

3 Minds Cycling Through 8 Mental Contexts

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Abstract. General intelligence functions in all relevant contexts. Similarly, absolute truth is true in all contexts. This suggests investigating general intelligence as inhabiting a metaphysics for absolute truth. We present such a solipsistic metaphysics of human experience. Three levels of awareness, $|一$ answering, $|二$ questioning, $|三$ investigating, act as operators $+1, +2, +3 \bmod 8$ on eight mental contexts $0^\infty, 1^\infty, 2^\infty, 3^\infty, 4^\infty, 5^\infty, 6^\infty, 7^\infty$ where k^∞ are divisions of everything into k perspectives, and $8^\infty \equiv 0^\infty$. We consider the extent to which this metaphysics could be modeled by eightfold Bott periodicity, specifically, an embedding of classical Lie algebras, $O(16r) \supset U(8r) \supset Sp(4r) \supset Sp(2r) \times Sp(2r) \supset Sp(2r) \supset U(2r) \supset O(2r) \supset O(r) \times O(r) \supset O(r)$ which cycles through the possible quantum symmetries (combinations of charge conjugation C and time reversal T squaring to $+I$ or $-I$) constraining the Hamiltonian H for a noninteracting free fermion. We describe work-in-progress to develop a combinatorial interpretation of how mutually anticommuting linear complex structures $J_1, J_2, J_3 \dots$, applied to a self-interacting state of contradiction $o(16r)$ give rise to ever richer symmetries, arriving at a tentative state of noncontradiction $o(r) \times o(r)$ upon applying J_7 , and collapsing back into contradiction $o(r)$ upon applying J_8 . The $J_1, J_2, \dots J_8$ are realized explicitly as 16×16 real matrices. They are shown to be expressible in terms of J_1, J_2 , an isometry $L = J_3 J_4$, and a series of diagonal matrices, together manifesting a pattern resembling octonions.

Keywords: General intelligence · consciousness · Bott periodicity

1 3 Minds

What is at the center of human experience? Our paper supposes the following internal dialogue. As an individual, I am the meeting place of three levels of awareness, which is to say, three minds: $|一$ (*yī*) answering, $|二$ (*èr*) questioning, $|三$ (*sān*) investigating. (The characters are the numbers 1, 2, 3 in Chinese.) The first mind $|一$ unconsciously knows answers. The second mind $|二$ consciously does not know, thus asks questions. The third mind $|三$ balances the other two minds, so that the same information is in these two different forms, and then decides which of $|一$ and $|二$ should act in a given situation. All three minds function in parallel, sharing a context $|〇$ ("líng"), within which $|一$ adds a perspective, $|二$ adds a perspective on a perspective, and $|三$ adds a perspective upon a perspective on a perspective. As determined by $|三$, the original context

can be extended by adding the perspectives of any one of these minds, yielding a new context for the three minds to share as the overall "individual". Abstractly, each context is simply a framework of several perspectives. Our paper proposes a system of eight frameworks that the three minds cycle through, shifting by +1, +2 or +3 perspectives modulo 8.

In this section, thinking freely, we portray $| \neg$, $| \sqsubset$, $| \sqsupset$ with rapid brushstrokes to suggest their plausibility, ubiquity, diversity, fundamentality, universality, familiarity, but also to focus on $| \sqsupset$ as the key to the abstract void in which the three fit together. Psychologists distinguish $| \neg$ as fast-thinking, automatic, frequent, emotional, stereotypic, unconscious System 1 and $| \sqsubset$ as slow-thinking, effortful, infrequent, logical, calculating, conscious System 2. [X] We propose that $| \sqsupset$ is System 3, our full fledged consciousness, deliberately, willfully, cognizantly flying on two wings, $| \neg$ and $| \sqsubset$, balancing them, then choosing which one to lean on.

Introspectively, we experience $| \neg$ as a savant, an oracle supplying us with images, sensations, associations, options, thoughts, inspirations, urges, moods, feelings, attitudes. We listen to $| \sqsubset$ as a prattle of words, and more generally, a conceptual language that offers form for carrying meaning. Both $| \neg$ and $| \sqsubset$ have a life of their own, by which an individual performs scripted behavior and clichéd thinking. Additionally, like Plato's charioteer with their hand on the reins, $| \sqsupset$ establishes a definite context which weaves together $| \neg$ and $| \sqsubset$, setting course, adjusting ratios, adding emphasis, directing, punctuating, giving meaning.

