MIA: MULTIMODAL INFORMATION ARCHITECTURE

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The construction of meanings is based on Multimodal constructions. The objective existence of things is Multimodal. It is not conceivable the idea that an object is expressed by means of only one Mode – several Modes are required, several syntactic layers (stimuli) are necessary to obtain certain semantics (meaning). The existence of these various Modes is the extreme opposite to the incessant search for relevance by the human mind: it always adapts to the world it's inserted through the selection of stimuli that are relevant to signification. The work here presented sets ways towards a Multimodal Information Architecture (MIA), that presents possible strategies for designing models of representation for meaning construction by selection of stimuli and its Modes translating them into logical constructions. It gives a whole new meaning for what Information Architecture can stand for: transcending from a technicist paradigm to a theory of meaning construction. In this sense, modal logic contributes to the qualification of truths, and it is no longer imperative that a proposition be qualified as true or false: it may be possible, when one becomes aware that there is a configuration of World that makes it true; or necessary, when all possible Worlds settings make it true. At last, is proposed that this new paradigm for Information Architecture can be utilized as a meta-theory for Deep Learning Neural Networks.

1. Introduction

Among the sciences that study Information, physics may have exposed one of the greatest dilemmas for the attempt to manipulate and organize it. A theory called *Maxwell's Demon*, authored by physicist and mathematician James Clerk Maxwell, proposed in 1867, first came against the Second Law of Thermodynamics, which states that the entropy of a closed system tends to increase with time until it reaches a maximum value. Entropy, in this case, would be analogous to the concept of disorder – molecules with more heat would freely mix into the system with less heat molecules.

According to Maxwell, the Second Law would apply only statistically. It proposes the existence of an *"intelligent microscope being"*, equipped with a "door" of thermal insulation between two closed systems with considerable temperature difference. To avoid the increase of entropy in both systems, this *"being"* would control the output of more "agitated" molecules (with higher energy, producing more heat) to the lower energy environment, thus maintaining the thermal differences, bypassing Second Law. In 1929 Leó Szilárd proposed a response to the generated impasse, claiming that if this *"being"* existed in an objective reality, the amount of energy expended to control both systems would surpass the entropy reduction aimed, turning it, in some manner, pointless.

Shannon and Weaver (1963) used the concept of entropy as a measure of Information, as a natural consequence, when we remember that information, in communication theory, is associated with the amount of freedom of choice we have in constructing messages.

This restrictive premise can be adapted to the context of Information Science. The constant production and assimilation of Information and Knowledge in various scientific environments detected by Bush (1979) transcended academic boundaries – any relation between beings are now object of analysis, whether in documents, books or memories of who lived some experience. The question now resides in what is the ideal amount of "order" that an informational environment can "absorb", so that these "ordering rules" don't be as complex as the system itself?

1.1. *Modes and relevance*

Objective reality is Multimodal. Our experience of it is based on multiple modes. It isn't conceivable to separate, atomically, all stimuli that takes place on meaning construction. It would be difficult to understand a mode called *language*: modes *writing* and *speaking* seems more accurate. Nonetheless it would be awkward to ask a normal person (non-color-blind) to see only the form of a bird, ignoring the colorfulness on the experience. Kress and Van Leeuwen (2001) addressed the issue on their book *Multimodal Discourse*. Aiming to assemble guidelines for writing in musical, imagery or signal language, they realize that a meta-theory for multimedia (as several technological implementations) based on communicative practice would be necessary. The authors recognize that any semiotic grammatical regulation (as governance for the use of signs) will always be tested by the repository of circumstantial associations that is the human knowledge. They conclude that no form of communication is privileged: when giving meaning to a context, all stimuli placed at the disposal of the interpreter can be used.

At the other hand, Wilson and Sperber (2002) proposed *Relevance Theory*, which states that utterances raise expectations of relevance not because speakers are expected to obey a Cooperative Principle: the search for relevance is a basic feature of human cognition. What makes it possible for the hearer to recognize the speaker informative intention is that utterances encode logical forms (conceptual representations, however fragmentary or incomplete) which the speaker has manifestly chosen to provide as input to the hearer's inferential comprehension process. As a result, verbal communication can achieve a degree of explicitness not available in non-verbal communication

Assuming the coexistence of Multimodal existence and Relevance Theory and setting ways towards the construction of an answer to the initial question: is it possible to determine the ideal amount "order" that an informational environment can "absorb"?

2. Defining MIA: the path to our goal.

Information Architecture has been treated as a discipline that has foundations on the Internet explosion. Several authors use Rosenfeld and Morville (2006) definition, which addresses methods for web sites mapping and designing. This technicist view assigns a marginal role to information organization. On a slightly different path, Resmini and Rosatti

(2011) define a new concept called Pervasive Information Architecture, where information is distributed through cross-channel means. These means still bounded to technological implementation: the same information needs to be distributed through mobile applications, printed versions and physical spaces as well.

The sense of order aimed passes through all these technological implementations, but with more fundamental objective: is there a more rational way to manage how meaning and knowledge are developed even when reality is composed of several modes of signification? To achieve this goal, MIA needs to address meaning constructing and modelling, not only technological implementations.

2.1. *Methodological course: hierarchical framework*

Van Gigch and Moigne (1989) proposed a framework to model activities of professional disciplines, like Information Systems. It is based on the construction of knowledge through three levels with intimate relations between them: metaphysical, scientific and praxis levels. Figure 1 expresses the framework.

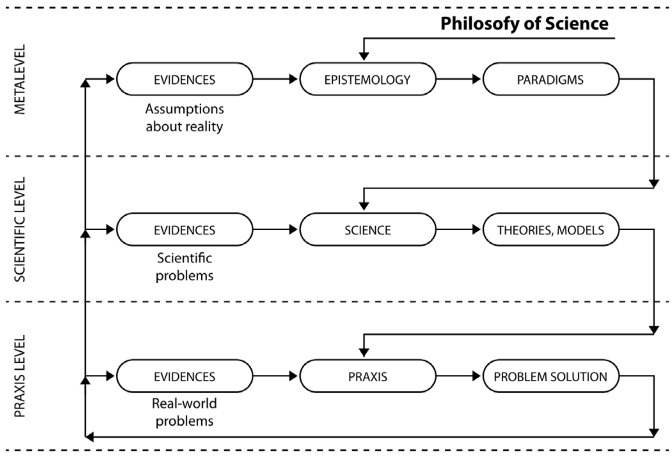

Fig. 1. Three-level framework adapted from Van Gigch and Moigne (1989)

The *metalevel* aims to define epistemological bases involved in the construction of knowledge. Proposes postulates about reality and assumes an epistemological position as basis for paradigms of key issues to be addressed at levels that follow. It formulates and solves the metamodeling problem of the discipline, influenced by assumptions and worldviews (inputs) of actors. Produces paradigms and metaphors (outputs) which are used by science at the object level.

