The Cognitive Machine as Mental Language Automata

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ABSTRACT

This article describes how learning is a native ability of the brain. However, very little is known of the process as it happens. The engineering model presented in this work provides a base to explore the innards of cognition. The computational implementation of the model is usable to assess cognitive profiles by means of machine learning and harmonic filtering. The model relies on an evolutionary dimensional space consisting of phylogenetic, ontogenetic and microgenetic timelines. The microgenetic space reveals the state machine nature of cognition, standing as an internal translator to a brain specific language. The study of this machine and its language is the key to understanding cognition.

KEYWORDS

Automata, Cognition, Engineering, Game, Language, Model

INTRODUCTION

Cognition is the drive of intellectual activity in the mind. It is the pathway where data becomes information, understanding and concept. Moreover, it is the main factor of evolution producing the homo sapiens sapiens, the very wise man. Although, whistl anatomic evolution leaves its traces, mind evolution can not be tracked directly. This leaves the study of cognition in the field of behaviorism, where the response to a stimulus is accounted as sign of mind activity. On the other hand, tracking the cognitive process is paramount to understand and optimize the thinking mind development. The best target to cognitive tracking is a model where some feedback from the actual brain process can assert the modelled internal behavior.

The actual complexity of cognitive process lays beyond any attempt to model it in fully fleshed dimensions. A feasible model must focus on a very constrained purpose in order to have tractable dimensions. This work focus on the study of the learning process, an essential aspect of cognition concerning the development of the individual and the species. An engineering model Hollnagel (2005) is such a proposal where cognition can be reduced to a simple machine. Within the semiotics perspective of cognition, the cognitive process is an unfolding of signs against their meaning. Yielding from this concept, an automata turns out to be a suitable machine to construct a model matching the requirements of simplicity and purpose.

Computational neuropedagogy applies neuroscience to the problem of learning. In the intent to achieve this it produces instruments to assess and intervene in human learning. Intelligent games are examples of such instruments, being computer games developed through a scientific process to achieve introspection into cognitive aspects of learning. They can tap into the unconscious process of learning and interchange information between computer and human cognition.

THE TANGIBILITY OF HUMAN COGNITION

Cognition is an internal process mostly inaccessible from the conscious mind. As Penrose (2014) remarks, consciousness is a process occurring as deep as quantum events in microtubules inside brain cells. The cognition process lies down beneath brain functionality, even more deeper away from consciousness, it belongs essentially to subconscious thought. The hermetic aspect of the particular processes poses as an overwhelming obstacle impeding direct observation with accessible technology for years to come. At psychogenesis level, examination can determine intellectual improvement, once it is a process that occurs in a couple of years. Microgenesis, evolving in the short span of minutes, leaves scarce traces of its whatabouts.

The microgenetic dimension encompasses countless microprocesses that bind in a logical sequence to complete the links of understanding that pertain to human reasoning. If any of these steps are broken, access to information is interrupted due to lack of meaning. When one speaks of microgenetics, there is a range of theories that approach the subject. Inhelder (1992) is co-author of the most accepted theory, largely drawn from the extensive works of her colleague Jean Piaget. Lemos (2014) increases the scope of Inhelder with modern works on this subject.

Microgenetics defines a set of states and a procedure to walk through these states using an internal encoding and processing befit to brain innards. In accordance with the microgenetic theory, the existence of these states and process arise independent of the lack of access to the current states or the mental operations. Regarding the nature and initial installation of the learning machine, it can be said that the distribution is the same for all brains. In contrast, each brain is characterized by an individual formation process, in addition to the cultural interactions that are responsible for reformulating some areas to prevail and others to recede. Inevitably, the theories of microgenesis presuppose the existence of a machine common to all brains capable of stepping through all these states until the cognitive process is completed.

On the empirical side, waywardly to theory expectations, instead of a consistently staging of learning performances, what comes about is a large diversity of cognition abilities scattered among human population. Such diversity sources from the psychogenic formation and matching predisposition of brain abilities from phenotypical DNA expression.

PROPOSAL OF AN ENGINEERING MODEL

An engineering model in psychology refers to an assessment of human behaviour which presupposes that the mind-brain system is a machine. This work states the mind brain system as a language processing machine. In the neural theory of language, Feldman (2009) support this approach:

> *NTL also suggests that the nature of human language and thought is heavily influenced by the neural circuitry that implements it.*

Since language is the very product of its brain circuitry, then a language processing machine is a good fit to represent the mental machine. In computing science, language processing machines are mostly implemented as an automata. States in this machine stand for representation levels for a given chunk of language. Since the machine in study is the cognition process, this automata goes beyond language parsing level up to the the outreaches of understanding. Ensues that linguistics must be the science to provide the basis to define each state for this automata. Simply stated, the proposed engineering model consist of finite state machine where the each state is defined by given level of complexity of language

Linguistics being a rather philosophical science, with many niches and streams of thought, several sources must be harvested to convey a manageable computational model. Narrative thinking, Robinson (1986) is a cognitive instrument that encompasses several cognitive characteristics relevant to the process of thinking. Choosing narrative as representative of an engineering cognitive model issues a simple but comprehensive spectrum. With this engineering simplification, the machine model can have a small number of states but each one being expressive enough to render the model useful.

