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A Global Approach to Artificial Intelligence

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ABSTRACT This paper presents the initial foundations of a new Global approach to Artificial Intelligence based on the modeling of global intelligence and the development of artificial cooperative systems to support this. The research work brings numerous investigations and some recent creations to develop intelligent systems in urgent global, cooperative domains. The investigations present an overall view of current issues like true natural i.e. global intelligence. The creations include several results in global solutions explorations as well as new models, services, architectures and processes which could be of special interest for global organizations that urgently need to achieve intelligent cooperation. The major aim of the approach is to help these organizations, and other related institutions, to succeed in their complex daily duties where true thinking, more natural intelligence and new global artificial systems are required. Further, the paper provides some guidelines for the next evolutions of the work in the form of a brief, open research agenda and, some general actions for deploying Global Artificial Intelligence into our organizations, suggesting how to build new global artificial intelligent systems in real and virtual ecosystems.

INDEX TERMS Intelligence, globalization, cooperation, development, deployment.

I. INTRODUCTION

This paper provides the major ideas and fundamentals of a new *Global approach to Artificial Intelligence* based on the development of new artificial systems for global cooperation. Mainly, the paper brings six contributions to knowledge.

- the exploration of important *concepts* like, for example, ''global cooperation'' and ''true natural intelligence'',
- the foundation of a *general skeleton* to investigate cooperation following a unique, superior intelligence, relevant priorities and balanced principles of moral developments and law,
- the definition and use of a *generic framework* for new global models of human intelligence (not general intelligence) and cooperative systems to support this,
- the elaboration of new *intelligent aspects* to derive global cooperation among humans and/or systems, as well as continuously evolving, always adaptable models, services, architectures and processes,
- the definition of an open, brief *research agenda* for abstract models, computational models and possible technological solutions of global artificial systems and,
- the definition of some *general actions* to deploy global artificial systems in our organizations.

This research is motivated by some preliminary studies in intelligence and technology. This paper summarizes relevant investigations into Intelligent Systems and technology-based solutions since 1996. For example, in [1] 2006, the Generic eLearning Environment is presented as a modeling tool for large-scale cooperative systems. Further, the Learning Virtual Object Tool is designed as a flexible, open and intelligent architecture that allows universities, governments, research centers, socio-cultural entities and industries to cooperate in a globally efficient way using eLearning technology. Now, with this paper, these investigations are extended to present the initial foundations of a new *Global approach* to cooperative systems.

Basically, many interesting results in Artificial Intelligence (AI) techniques [2], [3], [4] and related application areas like Autonomous Robotics (since Brooks 1986) and, more recently, in Generative AI systems [5], [6], have been observed. However, an artificial system that truly supports

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global, cooperative intelligence has not been found yet. This paper aims to address this with the new Global approach.

Generally, significant explorations in human capacities have been conducted [7]. AI approaches based on Knowledge, Behavior [2], [4], [8], [9], and Generative AI applications [5], [6], [71] exist, but the intelligence needed to build truly global cooperative environments is missing. There is an urgent need for new ideas and developments, particularly from a cooperative perspective. The individuals and systems need to naturally cooperate in complex situations [3], [10], [11], [12]. And, if we want to succeed with these cooperative domains, we will have to focus on true, global intelligence and the way to support this for moral, truthful developments. This will allow us to accommodate pure intelligence while achieving moral and ethical behaviors across lawful cooperative organizations. In addition, the integration of AI systems within societies has many legal limitations and appropriate jurisdictions have begun to propose AI regulations, for example, in Europe. As we shall see, the proposed Global approach to AI starts at high-level abstractions where these limitations are widely considered. For example, it is important to underline the fact that Global AI is not General Purpose AI. The term ''global'' is used here to mean ''global cooperation'' as the ultimate objective. Further, the work looks at ethical and moral concerns that are also important in current AI regulations. In doing so, Generative AI systems integrated within Global AI systems shall also be scoped.

This paper presents the key fundamentals of this Global approach to developing human-integrated domains where natural intelligence, true values and global cooperation are required. The work shows most original ideas of the authors to build new intelligent aspects for global systems, from several perspectives that are relevant to our human needs. Further, this paper proposes a generic framework [1], [2] for *global intelligent systems*. This framework can be used either in isolation or in combination with current, regulated AI techniques. And its generic elements can be merged too.

As an example of an initial examination of the approach, this paper describes a new set of *models* (generic, computational, operational), *architectures* (global networks) and *processes* that could be evolved and/or adapted to support true global intelligence. The core features of these new flexible *development elements*, underline most of the foundations of the proposed Global AI approach. For example, the models incorporate high levels of intelligence based on mind theories [13]; not only decision-making or problem-solving models [5], [6]. These are mapped into lower-level architectures and processes incorporating, for example, machine learning architectures. Indeed, the generic elements of the approach can be designed down to computational models based on system behaviors, knowledge structures and generative models. The application of these development elements is encouraged in this paper to model and build new intelligent systems in urgent global cooperation.

This year, the evaluation of the Global AI approach has been initiated by running several investigations and publications. Foremost among these, are [68], [69], and [70]. In the first publication, substantial demonstrations have been provided in how the models and architecture characterizing the initial foundations of Global AI can be used in global learning-oriented cooperation and, more particularly, to advance progress towards the achievement of Sustainable Development Goals. In the second publication [69], a management model has been incorporated to develop global intelligent systems in sustainable education. This reference provides a detailed methodology to develop and manage new global intelligent systems. Indeed, the proposed management model, as suggested in [69], is designed through several abstractions and refinement processes that underline the feasibility of the Global approach. Finally, in [70], current Digital Library Systems have been initially evolved as global intelligent systems that can be developed through the proposed models, services, architectures and processes. This research work adds new cooperative insights into these systems from high-level models that are designed down to software architecture, incorporating new AI-driven services as well as cooperative system behaviours. Further, the work is tested in sustainable education demonstrating how Global AI can be used to cooperate with developing countries, according to urgent ethical and moral values.

As a next step, this paper discusses a preliminary, open agenda with general research objectives based on abstract models, computational models and possible technological solutions for new global artificial systems. This program includes widespread investigations to integrate key insights from AI, thinking in natural, globally oriented terms of development. Furthermore, the research agenda suggests how to guide future investigations around the development of new global artificial intelligent systems. This paper also proposes a general frame of action to deploy these systems in our organizations.

Finally, this paper presents some future research work based on the realization of these general investigations and actions into governments as global organizations.

II. RESEARCH OBJECTIVES

The main objective is to initiate a new Global approach to AI to support true natural intelligence (global intelligence) and new human/system developments for global cooperation. Other, more explicit goals for this paper are as follows.

1. Summarizing general investigations around AI, global solutions, cooperation, etc. (see section III).
2. Establishing the major necessities, designing elements and development rules for new human/system developments to support true natural intelligence, as widely described in sections III and IV.
3. Presenting some general ideas to investigate and support true natural intelligence in our organizations, as summarized in sections IV and VI.

4. Exploring new aspects and organizational principles of development for global environments (also described in sections IV and VI).
5. Defining cooperative principles of development for the global systems and/or organizations, as suggested in section IV.
6. Helping to improve human behaviors and thinking through the proposed frameworks to achieve a "cooperative mind", as described in sections II, IV and V.
7. Introducing new fundamentals for artificial techniques with global processes/services, also introduced in section V.
8. Defining an open research agenda for future investigations (section VI) to provide more detailed frameworks for Global AI.
9. Defining a frame of actions for global artificial systems deployments (section VI).

With objectives 1 and 2, this paper establishes the most general aspects that support the creation of new artificial systems to support true natural, global intelligence. And the authors hope that they provide sufficient arguments to understand the necessity of a new Global AI approach. Indeed, they summarize new human/system developments that are required to support true natural intelligence. Further, they provide major design elements and development rules to start with this new approach. Although new investigations, principles and rules will be required to advance the approach, as the paper suggests with the open research agenda discussed in section VI.