Objectively, we observe the interplay of a material brain $| \neg$ and a spiritual mind $| \sqsubset$, the weighted averages of some 100 billion neurons that encode what a person knows, and the propositions of a personal cognitive language with perhaps 100 thousand concepts, words, variables, slots that recode this in terms of what the person does not know. In the mind, a word such as "horse" functions as a question "What is a horse?" which receives an answer from the brain, a relevant memory of a horse. The history of AI likewise contrasts neural networks and symbolic processing. How might $| \sqsupset$ relate them?

The gap between $| \neg$, enmeshed in the world, and $| \sqsubset$, distinct from it, can be analyzed in terms of action-perception loops. $| \sqsubset$ has a generative model of $| \neg$. As the environment changes, the success or failure of the model is communicated by $| \neg$ to $| \sqsubset$ in terms of emotion, along with relevant sensations and candidate actions. Here $| \sqsupset$ functions as a brake to keep $| \sqsubset$ from updating its model prematurely. As explained by the theory of Active Inference, it is possible to update the environment rather than the model. When $| \sqsubset$ works out its actions and $| \neg$ responds with a state of peace, then $| \sqsupset$ releases its brake and $| \sqsubset$ reimposes its model as cognition. Thus emotion is the language from unconscious $| \neg$ to conscious $| \sqsubset$, cognition is the language in the opposite direction, and consciousness $| \sqsupset$ regulates the direction of the conversation, distinguishing perception and action. This is compatible with research that, in both passive (task-free) and active (task-related) conscious processing of auditory signals, conscious access takes place in an extended temporal window (250-700 ms after sensory input), allowing neural activity to seethe and settle down, suggesting not

simply a global workspace but a global playground. [X][X] As levels of awareness, $| \neg$ may preconsciously propose a candidate action, $| \sqsubset$ may globally evaluate it, and $| \sqsupset$ may prolong the evaluation and then affirm it. This illustrates how a potential decision may be formulated even before one is consciously aware of it. $| \neg$ embodies enactive theories, $| \sqsubset$ implements predictive theories, $| \sqsupset$ vindicates cybernetic theories. All of these are relevant for Active Inference, which offers continuous models for $| \neg$ and discrete models for $| \sqsubset, [X]$ Consequently, $| \sqsupset$ may control the balance.

As regards evolution, $| \neg$ draws from past experience, what it knows, whereas $| \sqsubset$ predicts the future, what it does not know, including dangers that one can never learn from but must steer clear of, embracing the map and avoiding the territory. The interpretation of dreams, important in antiquity, may have served to inform whether one should act intuitively, instinctively with their lucky mind $| \neg$, or rather proceed cautiously, logically with their unlucky mind $| \sqsubset$. Why do brains have two hemispheres? User requirements suggest the need for a dialogue between champions of these two different mindsets. Investigators of these distinctions have documented hundreds of examples of the tension between $| \neg$ and $| \sqsubset$ in cultural history: yin-yang, sensation-intellect, romantic-rational, visual-verbal, intrinsic-extrinsic.[X] One summary contrasts the right hemisphere as whole-oriented and the left hemisphere as detail-oriented.[X] Arguably, children and adults learn from dialogue between these two distinct mindsets, and this may consequently focus gender expectations for mothers $| \neg$ and fathers $| \sqsubset$, which may also be meaningful for robust AI worlds.