Although the narrative model can be simple enough to build the cognitive machine, defining the relevant and consistent scope is still a extensive task. Described in an internal report, Ribeiro et al. (2015) cross referenced several proposals of linguistic narrative structures with analogous structures in mathematics and science up to the point that a consistent cognitive-linguistic model emerged. This model ensues from a combination of several linguistic sources filtered to the point where each statement could have a manageable computational implementation. The resulting machine describes twelve cognitive-linguistic levels of narrative skills. As Ribeiro studies goes, narrative is just one of the possible views of cognition machine formalisation, but good enough to describe the states in a manner that scientists from diverse fields can get a grasp of it. The resulting machine is an engine representing the internal and non observable steps of cognitive knowledge acquisition, or just for short EICA. In the research to match the engineering model to the actual mental-brain cognition process, language constructs are forced back into their originating neural circuitry. To achieve this, the automata description takes the form of a sieve, a filter that drives cognition through the machine steps, ensuing the opportunity for them to fire. Table 1 shows a sample of the sieve consolidated form linguistic narrative structure theory which constitute the core of EICA model.

Table 1. EICA Narrative Sieve Model

EICA states	Narrative Sieve			State Description
	linguistics	complexity	lower level	
Real Object of Knowledge (ROK)	Understanding of logical prepositions.	Affective expressions.	The development of thought and language.	The ROK is the beginning of the learning process.
Paradox		Approximation from the point of view of a narrator.	The psychological development	Absence of prepositions and nexus.

Language is the hallmark of civilization, the evolutionary step that took Homo Sapiens apart of other runner up species and the tell apart feature that characterizes human high level cognition. Language acquisition is now understood as innate human ability Chomsky (2014). Innate language acquisition is then just the ability to process language. Language processing is the process being modelled by this engineering model, and if this ability is innate, then so is the engine behind it.

AN INSPECTING MACHINERY TO ANALYSE THE COGNITION ENGINE

EICA is the Engine of Internal Cognitive Acquisition, universally installed in every human brain which is responsible for the main course of cognition process. Learning is accomplished by the EICA machine, consisting of eight recognized hierarchical states ranging from simple to high complexity.

Knowledge is the fundamental cognitive object of EICA, covering structures as data and information. It is forged by the natural automata EICA when it is elicited by its main category, that is, it is a conceptual knowledge to understand knowledge Wang (2017). This work, presents a basic study on a cognitive-linguistic engineering model of the brain-mind binomial. The microgenesis and narrativized fundamentals of learning generative rules of knowledge are explored, revealing the basic code structure of conceptual knowledge, which is a meta-formal concept of the transitivity of logical-grammatical thinking. The EICA Engineering Model allows the formal representation of elaboration-integration of knowledge through cognitive systems.

Intelligent games endowed with artificial intelligence are excellent candidates to observe, evaluate and intervene in the cognitive-linguistic processes that can be captured by computer systems and their algorithms to improve the user experience and expand the usability of adaptive and evolutionary systems to the promotion of advanced EICA development Ayesh (2016). The EICA engineering model provides accessible technology that can enable cognitive features such as capturing the quality and quantity of superior mental functions. EICA present a new approach that tries to find integrative automata patterns of microgenetic states among each other to construct the narrativization of concepts, representations and statements in a defined transphrase means. In doing so, it is possible to achieve a mechanism to generate a set of dynamically pendular procedures between states. These rules will implicitly encode a person's individuality by expressing their mental strategies, thus attesting their cognitive-linguistic signature.

Only a cognition tracking machine can then log the acquisition process and mark the level of understanding attained. Postulating on the existence of a cognition machine, more precisely an automata, cognitive processes evolves propositionally in a cascade of entangled and coordinated automata operations. More plainly stated, the full process of understanding develops inside the cognitive machinery as a continuous flow of intercommunicating languages across the several automata engaged in the reasoning effort Seminerio (1984). Thereafter, the whole process of accessing and acquiring a knowledge transcribes to a collection of scripts in a language circumscribed to the mental realm, unrelated to any other human language. Capturing and interpreting the internal cognition language is the key to assess the score of understanding.

Capturing vestiges of internal cognition operation enables a fine and non mediated assessing of learning, providing metrics on how to match each unique cognition with proper and adapted access to knowledge.

EICA state set is evenly distributed among even the smallest and heterogeneous population, notwithstanding the fact that it differs for each and every person, difference which must be dealt with to convey equality of understanding and universal access to information and learning.

Computational Cognition as Intervention Interface

Primary studies on mathematics and mathematical engineering Wang (2016b) led to the theory of abstract intelligence (AI), which is a set of mathematical models of natural and computational intelligence in cognitive computing (CI) and cognitive computing (CC). Abstract intelligence unleashes recent advances in cognitive systems, such as the EICA model of natural cognitive apprehension here proposed

The development of solid cognitive models can enable a whole new aspect of the human-machine interface. The current interfaces still regard the user as a stranger. As the machine manages to synchronize with the cognitive process, the computer becomes a new prosthesis. Cognition then proceeds to inform the computer of the opportunities presented so that it presents a coherent and timely intervention.