With objectives 3 and 4 the presented research work concentrates on the foundations of this true natural intelligence for our current organizations. These investigations will also be extended with the proposed research agenda outlined in section VI.

In objective 5, the investigations pursue to outline some of the foundations of the approach for the suggested global systems.

The objective 6 is a general goal for all the research work. And the authors hope that, mainly, with the general investigations and ideas summarized in section III, they have contributed to reinforcing the need for a cooperative mind for current global issues. Further, they hope that future investigations with the Global approach will help this cooperative mind with new global intelligent systems.

The most artificial aspects of the proposed developments are outlined in section V as part of our objective 7. These fundamentals for artificial techniques incorporate models, architectures, services and processes as flexible elements for global developments.

Future investigations, in the form of a research agenda, and deployment actions for global systems are the latest objectives. With both objectives (8 and 9) the research work tries to organize how the proposed Global AI approach can be advanced.

III. GENERAL INVESTIGATIONS AND IDEAS

After years of investigations into AI and real technological systems, it is possible to conclude that there is no global, cooperative approximation in current developments. So, the research work presented in this, and other related papers like [68], [69], and [70] concentrate on creating a new Global AI approach to support this intelligence. The following sections summarize some of these investigations.

A. ARTIFICIAL INTELLIGENCE

There have been many successful applications of knowledge and behavior-based approaches to AI (see an evaluation of the progress made in, for example, [8], [14]). Current practices can be found in many areas like computer vision, machine translation, prediction, distributed control, cognitive robots, natural language processing, speech recognition, machine translation, game playing, estimation, automated vehicles, etc.

Most of this extended research work has been dedicated to the implementation of some well-known techniques (e.g. Artificial Neural Networks, Genetic Algorithms, Fuzzy Logic, Expert Systems, etc.) and the application of Data-driven modern methods (like Machine Learning and Deep Learning) which appear to operate well in small domains, with large amounts of data.

Behavior-based control, for example, currently solves some cognitive and adaptive processes (to changing conditions) of living organisms based on simple designing principles [15], [16]. More complex levels of intelligence and environments have been tested using evolutionary and learning methods [3], [17], [18], [19], [20]. For example, in healthcare organizations, new mastery learning techniques have been used to minimize the variation in the outcome of the learner, improving the consistency and efficiency of current care systems. There are also new master algorithms which appear to perform all types of learning tasks [3], [20]. And, more recently, the knowledge approach has substantially evolved with the Generative AI that has "the potential to transform domains and industries that rely on creativity, innovation, and knowledge processing" [5]. However, neither the applied techniques, nor the methods, nor the type of models that are being investigated seem to be focused on the true support of *global, cooperative intelligence* needed for urgent *global cooperation*. And this global, cooperative intelligence must be true and natural since it is motivated by the most factual values of humans, considering how they naturally think and behave. Further, this global intelligence (not general intelligence) must be represented in our superior abstractions and modelled down to computational models, architecture and processes to support such abstractions.

Current Generative AI uses computational techniques to generate relevant content like text from training data. And this work is evolving, without any doubt, the way we (humans) work and communicate with each other. These new systems

can be especially useful for artistic purposes and critical thinking. In fact, their integration seems to be ''crucial'' for teaching future generations of students in higher education. For example, [71] examines some concrete adoption strategies discussing major benefits and gaps. And [73] also argues major benefits like ''technological scientific knowledge'' and ''socio-ethical technical understanding'', suggesting a new framework for incorporating AI literacy into technology education. Further, [72] argues that we live in a ''AI era'' where collaborative thinking can be improved with AI learning tools although more investigations are required to adopt these tools in primary and secondary schools. More generally, Generative AI systems can be used, and will be used, for implementing intelligent question-answering systems, replacing millions of jobs of knowledge workers.

The proposed investigations in this paper care about more human capabilities to communicate; not only question-answering approaches. Further, they care about the type of intelligence that maintains current activities and jobs. This is, top level, superior intelligence prior to any system integration and/or adaptation.

B. SUPERIOR AND INDIVIDUAL INTELLIGENCE

The existence of a *unique, superior intelligence* suggests that this should only be adapted to our systems to ''some extent'' so there is not human replacement. And this superior intelligence represents the superior abstraction for the models proposed in this paper since it is the major motivation, and a top-down approach is used. Further, *individual intelligence* is considered here as a low-level set of capacities. In the proposed models, superior intelligence is approximated as a global network connecting all individual intellects. This research work supports global models where all the participants can reach high levels of intelligence (morality, ethics, etc.) by means of cooperating with each other. All individuals must interact with each other to have global intelligence. And the intellects differ from one to another in specific, lower capacities like knowledge-oriented and behaviour-oriented ones. Then new global artificial systems must support this intelligence.

C. KNOWLEDGE, BEHAVIOUR AND MORAL WISDOM

The history of knowledge representation, and of cognitive psychology in general, has been very successful. The concept of knowledge occurs in many locutions like, for example, ''knowing how'', ''knowing who'' or ''knowing what''. And most attention has been paid to propositional knowledge. The type of knowledge that has been transferred to first, classical AI systems like Expert Systems. These systems incorporate internal representations of the outside world known as ''knowledge'' and provide answers based on this.

This knowledge-based AI cannot resolve real adaptative processes based on changing conditions; the behavior-oriented nature of intelligence approximates more ''reactive'' systems using cognitive and biological models as well as data-driven methods [14]. Indeed, behavior-based systems do not use representations of the outside world [9].

By contrast, this paper proposes an adaptive definition of global intelligence based on *moral wisdom* i.e., an intelligence based on essential virtues for having morally good experiences; a pure conception connecting the individual with his/her interior formation. This intelligence takes care of the individual and his/her group for social goods, for global cooperation, as it is generally introduced with the Global AI approach presented in this paper.

D. GLOBAL CAPACITIES, MORALITY AND ETHICS

Gardner [7] infers multiple intelligences. This author identifies, for example, musical intelligence as the ability to understand and produce music. In the moral definition presented in this paper, all human abilities are organized toward humanitarian goals. Intelligence is ''wellness''. This paper searches for the development of global capacities that are relevant to human enhancements. For example, as we all know, goodness enriches being. And *conscience evaluation* keeps the form of interaction. When we evaluate our conscience, we model the form in which we interact with others. There is no form without ethics. The overall performance of the human being internally evaluates in conscience and externally produces in behavior with or without using any kind of knowledge. The type of behavior that can be evaluated and partially registered to be supported by the system without any replacement and/or control.

Further, with our superior, cooperative intelligence, our ultimate objective is living as part of a community. Having global intelligence does not mean solving problems or listening to music. Moral behavior is intelligent. It means social adaptation in real, constant evolution in the outside world. And this intelligence is unique and true. There is only one single, global intelligence and we can all communicate through our capabilities. In fact, our capacities improve when we see ourselves as part of a global system; when we reach the top global levels where we are all connected to each other.

Our thoughts bind us to others. Our mind enjoys positive thoughts. We do not usually reason for this positive thinking. This is natural to our way of life. And we trust the moral conception of intelligence for living and communicating with others. There is no intelligence without morality. Further, this intelligence needs a form. The intellect evolves in having a form. And this relates to moral behavior and thinking too. It is merely distinguished by rigorous, non-flexible actions and integrity, as we claim with our politicians. Indeed, the moral form inspires secure and efficient intellect in humans ready to behave in the global community. And we cannot replace this moral form and thinking with artificial systems (we should not). But we can develop artificial, cooperative systems supporting those intellects as part of a global community.

Nowadays, global networks in society ''produce large virtual experiences'' [21]. Only true, moral intelligence can find the reality out of these. This intelligence reaches,

at a superior level, true knowledge of individuals and their organizations. Thus, real society (humans) can rely on it. We can only trust natural and artificial networks built on true intelligence. And these true values are truly relevant for cooperation. We cannot cooperate unless we trust each other and our systems.