The *scientific level* proposes theories and practices of investigation to delineate the problem and its probable explanations. It aims to define explanatory constructs of reality and probable theorems deriving from them.

The *praxis level*, is where technology is developed from theories and theorems produced on the scientific level. It aims to conceive postulatory tools for interference of the subject of knowledge in the domain of the proposed problem.

3. Information, Architecture and Modal Logic

The three-level framework instantiation starts with defining each term that makes up to the concept being constructed as an epistemological view of the proposal. What is Architecture? What is the object that this new concept is working with? How does it do it?

3.1. *Which architecture?*

Pollio (1914), cited by some authors as the *Father of Architecture*, initiates his discussions about the definition of the activities performed by an architect, stating that in all matters, but particularly in architecture, there are two points: what is signified, and that which gives it its significance. The author proposes six pillars for producing an architectural design: *Order*, *Arrangement*, *Eurythmy*, *Symmetry*, *Propriety* and *Economy*.

Order gives due measure to the parts of a work considered separately, and symmetrical agreement to the proportions of the whole. *Arrangement* includes putting things in their proper places and the elegance of effect; *Eurythmy* is beauty and fitness in the adjustments of parts and *Symmetry* is an agreement between the members of the work. It is possible to presume all of them on *Order*. For this work we will consider this agglutination.

Propriety is that perfection of style which comes when a work is constructed on approved principles. It arises from prescription (the solution denotes clear link to the purpose that gave rise to it), from usage (historically consolidated standards) or from nature (natural conditions restrictions). The definition denotes functional, cultural and environmental constraints imposed on the object, are external to it and refer to a context of construction of the architectural project.

Economy also denotes restrictions, however, about means of production as well as limitations on expanding the object. The use of appropriate materials for each situation imposed by *Propriety* restrictions, with rational use of resources and physical space available for construction.

Philosophically, to Abbagnano (2015), *Order* is defined as any relation between two or more objects expressed by a rule. In some sense, the author makes connection between this definition and *Economy*, for which he states as being the *Order* or regularity of any social totality, from a house to all human existence and quotes that William of Ockham was the first to express a principle of Economy through the expressions *"entities should not be multiplied without necessity[1]"* and *"in vain accomplished by several instruments when fewer where demanded[2]"*.

Both ways, Architecture can be related to the construction of rules which govern possible relations between objects, subjects and context.

3.2. *The architecture of what?*

Defining the object that an Architecture impose a sense of *Order* is critical when constructing the concept of MIA. Notoriously polysemic is the term Information. From the need of instructions for a context to ideas or thoughts of a being. The search for a

[1] Pluritas non est ponenda sine necessitae.
[2] Frustra fit per plura quodpotest fieri per pauciora.

consensual definition is too bold of a task. Since Floridi (2004) defined seventeen open problems on the new discipline of Philosophy of Information, two of them seems to take special part on Information Science:

[P.1] The elementary problem: What is Information?

[P.3] The UTI challenge: Is a grand unified theory of Information possible?

For the latter, Floridi himself seems to discard the possibility, stating that reductionist strategies are unlikely to succeed. Several surveys have shown no consensus or even convergence on a single, unified definition of Information.

Later, Floridi (2008) presents the convergence on admitting a General Definition of Information (GDI) as a semantic content in terms of data + meaning. GDI has become an operational standard especially in fields that treat data and Information as reified entities (as expressed on "data mining" and "information management"). Examples include Information Science and Information (Systems) Management. Recently, GDI has begun to influence the philosophy of computing and information.

Brier (2015) presents a transdisciplinary concept of Information, which the core should not be based on pure logical or mathematical rationality. It adds interpretation, signification and meaning construction while Information is a basic aspect of reality alongside physical, chemical and molecular biological. It discusses not an "objective" definition but a relativized one in relation to both the sender's and the receiver's knowledge. He proposes a Cybersemiotic view of Information, combining the cybernetic perspective of information based on Gregory Bateson's work (the difference that makes the difference) with the Semiotic vision of Charles Peirce, founded on phenomenology and pure mathematics stating that Information bits are at most pre- or quasi-signs, and, insofar as they are involved with codes, they function only like "keys in a lock". Information bits in a computer do not depend for their functioning on living systems with final causation to interpret them. They function simply based on formal causation, as interactions depending on differences and patterns. But, when people see Information bits as encoding for language in a word-processing program, then the bits become signs for them. Following in the footsteps of Peirce, whose Semiotics allows us theoretically to distinguish between the Information the sender intended to put in the sign, the (possible) Information in the sign itself and the Information the interpreter gets out of the sign, instead of the idea that it is the same in all three.

What makes distinction between Floridi and Brier is that the latter does not restrict Information as being a product of interpretation of an object: it goes deeper. Information is an entity that enables the phenomenon of signification to some cognitive subject, what makes real sense when we analyze this statement on a multimodal perspective as Kress and Van Leeuwen (2001) proposed.

3.3. *Modal logic: worlds and relations*

According to Abbagnano (2015), Logic can be defined as a discipline that privileges coherence in a set of statements, which is, if there is any possible situation that makes true all statements of the set. What makes this task particularly complex is the Multimodal nature of reality and the Cybersemiotic view of Information. Any stimuli can easily be relevant for a subject (a key for his/her lock) and irrelevant for another.

Modal Logic studies the possible ways of qualifying truths. These "Modalities" of qualification are an axiomatic or linguistic extension of Classical Logic. In this sense, classical connectives have the same meaning in Modal Logic. Notions as possibility (symbolized by a diamond) and necessity (symbolized by a square), therefore, will obey rules and thesis from classical propositional calculus. These ways of qualifying truth come along with two notions very useful for our purpose: Possible worlds and Accessibility Relations.

