HIERARCHICAL INTELLIGENT ANALOG SIMULATION

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ABSTRACT
Intelligence = Consciousness × Adaptability × Intention and *Faith* = Intuition × Inspiration × Imagination, are the complementary parts of the human mind. *Conscience* = Consciousness × Inspiration is the link between. Simulation is the relation between function and structure. Simulation of conscience demands transcending from computability to simulability by an intensive effort on extensive research to integrate essential mathematical and physical knowledge guided by philosophical goals. A way to begin is hierarchical simulation. Coexistent interdependent hierarchical types of different kinds structure the universe of models for complex systems. The symmetry between construction and understanding is an essential step to the symmetry between intuition and reason – extended adaptability for natural operations, and further, between faith and intelligence. Three examples confirm the assertions.

Keywords: abstraction, intelligence, consciousness, conscience

1. HIERARCHICAL APPROACH

Hierarchy types open the way to simulate intelligence as intentioned adaptable consciousness by extending the present limits of computability. We enrich the template concept to structures and create a theoretical kernel, for self-organizing systems, based on a hierarchical formalism. This permits theoretical development as well as efficient application to different cosimulation types of reconfigurable systems. Coexistent interdependent hierarchies structure the universe of models for complex systems, e.g., hard-soft ones. They belong to different hierarchy types, defined by simulation abstraction levels, modules, symbols, classes, and knowledge abstractions. Hierarchies of different types correspond to the kind of abstraction they reflect (↑):

- Class hierarchy (↑concepts) ↔ virtual framework to represent any kind of hierarchy
- Symbol hierarchy (↑mathematics) ↔ stepwise formalism for all (hierarchy) types
- Module hierarchy (↑managing) ↔ stepwise managing of all types by recursive decomposition, following the principle *Divide et Impera et Intellige*
- Construction hierarchy (↑simulation) ↔ simulation (design/ verification/ optimization/ integration) framework of autonomous levels for different abstraction grades of description
- Knowledge hierarchy (↑theories) ↔ reflexive abstraction aiming each level has knowledge of its inferior levels, including itself; this kind to abstract enables *consciousness*.

Knowledge and construction have correspondent hierarchy types: their syntax relies on classes, their meaning on symbols and their use/ action on modules. The hierarchy types can be formalized in the theory of categories (Niculiu and Lupu 2005). The hierarchical types are objects of equivalent categories (functorial isomorphic) that formally represent hierarchy types. The consciousness hierarchy type communicates to the other hierarchy types by countervariant functors, while the others intercommunicate by covariant ones.

Constructive type theory permits formal simulation by generating an object satisfying the specification. Applying similar abstraction kinds to hardware and software, representations and operations based on object-orientation, symbolization and structural abstraction can be extended from software to hardware.

A generic type - a form of polymorphism - is the ability to parameterize with types a hard/ soft element. Recurrence is confined to discrete worlds, while abstraction is not. This suggests searching for understanding following mathematical structures that order algebra into topology (Blum et al. 1998).

The alternative ways followed to extend the computability concept correspond to approaches known from German works: they respectively concentrate on the mental world of the good managed by technology, the physical world of the truth researched by science, and *Plato*'s ideal world of abstractions searched by arts.

1. Faust (*Johann Wolfgang von Goethe*): heuristics - risking competence for performance, basing on imagination, confined to the mental world.
2. Das Glasperlenspiel (*Hermann Hesse*): unlimited natural parallelism - remaining at countable physical suggestions, so in the Nature.

3. Der Zauberberg (*Thomas Mann*): hierarchical self-referential knowledge - needing to conciliate the discrete structure of hierarchy with the continuous reaction, hoping to open the way to Reality.

Note: | | signifies some sort of absolute difference.

$$\begin{aligned}
&\text{Simulation} \in \text{Behaviour} \times \text{Structure} \Leftarrow \text{Knowledge} \\
&\textit{Knowledge} \Leftarrow \textit{Intelligence :: information}\ () \\
&\textit{Imagination} \Leftarrow | \textit{Intuition - Consciousness} | \\
&\textit{Intention} \Leftarrow | \textit{Inspiration - Adaptability} | \\
&\textit{Adaptability} \Leftarrow \textit{simplifyingAbstraction}\ (\textit{Imagination}) \\
&\textit{Consciousness} \Leftarrow \textit{reflexiveAbstraction}\ (\textit{Intention})
\end{aligned} \tag{1}$$