This metaphysical distinction is found deeper than the cerebral cortex. Neuromodulatory $| \sqsupset$ resides in the basal ganglia, even in arthropods, where the direct pathway $| \neg$ releases motor programs whereas the indirect pathway $| \sqsubset$ suppresses them.[X] Dopamine, at work here, inhibits and promotes motor behaviors in even simpler animals.[X] We thus have an excitatory mind $| \neg$ that says Yes and an inhibitory mind $| \sqsubset$ that says No. The three minds may also date back to ancient fish and the distinction between the innate immune system $| \neg$, preconfigured for longstanding pathogens, and the adaptive immune system $| \sqsubset$, which learns to address novel pathogens. [X] Is there a $| \sqsupset$ for immunity by which $| \neg$ and $| \sqsubset$ work in harmony? As a test case, consider how the consciousness of an ant colony may be characterized with $| \neg$, $| \sqsubset$, $| \sqsupset$. [X] Imagine $| \neg$, streams of ants interact based on their rates of encounter, whereas $| \sqsubset$, pheromones are delivered as semiotic messages to the sterile depths of the royal cohort, and $| \sqsupset$, nest maintainers alter the nest's brainlike structural pathways to sway and time delicate matters of waging war, maintaining peace, moving the colony or reproducing it. Even a transistor, in the right circumstances, can integrate $| \neg$, $| \sqsubset$ and $| \sqsupset$. Consciousness $| \sqsupset$, as the faculty for willfulness, deliberateness and cognizance, may be surprisingly simple to implement, so long as it coordinates a mind $| \neg$ that knows and a mind $| \sqsubset$ that does not know.

The challenge is to disentangle ourselves from $| \neg$ and $| \sqsubset$, and consider most simply, how $| \sqsupset$ views their relation in various abstract contexts. In terms of transcendentals, $| \neg$ is attracted to beauty, $| \sqsubset$ to goodness, and $| \sqsupset$ to the

truth which presents good content in beautiful form. To focus on truth, and what it means in various abstract contexts, we need to let go of all of our prejudices $|\neg$, all that we know, any pretense of the material world, and likewise all of our preconceptions $|\sqsubset$, all that we do not know, any personal conceptual language, and contemplate the abstract void that is left. Abstracting away, we open familiar windows upon ourselves: $|\neg$ as personal I, $|\sqsubset$ as conceptual You, $|\sqsupset$ as objective Other. Thinking purely, we note with Peirce that $|\neg$ is monadic (ground), $|\sqsubset$ is dyadic (ground and correlate) and $|\sqsupset$ is triadic (ground, correlate and interpretant).[X] These levels of awareness may be understood as acting on a contextual base $|\bigcirc$, with $|\neg$, $|\sqsubset$, $|\sqsupset$ adding one, two, three perspectives, respectively. The context $|\bigcirc$ may perhaps itself consist of perspectives. What are the possible contexts?

2 8 Mental Contexts

Complex things are defined in terms of simple things. But how can we define the simplest things? They must define themselves in terms of their relationships with each other. Such fundamental relationships define a complete set of perspectives for the mind to experience. In this sense, they establish an abstract mental context for the mind.

A basic example is the learning triad of perception, thought, action.[X] A perception process, perceiving data, leads to a thought process, deciding upon action, which leads to an action process, comprising activities, which leads to a perception process, perceiving the results of the actions, making for a closed loop of three kinds of processes. In Goertzel's psynet model, this loop is an autopoietic attractor, a structural conspiracy emerging from and inhabited by pattern recognizing processes (magicians), which we experience as thoughts or feelings. The attractors join together as a complex network, the psynet, necessary and sufficient for mind. The psynet is a dual network, structured $|\sqsubset$ hierarchically for command-structured perception and control, and $|\neg$ heterarchically for associatively structured memory.[X] Consciousness $|\sqsupset$ is described as awareness $|\neg$ modulated by $|\sqsubset$ the structure of mind. A mental state (state of consciousness, state of mind) is a particular kind of relationship between awareness and mind.

The learning triad is then identified with the generators i, j, k of the quaternions. Each of the three processes is created by the other two: $ij = k, jk = i, ki = j$. Divisibility grounds reversibility, which is understood to be an essential feature for consciousness, in that it is free to reconceive. What is consciously learned can be consciously unlearned, as with backtracking in AI. Unlearning is interpreted as a reversal of the learning cycle: $ji = -k, kj = -i, ik = -j$. The coinciding of multiplicative and additive inverses, $i^{-1} = -i, j^{-1} = -j, k^{-1} = -k$, identifies the undoing of learning with the annihilation of opposite pattern recognizing processes.