Development of Research Model

Given a theoretical model of the analyzed machine, ensues the protocol required to reverse engineer the language processing mechanism. Figure 1 depicts the original theoretical machine model, based in studies of human linguistics. Named states and proposed transitions presuppose a linear progression in the interpretation of meaning.

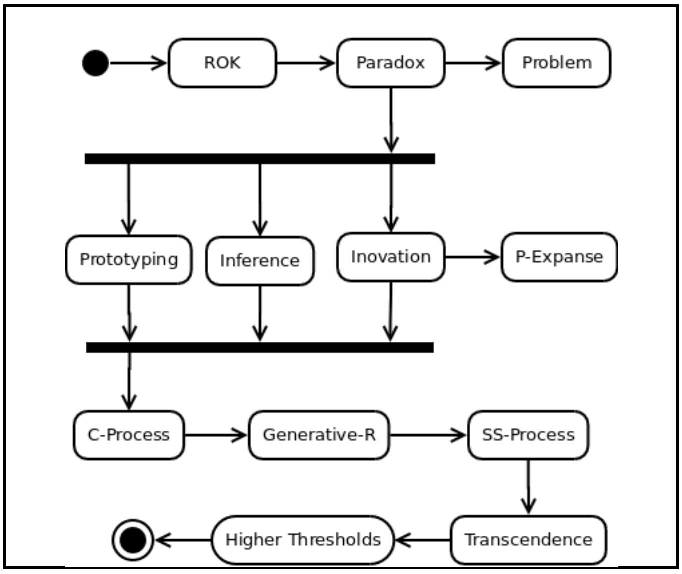
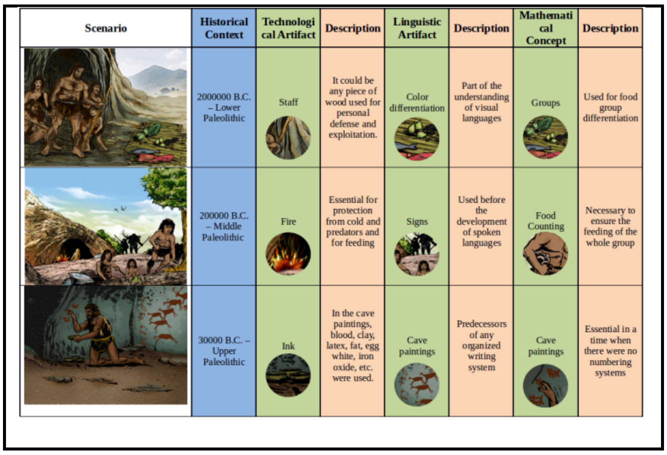


Figure 1. EICA State Machine

Since the study purposes the investigation of the learning process, a suitable dimensional space involves three views of temporal development spans. Those dimensions recur in the learning procedures and represent evolution in three scalar ranges, namely phylogenetic, ontogenetic and microgenetic Langer (1998). Figure 2 represents a fragment of the phylogenetic dimension. Learning is represented by the human achievements in mathematics, language and science in prehistoric periods Marques (2015).



Scenario	Historical Context	Technological Artifact	Description	Linguistic Artifact	Description	Mathematical Concept	Description
	2000000 B.C. – Lower Paleolithic	Staff	It could be any piece of wood used for personal defense and exploitation.	Color differentiation	Part of the understanding of visual languages	Groups	Used for food group differentiation
	200000 B.C. – Middle Paleolithic	Fire	Essential for protection from cold and predators and for feeding	Signs	Used before the development of spoken languages	Food Counting	Necessary to ensure the feeding of the whole group
	30000 B.C. – Upper Paleolithic	Ink	In the cave paintings, blood, clay, latex, fat, egg white, iron oxide, etc. were used.	Cave paintings	Predecessors of any organized writing system	Cave paintings	Essential in a time when there were no numbering systems

Figure 2. Phylogenetic dimension with historic marker of cognitive

A complete dimensional model was developed to infuse the required stimuli into the learning apparatus in order to capture the full transactional profile inherent to cognitive language processing. An intelligent game was designed and calibrated to three developmental dimensions to collect vestiges from the internal cognition engine and unveil the minutia of the language processing automata.

The various microgenetic states EICA integrate a large range of unordered short texts (actions, events, words, phrases and accumulation of sentences) with semantic coherence narrativized, since these short texts have vast decentralized topics, weak association relations, abundant noise and great redundancy. The challenging questions to solve the problem above include, what the ground of knowledge supports, the process of linking sentences and how to link these short unordered texts to achieve good coherence Liu (2017). Here, EICA develops a sentence-sentence linkage model, based on simultaneous and successive inference and innovation of the encoded cognitive-linguistic automata discourse of human beings, which is a layered semantics characteristic.

The game (figure 3) takes the form of a scene where a paleolithic character try to make his way into the observation of the world in which he lives. Carefully designed assets conducts the caveman actions into the prospective realm of cognition, forcing advances an retrogresses in the reasoning process, coupled with the respective volitionary investigative reactions determined by the internal automata.