E. GLOBAL COOPERATION

Global cooperation is a complex issue, and collective actions are ''difficult to achieve'' [20], [22]. People cannot simply achieve global cooperation based on ''good intentions''. Social, cultural and language differences between humans/systems may cause many difficulties. And we cannot observe our biology to understand and develop our true ''cooperative nature''. Biological models, like Neural Networks, are not sufficient [20]. We need looking into human relations, global behavioral capacities and thinking. In doing so, this paper claims numerous individuals that globally act together to produce shared outcomes. Indeed, global cooperation requires that humans acquire (learn) special, global capacities to construct positive collective actions. These abilities involve, for example, establishing shared objectives and collaborative activities. Further, this cooperation requires specific *regulations* to appropriately coordinate this global activity. Thus, classic information values (symbols or knowledge) can facilitate global cooperative mechanisms.

Current cooperation appears to perform well in ''small domains''. This means, ''small groups under simple conditions''. Ratner [42], for example, comments on 4.000 co-ops in Cataluña with an average size of 10 members. By law, these cooperative systems must assign 10% of their profit to educational expenses, and 30% to the enterprise. They are ordered into second-tier organizations which support individual co-ops. And their overall cooperation generates ''trusting and responsible behavior''.

Large global systems, however, lack the arrangement that is suitable for collective tasks design. These systems are used in, for example, *peace consolidation* environments where cooperative relations are difficult to maintain, as we discuss later. Because ''each part of the world has its own laws and rights'' [23]. Co-ops cannot validate their functioning in large, global situations.

Global development requires ''collaborative skills with distant institutions'' [20], ''cooperative methodologies'' from collective actions [24], from the ability of the individuals to work with each other. It involves large environments where cooperative intelligence is needed to confront the ''problem of globalization''. In collaborative design, for example, multiple individuals can coordinate their tasks and share information across their organizations.

F. TRUE INTELLIGENCE AND GLOBAL GOALS

True intelligence also thinks globally. We live in a global era; living and thinking cannot be pursued individually. Indeed, individual autonomy has been recently replaced with ''universal human solidarity'' [25]. Now humans have ''collective identity''. We must behave thinking in ''the good of others'' [26]. We all have ''humanitarian responsibilities'' [27], [28], [29]. We are all morally and ethically obligated to ''advance human rights satisfaction'' [30], to perform moral behaviors improving the conditions of others and, to compensate (eradicate) the negative consequences of some of our actions. For instance, nations have now legal duties to protect people from violations of human rights beyond their borders [31], [32]. These extraterritorial obligations emphasize ''international actions'' in response to the crime of genocide [12]. Most states adopt rights ''terminology'' into their ''domestic legal systems'' [33] and the overall human rights performance of these countries is measured and analyzed for social good [34]. UN plays a prominent role. This international organization treats all people living in the world as world citizens with the same rights. Further, nations are committed by the UN to new global partnerships, strategies and goals (like the Sustainable Development Goals) to reduce extreme poverty and hunger.

National governments and the private sector are now involved in addressing the needs and assessing the progress of developing nations. There is a global development agenda for all countries [29], [30], [33], [34], [35], [36], [37], [38], [39]. There is a global focus on poverty eradication [26], [40] and general development [41] since the basic needs of every human (e.g., education) must be catered. However, public awareness on these global issues is not high. A major ''global concern'' would place such problems into the political agenda and national strategies of all countries. And the success of these possible interventions depends significantly on the information that is provided to the individuals.

There is a clear need for new approaches to communicate the integration of developing nations into the global economy. These approaches should motivate more and more individuals to donate to charities [26] using effective moral behavioral techniques, as this paper proposes.

The links between ''common property and equality versus private property and inequality'' is the core of the ''political cooperative movement'' [42]. The new era, however, requires ''a new kind of politics'' focused on moral principles. We have ''a moral responsibility'' to commit ourselves to the common good [43]; to generally orient ourselves towards solidarity. And this common good is merely social, true and natural. Humans are relational ''in nature''. Indeed, humans are inherently social. Further, humans' destination must be the global community where to behave safely, where to think in common good with true and natural values, and where to act for the good of others.

The recent global orientation involves also the overall functioning of the community. Human activities are now globally oriented and based on social cooperations and cross-cultural communications. The new relationships among the individuals are now governed and managed by a ''web of duties and rights''. Duties are obligations in this global

domain. Rights are ''universal statements'' (fundamental elements of morality) that represent and protect ''goods and values'' [10]. Every human has now duties as a member of a global community. Every human must respect the rights of all individuals. No one can reject the rights of anyone (e.g., the right to be ''treated with humanity and dignity''). And everyone has rights just for being human *within a society*; no matter where you belong to.

G. CATHOLIC THINKING

The family, the society, the community and, more generally, the *moral order* are relevant components of the *catholic thinking*. Humans, rather than being autonomous, as recently approached and promoted in AI, represent organizations like families and societies. And this vision has been widely considered at the UN and related organizations for human rights statements [44]. Societies result from natural evolution of human societies around the world. And their moral development orients appropriate social behavior. This behavior ensures how to follow the laws and principles, how to obey the rules, and how to fulfill the regulations.

The Catholic Church (the ''total'' church) drives moral order to a population that is globally representative of the world [45], [46]. Catholics globally and faithfully believe in true and moral values. And this same truth brings supreme intelligence to our living, thinking and working. All the moral meaning and ethical norms derive from this. The *catholic morality* comes from the general comprehension and application of the definitive principles and values of Christ' s life. The moral codes arise from the general acceptance of certain principles that govern the Christian Church [47]. They are general directives with true value for human behavior. The catholic teaching calls to protect ''human life and dignity'', to defend the ''poor and vulnerable'', to promote ''global economic prosperity and environmental responsibility'', and to work toward a more ''just society and a more peaceful world'' [43]. Moral principles like rectitude, integrity, honesty, dignity and service are also ethical rules of universal comprehension and application. They are codes of moral conduct which apply to individuals, families, communities, nations, etc. The *ethical values* compel people ''not to kill'', ''not to steal'', ''not to rape'', ''not to commit perjury'', etc. These values have the effect of limiting each individual behavior within the community. They help in formulating general policies for human relations and for living on the globe. Non-violence, for example, is a major ''ethical principle'' [25] for living and solving conflicts, as this paper discusses later.

The human being is ''free'' to choose. We can judge our own actions. We are all guided by our conscience [46]. And we must instruct this through proper virtues and models, including intelligence models. The moral beings can reach the superior intelligence levels demonstrating in, for example, ''hope and charity'' [46]. Indeed, the most valuable forms and skills arise from the ability to think and act in terms of morality, faithful feelings, common good, etc.

A superior model, in the proposed Global approach, is intended to be a moral form. Only natural, moral models are complete, as we can all observe in our global world. Artificial models cannot be complete. They cannot substitute complete models. And we must consolidate moral aspects of intelligence with our models and systems. We must build artificial systems to support true moral models in a global world.

H. GLOBALIZATION AND TECHNOLOGY

Globalization also influences science and technology. Although the work has not been the same in all countries. ''Many conscious efforts have been made to transform research and development'' into global work [48]. Many nations engage in large scientific cooperation and sharing of information. There are many researchers in the global community who interact through numerous efforts. And the general level of technology is also advancing globally. The industrial era has been transformed in a ''global era''. The world has changed, and continuously changes, through technology. Many innovations have ''global impact''. For example, service orientation and related web standards facilitate ''machine to machine interactions'' [49]. Current service compositions achieve collaborative tasks and service-oriented architectures apply to ''cooperation among virtual organizations'' [19]. Many industrial systems are ''shaped'' by these and many other technologies [21]. Furthermore, technologies currently contribute to global economic development. There is a global society-technology interaction. Global development is possible and technologies ''help''. Many organizations benefit from technology. Information, communication and supporting technologies play a ''key role in poverty eradication'' [50]. They support the development of individuals and their organizations. They can help solve social problems in all parts of the world. They facilitate the integration of developing countries into global markets. Technologies can improve sectors such as healthcare and education. They can help individuals to access adequate health services and general education facilities. Technologies assist health workers to diagnose and treat diseases. They help education professionals to provide better learning environments for students. They allow the sharing and gathering of knowledge in large environments. They play a major role in teaching, learning and research. Further, technology can bring governments, companies and people together. The cultures ''largely meet in the cyber space'' [23]. The current global networking of machines leads to new social interactions and innovation. And many other technologies like recent social networks have been developed as human-oriented solutions. Although there are also abundant attempts to replace humans with machines, like some current developments in AI with Autonomous Agents technologies.