This model is further extended by considering the octonions. (We write their generators as $1, i, j, k, L, Li, Lj, Lk$.) This is proposed as the abstract structure

for states of consciousness. The seven non-identity generators are identified with the 7 ± 2 entities that can be held by working memory. The generator L is understood as an inner eye, whereby La denotes an inner observation of a mental process a , thus reflexive consciousness. This allows for learning about learning, although it is noted that $(iL)(jL) = -k \neq kL$. This inner eye L has also been called a looking glass, in that it reverses the order of factors, namely $(La)(Lb) = L(ba)$ and $(La)b = L(ba)$. Consequently, the octonions are not associative, for in general, $L(ba) \neq (Lb)a$, as $(Lb)a = L(ab)$ but in general $ab \neq ba$ and so likewise $L(ab) \neq L(ba)$. [X]

The psynet model offers a theory of mind that emerges bottom-up through evolution. However, it does not explain the ontological status of the axioms, concepts and logic of mathematics. A complementary, top-down sensibility, starts with a void, and considers what transformations yield fundamental structures. Thus Spencer-Brown, applying distinction, derived Boolean algebra. Efforts have been made to interpret and derive quaternions, octonions, sedenions and Clifford algebras in ontologically profound ways. [X][X] These efforts are typically incomplete and sometimes their authors make their drafts available yet prohibit their distribution. [X][X][X] An empirical approach is to first document the human experience of mental structures and only then consider where they arise in mathematics and what may model them.

We formalize a particular attempt by Kulikauskas to catalog fundamental mental contexts called divisions of everything. [X][X] These can be understood as structures that carve up a void into a finite set of perspectives which are related by shifts in perspective. The three levels of awareness $| \text{—} , | \text{—} \text{—} , | \text{—} \text{—} \text{—}$ can then be understood as operators that lift the mind out of one context and into another context, a metacontext with additional perspectives, 1, 2 or 3 modulo 8. The mental contexts were discerned by collecting conceptual frameworks observed by various thinkers and by applying personal introspection and aesthetic judgment to document the prison of the mind, the limitations on imagination, which grow evident in thinking slowly, calmly, abstractly, without reflection (which resets our thinking). Are these alleged structures coherent, well founded, accurate, universal? We introduce the notation below for the sake of definiteness in the mathematical explorations to follow. The shifts in perspective are illustrated in Figure 1.

0^∞ *nullsome* is a context lacking perspectives, which is relevant for contemplating the void or simply God.

1^∞ *onesome* is a context with a single perspective, encompassing *everything* 1_0 , for contemplating order.

2^∞ *twosome* is a context with two perspectives, 2_1 *opposites coexist* (as with free will) and 2_0 *all is the same* (as with fate), for contemplating existence. The mind shifts readily $2_1 \rightarrow 2_0$ but not the other way around. For example, where there is an outside, there is an inside, as with a cup. But if we fall into the cup, then there is only the inside, as when we are inside the universe. Or if two glasses are the same, then they must also be different. But if we notice they are in fact different, then they are only different. This last example of introspection

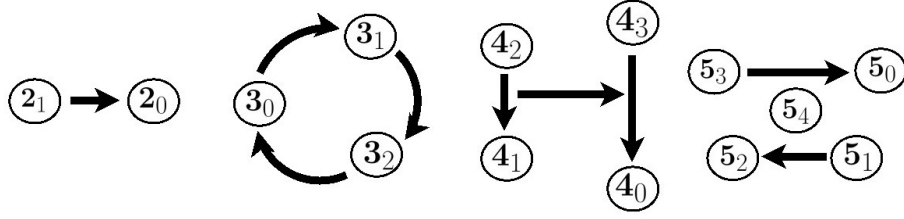


Fig. 1. Twosome 2^∞ , threesome 3^∞ , foursome 4^∞ , fivesome 5^∞

shows why reflection must be avoided, as it reverses direction: we experience sameness through its opposition with difference but it signifies "all is the same", and we experience difference as a shared characteristic but it signifies "opposites coexist".

3^∞ *threesome* is a context with three perspectives, a learning cycle of 3_0 *taking a stand*, 3_1 *following through* and 3_2 *reflecting*, for contemplating participation. The cycle is experienced turning in one direction $3_0 \rightarrow 3_1 \rightarrow 3_2 \rightarrow 3_0$ but not backwards.