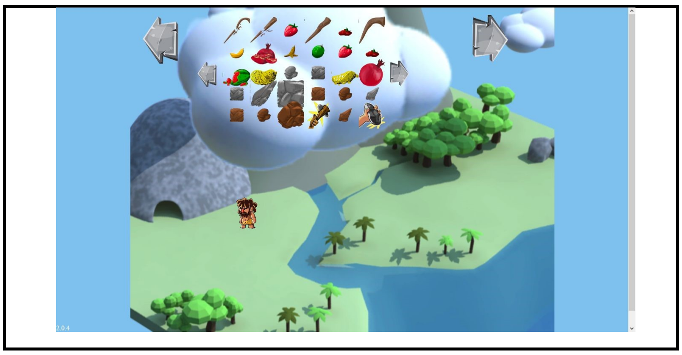


Figure 3. The intelligent game for EICA

This automata, entitled to compile the incoming sensory information into cognitive knowledge have being identified in Marques (2017) as the Engine of Internal Cognition Acquisition (EICA). EICA is a neurobiological computing apparatus installed ubiquitously in human brains which endows any individual with the cognition proceedings characteristic to the Homo Sapiens species. This machine is the evolutionary solution to achieve the high level of abstraction responsible for the outstanding human cognitive

Framework of EICA Engineering

The instrumentation and observation of EICA requires a complex study and development process capable of exposing the subtle telltale traces of internal cognition machinery. The basis to the aforementioned intelligent game is the exertion of the learning process. Learning is accomplished by the EICA machine, consisting of eight recognized hierarchical states, ranging from simple to high complexity.

EICA is the essence of human learning machinery, consisting of a finite state machine in which each subsequent state correspond to a more complex cognitive achievement. Observed in EICA tracking experiments, eight recognizable states are the hallmark of the cognition automata, shown in figure 4.

Colored sections represent the states and colored arcs indicate the transitions between states. Cognitive acquisition cycles follows sensory information with volitive prospectives responses emanating from evolving or involving transitions in EICA states. The ideogram demonstrates that beyond the linear perspective of the theoretical model, transitions occurs to non adjacent states and in both forward and backward directions.

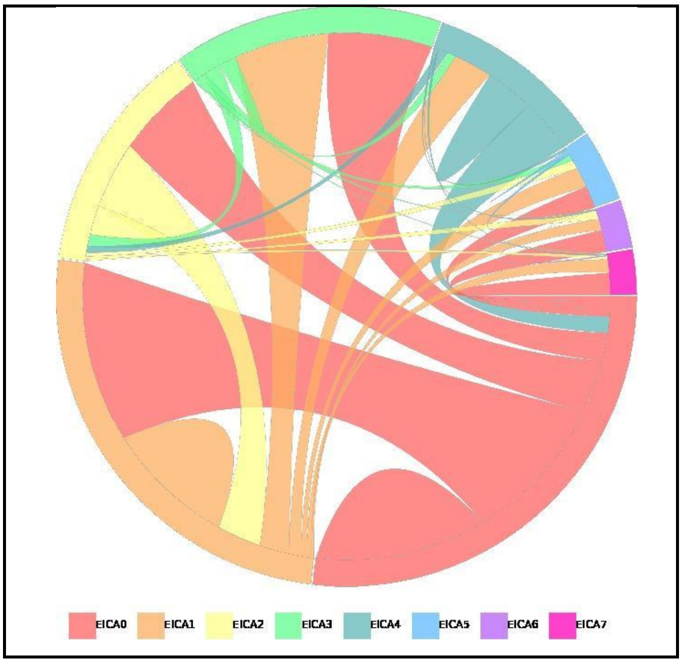


Figure 4. Ideogram representing EICA states and transitions

Ensuing transitive streams develop into concatenated expressions of meaning, imprinting the effectuated access to the given information as new linguistic nodes in the epistemic knowledge network. Although restrained to internal communication interchange among the internal cognitive structures those linguistic nodes can be observed to be the same across non related individuals. The reverse engineering necessary for that consists of inducing the volitionary response through the retrace of phylogenetic, ontogenetic and microgenetic path development. The prospecting instrument for cognitive unveillance guides the acquisition machinery into retracing the three dimensional ranges of thought development, namely the evolution of reasoning within the species, within the development of an individual and within the coalescence of an idea.

Inferably, most volitive responses that encompass a motor activity originate ultimately from transitions inside the cognitive machinery. Transitions are convulsive physical events incurring in telltale evidence, namely high order harmonics, that may propagate unintentionally through the whole system and end up as an elusive signature of cognitive state shifting.

Knowledge learning is the most fundamental category to simulate brain in machine learning . Along these lines, the EICA engineering model assumes that the semantic space of knowledge is a microgenetic epistemic network of hierarchical concept, which can be rigorously represented by formal concepts characteristic of the semantic structure of narrative discourse. This article presents theories and algorithms to classify a hierarchical microgenetic state machine through qualitative and quantitative semantic analysis based on artificial intelligence to install the learning competence to observe the cognitive-linguistic activity of the human being. The semantic equivalence between the formal concepts of each EICA microgenetic state is rigorously measured by a semantic hierarchy that is quantitatively determined by a Relational Semantic Classification Algorithm (ARSC) Wang (2016b). .The application of the EICA model evidences a deep understanding of the microgenetic states machine and their relationships in hierarchical semantic discursive narrative space through the learning of machines to capture directly unobservable events, as well as the perspectives of empirical observations of human logical-grammatical processing and cognition.