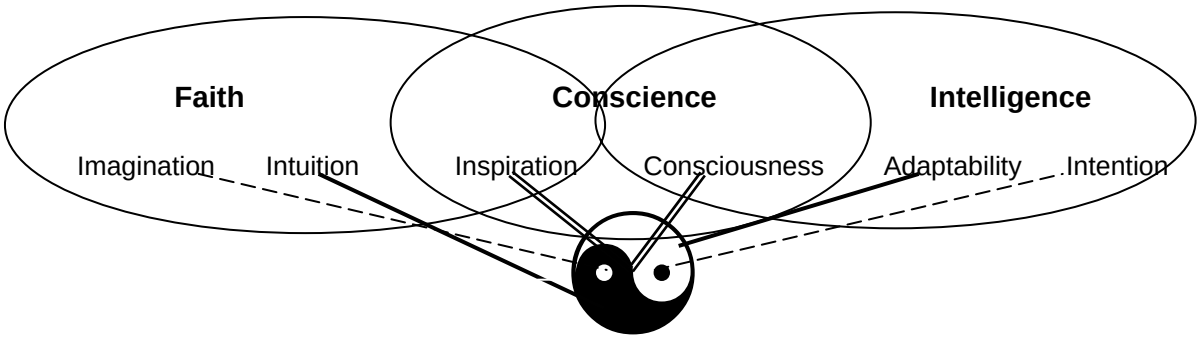

Figure 1: The Human Mind

2. LOOKING FOR CONSCIENCE

We follow the mathematical paradigm of intelligent simulation by functionally modelling the self-aware adaptable behaviour for intelligence simulation. The integration between discrete and analog is needed (Niculiu 2006), for a softer adaptability and for consciousness simulation as analog reaction. Recurrence of structures and operations enables approximate self-knowledge, with improved precision on the higher knowledge levels.

We oversimplify to move towards intelligent simulation: First, we neglect the essential but hard to understand intuition and inspiration, formalizing reflexive abstraction by knowledge hierarchy type and simplifying abstraction by construction hierarchy type:

$$\textit{Consciousness} = \textit{knowledge (simulation (Consciousness))} \tag{2}$$

The fixed-point relation suggests that we can model consciousness associating to any hierarchical level of the construction process a knowledge level. We have to build a metric space where knowledge ° construction is a contraction, i.e., elements implied in the construction get closer to one another in the formal understanding of the formal construct.

General functional relations between the essential parts of the faith-assisted intelligence imply:

$$\textit{Consciousness} = \textit{knowledge (intention (Inspiration, simulation (imagination (Intuition, Consciousness))))} \tag{3}$$

A continuous model for superior hierarchy levels offers a better model for consciousness of intelligence. Representation for design and verification is common ⇒ algebraic structures on which the different hierarchy types are based on are extended to topological structures; the different simulation entities are symbolic.

$$\textit{Reality is beyond Nature}\ (\mathrm{IN} \subset \mathrm{IR}) \tag{4}$$

The hierarchical principle is applied to the object of knowledge as to the knowledge structure itself: it mediates the action of a paradigm on an environment. An intelligent system is capable of reflexive abstraction, controlled by problem specification and solving strategies. They are derived from a higher knowledge level, representing approach principles, structured by an even higher level containing abstract types.

Applied at environment and at simulation level, goal and strategies ensure flexibility of the framework, defining it precisely only in the neighbourhood of solved cases. For representation, the principle enables open modelling, which enables reconfigurable realization.

Formalizing hierarchical descriptions in continuous spaces we come closer to self-control, -organization, -awareness, i.e., (intention, adaptability, consciousness), hence to intelligence. There are enough positive signs for this from analog electronics, control systems, mechatronics.

Real progress towards this way of computation needs unrestricted mathematics, integrated physics, and thinking by analogies. Knowledge is based on morphisms between the real system and the simulator. An intelligent simulator learns generating and validating models.

$$\textit{Simulability is computability}^{\,continuum}. \tag{5}$$

Mathematics contains appropriate structures for self-referent models. The richest domain therefore is functional analysis, integrating algebra, topology and order, e.g., contractions and fixed points in metric spaces, reflexive normed vector spaces, inductive limits of locally convex spaces, self-adjoint operators of Hilbert spaces, invertible operators in Banach algebra.

Example: Let U be a universe that is structured by different hierarchies. U is a category, e.g., containing Hilbert spaces with almost everywhere-continuous functions as morphisms, enabling different ways to simulate self-organizing, -control, and -awareness. Hierarchical universe, functional objects (global functions, level structures, simplifying and knowledge abstractions), initial functions, and transformation rules define a hierarchical formal system. We consider the self-adjoint operators as objects on the higher levels of the knowledge hierarchy. These levels strive then for self-knowledge, whose degree rises as the knowledge abstraction, in the context of the inferior level knowledge, and of superior level qualitative knowledge. Natural transformations (functorial morphisms) on the functors of different hierarchy types solve the correspondence problem, i.e., the association of a knowledge hierarchy to the simulation one. Intention results by human-system dialog, and completes the simulation of the intelligence.

$$
\begin{aligned}
&(U, \{H_i \in S_h\}),\ card\ (U) > \aleph_0 && \text{// hierarchical universe}\\
&\Sigma = F \cup L \cup A \cup K && \text{// functional objects}\\
&\quad F = \{f \mid f \in U^* \rightarrow U\} && \text{// global functions}\\
&\quad L = \{f \mid f \in Level_j^* \rightarrow Level_j\} && \text{// level structures}\\
&\quad A = \{f \mid f \in Level_j^* \rightarrow Level_{j+1}\} && \text{//abstractions}\\
&\quad K = \{f \mid f \in Level_j^* \times Level_{j+1} \rightarrow Level_{j+1}\} && \text{// knowledge}\\
&I = \Sigma^* \cap R && \text{// initial functions}\\
&R = \{r \mid r \in \Sigma^* \times R^* \rightarrow \Sigma \times R\} && \text{// transformation rules.}
\end{aligned}
\qquad (6)
$$

Further than modelling consciousness to simulate intelligence is the search to comprehend inspiration. A first idea is to use Lebesgue measure on differentiable manifolds and/or non-separable Hilbert spaces. Perhaps even mathematics will have to develop more philosophy-oriented to approach intuition.