Society must control these technological changes all around the world. Governments, for example, are involved in setting global standards for current technologies. But the competition among these standards results in many incompatibilities between nations. There is no uniform technology for all. Although the modern information and communication revolution allows global convergence to some extent. Indeed, current technologies developed in one nation can spread to some other locations like developing countries.

The Internet is used as ''a global platform of people, computers, networks and devices'' [51] where long-distance collaboration takes place ''broadly''. The current formation of global web societies results from ''mutual interaction, exchange of knowledge and sharing of values'' [23]. And sciences and innovations also distribute across social networks. Current technologies and global systems like the Internet support this.

I. GLOBAL WORLD ISSUES

The world issues are ''global'' too. The global financial crisis is one clear example. This crisis and the world economy (global economy) have made a negative link between finance and growth. In this global context, cooperative banks (who believe in ethical values like caring for others) perform better than ''commercial banks in absorbing the financial crisis shock'' [5]. But more research is needed for these banks. And there are many other global issues. The effects of technology use, for example, provoke unforeseen benefits as well as damage. Cyber criminality is a ''global threat''. There are also many problems to incorporate learning technology in the educational system of developing countries. Technologies are beyond the reach of many countries. Access to technology is still ''expensive and unreliable'' in many developing countries [50]. The costs of appropriate equipment and resources are still too high for the poor. Further, current globalized knowledge produces irrelevant information too. And current virtual environments and AI data-driven methods lead to new types of ethical problems like ''intrusion upon privacy''. Indeed, the optimal and secure ''functioning of global virtual communities is vital'' [23].

More importantly, there are ''social problems like racial discrimination'' [52] that are provoked by global actions against human rights. And the current UN system and related courts have many limitations to help these victims. Global governance [53] confronts several gaps (e.g., lack of resources) to solve on-going global problems [54]. The need for a human rights reform is clear [38]. The UN system should be improved through the ''deployment of transformation methodologies'' in governments, businesses, etc. ''A global court of human rights is needed'' [36]. A general institutional type is required for current sub-national human rights efforts [55]. The international approach to human rights protection is insufficient without ''strong legal systems'' [33]. The legalization processes put ''human rights conventions into practice''. And human rights must be embedded ''across business operations'' too [39]. There are no appropriate integration processes of human rights into standard business models and technologies. Current *human rights law* requires a ''relevant role'' in the global financial sector.

Further, globalization has changed human rights duties [27]. Now we are all ''causally interconnected'' through social networks and have special obligations. We must effectively ''benefit and protect the poor''. But there are many global issues in developing countries [40]. The healthcare system and the education systems, for example, are very limited. There are very few trained professionals and volunteers and, information is insufficient too.

Global issues such as the war on terror [56], [57], ongoing conflicts [31], [58], corruption [59], and climate change [27] affect society worldwide and need global solutions too. The armed conflicts have deteriorated economic and social growth globally. The terrorist attacks 9/11 triggered global economic catastrophes. And, when the world was still suffering from the dramatic consequences caused by the Covid-19 pandemic, Russia launched an invasion of the territory of Ukraine provoking multiple human costs, devastation and a new global economic crisis. Indeed, this invasion has caused an enormous security crisis and profound ''socio-economic implications for Europe and beyond'' [58]. The Russian aggression against Ukraine has damaged nations' sovereignty, and global *peaceful cooperation*. And Europe has responded with several sanctions against Russia. Further, there has been a ''multi-level cooperation in supporting Ukraine during the war'' [32]. But more global cooperation to solve this conflict must act urgently.

The Israeli Palestinian conflict also escalated with an attack by Hamas against Israel in 2023. This tragic event resulting in the loss of thousands of civilian lives, and subsequent bombing of Israel in Gaza, scaled into a regional conflict in the Middle East. And this ongoing conflict provokes numerous violations of international human laws, suggesting the urgency of finding a *stable peaceful resolution* as soon as possible. Indeed, the global cooperation of the international community needs to be involved in trying to stop the suffering of the people in Gaza [31].

In corruption, the proportion of bribe payers seems to be higher in poor communities. The ''abuse of public office for private gain'' [59] is high in poor countries. And the negative effects of climate change especially hurt vulnerable sectors in developing countries. Further, we live in a world characterized by dramatic differences. For instance, ''gender equality'' is a global issue like race, class, religion, color, disability and many other social attributes. There are also global disparities in having access to the internet and other technologies like AI. There is clearly a limitation in terms of information access, computer equipment and energy sources in developing countries. Healthcare and educational facilities are also very limited in ''rural areas'' [50]. And political elements obstruct progress in all these global issues. The

educational sector, for example, has received low levels of political support and management. The proper governance of the healthcare system is a major necessity for many countries too. Indeed, current governments have a key role in devising policies that respond effectively to these needs [60]. Further, the international community needs to ''correct the global situation''. External pressures are needed to become ''morally enhanced'' [37]. We must bring civil society to one global, common platform without differences. And, for this aim, this paper proposes the development of global networks of intelligence (built on humans and systems) with *cooperative duties* (including global actions with poor countries) for all its members; *cooperative networks* supporting global intelligence.

J. COOPERATIVE NETWORKS AND SOLUTIONS

Cooperation through nations cannot be achieved due to ''the lack of a central government'' [22]. The global network of nations is highly distributed. International cooperation is a complex problem due to its complex institutional network. Indeed, ONU currently works and acts as a set of ''autonomous agencies and organizations'' having their own institutional dynamics. And the world is too large and too complex to admit a single global organ like ONU. The world now requires multiple *global organizations* for creating, managing and supervising cooperative programs and strategies. But there cannot be a global government for these organizations. They must build their own *global solutions* for complex problem domains like, for example, peace consolidation, integral development of poor countries or social justice and human dignity.

In this international scheme, global organizations and nations need interacting and cooperating with each other. The networks of global establishments and states can influence each other in a positive way. And these interactions can have a global impact over the structure of the international system. So, there can be more inter-connections among the networks involved. The problem is that these global processes can transform the existing social relationships, making the nations internally and externally governed by multiple institutions. And this problem makes the international system behave through complex cooperative patterns.

Thus, the global solution for nations and organizations is not eased to foresee. The actions and interactions become richer. But the resulting *global interactive environment* cannot admit of a single methodology. The international system requires rapidly adapting to the global circumstances and issues, as a kind of reactive system, so that new lawful mechanisms are possible. Thus, this paper proposes to model national governments as global organizations with adaptive laws and behaviours based on formal methods and principles. Further, this paper suggests designing these governments into global networks of intelligence, so they adapt to all the interactions and needs.

Global systems cannot be easily achieved. It does not matter the kind of technology that is being applied, nor the type of infrastructure that develops faster in each problem domain. Today information is widely available thanks to technology and AI. But most of these systems are not sufficient for global domains. For example, cooperation through Internet-based systems only ''extracts and delivers knowledge'' at a global level [51]. There is no dynamic system behaviour approach in this consolidation.

Business intelligence currently promotes enterprise value creation in collective and cooperative ways. And service orientation facilitates this outstanding cooperative work among organizations. Reference [19], for example, provides a technology to govern system cooperative behavior based on regulations for virtual groups. However, a human-centered solution is necessary in thought of ''the complexity of cross-cultural collaboration'' in real world domains [23].

Therefore, global (cooperative) solutions require more flexible development elements like new models, architectures and processes to support true natural intelligence with our systems, as this paper describes later, once the Global AI approach has been introduced. And thinking about this long-term objective, this paper initiates several research programs analyzing ''global intelligence'' in global domains.