Microgenetic States of the EICA Automata

The EICA state machine is a set consisting of articulated parts. The parts are called states and the joints are called relations, by means of which any state of the machine can be obtained. This means that EICA is an engineering model. The EICA engineering model was built on the notion of pertinence, that is it only considers the cognitive states relevant to learning in a simplified structure. At a later stage, this simplified structure will become, in future works, a state of a more complex machine to approach a more explanatory and less generalized complex engineering model of the metacognitive system (EIMA-Internal Metacognitive Learning Structures). Either way, both are engineering models that consider combinatorial by partition operations and state commutation that reconstitute the whole.

In general, the mind-engineering models present theories in the form of conceptual language used as methodological tools for transforming the language of objects into logical-grammatical interpretation entitled as knowledge.

What follows is that the EICA machine-internal cognitive learning structures) is a language model in the semiotic sense (semiological heterogeneity) and in the syntactic sense (homogeneity of logical operations characteristic of a brain-mind coding system), empirically tested Marques (2017)

In this work, for the experimentation and verification of EICA, an intelligent game with artificial intelligence was developed to capture twelve cognitive states. These states were predicted in an engineering model and its empirical validation was based on the analysis of the time series in between clicks of the mouse, the observation of the sequences of icons selected by the player (forming statements that overlap with other statements containing semantic value) and transitivity (reapplication of isolated signifiers or in several combined sequences to form narratives in different areas of knowledge). In this respect, it is the use of arrangements of iconographic signifiers, composing phonemes, syllables, words and sentences of the brain-mind linguistic code (cognitive automata) that emerge from the chain reapplication of significants between different virtual environments with proper affordances of three different areas in knowledge: mathematics (classes and series), language (basic structure of sentence: subject-verb-object) and Science (world-knowledge).

The above graph indicates the degree of transitivity of thought based on the number of knowledge representation icons used and the amount of integration between different types of narrativization proper to epistemic areas, in this case science, mathematics and language. Henceforth, we define the classification presented in Table 2.

Table 2. Transitivity Classification

Index	Classification	Description
1	Zero Transitivity	Use of random object- Zero integration
2	Low Transitivity	1 Integration between narrativization
3	Medium Transitivity	2 Integration between narrativization
4	Good Transitivity	3 Integration between narrativization
5	High Transitivity	Total Integration between narrativization

The separation of states is apparent because the EICA state machine model presupposes the existence of a cognitive-linguistic automata that interprets message cosmologies that originate a logical-conceptual narrative discourse codified to make the transphrase language system of thought work. The engineering model of the EICA machine simplifies the understanding of the basic mechanisms of the infinite potentials of coding and decoding to fit a model that favors the narrative structure and its decomposition into smaller elements: phrases, words, syllables and phonemes.

Thus, the theory of narrative structure is a pilot through which the EICA machine is constituted by a heuristic model of invariant elements of code, forming a bundle of redundant microstates in a formal and taxonomic architecture McGarty (1999) . As a result, the cognitive-linguistic code of the brain-mind binomial is constructed by universals with different levels of depth of successive and pendular operations that form a systemic dialectic algorithm that supports the manifestations of meaning attribution.

Hence, the states of the EICA machine present the learning being as possessor of a cognitive-linguistic automata processor that is elicited through logical operations transformed into syntagmatic grammatical actions. These are instantiated in transformational and articulate narrative thinking for the elaboration of canonical matrix rules Barthes (1971) , canon that are characteristic of the abstract meta-level formulations of cognitive procedures.

This automata offers the degrees of freedom and restrictions necessary to the acquisition of generative rules that allow the transitivity of thought towards the generalization of awareness from different areas of knowledge. This allows the use of narrative transformational and actuarial models to activate systems of systemic codification and decoding transphrase.

Therefore, the cognitive-linguistic universality of narrative nature, has classificatory principles (state machine) and serial focus (time). Thus, conform to an implicit system of units and rules, whose EICA model is the instrument of theoretical description of the plurality of logical and semiotic operations, it is based on an overall mathematical structure: where the whole and its articulated parts (elements) indicate relations that recover the whole, since the parts have pertinence value (engineering model).

EICA's microgenetic states are original units as statement's phrases, integral segments representative of brain-mind discourse. This set of states constitute a language that is superior to one of the linguists (langue) , together the state's function as a great phrase with a formal organization that regulates the representative discourse of the secondary systems to generate the double articulation of the EICA, here, it is a mental instrument capable of eliciting metalevel language, homologous and formally corresponding to the level-object processing.

The general language of EICA is understood under the narrativization phrasing model of thought that is capable of being subdivided into levels Beneviste (1939) of stacks operations of linguistics, integrative, established between different microgenetic states of hierarchical perspective. Finally, these transactions of stacks operations combine Todorov (2008)to form the cognitive syntax instantiated in horizontal threads and vertical axis for the formalization in a progressive integration mode of the discursive knowledge with proper code that goes beyond the individual knowledge for the development of unifying principles.