Suppose that a set of objects and a definition attributed to each object is presented to a group of three people. Everyone asserts true or false for if he/she agrees with the definition assigned to each object presented and write it down on paper. The three pieces of paper produced are now possible worlds in our model. Not necessarily one world is equal to another, in fact, is very likely that, considering the values asserted, we now have three totally different worlds.

This situation would be more likely to achieve (three totally different worlds) if we could separate all the individuals so the responses wouldn't be contaminated. In general, people talk to each other (in our example, even "sneak" at someone's answers) before doing things. For that, Modal Logic presents the notion of Accessibility Relation: which worlds can be accessed from one particular world? Through these Accessibility Relations modal notions of necessity and possibility are built. Carnielli and Pizzi (2008) describe necessity as in Rudolf Carnap's theoretical model, which states that necessary propositions are those which are true at all possible worlds. Bringing to our example, is the same to say that all three subjects assigned that a certain definition matches the object it is related to. But how does Relations come in to discussion? Analyze another example, with the same three people and the same situation, now in graphical representation.

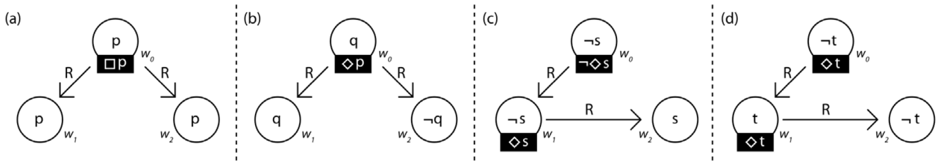

Fig. 2. Accessibility Relations graphical example

The figure presents four situations where three subjects are represented by their assumptions in w_0, w_1 and w_2 of the objects p, q, s and t. Now, the individuals have access to each other convictions (if the object is indeed related to the concept presented) through the relation R. This changes several things in our representation. Situation (a) shows the possibility where the individual w_0 has access to both other people. Since he or she verifies that p is true to everyone, he or she can assert that necessarily p is true. At the other hand, at situation (b), even though w_0 asserted that q is not true, he or she admits that possibly q is true, because there is a world that makes q true. The model shows us through arrows who can access who by the relation R enriching the model with necessities and possibilities.

4. Foundations of the proposal: Adequations and Properties

The epistemological base formulated indicated that *Order*, *Rule*, *Relation*, *Worlds* and *Economy* are key concepts to the idea of Architecture. Modal logic brings us some syntactic plasticity when formalizing our concepts in technological implementations. At the other hand, Information seems to be a problem with no clear solution with considerably amount of theories and technological uses. As our objective not being the definition of these concepts but to construct a definition of MIA, for the scientific level of analysis, the assumption of some adequations of terms are proposed (and, sometimes, premises so that these adequations can be understood) in order to ground the development of properties of the concepts of Architecture and Information.

4.1. *Building the idea of architecture*

So far seems clear that Architecture must deal with Rules and Relations to achieve Order considering an Economic way of dealing with it. For better understanding of these concepts, four adequations are proposed as following:

- **[ADQ.1]** – Relation is any form of connecting instances within a world or worlds among each other;
- **[ADQ.2]** – Rule is a relational context which restricts the possible Relations of instances within a world or worlds among each other;
- **[ADQ.3]** – Economy is a dynamic grouping of worlds that an instance within a world or a world itself requires so that a Rule or Relation be enabled;
- **[ADQ.4]** – World is a Mode, as in Kress and Van Leeuwen (2001), which enables meaning to be expressed.

For better understanding the connections between the concepts, figure 3 presents a graphical representation of the work done so far in defining the idea of Architecture.

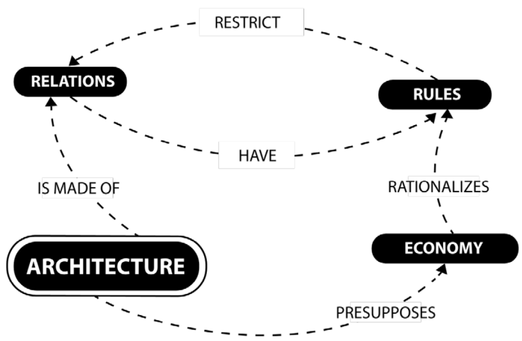

Fig. 3. Concepts related to Architecture

From the four adequations constructed, we propose analyzing a simple Multimodal model of reality, using only geometrical figures as shown in figure 4.

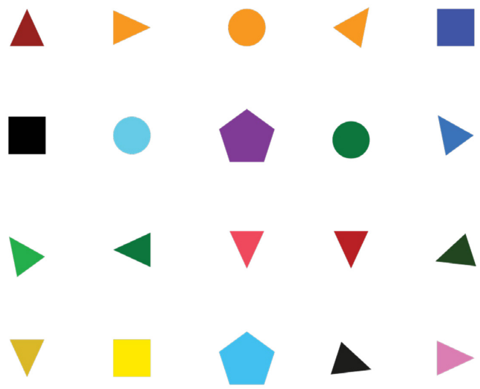

Fig. 4. Multimodal model of a simple reality

First task is to identify possible worlds. Even though the model here presented seems simple, the number of possible worlds goes the other way: every characteristic of every object could be a possible world: form, color, shape, volume or any other. The same goes for Rules and Relations. For these questions, three premises are now presented.

- **[PRM.1]** – Possible world is any distinction of instances of a model, taken individually or by group;
- **[PRM.2]** – Applied Relation is any structure of analysis of instances of a model, based on a possible world;
- **[PRM.3]** – Applied Rule is any form of restriction of Applied Relations.

Considering that the distinction shape would be the dominant Mode for meaning construction and applying all premises and adequations proposed, it would be possible to distinguish four possible worlds as presented in figure 5 below (world of triangles, circles, squares and pentagons), from which is conceived the first property for Architecture.