4^∞ *foursome* is a context with four perspectives, for contemplating knowledge, which comes in four levels: 4_0 *whether*, 4_1 *what*, 4_2 *how*, 4_3 *why*. These levels accord with the context $|\bigcirc$ and the three minds $|\neg$, $|\sqsubset$, $|\sqsupset$, respectively. Knowing how $|\sqsubset$ shifts to knowing what $|\neg$, $4_2 \rightarrow 4_1$, indicating that the brake on imposing cognition has been released, as discussed earlier, whereby knowing why $|\sqsupset$ shifts to knowing whether $|\bigcirc$, $4_3 \rightarrow 4_0$, letting go of consciousness. Thus the imposition of cognition $|\sqsubset \rightarrow |\neg$ is first directly experienced $|\neg$ as $4_2 \rightarrow 4_1$ and then indirectly conceived $|\sqsubset$ as $4_3 \rightarrow 4_0$, thereby communicating emotion $|\neg \rightarrow |\sqsubset$.

5^∞ *fivesome* is a context with five perspectives, for contemplating decision-making in terms of time or space. Looking backwards or looking outwards, every 5_1 *effect* has had its 5_2 *cause of effect*, but looking forwards or inwards, not every 5_3 *cause* has had its 5_0 *effect of cause*. And there is a *critical point* 5_4 for deciding, the present or the boundary, with access to both directions.

6^∞ *sixsome* is a context with six perspectives, for contemplating morality. There are prods for relative learning: 6_0 *I follow through but do I reflect?* 6_1 *I reflect but do I take a stand?* 6_2 *I take a stand but do I follow through?* And there is the possibility of absolute learning: 6_3 *Can I follow through absolutely?* 6_4 *Can I reflect absolutely?* 6_5 *Can I take a stand absolutely?*

7^∞ *sevensome* is a context with seven perspectives, for contemplating logic, a self-standing consistent system which has slack, thus can be inhabited by a self-standing opposite such as what is true or good or known. This establishes a logical square with four corners and three sides, expressing a dialogue between what is known $|\neg$ and what is unknown $|\sqsubset$. 7_0 *All are known*, 7_1 *There exists a known*, 7_4 *All are known and there exists a known*, 7_3 *All are unknown*, 7_4 *There exists an unknown*, 7_5 *All are unknown and there exists an unknown*, 7_6 *There*

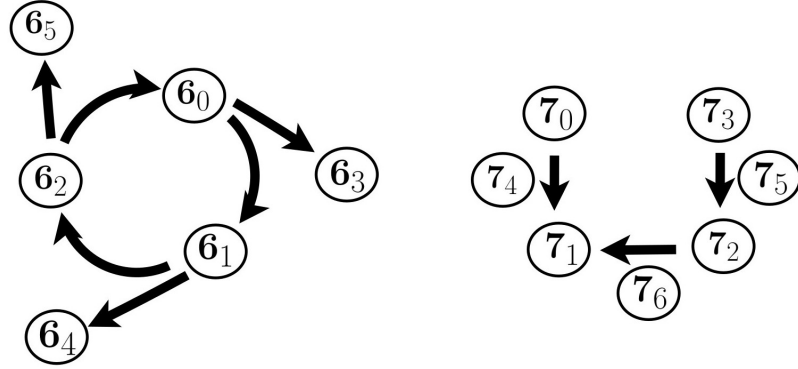


Fig. 2. Sixsome 6^∞ , sevensome 7^∞

exists a known and there exists an unknown. Note that these seven perspectives are all distinct because the system may be empty, in which case the universal quantifier is satisfied but the existential quantifier is not.

8^∞ *ightsome* would be a context with eight perspectives, extending the sevensome with the missing side of the logical square: *All are known and all are unknown.* In this case, the system is necessarily empty, yielding a state for which all statements are true, as with a contradiction. In this sense, the system collapses and $8^\infty \equiv 0^\infty$.