The Microgenetic-Paleopathic Resonance

The foremost feature of this intelligent game resides in exploiting the microgenetic-paleopathic resonance to expose the innards of the learning cognitive apparatus. Encompassing the whole stream of prospective reactions, emerges a common pattern, recognizable for every and each individual. The pattern features a rhythmical response interwoven with seemingly chaotic jitter, apparently disconnected of the given information. The microgenetic-paleopathic resonance or Resonance of Marques (2017) consisting of coupling between the high energy nervous motricity impulses and the faint and undetectable occurrence of transitions within the cognition machinery. A precisely calibrated analog-digital discriminator can recognize and trace (figure 5) the disturbance in the output signal caused by the originating cognitive computation of meaning orchestrated by the EICA machinery. EICA state set is evenly distributed among even the smallest and heterogeneous population, notwithstanding the fact that it differs for each and every person, difference which must be circumvented to convey equality of understanding and universal access to information and learning.

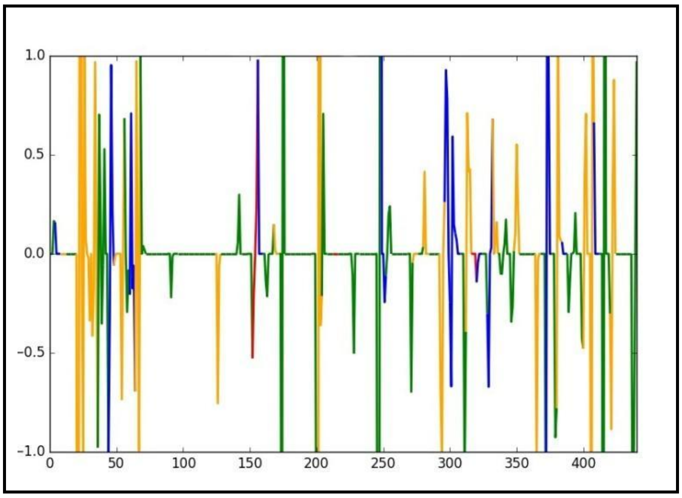


Figure5 . Emerging pattern already marked in colors by the discriminator

Account on Cognitive Demographics

The EICA machine operation complies with a rather strict deterministic behavior which is the same in every individual observed in the available experiments. The temporal distribution of states and transitions are rather logic and regular across the sampled population (figure 6).

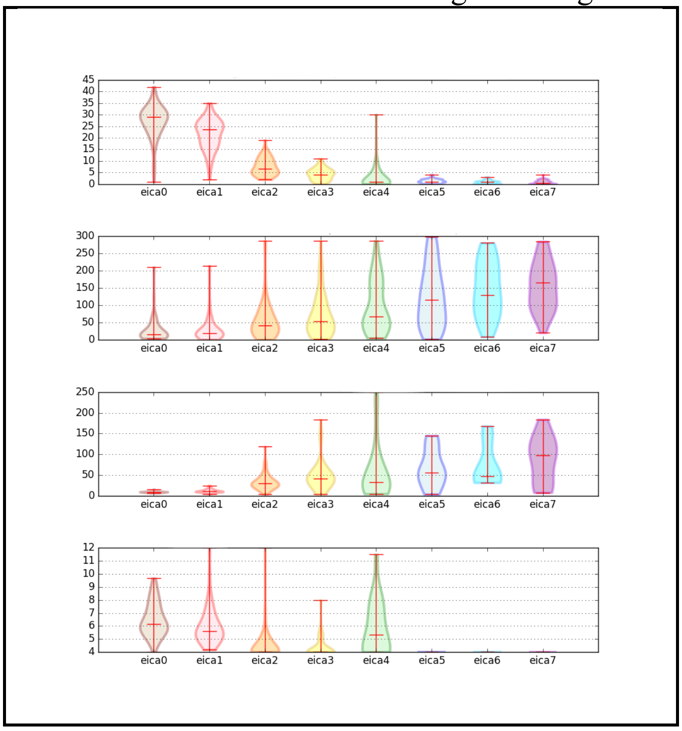


Figure 6. Violin distribution of EICA state characterization

Equity in EICA machine configuration among the human population implies, from the cognitive point of view, that all individuals have the same aptitude to learn, therefore deserving equal and universal access to knowledge and understanding. Uniqueness in individual experience and education results in a idiosyncratic usage of EICA machinery, departing each person from the expected EICA behavior. Those unique usage patterns are kindred to personality formation and may not imply in a better or worse cognitive performance (figure 7).