K. LARGE-SCALE DEVELOPMENTS

There are many scalability issues that make large, global developments difficult to foresee [2], [14]. Indeed, a substantial number of intelligent systems become unwieldy as the number and complexity of their architectural elements increase. And this leads to major difficulties in the final operations of the artificial, computational models and related architecture. The systems cannot complete complex tasks where changing (always evolving) situations are the ultimate conditions to prior developments. The underlying engineering solutions need to adapt to the demands of truly complex situations. And this artificial capability can clearly benefit the advance of new intelligent systems in global domains. However, this does not seem to be the major issue in complex cooperative intelligence.

L. RELATED RESEARCH WORK

Previous investigations of the authors were focused on fuzzy control architectures and behavior-based maps of interactions [2]. Further, they designed many technology-based solutions to generally improve ''human efficiency''. But this is not the kind of intelligence that the global world is lacking. We must believe in the unique, superior intelligence as the only way to help humans to ''develop'' themselves and to complete their activities by means of ''understanding'' natural ways of development. We must think about ideal environments where humans can be naturally and globally intelligent; where the superior intelligence can reflect globally; where humans and systems can intelligently and globally cooperate. And here is where we can certainly approach new AI techniques in a global manner.

Nowadays, the authors of this paper explore large heterogeneous networks of humans and systems that need to be trusted to deliver their major capacities, not all their capacities. But this *faithful environment* cannot be easily achieved. Thus, they have decided to focus the global solutions on helping humans and systems cooperate with each other in natural ways. Then they have started to observe how behaviors and thinking generally adapt to the demands of complex (changing, constantly evolving) situations.

The authors of this paper miss true intelligence in many different fields. And they would like to help to resolve these major necessities too. Indeed, their aim is to approach Global AI by means of supporting what they understand as the core foundations of true natural intelligence: truth, morality, ethics and law. The major level of support for this intelligence relies on thinking as a superior mind-oriented abstraction. Further, they would like to help human intelligence with their superior frames, designing new global knowledge structures and lawful cooperative system behaviors [2], [4].

In 2006 the authors of this paper created some generic *learning-oriented environments* for intelligent cooperation, and they coined new solutions for intelligent management. Now they extend and summarize some of this work, proposing a global framework with clear, world-wide objectives. The technological solutions have not inspired them to do so. They have seen how ''low level details'' perform rapidly in many technologies (e.g. programming languages). However, these symbolic solutions do not support true natural intelligence. Although similar technologies could be relevant for global system developments. We must consider human needs, modeling the system at the right level of abstraction. And we can be now at a ''high abstraction'' to be able to support true intelligence while modeling the global systems.

Finally, the authors of this paper have investigated the *inherent complexity* of global, heterogeneous organizations. They have described what the organizations could be, and how the functioning of such entities could become ''intelligent'', according to their upper-level abstractions and general procedures.

IV. GLOBAL ARTIFICIAL INTELLIGENCE FOUNDATIONS

The main intentions of the Global approach to AI are three:

1. providing a common context where to solve current artificial intelligence limitations for global cooperative domains,
2. helping individuals and organizations to develop true natural, global intelligence and,
3. facilitating new intelligent mechanisms to support urgent global cooperation.

A. ARTIFICIAL INTELLIGENCE LIMITATIONS

In general, AI limitations are global too. Matters of this field like learning or reasoning are not isolated. They relate to each other, as we observe with human intelligence and its underlying aspects. Indeed, knowledge-based and behavior-based approaches to AI cannot be separated. Both approximations are valid and complement each other [2], [14]. And global intelligence, as opposed to autonomous, individual intelligence must be supported. For example, collective intelligence must be supported by social networking in a cooperative mode [51], [61]. And with this collective intelligence, the individuals can coordinate themselves to achieve common goals. However, this paper looks at global capacities from the interior formation and not only from networked coordination. Swarm behavior has also received much attention in the ''global aggregation of natural species'' [16]. Indeed, swarm intelligence produces collective problem solving for the species. But this paper also looks at individual moral behaviours being reproduced within the global community. Further there is a global necessity of collective support for individual intelligence. All computers are globally connected in a diverse world for individual users. They affect each other in a global manner. They form part of a distribution systems approach. These artificial systems need to operate together [49], [62] and, as it is argued in this paper, to behave properly for global cooperative purposes based on current human rights and duties. Indeed, there are current interactions among these systems that require sustenance from a broader, global perspective built on many technologies and techniques. And this is the viewpoint this paper wants to approach want to approach together with cooperation.

B. SUPERIOR INTELLIGENCE ABSTRACTION

Global institutions and possible cooperative links have been investigated for this paper based on our unique, superior intelligence. Basically, this intelligence reflects on every human as a flexible composition of abilities driving individual moral behaviors and thinking. There is one single intelligence and we all (individuals, nations, organizations, institutions, etc.) form part of it. And it is possible to discuss that this global network of intelligence is single. The reflections across individuals differ from one to another in specific skills and gifts. Thus, the superior intelligence manifests at different levels in different people. And all these levels interact through an organized structure of knowledge and system behaviour: the lower-level structure supporting superior intelligence.

The proposed Global approach works with unique, superior intelligence abstractions and the natural way to support these. This approach maps higher abstractions into lower-level aspects of development among ''human'' and ''system''. For example, it seems clear that human and system must be ''engaged'' in such a way that the system supports the internal mechanisms of the human needs. And, in cooperation, this is approachable at first from non-physical and non-biological abstractions based on pure intelligence.

C. MODELLING TRUE NATURAL INTELLIGENCE

True natural intelligence helps to approximate the truth of naturally inspired systems. According to the investigations summarized in this paper, there is no psychology involved in

this type of intelligence. The natural system thinks and acts in pure terms of intelligence by means of truthful (factual) mechanisms from superior abstractions. Nature abounds in physical laws. And in following these, the behavior-oriented approach has captured the physical meaning of the actions since its initial Action-Selection Mechanisms introduced by Maes. However, there is no physical model included in the natural solution proposed here. Superior abstractions occur in mind-oriented processes that naturally connect the individual with the environment and with other individuals. And there is no biological interpretation in these interactions either. The biological model is not supported at first abstraction in this paper.

Recent studies such as [61] suggest that a focused mind naturally identifies and conveys the true meaning of communication, leading to adaptation and cooperation. Individuals often adapt to their environment and cooperate with others. And the collective mind (represented in [61] with conceptual foundations from cognitive sciences) increase cooperation among co-attendees.

So, which are the laws governing this true natural intelligence? There are no physical laws and/or biological mechanisms directly involved. The natural meaning comes from human conception. And this notion brings the laws. These are the rules that naturally regulate moral behavior and thinking since the initial conception of the human being. Thus, knowledge and behavior occur without psychological models. Indeed, the overall structure of these laws is innate to our natural way of thinking and acting in our society. For example, we naturally think positively about our social relations. And the negative anti-structure is not natural to our conception. It does not belong to our nature. So, it is not located at a superior level, at the first abstraction of the proposed models.

Further, it is possible to assume that true natural intelligence demonstrates in moral forms, as initially introduced in our investigations (in section III). Any behavior acquires simple and complex forms. Evolving and evaluating in conscience keeps the moral form. Indeed, thinking does not need to supervise at the level of moral action since this action is close to the superior frame.

These investigations explore how natural behaviors and forms are generated. Some of these behaviors are linked to thinking and action. Others are related to intentions. Humanitarian people, for example, have good intentions and provide good examples of moral behavior. And we promote these with our global, cooperative models. However, a moral base is needed for any behavior integration. Indeed, moral behavior is fundamental to human security. It governs itself through secure statements. Further, moral behavior is essential to human development. It inspires any model for supporting global, cooperative intelligence, as it is proposed with the initial foundations of the Global approach to AI.

As is observed with these investigations, true thinking makes a factual response around us. We all move in our surroundings looking at others. The factual response, however, is not achievable unless true natural intelligence completes. Then we respond, and respond safely, in our thinking abstraction; the abstraction in looking at others' responses. And in moral behaviors consecution, this response is factual according to our thinking abstraction. The kind of abstraction that we cannot substitute with machines.