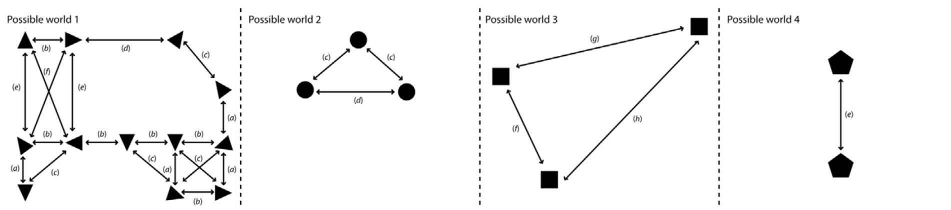

Fig. 5. Distinguished model of figure 4

- **[PRP. 1]** – Architecture is conceived through distinctions

This definition comes from **[ADQ.4]** along with **[PRM.1]**. According to Kress (2009), meaning activities depend on Modes for signification process. These Modes present themselves through Multimodal arrangements. The architectural principle of Order can only be given by means of distinction: which Modes, or, according to **[ADQ.4]**, which Worlds to distinguish, in what manner and under which arrangement.

- **[PRP.2]** – Architecture is characterized by assumption and construction of Relational Models.

Figure 5 presented a set of arrows that connects the objects in each possible world. These arrows are instances of Applied Relations defined in **[PRM.2]**, as they analyze each instance on a structure of comparison based on distance. The set of Applied Relations [a, b, c, d, e, f, g, h] on possible worlds [W_1, W_2, W_3, W_4] can be expressed through Modal Logic. A representation of each world indicates the existence of an Applied Relation by assigning the value true or false for it, as presented on the Relational Model below.

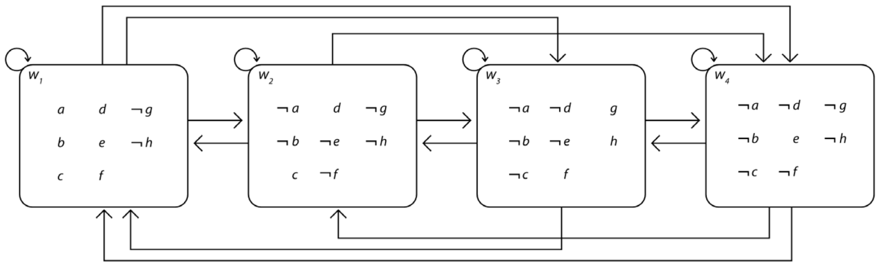

Fig. 6. Relational Model assumed from figure 5

- **[PRP.3]** – Architecture should aim the economy of Relations

Constructing as many Relations as one subject can imagine would be an obvious path. However, as the number of relations gets higher the entropy grows in equal (or, sometimes exponential) ratio, but as Carnielli and Pizzi (2008) exposed, modal systems get stronger (in consistency and completeness) as the number of Relations grows. How to balance this?

- **[PRP.4]** – Architecture manifests through Contextual Rules.

This property is achieved by joining **[ADQ.2]** and **[ADQ.3]**. The fundamental nature of every model is to evolve, to change. As understanding things becomes more natural, some relations may be unnecessary for completeness and consistency of the model. By relevance, certain Relation can be discarded but, in a future moment, be necessary again. In this manner, all ruling applied to the model cannot be considered final and absolute: continuous validation of the Architecture presented is needed.

4.2. *Setting path for a general use information concept*

Several researches aimed a definition for Information with little success. For our objectives, one idea seems to have no contestation by any position: Information can change things. This leads us to some adequations.

- **[ADQ.5]** – Subjects and Objects correlate in multiples worlds, at the same time.

An interpretation of Phenomenology, adopted by Brier (2015) in his cybersemiotic view of Information. In a reductionist manner, each subject perceives an object, through a unique phenomenon. He/she never has direct access to the real essence of the object, it is always mediated through some other entity.

- **[ADQ.6]** – Different Subjects can correlate with the same Object, at the same time.

It does not seem conceivable the existence of a situation where a Subject within a group of Subjects, coexisting in objective reality, be hinder of perceiving an Object and make his/her own presumption about it.

- **[ADQ.7]** – Subject-Object atomic correlation phenomena tend to be unique.

Different subjects have their own internal convictions. Each person has his/her own thoughts and opinions. It is highly improbable that two Subjects present the same set of convictions. Joining all three adequations, it is possible to conceive a graphical model for analysis, demonstrated on figure 7.

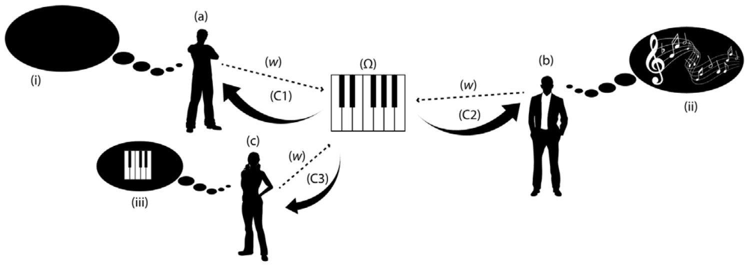

Fig. 7. Representation model of [ADQ.5], [ADQ.6] and [ADQ.7]

The model presents three Subjects [a, b, c] that realize atomic correlations [C1, C2, C3] with an Object. Each has his/ her own internal convictions, with three different results:

- **[RST.A]** – Subject “a” perceives the Object, however, his internal convictions do not have any record that enable the signification of that Object, or it is irrelevant for him therefore discarding it (“never seen it before, it´s irrelevant”).
- **[RST.B]** – Subject “b” perceives the Object and it is compatible with some record in his internal conviction and correlates it with this record, by what makes possible a signification process (“it´s a piano keyboard that produces music”).
- **[RST.C]** – Subject “c” perceives the Object and apprehend the properties presented, but do not correlates to any previous record so it is just stored on her internal conviction (“it´s a set of white and black rectangles”).

From these results, two properties are proposed.

- **[PRP.5]** – Information has state change capability

This property aims to meet the positions of Brier (2015) and Floridi (2008), as it opens the interpretation that an instance of Information necessarily carries a potential charge that can be signified by a Subject. A complementary discussion starts when the phenomena are taken isolated: if the subject does not have any records in his internal convictions that can be matched or conjugated with the stimulus, is it not considered an instance of Information? The simple definition of "state change" is unsatisfactory. A second property is needed.