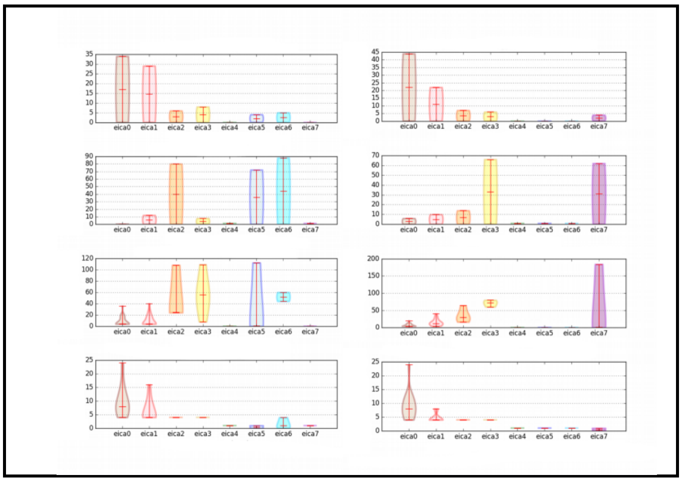


Figure 7. Statistic variations of EICA state events

Universality and individuality are both inherent to EICA machine manifestation in human population. Universality express itself as a recognizable consonance of operation and as well as commonalities in the reasoning stream development.
Individuality concerns to variations in states and transitional sequences defining a peculiar traversal of cognitive acquisition landscape singularizing a personality driven behavior. Similarities in the diverse meaning construction narratives demonstrates that all cognition processes converge to a prototypical epistemic subject quiescent in every person whilst particularities alert to an adaptive conformance requirement for accessible knowledge outspreading. The personal idiomatic nature of cognition inflow requires the assessment and compensation of those differences hitherto taken for granted in education, eventually hindering the establishment of a universal access to knowledge.

Demographic Cognomics

Cognition is the mechanism by which all learning, reasoning and reflection on any knowledge is realized. Also therein lies every obstacle to understanding when some cognitive mechanism or procedure is not perfectly functional. Understanding cognition is a crucial path for fair and equitable access to knowledge and understanding of the world around us.

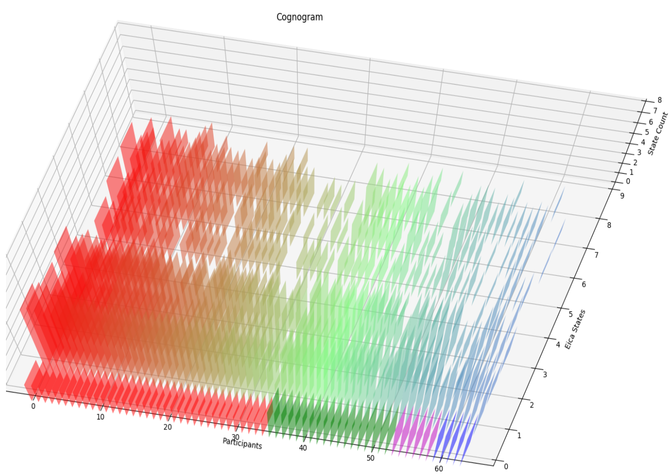


Figure 8. Demographic count of EICA states

Investigation on the use of EICA automata by each participant depicts how the cognition machinery is used among distinct individuals. The distribution cognogram in Figure 8. shows a collection of histograms accounting the use of each EICA state by a given participant. Participants are arranged from left to right grouped on cognitive classes **Veritable Success, Success**, **False Success** and **Exclusion Failure**. Density of state use also decreases from left to right, i.e. from participant 0 to 63. Noticeable in the picture, some sparse areas of low or zero count are scattered mainly in the top right side of the picture. This ensues from the high latency of higher states, taking longer to appear the the lower levels. This indicates that individuals with low cognitive profile can just take longer to engage higher abstraction thoughts. Nonetheless, the graphic still shows that EICA states are available and reachable by the majority of population.

The inference that cognition machinery is equally available to every person is the principle behind the proposition of an effective universal access to knowledge. Monitoring the EICA machine performance is a mean to assess and even adapt the process of learning. Under the universal access principle, this means that beyond all the differences that uniquely identify each individual, everyone can have access to knowledge through intelligent systems.

The temporal space considers the models according to the sampling time granularity of cognitive development . This space delimits research strategies that are mainly focused on the individual. This space should prioritize the diversity of intelligences and highlight individual differences as the essential patrimony of humanity.

Populational space portrays the variation of cognition among individuals in a population. This study should delimit favorable and unfavorable variations. The favorable ones offer a differential to the individual that qualifies him to a relevant social position. The unfavorable ones can mean failures in the individual cognitive apparatus and must be analyzed and corrected. Cognitive models must be parameterized so that they can preserve the diversity of the population, ensuring that all necessary skills are nurtured in education.