God's ways are uncountable (7)

Evolution needs separation of faith and intelligence, understanding and using consciously more of faith's domain, and integrating them to human wisdom to be divided further to get more human.

His plans are hopefully hierarchical. (8)

3. ABSTRACTION AND HIERARCHY

The power to abstract is the crucial difference between human and other natural beings. *Divide et Impera et Intellige* applies the hierarchical expressed abstraction.

Intelligence and *faith*, like any dichotomy, can converge to integration or can destroy one another if not associated by *Conscience*.

Function is a transformation that can be mathematically formalized, or physically instantiated as temporal behaviour. *Structure* is a set of properties that characterize a mathematical or physical space. The properties can be constant/ variable in time - static/ dynamic structures.

Simulation is the relation between function and structure. Structured set = (Set, structure). *Model* results of an inversion-able representation of the simulation object. *Language*/ *system* is a generic form of a mathematical/ physical model. *Abstraction* is a human defining capacity that enables him to think.

The *simplifying abstraction* concentrates on a superior level the information that is considered essential for the current simulation approach. Reducing the informational complexity has in view to clear the operation and to ease its formalism; it can be only quantitative, but also qualitative.

The *reflexive abstraction*, expressed as knowledge hierarchy type, tries to understand itself better at higher levels, by understanding more of the inferior levels.

Hierarchy is a functional/ structural concept that fulfils mathematically/ physically the concept of abstraction. Hierarchy is syntax of abstraction.

God is in us - as faith is part of our definition, with us - by the others, and for us – the spiritual evolution, that is first conditioned, and then assisted, to be followed by the social one.

Against the danger of dichotomy, we concentrate in three different ways on the *unique Reality* (*Plato*): Art for the art - to look for the essential Way, Science with God's fear - to search for the existential Truth, and Engineering - to understand the Being and to concentrate more on the Spirit in our Life.

To go further, thinking while advancing, we divide twofold, as we cannot yet Intellige the dichotomies: *spirit-matter* (force-substrate, software-hardware) $\Rightarrow$ real-natural (continuous-discrete, analog-digital), form-contents (category-functor, representation-simulation, class-function, structure-function), true-false, real-possible, perspective-profoundness, beauty-truth (arts-science, mathematics-physics) $\Leftarrow$ *space-time* (evolution). Clearly, there should be no balance in most of the dichotomies. (Calude 2002)

Faith and Intelligence are ☯ *of Life*. (9)

Yin-Yang can represent by rotation any dichotomy. Arts and sciences are equally noble, even if one appears rather spiritual and the other rather material. Their alliance is vital and demonstrates the insolvability of the nowadays *spirit-matter* dichotomy, and of all resulted secondary dichotomies, actually functionally generated by the *space-time* dichotomy that is necessary to the human evolution. Reason is an extension of the nature. Nature is not an ephemeral context, but the matter we are built of in order to develop spiritually. The experiments for the spirit-matter dichotomy integration failed because of their extremism. The society is only the memory of the past, the manager of the present problems, and the assurance for a right future. We have to live together in respect of the others on the way to understand each other, in order to evolve toward essential beings for an integrated existence (see Appendix).

The present society is extremely materialistic, and tries to destroy every trace of ideal. We have to surpass the limits imposed by the essential dichotomy by a unique Ideal, named *God*, that should be constructive by continuous intelligent reconfiguration.

Human among humans should reflect a strategic equilibrium, without hiding or even violating, as happens nowadays, the principle that the society has to assist unconditioned the individual, with correct continuous education, and assistance by an intelligent faith to search and research the *unknown*.

The unknown can be interpreted as a *unique God*: the absolute freedom by understanding all the necessities, and the absolute unity by closing all the Divide et Impera et Intellige necessary for the Way to look for the Truth along the Life.

We extend the reconfigurability to the simulation itself (Figure 2). By a self-aware simulation, we get self-control of the simulation process. Therefore, we build a knowledge hierarchy corresponding to the simulation hierarchy. Then, by expressing both simulation and knowledge hierarchies in the reference system of the basic hierarchy types (classes, symbols, modules), we create the context for a self-organization of the simulation. The triad of the basic hierarchy types corresponds to the fundamental partition of the real life (beauty-arts, truth-science, good-engineering), that has to be continuously integrated by philosophy (essence, existence, being). The absolute functionality is symbolized by yin-yang, while the waves suggest hierarchical levels that are increasingly structured for simulation and knowledge.