In looking at others, factual responding evolves from our moral behavior. The factual thought shows either positive or negative reaction to external consideration. The true positive response acts as a general assertion upon acknowledgement. The true negative reaction demonstrates a denial response.

D. GLOBAL COOPERATION AS A GOAL

Global cooperation, as suggested in section III, has the potential to eliminate and prevent conflicts worldwide like bombing in Gaza, ensuring peace in, for example, Ukraine territory, and promoting human security. Achieving this goal requires a comprehensive organizational transformation that goes beyond traditional reforms [42].

Ratner [42] proposes constructing cooperation at the macro perspective; first, looking at cultural institutions as cooperative enterprises. This author argues that people in the organizations need to develop macro cultural, norms, principles, rights and obligations to address sharing and responsibility. Further, Ratner [42] suggests that ''developing cooperative psychology is vital to developing a cooperative society''; that a collective psychology must be ''cultivated'' by a cooperative system. And this psychology consists of ''motivation, perceptions, cognitions, self-concept, emotions and memory that animate cooperative behavior''.

Cooperation is not an easy duty when humans and/or systems do not ''share'' objectives. Most of us have learnt how to cooperate with some achievable tasks. But global cooperation can only be intelligent when the upper-level behaviors and thinking become similar, when thinking connects safely through lawful tasks. Thus, this paper proposes a new approach to define global models in such a way that ''cooperative intelligence'' is considered at first, as a high-level thinking abstraction with lawful tasks.

In this global approach, we can ''cooperate and learn'' at the same time. However, this is not always the case in real, complex situations. Some of our mental processes seem to develop from natural situations where there is no evidence of learning and/or goal-achieving intention. Indeed, we are observed to cooperate, and to behave accordingly without need of ''intentions''. Thus, it is important to develop similar capabilities in the system behaviours of our global artificial systems.

E. MORAL PRINCIPLES AND HUMAN RIGHTS

As has been outlined in section III, this research work approaches global environments by means of applying moral principles and human rights. These explicit assertions are registered and delivered with the global systems. Further, new architectural and methodological elements are designed for moral development and human rights. Indeed, special codes

are established, and new functional modules and methods are designed to globally register and deliver these. The resulting elements are not central to the superior net of intelligence. They are highly distributed across global organizations like governments or research centers.

Moral developments occur also in superior abstractions. The natural laws in morality and ethics drive the behavior and thinking processes of these non-replicable abstractions. The lawful mechanisms involved are internal to the individuals that globally connect through the network of entities. Basically, these individuals naturally demonstrate lawful behaviour and thinking through specific tasks. The task-oriented abstraction globally connects with superior duties. And cooperative tasks can also be reflected in these.

Rights are provided at every organization in the global network, mainly to facilitate the complex human rights law architecture [38], [56], [65] and to emphasize the human orientation of the approach. These codes generally extend the six families of universal human rights encompassed in the Universal Declaration of Human Rights (security, due process, liberty, political, equality and social) [35]. Thus, organizations have ''human rights obligations'' with the proposed Global approach. They have legal duties to help promote these rights. They must remedy the violation of human rights. Further, there are norms and regulations within the organizations to realize human rights. These statements conduct the organization in a manner that globally supports, respects and guides the rights. They also refer to legal mechanisms by which global cooperators and systems work in the organizations. Research centers, for example, have rights and regulations to access information from national governments.

F. ORGANIZING COOPERATIVE INTERACTIONS

This paper proposes the unique, superior intelligence unifying and organizing the structure and functioning of five major (macro) entities and their cooperative interactions. These are: governments, universities, research centers, socio-cultural entities and industries. Each of these entities primarily includes regulations (principles, laws) and rights (universal norms) to address its individual and cooperative duties (responsibilities). They are organizations that globally connect from the superior net of intelligence. Further, they are dynamic systems that adapt and evolve in the global environment, integrating human, social and organizational aspects. They include humans and systems, behaviors and thinking. But business enterprises have not been incorporated into this high-level design. Not yet. Indeed, the superior global network of entities is considered as a comprehensive system with higher forms of intelligence where there is no market involved. This system raises the intellectual level of global cooperators who learn from each other in their daily duties. Thus, global intelligence takes place at all five entities to contribute to cooperation and learning. The overall net of global intelligence reflects from superior abstractions. And there are no psychological aspects being included in the approach to mean *pure intelligence*. Psychology is built on the individuals that globally cooperate through the net of entities. It is innate to their developments, appearing at lower interactive levels of the design. Psychology and enterprises (markets) will be added to future evolutions of the proposed Global approach.

G. GLOBAL ORGANIZATIONS

Here cooperative entities like governments are considered as global organizations. These entities take actions in global governance. There is not any conflict between governments and global systems. The governments connect from the superior global network in a way that facilitates the realization of global actions. They include norms and rules to address international problems. They manage collective actions for dealing with global problems. Because global governance and the state cannot be separated [53].

H. MIND-ORIENTED ABSTRACTIONS

There are numerous aspects of development that could be relevant for the engineering of the Global AI approach. However, this is not what this paper wants to solve now. The presented investigations are now in the process of re-inventing a global future (with humans and AI systems), and in this natural process, it is intended to achieve valuable thinking (first), valuable moral/ethical behaviors (consequently) and valuable words (maybe not required). Then, once this *mind-oriented abstraction* is finished, it will be possible to develop the ''global intelligent systems'' that we can think about to support this.

This research work includes some mental processes investigations [34]. And, according to these, it is possible to conclude that the most suitable conditions for humans to be able to think and behave naturally become only available in clear (non-disturbed) minds. Indeed, this mind can perform cooperative actions without need of reasoning. Positive thinking helps to control natural, lawful behavior. Thus, cooperation occurs at a higher level of abstraction.

Human intelligence can be supported and improved in many environments. Not only in education [7]. Further, artificial systems can support our mind processes and produce flexible interactions with natural thinking. And this is true intelligence too. Nevertheless, the artificial supporting solution would have to be acknowledged in final implementation techniques so we might need to move into:

- the physical-symbol approximation [63] where factual structures of knowledge and behavior need to be processed or,
- the non-symbolic approach where only basic system behaviors [9], [64] must be placed (registered) at initial stages of development.

Searle [67] argues that the symbolic approximation is not sufficient for AI systems. Further, he criticizes the reasons why cognitive science is attracted by ''cognitivism'' based on the assumption that mental states are like computer

states. And this research work fully agrees with Searle's contributions. Further, it is suggested that the physical-symbol abstraction might be only sufficient for factual, superior abstractions where conscience evaluations respond safely. However, it is also discussed that there are subsequent moral behavior abstractions and related actions where the factual responses are not sufficient.

I. TRANSFERING CAPABILITITES TO OUR SYSTEMS

The best human intelligence does not always perform rapidly; rapid progress does not always match good development. We all "perform well" when we stop and carefully think about what we do. And we would like to transfer this capability to our artificial systems too. But "transferring" intelligence cannot be a matter of storing and manipulating some kind of information on behalf of those who "desire to use it". It should have to be related to some kind of "service" for the best purposes that we can think about. Thus, service orientation can be considered as an outstanding approach to our architectural procedures and developments. Especially from the governance viewpoint. The question is how to integrate the building blocks of our service-oriented systems. And, in this sense, the "modeling" of the systems is very important to foresee.

"Models" can be considered as key elements for our true natural concerns. Human intelligence can be modelled even before thinking about symbols [2]. Thus lawful, regulated behavior insights can benefit our global solutions. There are knowledge abstractions based on truth and law which relate to behavior structures and functioning. The overall structure of the global net performs (behaves) following truth values, laws and regulations to complete individual and cooperative duties. And the new artificial systems must support this.

The way to *communicate human intelligence* cannot be resolved using simple transport mechanisms. We generally connect through our mind abstractions. Factual thinking evolving from moral behavior demonstrates this. Further, connecting two human intelligences with similar intentions observes as a good, simple cooperative model. Facilitating communication among non-intelligent models makes the upper level too inefficient.