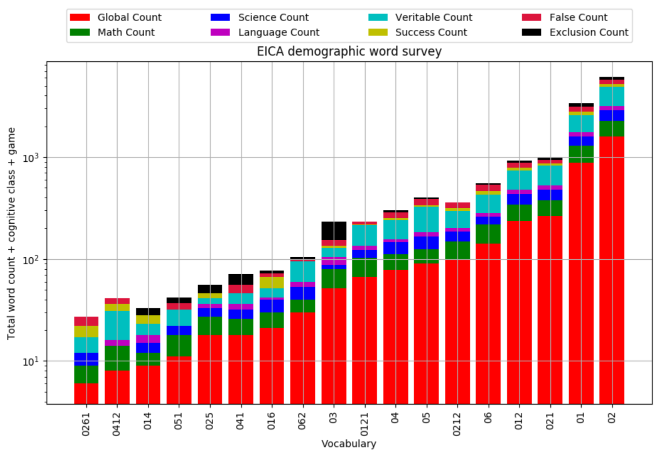


Figure 9. Demographic distribution of EICA word uses

As cognomic data emerges from EICA readings, more understanding of cognition distribution it brings about. The graphic in Figure 9. depicts how EICA states can form words and how these words are used by the investigated group. Individuals with **Veritable Success**, showing in cyan, make use of all words detected in the EICA vocabulary. The same does not apply to the other three groups (**Success**, **False Success** and **Exclusion Failure**). There is a characteristic set of words dominated by each group and some words are not used at all by the group. Regarding the task where these words occur, Math tasks use regularly all words while not being true for the other two tasks. Words **0261** and **051** are not present in language tasks, whilst Science tasks use a minimum of word **0412**. This indicates that further investigations can make sense of those words or at least determine whether they are necessary for each different cognitive operation.

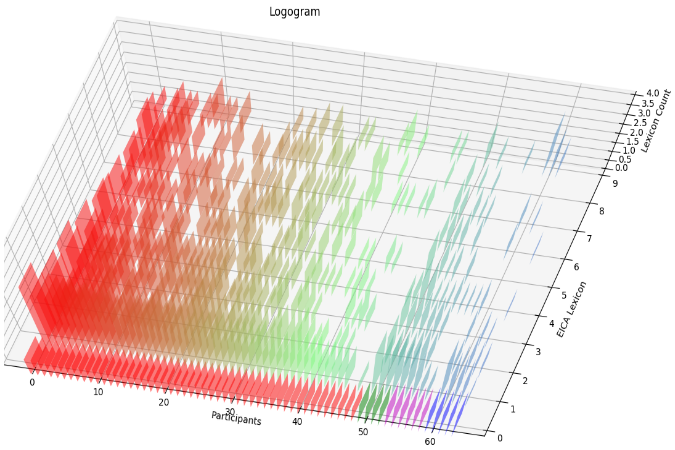


Figure10. Demographic count of EICA word uses

More diversity of EICA automata use appears in Figure 10. The account of individual word incidence shows a rarefied space spreading to the right side. Regions of word absence can be spotted on different levels across the graphic. The occurrence of EICA words indicates increased complexity in the meaning of cognitive operations. The classes of lower cognitive performance to the right incur in larger and scattered gaps in word count. Noteworthy, however, are some high counts on complex words on the top of the lexicon axis, issued to the lower cognition participants. This can bring the discussion up to differences in cognitive style rather than just lower cognitive abilities. Diversity in this sense can mean that some cognitive setups are not being promoted by the common sense of regular education.

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The diversity of intelligences is the main legacy that must be preserved in the human species. Education must be rethought so that individual differences are taken into account. Cognitive models should be developed with this variability in mind. They will be the facilitators of the personalization of the educational process, preventing the mass process from misrepresenting the purpose of bringing everyone to full development.

Within the diversity of the cognoma in a population it is possible that characteristic groups emerge. The identification of these groups is part of the population study. These groups can be used to improve understanding of the cognoma, noting the differences between them.

Both differences and similarities are important points in cognitive modeling. Differences mark the limits of cognitive distribution in a population. The similarities are markers of cognitive specializations that must be considered in both the modeling and the teaching process, which must take into account these peculiarities. Monitoring eica machine performance is a mean to assess and even adapt the process of learning.

Understanding both the universality and nonuniversality of cognition process assures that learning is accessible to any human being at any level. The inference that cognition machinery is equally available to every person is the principle sustaining the proposition for an effective universal access. However, unique and personalized use case profile of EICA states provides both for essential diversity and complexity for effective and efficient learning. Monitoring EICA machine performance is a mean to assess and even adapt the process of learning.

CONCLUSION

The actual report for EICA model is a collection of lecture notes spanning ten years of Computational Neuropedagogy Post-Graduate course, each year focusing in a specific area of the concerning research. Hundreds of students produced thousands of pages to accomplish this elegant and comprehensive model. Glimpses of EICA can be observed out of simple tabletop wooden games, but are much less consistent than needed to comply with the rigors of science. Nevertheless those observations were good enough to guide the path of science towards a better understanding of the innards of cognition.

EICA model is an instrument of neuropedagogical science, devised to understand failure of learning and guide solutions to this problem. It is the result of systematic study of several relevant authors in cognitive science. EICA comes true by abandoning attempts of reaching to the actual complexity of the mind in favor of an engineering solution that can produce coarse but useful results. As much simplistic it can seems from computational science, EICA has shown the potential of understanding both individual and populational cognitive features. Statistical coherence of the model is reassuring of its potential not only for the study of human learning process but also for other related fields like ergonometrics and high performance requirements.

From what can be learned from this work, this model just opened a small peephole into the vast field of computational cognitive science. The great challenge opened is what can be named as cognomics, the study of the complete set of languages and cognitive language expressions that comprises the inventory of the thinking process and the corresponding epistemics, the effective knowledge that emerge from the given cognitive microgenetic scripts. This can open the path for a better humanity where cognition can be evenly distributed and every person can experience the benesses of being a fully developed Homo Sapiens.

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