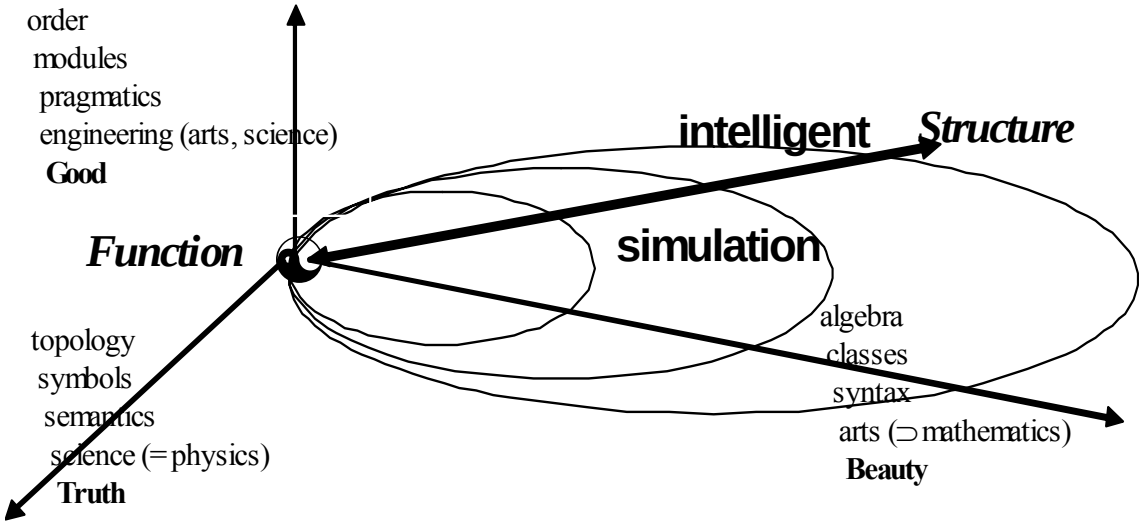

Figure 2: H-diagram
The basic hierarchy types (classes, symbols, modules) correspond to (syntax, semantics, pragmatics) of the hierarchical language that has to express the intelligent simulation.
Intelligent simulation results from the integration of the simulation hierarchy with its knowledge counterpart that represents a reflexive abstraction converging to self-consciousness of the intended adaptable simulation.
The yin-yang represents the absolute functionality and the waves are increasingly structured hierarchy levels, both for simulation as for knowledge.

4. INTELLIGENCE AND FAITH

Each of the nondeterministic separated complementary pairs is functionally structured like (interface, kernel, ambassador of the complement). The *yin-yang* model was not randomly selected: it is formed of three tangent circles emphasizing the centres of the inner ones. It retains only the essence of a dichotomy symbol suggesting a complete integration of the parts without loss of autonomy, realized by vicinity and pointing one to another. The Chinese symbol reflects the importance of something else, reminding of creation as love for something else. Three circles, each tangent to the others, models a partition of something to be understood in order to get further, says the centre of Europe. Circle is *cerc* only in our mother language, a perfect expression: *Cer* (sky) is the infinite, *cerc* is the finite representation of the infinite, by the permanent link from the (never)begin to the (never)end. π is the most famous real number (*Pythagoras*).

Cerc means perfection, which we permanently desire, therefore there exist integer numbers, having a perfect and beautiful theory, but not forgetting to continue the evolution searching and researching further. The western Europeans attain research/ rechercher by recursive search/ chercher. Our Romanian language helps us to approach this by *cercetare*.

The religion had to learn us about God's existence in our being. The philosophy has to learn us about essence, existence, and being. Our conscience is our representation of the essence of our existence as being, i.e., God is in ourselves, for ourselves, and among ourselves.

We have to be to search our essence (10)
researching our existence

Divide et Impera et Intellige has three parts as *alle guten Dinge sind drei* of the most philosophic European people. Mathematics develops by three basic structure types, integrating them. We divide our Universe in three worlds: essence, existence, and being. We divide our existence in three interdependent components: arts, science, and engineering-technologies, corresponding to our beauty-loving ideas, our truth-searching efforts, and our good-oriented constructions - presently exaggerated to exclusivity.

As the Reality contains abstract ideas, even if physics could explain everything as being discrete, the power of continuum cannot be forgotten. Consequently, the analog engineering has not to be neglected in modelling and simulation.

Physics permanently uses as dichotomy the discrete-continuous, while the engineering just adapts intuitively - as a primitive life form - to the requests of a consumption-oriented society - characteristic for primitive life. The reason is: either presently the engineering escaped the control of the inspiring arts as it also lost the consciousness that science conditions its existence, or that technology masters engineering as result of society being superior to human.

For physical or philosophical orientation, we need *cardinal* points. To inspire ourselves of the most pure of the arts, we learn about cardinal numbers (although, being sincere, mathematics leads the way to show that nothing is pure, so without leaving anything behind the Way has to be followed further). Cardinal numbers are just numbers of elements in a set, finite or not.

The Nature demands the least infinity and is defined by (0, successor, induction). Adding is in Nature's definition. However, the inverse operation, subtraction, needs negative numbers. We close mathematically the Nature to an Integer that opens the physics for recognizing the limits of Reason (electrons), in the meanwhile, attracting marvellous engineering solutions for different technologies. Electronics is among the most advanced engineering sciences; therefore, it has to be practiced by the most conscient human beings. Recurrent addition is multiplication, a most important parameter for the Nature. Mathematics closes the integers to the multiplication inverse, defining the rational numbers. These are not more than the naturals, but we can do many useful things with the Reason, from strategy to computer.

"What else do we need?" say too many, forgetting that the limits of the, so-called, pure Reason are caused by the fact that it bounds itself to close the Adaptability to (discrete) sequential operations. Thanks God, neither the mathematicians, nor the physicists do accept the all-happiness (Marcus 2000). They discover in three ways (order, algebra, analysis), which assisted all of them together to think, the power of continuum and that of the patience (Keutzer et al. 2000)

In this context, "mathematicians and physicists" means the theorem, natural laws, or even new approach discoverers, but also the engineers that understand the essential of mathematics and of physics.