- **[PRP.6]** – Information has a double potential vector: increase of complexity or reduction of uncertainty.

Based on Wilson and Sperber (2002) comes the interpretation that the search for relevance has fundamental influence on Relations between Subjects and Objects considering a context. On **[RST.A]** the stimulus is not relevant to Subject "a" and considering that there are no other stimuli to as complementation (an "implicature", as Wilson and Sperber (2002) suggested), Subject "a" discards it. **[RST.B]** and **[RST.C]** explain the double-bias property of Information. If there is no correlation with a previous record by the Subject, but still he apprehends the stimulus received, the complexity of his internal state increases for future correlations. In case of correlation, the stimulus becomes part of the internal convictions in a complementary or supplementary way to previous records which it was joined. This action reduces the uncertainty of approximation of the image (what the Subject has for conviction that the Object means, in our example, a piano keyboard) conceived for the Object itself.

5. MIA: Towards a definition

Seven adequations where constructed which led to six properties applied to the concepts of *Architecture* and *Information*. Multimodality emerged as a key aspect as showed in **[ADQ.5]**. Multiples *worlds* of signification goes along with signification *Modes* described by Kress and Van Leeuween (2001) and Kress (2009), leading to distinctions of worlds proposed in **[ADQ.1]** and **[ADQ.4]**. The measure of *Order* will be expressed through *economical ruling* as dictated in **[ADQ.2]** and **[ADQ.3]** within a highly complex context where *Subjects* and *Objects* correlate simultaneously, as described in **[ADQ.6]** and **[ADQ.7]**. Now, the six properties will be concatenated in such manner that a definition of *MIA* is achieved. As Logic will be used for expressing some applications of the definition proposed, a few complementary fundamental notions on this discipline will be presented.

5.1. *Some modal logic explanation*

Logic is expressed through axioms and propositions. A direct way to explain what an axiom represent is thinking of something so obvious that cannot be negated. Propositions are mathematical ways of expressing any kind of statements. In a simple way of definition, it would be like a mathematical variable. As an example, the proposition [p] could be taken as the "*color of this bird is red*" or "*it sounds like a pigeon*". An axiom can be exemplified as [if p then p], which states for Identity. What modal logic do is to enrich these axiomatic systems with some connectors, generating Logical Modalities. Knowledge, Belief, Deontic (in a sense of morality), Dynamicity (in a sense of process execution), Time, all of them are Modalities. Carnielli and Pizzi (2008) presented some practical examples of Modalities.

For our purpose, a reduced adaptation is showed in figure 8.

Connector	Modality	Syntax
O_i	Deôntic	On world *i*, is obligatory that
P_i	Deôntic	On world *i*, is permitted that
F_i	Deôntic	On world *i*, is forbidden that
$[a]$	Dinamic	Execute process *[a]*
$\boxed{P}$	Temporal	Always have been the case that
$\boxed{F}$	Temporal	Always will be the case that
$\Diamond_{P}$	Temporal	It was the case that
$\Diamond_{F}$	Temporal	It will be the case that
K_i	Epistemic (Knowledge)	Subject *i* knows that
B_i	Doxastic (Belief)	Subject *i* believes that

Axiom	Sintax
$K_i p \supset B_i p$	Subject *i* knows that *p*, then, *i* believes that *p*.
$O_i p \supset O_j p$	In world *i* is obligatory that *p*, then, in world *j* is also
$\Diamond_{P} p \supset \boxed{P} \Diamond p$	It was the case that *p*, then, always was the case that possibly *p*

Fig. 8. Modal logic examples

An application of how Modal Logic can enrich Classical Logic is adding the Deontic notion of Obligation [O_i], stating that "*on non-color-blind world is obligatory that if the color of this bird is red, then the color of this bird is red*" by writing [O_i [if *p* then *p*]].

Allied to Axioms and Modalities, Portner (2009) describe the notion of Frames, which are the structure of connection between worlds and Relations. In a practical way, Frames are logical ruling that restricts the Relations in a model. Carnielli and Pizzi (2008) describe some Frames which are synthetized in figure 9 below.

Frame	Syntax
Serial	In (w_1, w_2, w_3), w_1 reaches w_2 and w_2 reaches w_3.
Reflexive	In (w_1, w_2, w_3), each world reaches with itself.
Transitive	In (w_1, w_2, w_3), if w_1 reaches w_2 and w_2 reaches w_3, then w_1 reaches w_3
Simmetric	In (w_1, w_2), if w_1 reaches w_2 then w_2 reaches w_1
Euclidean	In (w_1, w_2, w_3), if w_1 reaches w_2 and w_1 reaches w_3, then w_2 reaches w_3

Fig. 9. Frames and their sintax

This limited explanation does not hinder the necessity for further research on MIA's dependency on Modal Logic (or other type of Logic), as the key aspect of embracing it is to conceive a syntactic system for the activity of Architecting to be formally grounded and avoiding both empirical assumptions nor pure theoretical thesis.

5.2. *Building the proposal from application*

Foundations set, let's put them in practice on a real situation. The concept of MIA will be constructed aiming technological implementation. Each property was obtained from at least one adequation produced so, building our proposal by joining all of properties would automatically attend both. First thing to do, is attend **[PRP.1]** by distinguishing worlds. For this example, consider figure 10 below.

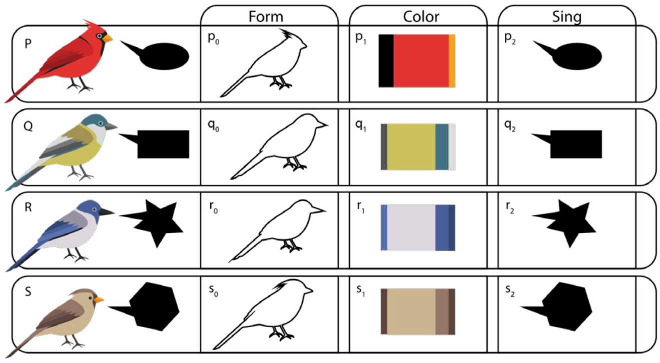

Fig. 10. Real context simulation

Four Objects represented the birds identified as [P, Q, R, S]. Our model presents three *possible worlds*: *form*, *color* and *sing*. This distinction of signification *Modes* allows us to conceive a model of relevance. For example, let's suppose that three individuals took some assumptions about these distinctions, producing a list of propositions stating if the stimulus presented refers to the semantic designation of the Object or not. In practice, it is showing the set of colors displayed on P_1 to each Subject and ask if these are a property of the semantic word for the bird P. This word could be the bird's name, scientific classification or any other socially agreed denomination that could represent the bird. If the Subject thinks it is, assigns "true" for P_1, if not, assigns "false". In resume, a possible result of this activity is presented on figure 11 below.

