little clarifying detail. Debate on 'the claim' thus endures while clarity remains absent. This essay takes a third approach, that of directly assessing the Hard Problem's assertion *contra* natural selection in the formation of human consciousness. It examines Chalmers's logic and evidence for this view, taken from his articles over the years. The aim is to set an initial base where it then becomes possible to attempt resolution of the aforementioned 'issue of phenomena' (8 pages: 4,000 words).

Title: *ONE PROBLEM - ONE THOUSAND FACES*: IS4IS 2015 (International Society for Information Studies, conference presentation) — gives a broad abstract view of the model's basic approach, and further details the first bullet point in the step-wise model (Sect. 3) above.

Link: https://vimeo.com/140744119.

Abstract: This video (23 min) gives a broad view of *a priori* notions of information. It names an initial general 'theory of meaning' and 'theory of information' that emphasize scalable **primitive** *subjective* and *objective* facets. In brief, the model synthesizes Shannon entropy, Bateson's different differences, and Darwinian selection (an S-B-D model) to derive *meaningful information* across diverse disciplines.

In the video: Basic issues and questions are framed (2:30 min). Known meaningful metadata traits are detailed (2:30 min). Next, metadata's role is fully deconstructed in remaining minutes to name universal *a priori* facets. Lastly, the model is re-constituted 'from the ground up' to present a fully synthesized S-B-D *a priori* view. Text for the video voice-over can also be read or downloaded at: http://issuu.com/mabundis/docs/oneprob.fin

Title: *A GENERAL THEORY OF MEANING: Modeling informational fundaments* — details the second bullet point in Sect. 3.

Link: https://issuu.com/mabundis/docs/abundis.tom.

Abstract: This essay targets a meaningful void in information theory, as named by Shannon and Weaver (1949). It explores current science (i.e., the standard model in physics, the periodic table, etc.) in relation to information and consciousness. It develops a 'bridge' to join these topics by framing *meaningful* information, or a 'natural/core informatics'. The study posits a general theory of meaning, where three types of informational meaning are detailed. As such, the model uses type theory to re-frame classic conflicts that arise across diverse informational roles, with Bateson-like (1979) 'differentiated differences' (or *types*) as informational fundaments (12 pages; 5,700 words).

Title: *NATURAL MULTI-STATE COMPUTING - Engineering evolution: Simple machines and beyond* — supports the third bullet point in Sect. 3.

Link: https://issuu.com/mabundis/docs/multistate.

Abstract: This essay covers *adaptive logic* in humans and other agents, and complements a related 'general theory of meaning' (Abundis, 2016). It names informational roles needed for minimal adaptivity as a *direct experience*, versus the 'reasoning by analogy' typical of artificial intelligence. It shows how levers, as a computational trope (adaptive template), typify *meaningful adaptive* traits for many agents and later afford the advent of simple machines. To develop the model: (1) Three lever classes are shown to compel a natural informatics in diverse agents. (2) Those lever classes are next deconstructed to derive a 'scalable creativity'. (3) That creative logic is then detailed as holding three *entropically generative* computational roles. (4) Lastly, that adaptive logic is used to model tool creation. Thus, the analysis frames systemic creativity (natural disruptions and evolution) in various roles (discrete, continuous, and bifurcations) for many agents, on diverse levels, to depict a 'general *adaptive* intelligence' (16 pages; 6,600 words).

Title: *SELECTION DYNAMICS AS AS ORIGIN OF REASON: Causes of cognitive information - a path to 'Super-Intelligence'* — covers the fourth bullet point in Sect. 3.

Link: https://issuu.com/mabundis/docs/lgcn.fin.4.15.

Abstract: This study explores 'adaptive cognition' in relation to agents striving to abide *entropic forces* (natural selection). It enlarges on a view of Shannon (1948) information theory and a 'theory of meaning' (Abundis, 2016) developed elsewhere. The analysis starts by pairing classic selection pressure (*purifying*, *divisive*, and *directional* selection) and agent acts (as *flight*, *freeze*, and *fight* responses), to frame a basic model. It next details ensuing environs-agent exchanges as marking *Selection Dynamics*, for a 'general *adaptive* model'. Selection Dynamics are then shown in relation to chaos theory, and a fractal-like topology, for an initial computational view. Lastly, the resulting *dualist-triune topology* is detailed as sustaining many evolutionary and cognitive roles, thus marking an extensible adaptive informational/cultural fundament (13 pages: 5,700 words).

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