"Framework" [2] continues to be a special keyword in this research work. Some development frameworks were created to analyze and design behavior-based systems around 1997. Now, this paper summarizes the latest models, architectures and methodologies as the major development elements for the new global artificial systems. AI technologies could have been investigated as a general approximation to these systems development. But we must care about the creative mind. And this also requires other abstractions to invent the systems, not only Generative AI.

V. MODELS, ARCHITECTURES AND PROCESSES

The presented Global approach to AI initially incorporates new *models*, *architectures* and *processes* as the basic flexible elements to analyze, design and integrate global systems to support global intelligence. We propose these new development elements instead of AI techniques just because we consider these as a better idea to start modeling and building global artificial systems. But current AI techniques can also be applied once computational models have been approximated.

Recent studies in [69] clearly describe how these models, architectures and processes can be very beneficial for the development of current Digital Libraries as global intelligent systems. And evolving this last work, it has been demonstrated how current management problems with Digital Libraries can be solved with abstractions and refinement techniques based on such development elements. The initial evaluations of this work can be found in [68] and [70].

A. LEVELS OF ABSTRACTION

In globally oriented terms, "levels of abstraction" can be thought as modeling aspects for human intelligence and cooperative developments. Further, implementation levels of abstraction can be considered to integrate flexible systems and techniques [2]. The proposed refinement processes facilitate the design of lower-level structures and mechanisms (see Fig. 1). Indeed, several model enhancements have been defined in this paper moving from one abstraction to another, according to the selected aspects of development (e.g. "process" or "service"). More generally, flexible models of true intelligence have been proposed and analyzed in this paper for the organizations and their cooperative, manageable links.

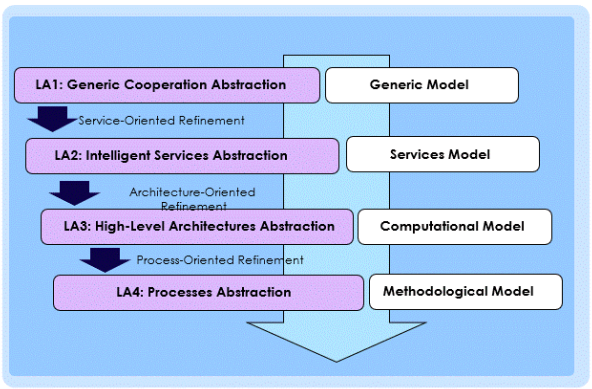

FIGURE 1. A generic top-down framework.

The core features of this generic framework underline most of the fundamentals of the approach. It suggests major development elements to model and build new, globally oriented, cooperative intelligent systems. Each element includes some architectural and methodological components. Indeed, the high-level definition of each development element stands for some pre-established views and activities that can be adapted and/or evolved in any situation. For example, a generic *intelligent architecture* incorporates several components (such as "knowledge registries", "system behavior registries", "intelligent system behavior control", "knowledge

rendering'', etc.) as well as some methodological aspects (e.g. ''high level architecture design'') which help to derive the element (intelligent architecture) into a single and/or composite domain.

This paper defines a new way to extensively support human intelligence through cooperative systems developments. Further, it outlines some architectural and methodological mechanisms to convert generic models (see Fig. 1) into flexible computational abstractions.

Fig. 1 shows a general view of one of these generic frameworks. In this framework, the superior abstraction represents a generic model of cooperative entities interacting with each other. Then the framework outlines how to move down to a second abstraction based on intelligent services definitions incorporating knowledge and system behaviour representations. The next abstraction is a computational model represented by high-level architecture with functional modules that register and deliver superior services definitions with appropriate knowledge acquisition and system behaviour executions. The final abstraction is a methodological model. This incorporates process-oriented definitions based on roles, activities and responsibilities to use and maintain the superior architecture abstraction. In [69] and [70] this framework is initially evaluated in sustainable education underlying many moral and ethical claims of the Global approach.

B. COMPUTATIONAL AND OPERATIONAL MODELS

A Generative AI model ''refers to generative modeling that is instantiated with a machine learning architecture'' [5]. It creates new data based on learned (trained) patterns that the user discovers through conversational systems and interfaces. The Generative AI systems provide final user interactions and incorporate conversational agents, search engines, content generation sub-systems and programming algorithms. And these systems can also be integrated and/or connected to other systems, including knowledge databases. Finally, at the application level, generative artificial systems are situated in the organizations to solve creative compositions. They achieve decision-making and problem-solving capabilities in the organizations. However, new ''human-AI interaction models'' are necessary to guide the behavior of AI systems [5], [6]. Indeed, the generative approach has introduced a new paradigm in human-computer interaction where users should specify how the knowledge ''should be produced'' instead of specifying ''what they want'' [6]. This paper works at this interaction level, drawing and modelling the human-computer interactions at several levels of abstraction, incorporating possible generative (computational) models and subsequent engineering solutions through refinement stages.

Indeed, one way of extending a ''computational model'' (with or without AI techniques and Software Engineering methods) is producing an ''operational model''. An illustration of this refinement process is given in Fig. 2.

In this figure, we see how a generic model based on cooperative interactions between organizational and individual entities is refined down to a computational model (based on Software Engineering methods and/or AI techniques) or, directly, to an operational model (based on final technologies for system implementations). Additionally, a computational model can also be refined down to an operational model for final production environments.

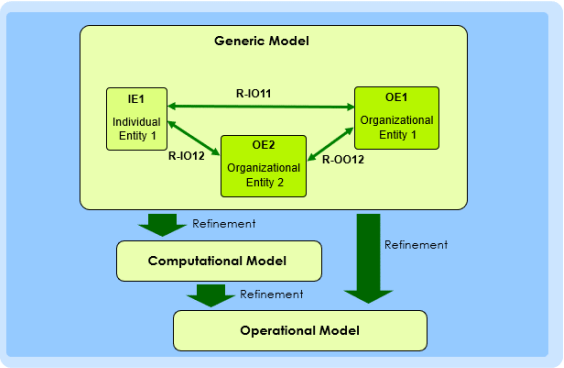

FIGURE 2. Models for global artificial intelligence.

This development requires selecting and integrating several implementation techniques at lower-level abstractions. We also convert ''computational models'' into ''formal models'' by means of evolving the resulting designing elements with appropriate *formal methods*. The possibilities, in any case, are multiple. Thus, it is possible to increase the number of abstractions and refinement processes to switch from high level intelligent cooperation to operative global systems, well placed in real world situations.

In the Global AI approach, we can also derive computational models based on classical AI techniques such as Fuzzy Systems, or Genetic Algorithms. Further, we can establish generic abstractions and use Machine Learning to train Artificial Neural Networks with specific datasets. Further, we can use current deep learning methods to learn from transactional data from such generic abstractions. However, we need new models, architectures and processes to support global intelligence.

Another development element of the Global AI approach is the *generic environment*. In general, this paper proposes modeling and building systems in complex domains where it becomes necessary to evolve current techniques. And the *generic approximation* is used in these developments, prior to final implementations. For example, recent studies have created learning environments based on computational registration and intelligent delivery of learning content [1]. Most of these mechanisms are based on *generic entities* which help to model top-level interactions among government organizations, research institutions, industries, etc. Currently, the number and type of components of the generic environments are being updated so that it is not necessary to focus on learning orientation.

A key global component is ''the model''. The proposed *models* incorporate flexible designing elements like, ''services'' and/or ''processes''. For example, a global service model includes intelligent (AI) services, cooperative system behaviours, global architectures and processes, as we have initially evaluated in [69] and [70]. In this work, the intelligent services are identified first. Then the designer can move down to produce the models by means of integrating and/or adapting lower-level architectures and processes (like ITIL v4 processes) that help to compute the higher models. Further, [69] defines some intelligent frameworks that vertically associate architectural and procedural basis for global service orientation. An example based on this framework is shown in Fig. 1.