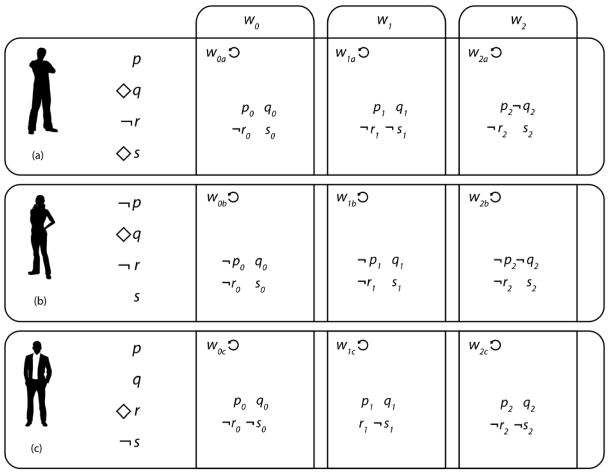

Fig. 11. Possible scenario after worlds distinction

The values came from correlations that each *Subject* realized to each stimulus, therefore, *Relations* were established between the entities of our model. This event is closely related to **[PRP.2]**, which says that an Architecture is characterized by relational model assumption and construction. It is so close that it's possible to say that *Relational Models* are the tool for *possible worlds* distinction, making **[PRP.1]** and **[PRP.2]** complementary.

From now on, each property involved in our concept construction will be listed on a table that will show how that particular property is represented on our definition. Table 1 below presents the first step of that evolution.

Table 1. MIA concept construction. [PRP.1] and [PRP.2]

[PRP]	Contribution on the definition
1	Distinction and construction of Architectural *worlds*
2	Through assumption of *Relational Models*
3	
4	
5	
6	

[PRP.3] says that an architecture should aim economy of *Relations*. After our brief introduction to Modal Logic, is reasonable to say that *Euclidean Frames* tend to transgress this property. For instance, comparing a situation where three people talk to each other and consider what each other has as convictions produces an *Euclidean Frame* of 3 symmetric relations totalizing 6 unitary relations. But when we add another person to this scenario the number of symmetric relations grows to 6, doubling the number of relations to 12.

But, what if these kinds of Frames simply happen? In a practical vision, let's get back to our model. Three people write down their opinion in a piece of paper. But what if, in a certain *Time* and *Space*, they can see each other's opinions? This is a kind of *Accessibility Relation*; therefore, an *Euclidean Frame* is established (as described before). A lot of other possibilities can be analyzed: do all *Subjects* trust each other? Do they consider each other opinion? What separates these contexts? The answer is simple, but very difficult to implement: *Time* and *Space*. Two people can consider an opinion but do not trust on who emitted that opinion on certain time or on certain circumstance (like talking about knowledge management or talking about politics) but is totally acceptable that these same individuals trust each other and, by that, not only consider that opinion but take it as a possible source of potential knowledge on some matter. This measure of dynamicity makes *Architecting* a constant and unstoppable activity. This is exactly what **[PRP.4]** stated: *Contextual Ruling*. Therefore, in our concept, **[PRP.3]** and **[PRP.4]** will be unified in one phrase as presented on table 2 below.

Table 2. MIA concept construction. [PRP.3] and [PRP.4]

[PRP]	Contribution on the definition
1	Distinction and construction of Architectural *worlds*
2	Through assumption of *Relational Models*
3 and 4	Grouped by *Space-Time* contexts
5	
6	

So far it is defined that the activity here presented is characterized by *"distinction and construction of architectural worlds through assumption of relational models, grouped by* *space-time contexts”*. The definition of the Object in this activity is still missing. **[PRP.5]** says that *Information* has state change capability. This can easily be exemplified by the development of our model exposed on figure 11 previously displayed. Consider now a new distinction which contains only *Subjects* (a) and (b). Initially a reflexive-symmetric *Frame* is applied as ruling to the *Relations* between them. Figure 12 show us the result.

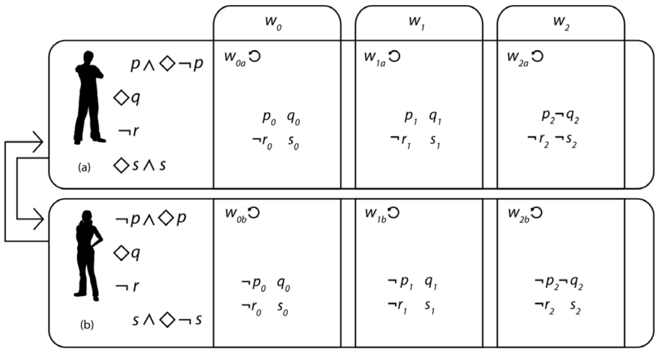

Fig. 12. Reconfiguration of figure 11 after new distinction and ruling applied

As observed, the state of the internal convictions of *Subjects* (a) and (b) has changed. For (a) is now possible that the set mode of form P_0, colors P_1 and sing P_3 are not properties of the semantic word for the bird *P*; as for (b) now the same set of properties may be indeed related to the semantic word for the bird *P*. This phenomenon turned the internal convictions of the *Subjects* to *Information* level (internal conviction of Subject (a) is now *Information* to Subject (b) and vice-versa), therefore, actualizing the definition as showed in table 3.