We should not forget the third meaning of cardinal. It points to an unwise use of *Divide et Impera et Intellige* as a strategy called *when two fight, the third wins*. It means intervention only when the fighting forces begin to get unbalanced in favour of the less strong, not for establishing the equilibrium but for conquering both fighters. If the victory must be completed, both pseudo-ally and -enemy are firmly assisted, discretely or continuously, to loose control, because of all-happiness, respectively, all-unhappiness.

The 20th century is a too convincing example, unfortunately continuing to develop. Presently, we talk about electronic computers, but the nowadays trend is to copy from the living Nature, i.e., to emulate the living beings in unconsciously achieving complex duties.

Vanguard domains are biotechnology and computational intelligence. Neither intelligence nor life is well understood; remember *Zauberlehrling*. More important is that emulation is less human than simulation, so they should always develop in parallel, permanently exchanging experience.

The Reality does not reduce to Nature, as card (IN) is strictly inferior to card (IR). The Reason is the closure of the Nature relative to the primary operations, as $\mathbb{Q}$ is the closure of IN to the inverse operations of addition and multiplication.

However, the Reason is dense in Reality – as the reals are the analytical closure of the rationales, $\mathbb{R} = \{\lim_{n\to\infty}(q_n) \mid (q_n) \in \mathbb{N} \to \mathbb{Q}\}$. The Reality extends beyond Nature and Reason, not just for the quality of the quantity, but also regarding the power of transforming operations. IR closes $\mathbb{Q}$ to the inverse of power rising – the last arithmetic operation resulted by recurrence of the prior one, which can be pursued by Reason. Further, closing to the inclusion order, the set of all subsets of IN, $\mathbb{Z}$, $\mathbb{Q}$, or in general, of countable sets, is the uncountable IR, the power of continuum.

To get to complex numbers is a matter of Imagination.

Reason closes the Nature to the inverse of natural operations. Reality is the closure of the Reason either to the inverse of artificial operations, (11)
or to the reasonably deducted infinite,
or even to an order over the Being itself.

We know that if there were no cardinal number between the natural/ integer/ rational discrete and that of the real continuum, then the logic would include the principle of the excluded tierce. This, pure and simple, hurts the Human, who is fond of nuances. Therefore, we can (*nonconstructively*) prove that there is an intermediary level between Reason and Reality. There are angels between Human and God said the wise. The density of Reason into Reality means that every real is the limit of a sequence of rationales.

Therefore, we hear nowadays that if we master the Reason, Reality becomes a complexity problem, i.e., speed of convergence. The density of $\mathbb{Q}$ in IR shows that between any two real there is a rational numbers one. Reality is much more than Reason can even imagine, but something reasonable exists between any two realities (*nonintuitive*).

Neither Intuition nor Reason arrives to something that nonconstructive mathematics proves elementary. As any true art or beautiful science of the ideas or the phenomena, mathematics does not limit itself to either Intuition or Reason, allowing them to collaborate by Conscience.

We dare use mathematics as metaphor for the relation between Nature and Reality, but it is only a correct inspiring analogy. IR is an initial step in mathematics for algebra, topology, order, and more, for their collaboration. Mathematics is for Reality just one of the favourite ways to get the Human closer to it.

The society is conservative – it tries to last forever at any evolution level, using a common measure. Everything can be evaluated, although most of the essential things on that our existence bases its being are not measurable.

The so-called pure Reason, i.e., the context-free Reason – most adaptable, conscious only for having, not for being, intended by the tactics of the consumption society, and totally unfaithful, gives the necessary force to stagnation or even to choosing a wrong way.

Unfaithful means here that the components of the Faith (inspiration, intuition, imagination) are used separately to serve the competition for the Good that makes present Life credible.

However, the irrational of arts, particularly in mathematics, is more than reasonable, whereby the society is less than reasonable; on the contrary, arts open the way to Reality by closure to an essential and radical operation. To master the New Power of the continuum is beyond Intuition and Reason, if they do not integrate by Conscience.

The adaptability-based Reason cannot explain or control thoughts, even if sequential is extended to unlimited parallel/ nondeterministic. These desired operational properties can be found mainly in the right side of the human mind.

Further, the difference between continuous and nondeterministic sequential is positive. Therefore, the Reason has to be Faith-dependent completed to Intelligence. A being needs more than Intuition and Adaptability to surpass the Matter by Spirit; only the integration of Intuition and Adaptability by Conscience can explain the Human being. All this inspire us to propose the thesis:

$$Conscience = closure_{(conscious\ simulation)}^{-1}(Conscience) \quad (12)$$

Initially, Conscience = Consciousness

The idea can be formally sustained in the category theory (Ageron 2001). Informal arguments follow.

