

The Natural, Artificial, and Social Domains of Intelligence: A Triune Approach [†]

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Abstract: A “triune approach” to the three main domains of intelligence is advocated. It would be the most cogent way to understand the uses and impact of artificial intelligence in its intrinsic relation with human nature and social structures. The enormous technological success of artificial intelligence and the widespread social applications, impinging both in individual lives and in multiple economic and social structures, are making necessary a reflection on the wider dynamics of intelligence, interconnecting the artificial information pathways with the natural information flows and the social structural substrates. As a telling instance, the traditional poor understanding and management of “social emotions” is dangerously amplified in today’s social networks, contributing to unrest, polarization, and widespread desocialization processes. In contemporary societies, the essential link between intelligence and life has to be plainly revealed as a counterpoint to the link between artificial intelligence and computation.



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1. Introduction: The Three Main Domains of Intelligence

Essentially, we argue that there is an important connection between the three main domains of intelligence—natural, artificial, and social—that has not been sufficiently recognized, neither in theory nor in practice. However, the realization of this connection could contribute not only to interdisciplinary developments but also to clarify different troubles and biases in AI applications.

Conventionally, the phenomenon of intelligence was restricted to human individuals in the philosophy and the disciplines of previous centuries, and it was reoriented to computing machines and to animals endowed with relatively advanced nervous systems only during the second half of the past century. Artificial intelligence and biological intelligence notwithstanding, important mutual relationships (for instance, the biological conceptual “loans” of perceptrons, neural nets, and genetic algorithms) were never seriously contemplated regarding their possible integration. In the related fields of cognitive science, the multidisciplinary efforts were mostly focused in the linguistic, logico-philosophical, and computational challenges along AI developments.

Concerning natural intelligence, or biological intelligence, its recent advancement was due more to the new ideas derived from the biomolecular revolution of past decades than to the works of classical ethologists, as we argue below. Lastly, by using the term “social intelligence”, we are putting together some conceptual discussions and strands of thought about the development of social complexity [1] and about the most compelling adaptive solutions of human societies [2].

How these three domains of intelligence may dovetail will be discussed in the next sections, with particular emphasis in the necessity of a new understanding of social emotions.

2. The Contraposition between Artificial Intelligence and Natural Intelligence

One of the main points of the present work concerns the dichotomy between the “artificial” and the “natural”. The “sciences of the artificial” were booming in the 1950s and 1960s [3]. Pragmatically, it was a multidisciplinary endeavor around the nascent computer science and technology, looking for the ‘mechanic’ realization of intelligence in computers. The new field of AI, as their pioneers stated, was originally interested on automatic computers, the programming of language, neuron nets, complexity measurement, treatment of abstractions, and randomness and creativity [4]. A series of booms and busts accompanied this field, in general solved via the continuous increase in computer power following Moore’s Law. Notwithstanding the magnificent achievements of AI in many orders, some of the current troubles of the field seem to denote a lack of “ecological grounding” in human cognition, human emotions, and human social processes of communication [5].

By the counterpoised term “natural”, what we mean is the growing sense in biology, bioinformatics, systems biology, neuroscience, and related fields about the necessary categorization of a general property of intelligence, which would have emerged along the evolutionary continuum. It is interesting that in parallel to the computer revolution, the biological fields were incubating their own revolutionary development. It was ignited by the discovery of DNA structure and the subsequent application of computer technologies to biological data. The different technological and scientific strands converged on the bioinformatic and omic revolution, mainly during the last two decades, with the sequencing of human genome and the fast expansion to thousands (millions) of other genomes and the full automatization of most biomolecular research procedures [6]. The classical notion of animal intelligence introduced by ethologists (Lorenz, Tinbergen, Eibl-Eibesfeldt) was overcome by the notions of cellular intelligence, biological intelligence, and natural intelligence [7,8].