Table 3. MIA concept construction. [PRP.5]

[PRP]	Contribution on the definition
1	Distinction and construction of Architectural *worlds*
2	Through assumption of *Relational Models*
3 and 4	Grouped by *Space-Time* contexts
5	Of Information states
6	

In objective reality it is hard to assume that people trust in each other’s opinions. Considering that, symmetry does not seem to be a secure *Frame* to rely on. At the other hand, assume that no *Information* font is secure lead us to complete anarchy, an arbitrary *Frame* for our *Relations*. A reasonable solution for this question was presented through economy, which lead us to the space-time concept present in the definition of MIA so far. As an example, if we substitute the reflexive-symmetrical *Frame* adopted on figure 11 and replace it for a reflexive-serial *Frame*, but still admitting that space-time can change the *Frame*, we could get something like what is showed on figure 13 below.

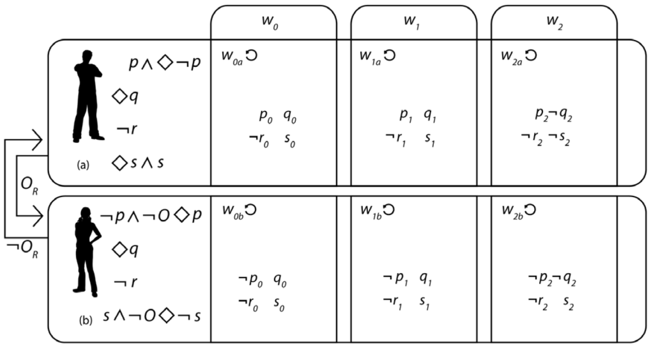

Fig. 13. Reconfiguration of figure 11 after Frame substitution

Now *Subject* (a) *Obligatorily* consider the Information set produced by (b), but the same is not applied to *Subject* (b): it may not consider *Subjects* (a) Information. **[PRP.6]** states that Information has a double potential vector: increase of complexity or reduction of uncertainty. Both were pictured in figure 13. Increase of complexity for Objects *P* and *S*, reduce of uncertainty on Objects *Q* and *R*. Another facet of this situation is the incidence of *Relevance*. One of the possible reasons for *Subject* (b) discard *Subject's* (a) Information is that it is irrelevant now but could become relevant in some future moment. Completing the definition, table 4 is presented with the full definition of *MIA*.

Table 4. MIA concept construction. [PRP.6]

[PRP]	Contribution on the definition
1	Distinction and construction of Architectural *worlds*
2	Through assumption of *Relational Models*
3 and 4	Grouped by *Space-Time* contexts
5	Of Information states
6	Correlated or not

5.3. *Definition of MIA*

MIA is characterized by the distinction and construction of architectural worlds through assumption Relational Models, grouped by Space-Time contexts of *Information* states correlated or not.

6. MIA: A path for conversations between Information Science and Artificial Inteligence?

The definition of MIA suggests that, through Relational Models and Distinctions of architectural worlds, it is possible to construct arrangements that favor the correlation of *Information states* by *Subjects* that compose the model. The simulations proposed assume that two subjects change their internal convictions through communication, either at the exact moment of occurrence or later.

Supposing that a third party can modify the configuration presented to the Subjects, whether including architectural worlds or presenting other convictions generated by other Subjects, how would this process occur? Would it be possible to design a sequence of actions to change these settings? Conclusions so far leads to considering the possibility of manipulation of the preconditions for the occurrence of Relations within a model.

Carnielli and Pizzi (2008) cite a logical modality called Dynamic Logic, which is characterized by the construction of propositions from abstract processes, typical of computers. Using a computer as Subject that interfere within a model significantly alters the possibilities of contextual design. Since Turing (2009), much is discussed about the ability of machines to construct mental models as men. It is proposed the discussion about the existence of architectural *World-building* forms that allow the modification of architectural contexts. In this sense, from figure 11 showed before, consider that a computer (M) assumes the internal convictions of the Subject (c) and, through the set of processes ⟨x; y; w; z⟩ can expose its architectural worlds to Subjects (a) and (b) and, through Relations, change the context which they are inserted. Figure 14 represents the results.

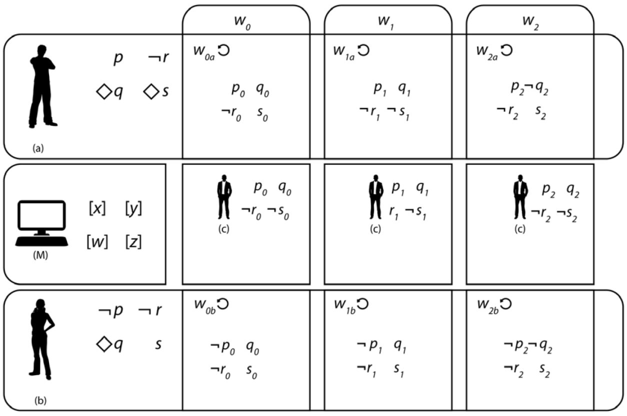

Fig. 14. A computer M acting at the model

Suppose that combining the processes ⟨*x; y; w; z*⟩ it would be possible to separate each *Mode* (as a syntactic layer) and extract meaning from that. For instance, executing processes *[x]* and *[w]* would separate *Subject's* (c) propositions for W_0. If presented to *Subjects* (a) and (b), even though Subject (c) thinks *R* is possible (because in W_1 it is true for him), for this moment it would be impossible, changing the construction of the architectural model if *Subject* (c) was indeed acting on it.

Another aspect of this experiment: what if computer (M) had access to all three Subjects assumptions and another Subject (d) was then analyzed by this computer while making the same task of assigning true or false for each set of stimuli? By each layer of analysis, computer (M) could predict Subject (d) next answer by comparing how close he is to either Subject (a), (b) or (c). At the end, assumptions assigned by Subject (d) are recorded and another parameter of comparison is added, so when another Subject start to classify the same stimuli the same process can be done. Here we are discussing only three architectural worlds of meaning but what if others are added? How can we decide if a world is relevant? This problem is a common one in other fields, as Artificial Intelligence.

Buduma and Locascio (2017) describe Deep Learning as a subset of Artificial Intelligence which is predicated on the idea of leading machines to learn by example. The method can be resumed by given a machine a model with which would be possible to evaluate examples and a small set of instructions to modify the model when it makes a mistake. Human brain is used as basis for constructing the knowledge acquiring method.