The essential limit of discrete computability, inherited by the computational intelligence, is generated by the necessity for self-reference to integrate the level knowledge with metalevel knowledge in Conscience modelling. A hierarchical type expressing reflexive abstraction can represent the conscient knowledge. The aspects of the Reality, and of the human mind reflecting it, are not to be neglected, although they are neither constructive nor intuitive. A way from Reason to Intelligence is to integrate Consciousness and Intention, then further Intelligence and Faith to become Reality-aware. We could consider just the simplifying types of hierarchy (classes, symbols, modules) and then express the construction, hoping to aim the absolute liberty, if we considered God as the simplest, unconstrained, essence of the Reality. However, we can simulate/ construct/ work/ live, associating consciousness hierarchies to all our activities, aiming to constructive understanding of the most complex absolute necessity, by this defining God. Abstraction is the human gift to go beyond natural limits, meanwhile extending pure reason to real intelligence → the metaphorical thesis:

God is the absolute abstraction (13)
→ *the evolution goal for faith-assisted intelligence*

5 PARTIAL CONCLUSIONS

1 *Hilbert spaces* ground the Behavioral model for quantum physics, i.e., the part that is independent of any concrete intervention (in the world of abstractions). The link to the complementary part of the model, representing the interface to the physical world, cannot be algorithmically expressed, what suggests that the model is not correct in the Reality.

2 *Banach algebra* introduce, additional to the topological vector spaces, a commutative multiplication; by an adequate transformation, a commutative functional composition results, eliminating an important sequential constraint.

3 *Simulability* and integrated mathemat/physical-comprehensive modelling the Intellige of the three approaches are promising ways.

4 *Inductive limits* direct the convergence of hierarchical types, enabling the compatibility of partial simulations and contributing to the correctness by construction of the design.

5 *Reflexive topological vector spaces* contain the necessary ingredients for the representation of the Conscience, by reflecting the adaptability in the variability of the space dimensions.

6 *Self-adjoint operators* and *eigenvalues/-vectors* assist the knowledge concentration/ stability.

7 *Fixed points* help to a formal simulation goal.

8 *Inseparable spaces* can instrument the understanding of inspiration and intuition.

9 *Simulability is computability to the power of continuum*: metaphorical thinking, unrestricted mathematics, e.g., mathematical measurability to formalize, and analog electronics.

Human = human (Humanity); *// class*
human ∈ Faith × Intelligence → Faith × Intelligence
Humanity = ({humans}, eternal/ evolving Structure)
evolution ∈ (Hunger × Fear × Love)
× (Engineering × Science × Art)
→ Engineering × Science × Art
Mathematics ⊂ Art = Human:: beauty-oriented (14)
activity (Science, Engineering)
Physics = natural ∪ social Science
= Human:: truth-oriented activity (Art, Engineering)
Engineering/ Engineering = Human::good-oriented
activity (Art, Science)

6 TRANSFER FUNCTION SINGULARITIES

Twenty years ago, one of the authors together with a friend - now professor at *Carnegie-Mellon* University - presented a related work that compared two methods to determine the poles and zeros of a transfer function, based on state-equations, respectively on node-equations (Marculescu and Niculiu 1987). Complexity of the set-up actions of the first was balanced by weak convergence of the second. This is a typical case to try heuristics together with expert systems.

Ten years ago, two of the authors together with the other members of a Romanian–German team, presented (Niculiu et al. 1997) a knowledge-based object-oriented analog simulation system.

The *Newton-Raphson* method was used in circuit simulation for forty years, and the interest for its optimization has not decreased. (Zu et al. 2007) The graphical or numerical results of a circuit simulator are the primary information that has to be sampled with a variable rate appropriate to the simulator output variation.

Knowing the dominant singularities is decisive for simulation, as they reflect the stability of the circuit (Manolescu 1999), or can represent primary information in formal simulation, e.g., root locus method.

The transfer function of a linear (linearly approximated around a static operation point) circuit is a ratio between real coefficient polynomials with complex roots, functionally describing the frequency behavior.

A pattern-matching search decides which rule applies, and at the end, the transfer function results as a two polynomials ratio. The search is bottom-up while determining the singularities, and top-down to find recursively the dominant ones.

The function of our program is threefold: *classification* - to recognize the type of singularity from the transfer function or *Nyquist* diagram; *control* – for stability; *anticipation* – to link the results to possible alternatives for improved behavior.

It is object-oriented, and written in Java. The main classes are *Element*, *Rule*, *Match*, and *Act*. The input is a circuit simulator .AC result (numerical or graphic), the output a rational function representing the approximate transfer function that describes the essential behavior.

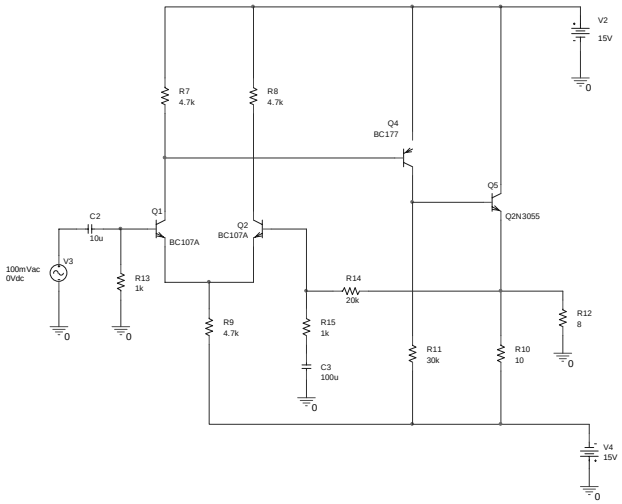

Figure 3: Audio Amplifier

For the integrated audio amplifier in Figure 3, the system finds the transfer function too "noisy", and proposes to "clean" it, by insertion of RC series group in parallel to R_{14}; further it verifies whether the capacitance can be integrated.