To reiterate, to what extent could natural intelligence represent a complementary attempt to AI? Just a personal note from one of the present authors: In the early 1980s, the formal computational schemes around artificial intelligence were in full swing, the only game in town—expert and logical systems, perceptrons, neural networks . . . I disagreed with that computational stance, and started my own personal orientation, later on developed as a PhD Thesis: “*Natural Intelligence: The Evolution of Biological Information Processing*” [9]. Unfortunately, at that time many biomolecular aspects of cellular life were unknown or too fragmentarily known. Nevertheless, this approach was pointing to fundamentals of cellular, neuronal, and social intelligence that, overall, continue to be valid and of interest. In the next section we actualize these ideas and depict the nucleus of natural intelligence.

3. The Living Cell as the Basic Unit of Intelligence

Information processing is at the heart of natural or biological intelligence, but it is very different from the way it is organized in artificial systems [7,10]. The living cell provides an alternative paradigm, a new conceptual panorama, where information flows, signaling systems, gene transcription and protein synthesis are contemplated as a coherent, integrated system. It results in the adaptive life cycle, which manifests intelligence, communicates and produces meaning, and finally is capable of evolving. In an artificial system, we would be talking about perception, memory, learning, anticipation, decision making, and so on, all of them carried by means of dedicated computations. However, the inner ‘mechanics’ of natural intelligence is utterly different.

3.1. The Simplest Life Cycle

We may see the life cycle of cellular systems (the simplest ones, prokaryotes) as a trivial characteristic of life, but actually it is the most amazing information design any engineer

could think of. The living cell is a system that self-constructs out from environmental stuff according to an inner blueprint that is separated from the constructive system itself (echoing von Neumann self-reproducing automata. This vast constructive process distributed across the cell system only needs some transient copies of mRNAs and the raw basic materials [8]. Reproduction will follow. With unencumbered repetition of the reproduction cycles, *systemic variations* affecting the blueprint will appear, becoming phenotype changes and implying *differential survival*; thus, evolution occurs [10].

3.2. Complex Multicellular Organisms: New Forms of Intelligence

The different kind of intelligence that eukaryotic cells and multicellular organisms have evolved with respect to prokaryotic cells has been discussed in [6]. There are a few evolutionary guidelines on the fundamentals of the ‘new eukaryotic order’: symbiosis, signaling expansion, cell-cycle modularity, and ontogenetic multicellular development. Nervous systems appear as a very special electro-molecular tissue capable of orchestrating a new type of information processing—providing the organism with an instantaneous evaluation of fitness, an informational capture *always at the service of advancing the life cycle*.

The further evolution of intelligence in Nature has kept pace with the progressive complexification and sophistication of the nested information flows of the different realms of life. From the diffuse neural nets of coelenterates to ganglions, cords, and cerebroids of invertebrates, and to central nervous systems of vertebrates, we see an informational crescendo that culminates in advanced mammals and anthropoids—with individuals organized not only in ecosystem disperse networks but also in close-knit societies. Adaptive action, guiding the organism and its genetic associates to the realization of long-term fitness, becomes the litmus test of intelligent behavior. Adaptability defines and establishes the realm of natural intelligence. Whatever sophisticated neural processes emerge in complex organisms, they are *always at the service of advancing the life cycle*.

4. From Human Intelligence to Social Intelligence

Seemingly the linguistic capability of humans has put our societies in an entirely new path. However, we can also analyze the evolution of the information flows and the processing structures in our societies along some of the previous guidelines: both the natural information flows related to the individual lives, and the artificial flows generated via technological systems. Like in the case of living cells or in nervous systems, a degree of “social intelligence” might also be ascertained regarding the combined working of individuals aggregated into social entities and institutions in order to advance their own life cycles. Let us establish a few basic points.