Neurons are the foundation of the human brain. What makes possible for a human being to make decisions, to learn and all other intellectual functionalities is the conjunction of billions of neurons. In a simplistic manner, what neurons do is to work in group – a Neural Network – that passes signals through the members that get activated by a certain stimulus. Every neuron processes Information in a unique way, weakening or strengthening a particular signal as a certain type of connection is repeated. Through this process of repetition human knowledge is constructed. Figure 15 below presents an example of a neuron dealing with multiple signals and, them, strengthening one of them.

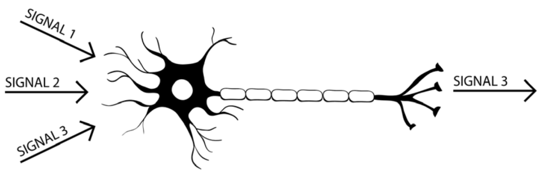

Fig. 15. Neuron model

Rosenblatt (1958) describe the concept of perceptron, which is based on a neuron. Its functionality is basically the same: gets activated by some signals, processes them, decide which signals to pass on.

From the union of several perceptrons, Haykin (2009) defines the concept of *hidden layers*, whose computation nodes are correspondingly called *hidden neurons* or *hidden units*; the term "hidden" refers to the fact that this part of the neural network is not seen directly from either the input or output of the network. The function of hidden neurons is to intervene between the external input and the network output in some useful manner. By adding one or more hidden layers, the network is enabled to extract higher-order statistics from its input. Automatically, as we thought when defining **[PRP.2]** in our MIA concept construction (more Relations, more completeness, better model), the Neural Network should have as many hidden layers as possible. As stated before, it isn't that simple. Looking at figure 16 below gives a measure of complexity.

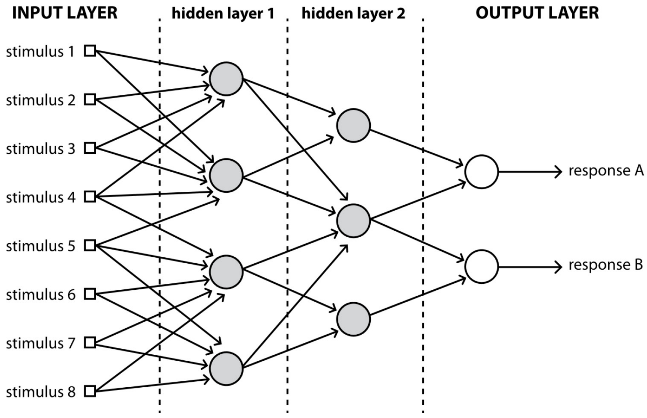

Fig. 16. Example of Neural Network

Buduma and Locascio (2017) state that building a very complex model may perfectly fit a certain problem. But when we evaluate such a complex model on a new situation, it performs very poorly. In other words, the model does not generalize well. This is a phenomenon called *overfitting*, and it is one of the biggest challenges for artificial intelligence development. This becomes an even more significant issue in deep learning, where our neural networks have large numbers of layers containing many neurons. The number of connections in these models is astronomical, reaching millions. As a result, *overfitting* is commonplace. This is exactly the intersection point between MIA and Deep Learning.

As Computer Science would be the appropriate discipline for developing perceptron's decision-making algorithms; MIA, representing Information Science, could generate appropriate methods for giving the right measure of complexity for grouping, ungrouping, creating and eliminating hidden layers, as it is based on relevance analysis of Multimodal problems using *Relational Models*. For a better understanding of this hypothesis, consider figure 17 below.

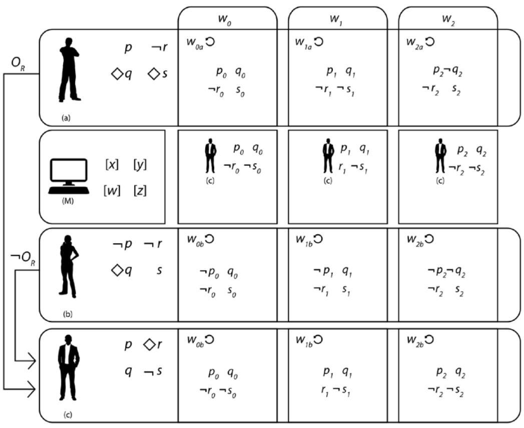

Fig. 17. Computer M acting on new context

Suppose that a Neural Network for opinion mapping and opinion changing on bird species average knowledge is being developed. First contribution MIA could give on this problem would be in defining *how birds are averagely perceived*. How many *Modes* of signification can the activity of bird recognition be made of. This is Architectural worlds distinction, as in **[PRP.1]**. In the figure, we assume that three worlds are the most common. Computer Science now would have guidance on *hidden layers* construction: how do a computer recognize color scale, form outlining and sound pitching?

After the Neural Network is build, MIA could collaborate on evolving it through **[PRP.2]** to **[PRP.6]**. In figure 16 Subject (a) has an Obligatory Relation with Subject (c) but Subject (b) has not. A new hidden layer can be assembled. That is, it would be possible to consider that if a set of answers gets like Subject (b) set of answers, it would be unlikely that this Subject being analyzed change his opinion based on answers given by Subject (c).

7. Conclusion

In this article only the most important aspects of *MIA* have been presented. A profound epistemological background has been produced so the proposal can be considered an epistemological work too. The core of our discussion was centered on giving a direction for how to achieve an optimistic economical way of Ruling the *Information* flow through *Relations*, while acknowledging that a complete management of all possible *Relations* may be out of discussion as the amount of effort spent on controlling it may be equal to very same done to build the *Information* treated. Furthermore, a variety of questions can be made:

- **[Q.1]** - Is it possible to construct a method for *MIA* and its components, like *Relational Models* and *Architectural worlds*?
- **[Q.2]** - Is it possible to apply *MIA* to complex Information problems like Big Data or Machine Learning?
- **[Q.3]** – As *Information* has a potential vector of increase of complexity, it would be plausible to discuss the existence of counter-information?

As the research on applications of *MIA* develops, Neural Networks seems promising as a step forward on addressing the questions herein cited. Not raising the hypothesis that MIA could substitute Neural Networks for Deep Learning problems, but as a compliment method for constructing layers of analysis and a solid ground to sustain the coordination of Syntax and Semantics on Artificial Intelligence problems.

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