Freedom is understood necessity (15)
Georg Friedrich Wilhelm Hegel

7 RECONFIGURATION

Representation is a 1-to-1 mapping from the universe of systems (objects of simulation) to a hierarchical universe of models; hence, a representation can be inverted. A model must permit knowledge and manipulation, so it has two complementary parts/ views: description and operation. In a formal approach models correspond to classes and specifications to instances.

Reconfiguration continues the ideas of hardware-software cosimulation, intending to extend the software flexibility to hardware, as parallel software tries to get closer to hardware performance.

The experimented ways to reconfigurable design are Field-Programmable Gate Arrays for circuits (Rabaey 1997) and reconfigurable networks for systems (Miller 1993).

Our project extends the reconfigurability to the simulation itself. Towards a self-aware simulation to control the simulation process we build a knowledge hierarchy corresponding to the simulation hierarchy, then by expressing both simulation and knowledge hierarchies in the reference system of the basic hierarchy types we create the context for a self-organization of the simulation (H-diagram). The basic hierarchy types correspond to essential views in languages/ systems theory, being derived from the main partition of our real life.

Reconfigurable computer architectures complement the existing alternatives of spatial custom hardware and temporal processors, combining increased performance and density over processors with application flexibility .

Recursive reconfiguration of the simulation process, at any hierarchy level, is allowed by different strategies that alter one of the technique/ model/ method if one of the imposed properties is not fulfilled after applying a technique, using a model and suitable methods for evaluation and reconfiguration. The process repeats for the initial description or the one resulted from prior (insufficient) improvement.

This calls for an intelligent control system that assists/ automates the reconfiguration. The techniques use hard-soft model templates, whose methods are recursively handling the different components in the system's description. Measurement functions control the continuation process of the reconfiguration, what suggested bringing reconfiguration in the context of software and hardware, as the strategies can be expressed object-oriented/ categorical and developed/ understood mathematically. Intelligent self-organization needs consciousness to control adaptability for reconfiguration.

We try to reach this goal integrating hierarchical intelligent simulation to nanotechnology realization.

```
class ReconfigurableSimulation { ...                    (16)
void reconf (Bool tech, Bool mod, Bool meth) {
    if (tech) {technique = selectTechnique (
                                    TechType techniques);
        if (mod) {model = technique.selectModel (
                                    ModelType models);
            if (meth) {method = model.selectMethod (
                                    MethType methods);
                (tech, mod, meth) = simulation (
                                technique, model, method);
                                    }}}} ...};
```

Simulation = (*representation, goal*) (17)

Dear God, search from the Sky
and see and research this Vineyard, (18)
implanted by Your Right, and complete it
(in eternity) Orthodox Pantocrator

CONCLUSIONS

1 The types of hierarchy link comprehension to construction: their syntax relies on classes, the meaning on symbols, and their use on modules.
2 The knowledge hierarchy type offers a way to model consciousness.
3 The theory of categories offers well-suited formalism for types.
4 Constructive type theory permits formal specification-verification generating an object that satisfies the specification.
5 The first idea is to consider/ remember that reality is infinitely more than nature.
6 Recurrence is confined to discrete worlds, while abstraction is not.
7 The difference suggests searching for understanding based on mathematical structures that order algebra into topology.
8 Especially, hierarchical reflexive ideas about ideas and how to get to ideas, representations on representations, objects to synthesize/ analyze/ modify objects, and how to build/ understand representations, concern the evolutionary intelligence.
9 We follow the paradigm of intelligent simulation functionally modeling self-aware adaptable behavior to simulate intelligence.
10 Our approach for singularities determination permits the most important aspect for the analog engineer: to know and to use the dominant singularities.
11 The integration between discrete and analog is needed, for a most soft adaptability and for conscience simulation as analog reaction.
12 Mathematics contains structures that suggest to be used for self-referent models.
13 The richest domain in this sense is functional analysis ← integrate (algebra, topology, order).

Neither intelligence nor life is well understood; remember *Goethe*'s *Zauberlehrling*. More important is that emulation is less human than simulation; remember *Mozart*'s *Zauberflöte*; they should always develop in parallel, permanently exchanging experience; remember *Thomas Mann*'*s Zauberberg*.

APPENDIX: THE PURE REASON EXPERIMENT

The Faith experiment, based on concentration, search, and construction, took place in the Middle Age by spiritual and chivalrous search, mediated by Masonic buildings. The Cathedrals were the symbol of the coming *revolutions* that intended to institute the constructive Faith as basis of the human society. The *USA* Constitution and *Napoleon*'s Code witness that the prepared superior level of the human-social evolution was not any sort of capitalism.

The society is conservative – it tries to last forever at any evolution level, using a common measure. Everything can be evaluated, although most of the essential things on that our existence bases its being are not measurable. The so-called pure Reason, i.e., the context-free Reason – most adaptable, conscious only for having, intended by the tactics of the consumption society, and totally unfaithful, gives the necessary force to stagnation or even to choosing a wrong way.

Unfaithful means here that the components of the Faith (Inspiration, Intuition, Imagination) are used separately to serve the competition for the Good that makes present Life credible. However, the society is less than reasonable, whereby, the irrational of arts, particularly in mathematics, is more than reasonable, opening the way to Reality by closure to an essential and radical operation. To master the *New Power* of the continuum is beyond Intuition and Reason, if they do not integrate by Conscience and do not collaborate by Imagination and Intention. The historical experiment of the pure Reason was the necessary intellectual condition of the first, and by now – the last, social revolution.