1. **The social brain:** We have evolved our big brains adapting to cooperation and communication in big, close-knit ‘natural groups’ (Dunbar’s number refers to 150–200 individuals) and to achieve affective-effective bonding [11].
2. **The sociotype:** From the action of our social brain there emerges a wide similarity of social bonding, which is evolutionary rooted (“stemming from our genes”). The sociotype represents our adaptive sociality, the relational whole composed by the bonding circles of family and relatives, friends, and acquaintances [12,13].
3. **Social emotions:** We need instinctive reactions for achieving our individual fitness in the group and for achieving and maintaining our own sociotype, and also for achieving collective “social intelligence” in the group [2].
4. **Social intelligence:** There is crystallized social intelligence in our complex societies, in the different social structures, institutions, associations, enterprises, markets, etc., and in the whole dynamics of cultures and countries [1]. Social intelligence means collective adaptability, establishing the balance between individual fitness (happiness) and collective efficiency. This collective balance is always in the making and in the dismantling (e.g., generationally) in an unstable equilibrium difficult to set.

To summarize these views, Figure 1 depicts the three fundamental domains of intelligence and their respective overlapping. We have described some research themes

that approximately correspond with the different intersections. Well, in the middle, there appear social emotions and a new brain theory. More in general, the essential link between intelligence and life has to be plainly revealed as a counterpoint to the link between artificial intelligence and computation.

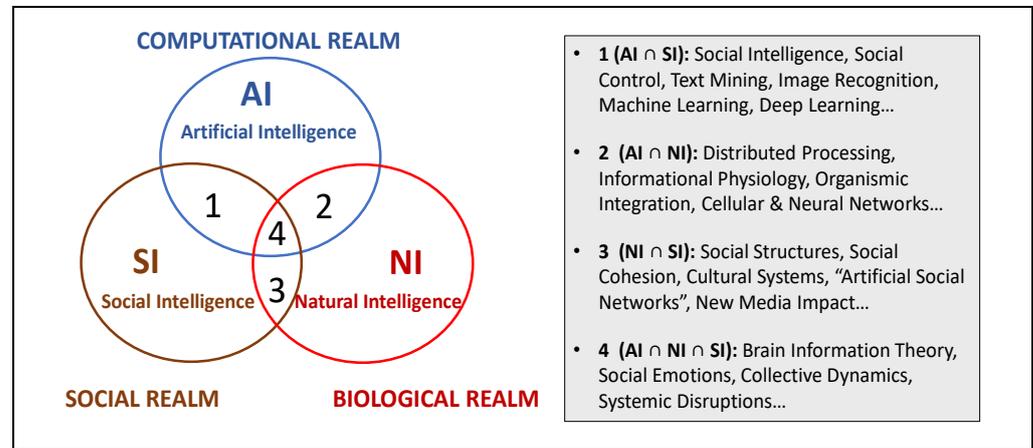


Figure 1. The triune approach to intelligence: The three proposed domains of intelligence are showing their respective intersections. On the right part of the figure, possible contents of the different intersections are suggested.

In Figure 1, it is implicit that we do not have an efficient brain information theory on individual and social behavior yet, nor a clear understanding of social emotions. In human societies, the new thinking derived from natural intelligence and information science should contribute to a more cogent understanding in these matters, and to improve the social management of the new mass communication systems. For the blindness on social emotions is dangerously amplified in today’s social networks, contributing to unrest, polarization, and widespread desocialization processes. The “big six” emotions traditionally discussed by emotion theorists are the most salient ones concerning their facial and bodily expression (fear, disgust, happiness, sadness, anger); but it does not mean they are the most frequent or relevant ones in our daily social life, or in network communication. In our work in progress, concerning the detection of emotions in written texts, or “sentiment analysis,” we appreciate a frequent presence of group-oriented polar opposites such as inclusion–exclusion, friendliness–hostility, sympathy–antipathy, admiration–envy, love–hatred, shyness–arrogance, irritation–tranquility, etc. See Jorge Navarro in [14]. Our research goal is to establish a system of reference for these “negligible” social emotions, with valence, arousal, social bonding effects, and perhaps fitness gains–costs, like the well-known Cartesian picture of emotions [15], based on valence and arousal. It might also allow for the assessment of social support for different health, social, and economic policies.

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