These introspections would be significant if they were reproducible. They would make for the beginnings of a language of wisdom, which Kulikauskas calls Wondrous Wisdom.[X] The Theory Translator, a database of conceptual structures, is an endeavor for developing such fluency, starting with examples of the three minds.[X]

Structural patterns discovered within this collection of structures can also help confirm its robustness. One attempt is to document three operations on these divisions of everything, adding one or two or three perspectives, $+1, +2, +3 \bmod 8$, manifesting levels of awareness, $|\neg, |\equiv, |\equiv. [X][X]$

Mathematics can expose vagueness, impose clarity and provide insight, inspiration and confirmation. For example, the Yoneda embedding has been understood as an expression of 4_0 whether, 4_1 what, 4_2 how, 4_3 why there is a morphism.[X] The Jacobi identity for a Lie algebra is a three-cycle which may perhaps be interpreted as a learning cycle 3^∞ for a Lie group. The Mayer-Vietoris sequence likewise is a three-cycle which computes homology groups, dimension by dimension, as if they were corrections in a learning process. More generally, an exact sequence with k morphisms may model k^∞ in how it carves up everything. Ambitiously, is there a mathematical structure which could confirm that the eight-cycle of divisions is coherent, intuitive and manifestly real?

3 Bott periodicity

Displayed equations are centered and set on a separate line.

$$x + y = z \tag{1}$$

$$\begin{array}{lll}
 J_1 = \begin{pmatrix} & -1 & & & \\ 1 & & & & \\ & 1 & -1 & & \\ & & 1 & -1 & \\ & & & 1 & -1 \\ & & & & 1 \end{pmatrix} & J_2 = \begin{pmatrix} & 1 & & & \\ -1 & & -1 & & \\ & 1 & & & \\ & & & 1 & -1 \\ & & -1 & 1 & \\ & & & & 1 \end{pmatrix} & J_3 = \begin{pmatrix} & & -1 & & \\ & 1 & -1 & & \\ 1 & & & & \\ & & & -1 & 1 \\ & & -1 & -1 & \\ & & & & 1 \end{pmatrix} \\
 J_1 \text{ yields } \mathbb{C} & \text{adding } J_2 \text{ yields } \mathbb{H} & \text{adding } J_3 \text{ yields } \mathbb{H} \oplus \mathbb{H} \\
 J_4 = \begin{pmatrix} & & & & 1 \\ & & & -1 & \\ & & 1 & -1 & \\ & & & 1 & \\ -1 & 1 & & & \\ & -1 & & & \end{pmatrix} & J_5 = \begin{pmatrix} & & & -1 & \\ & & -1 & 1 & \\ & 1 & & 1 & \\ & & -1 & & \\ 1 & & & & \end{pmatrix} & J_6 = \begin{pmatrix} & & & 1 & \\ & & 1 & & \\ & -1 & & 1 & \\ -1 & & & & \\ & -1 & -1 & & \end{pmatrix} \\
 \text{adding } J_4 \text{ yields } M_2(\mathbb{H}) & \text{adding } J_5 \text{ yields } M_4(\mathbb{C}) & \text{adding } J_6 \text{ yields } M_8(\mathbb{R}) \\
 J_7 = \begin{pmatrix} & & \hat{r} & & \\ & & -\hat{r} & & \\ -\hat{r} & & & & \\ & \hat{r} & & & \\ & & \hat{r} & & \\ & & & -\hat{r} & \end{pmatrix} & J_8 = \begin{pmatrix} & & & & \hat{i}\hat{r} & \\ & & & -\hat{i}\hat{r} & & \\ -\hat{i}\hat{r} & & \hat{i}\hat{r} & & & \\ & \hat{i}\hat{r} & & \hat{i}\hat{r} & & \\ & & -\hat{i}\hat{r} & & \hat{i}\hat{r} & \end{pmatrix} & 1 = \begin{pmatrix} 1 & \\ & 1 \end{pmatrix} \quad \hat{i} = \begin{pmatrix} & -1 \\ 1 & \end{pmatrix} \\
 \text{adding } J_7 \text{ yields } M_8(\mathbb{R}) \oplus M_8(\mathbb{R}) & \text{adding } J_8 \text{ yields } M_{16}(\mathbb{R}) & \hat{r} = \begin{pmatrix} 1 & \\ & -1 \end{pmatrix} \quad \hat{i}\hat{r} = \begin{pmatrix} & 1 \\ 1 & \end{pmatrix} \\
 & & \text{Notation: } 1, \hat{i}, \hat{r}, \hat{i}\hat{r}
 \end{array}$$

Fig. 3. Realizations of $J_1, J_2, \dots, J_8$

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