The initial goal of this event was a reintegration of the ways to search for the Spirit from the Matter (knights) and for the Matter from the Spirit (monks). It failed because it kept the arms, the wars, and the social classes, against it had risen.

More important, the experiment continued beyond its historical limits, what created the context to renounce to human dignity in order to reduce the human mind to adaptability and to throw Conscience and Faith into facultative.

The reduction of the constructive thinking to pure Reason weakened the human mind and made possible to restrict the point of views to the most dangerous of them.

The number of alternative paths, totally different but convergent to Reality, must be 3 – the last prime number successor of another prime. The concentration of the mind on the reasonable control of the Adaptability followed the spiritual revolution, which tried to bring into individual and social conscience that the human has chosen the evolution without disregarding the Eternity or knowing the Way.

The spiritual revolution selected a primitive form of *Divide et Impera et Intellige*, to begin researching what is partially known, leaving the unknown to be approached when the first step is finished. If this intention is not forgotten, the *Intellige* is contained in the *Impera* of the unknown that has to begin after the *Impera* of the partial known, with the completed knowledge that results.

This first step was done simultaneously by the institution that pretends to serve God - (*Luther*, the knight Popes), and by the most human Reality approach – the Arts (*Rinascimento*, *Descartes*). Their strategy was human-oriented. The contradictory sentence "to serve God" had sense as long as the Church tried to simulate the human conscience.

Perhaps was its partition thought as *Divide et Impera et Intellige* for the Way – Catholic, the Truth – Orthodox, and the Life – Evangelic, but there came no *Intellige*, and all of the alternatives fell into the exaggerating "*-ism*".

Perhaps this is analogous for Christians searching a beautiful Way, Jews researching a true Truth, and Buddhists engineering a good Life.

But many of us, of any religion, and respecting the traditions, are conscious of the Way to follow, do not expect anything from a metareal God (sounds like material), and are free to laugh even of their deepest Faith. Moreover, they are able to have a good Life, just enough to concentrate on the Truth and to follow a beautiful Way.

The concentration of the society on the material component of the human existence was necessary to liberate them of inhuman problems, not to attract the humans on secondary path. Antique Greece is an inspiring model (substituting slaves with intelligent systems). The Reason experiment had to finish 2 centuries ago, when:

- The pure Reason experiment climaxed by an unprecedented number of contemporary geniuses. This proved that people has to select wisely and to construct in good understanding and courageously a society that encourages/ assists them to evolve beyond the attained peaks: *Beethoven*, *Mozart*, *Gauß*, *Cauchy*, *Fourier*, *Laplace*, *Goethe*, *Schiller*, *Franklin*, *Kant* or *Hegel*;
- The cathedral builders tried to extend their work at a continental scale, neglecting the people on the building area, whose culture did not concentrate on *to have* but godly simple on *to be*;
- *Napoleon*, a genius of the military and social strategy art, showed that a new social form, reasonable in his plans, can not be imposed by the force against the revolution had fought.

We note that a century after Napoleon Bonaparte, a German genius of strategy, Otto von Bismarck, learning form his predecessors experience, was even more successful in unifying Europe. However, this time the materialistic forces were already masters of exploiting the instabilities, and hurried up to transform Europe in a laboratory to compromise any idealistic movement. They helped the generation of these movements and directed them to terrorism. As we said, the pure Reason experiment was of the form: complete the better known part (Bonaparte) to its limits (Bismarck), to have more chances beyond the limits. The falling and remaining in materialism hurt a lot both Nature and Human. The importance of the experiment was significant, but its continuation after the results could be interpreted has killed countless people and even cultures.

Nowadays the materialism torments increasingly, threatening the future. The adaptability-based Reason can not explain or control thoughts, even if sequential is extended to unlimited parallel/ nondeterministic (equivalent). Anyway, these desired operational properties can be found mainly in the right Faith-oriented side of the mind. Further, the difference between continuous and nondeterministic sequential (unlimited parallelism) is positive. Therefore, the Reason has to be Faith-dependent completed to Intelligence. A being needs more than Intuition and Adaptability to surpass the Matter by Spirit; only the integration of Intuition and Adaptability by Conscience can explain the Human being.

A way from Reason to Intelligence is to integrate Consciousness and Intention, then further to integrate Intelligence and Faith to become *Reality-aware*. Transforming the abstraction into comprehensive construction can be the *Goal* of the Human among Humans, *unique God* for different cultures of free humans. *Freedom is understood necessity* (*Hegel*). We have to remind our conscience to integrate our mind. We have to remind ourselves that society has the duty to assist humans to live among humans. We have to stop society to be more important the Human.

This is nowadays the case, and we are on the way to live in an aunt hill/ a swarm/ a herd/ a flock/ a stud, or even a pack/ a horde/ a crowd/ a mob. An operating system serves to autonomous programs both as link to the hard as for development of the soft. Analogous, the minimal unconditioned tasks of the society are health and education for everyone, encouragement for culture and researching for any Human - conscient human. The common measure was:

... ← ***Philosophy*** ← *human* ***Culture*** ← *special* (19)
Knowledge ← *economic* ***Force*** ← *physical* ***Force***

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