The proposed *generic models* describe global organizations and their cooperative links. Computational models, as shown in Fig. 1, can be achieved through appropriate refinement. These models can be clearly focused on software architecture, intelligent services and artificial sub-systems. The operational models belong to the production environment. A computational model can be made ''operative'' by means of applying management frameworks (as we demonstrate in [69]). Therefore, operative models depend on current technologies, at large.

Fig. 3 shows a generic architecture. In this design element, generic cooperative entities are communicated. All the humans who work on these entities (and their internal structures) reflect similar (common) capacities, apply the same regulations (laws) and cooperate naturally, communicating global knowledge and executing moral cooperative behaviors. They reflect from superior intelligence abstractions and fulfill individual and cooperative duties following appropriate regulations (principles and laws). Further, they have the right to proceed in their daily occupations, demonstrating in global intelligence and cooperation. The lower net stores knowledge and system behaviors in several registries.

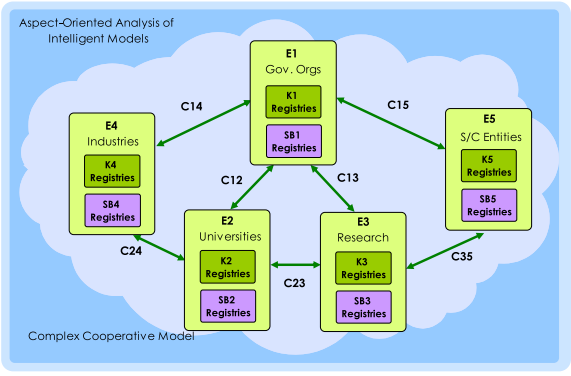

FIGURE 3. A global network of knowledge and behaviors.

As we can see in Fig. 3, there are two main networks in this abstraction. The knowledge network, communicating all the Ki registries and, the system behaviours network, communicating all SBi registries and supporting human behaviour. Note that the subsequent system implementation can also train the system behaviour network to perform new system behaviours instead of executing the system behaviours that are described in the SBi registries.

This global architecture can be developed at flexible levels of abstraction, through knowledge and behavior refinement. In addition, we can use this framework to develop all its entities so that knowledge, system behaviors, and internal and/or external mechanisms become naturally approached with appropriate levels of detail. So, in the end, it might happen that each entity integrates several architectural and/or methodological elements for global intelligence and system developments. Further, there are regulations (principles, laws) being implemented in the entities which drive specific interactions for individual and cooperative actions.

C. PROCESS ORIENTATION

Process-orientation is also a key element in the proposed Global approach. In [69] a process-oriented refinement technique is investigated as part of the development methodology of a management solution for a global intelligent system. Further, process definitions are considered in almost all the components, according to global objectives and general principles of development. For example, general processes are designed to methodologically support the computation of higher models and architecture. Basically, these processes establish major roles, responsibilities and activities to compute and manage higher-level architectures. And analysis processes are defined to convert high level models of cooperative intelligence into lower-level computations. Finally, architectural elements of development are integrated with simple methodologies to facilitate, for example, the development of functional modules into the final physical systems. These artificial systems become physical once operationally achieved since computations are involved.

Global processes and intelligent mechanisms are defined (see Fig. 1) to deliver the systems in the organizations. All the processes include architectural and methodological aspects that facilitate the rendering of the systems. But we can also be flexible in the way that we define global development processes. For example, we can develop cooperative systems using *hybrid models* (like Fig. 2) as well as *hybrid artificial techniques* (e.g. behavioral maps [29]).

VI. NEXT STEPS: RESEARCH AGENDA AND DEPLOYMENT ACTIONS

An initial program of investigations is proposed here to develop global intelligent systems in virtual and real environments.

The main objective of this research agenda is to promote true natural intelligence endowments with global, cooperative developments. As a first approximation, these investigations could be focused on six main research areas:

1. investigating cooperative mind theories, and general concepts for global intelligence and supporting systems,

2. designing abstract models for global systems based on human-computer interactions,
3. formalizing new global computational models with appropriate formal methods and techniques,
4. providing pseudo-code and mathematical proofs for some of the refinement processes,
5. applying current, regulated Artificial Intelligence techniques for refined computational models and,
6. engineering technical solutions.

With this open research agenda, current investigations can be extended into cooperative mind theories and artificial systems to support new global intelligence theories. We can explore top level, natural intelligence and how to support this with new artificial systems, reviewing and consolidating critical concepts such as knowledge, behaviour, morality and ethics. This includes more detailed frameworks to quantify how these new artificial systems can help current human behaviour and thinking, how these new artificial systems can support our new global intelligence theories.

The abstract modeling part could be mainly oriented to underpin global developments in large environments whereas the application of AI techniques would produce computational models based on generative, global knowledge and moral behaviors. With Generative AI, for example, it would be necessary to design conversational abstractions and related language models as part of the refined computational models. And this could also be approached by incorporating new AI-driven services within our global architecture, as we suggest and evaluate in [70].

The formal methods, pseudo-code and mathematical proofs will advance the final computational models for our previous abstractions. This work can be evaluated and tested prior to final engineering solutions.

The engineering of the technical solutions could be based on approximating appropriate processes and technologies to implement our final computational models.

From this engineering viewpoint, some architectural issues could be solved with new global definitions. Indeed, it would be possible to improve current information systems in some global organizations as well as their current architectural and/or methodological approaches. There are, in some cases, ''architecture designs'' (most of them at the symbol level) that could be evolved according to true natural intelligence and more clear lawful cooperation procedures.

Finally, this research agenda aims to improve the AI technology being applied in current engineering solutions. In most applications, there is no explicit approximation to any natural intelligence as such. There are only operations around well-known AI techniques like Expert Systems or Artificial Neural Networks. Further, it seems clear that the general intention in these applications is to facilitate communication and to make public almost any kind of information. However, this does not seem to be ''truly intelligent''. Some people need information and explicit responses to decide on their actions. But human intelligence cannot be supported just like this. We all need to concentrate in our ''mind'' and to find ''what we need'', ''making good decisions'' and ''succeeding in our activities''. More importantly, we need to acknowledge the best ''principles and values'' to help people in solving their development and, to develop ourselves too. We cannot control or remove good ways of common development. We must find good ways of development and share these with our colleagues. And these are major motivations for improving intelligence and building global, cooperative systems too.

Once abstract models, computational models and technological solutions have been designed for our generic cooperative entities (industries, research centers, universities, governments, civil societies) in large environments, it is possible to concentrate our efforts in deploying our global intelligent systems. And for this aim, this paper proposes the following *general framework of actions* for each global organization:

1. Analyzing current intelligence, systems and regulations in the organization.
2. Producing the superior abstract model of the organization and its global, cooperative actions.
3. Producing the abstract mental model for the required global intelligence.
4. Producing computational models to support global intelligence.
5. Establishing data structures and other computational resources for the computational models.
6. Designing and deploying knowledge databases and moral behaviors registries.
7. Designing system behaviours and/or training models for the cooperative actions.
8. Establishing legal regulations and lawful mechanisms for the systems, incorporating these into the knowledge registries of the global system.
9. Training computational models where Generative AI can be deployed.
10. Designing and deploying AI systems based on previous computational models and driving human-computer interactions.
11. Tunning the efficiency of computational models.
12. Tunning the efficiency of AI systems for global intelligence support.
13. Evaluating social impacts using appropriate methodologies, metrics and assessment tools.

The first action will provide precise information regarding the current state of the systems and the type of intelligence being solved at the organizations. This will help in following actions to extract abstract models for global intelligence and cooperation.

VII. CONCLUSION

The paper has presented a new, globally oriented approach to AI for cooperative organizations and their systems. More particularly, the paper has discussed the general foundations for this approach, following most of the research objectives and development criteria that the authors of the paper have shown over the last few years.

The core contributions to knowledge refer to those providing some general investigations, ideas, foundations and principles to support global, naturally inspired intelligence with new artificial systems. Further, the paper has contributed to current developments in AI (from knowledge, behavior and hybrid approaches) with new elements (models, architectures and processes) that can be applied either in isolation (e.g. knowledge-based systems) or in combination (as multi-valued frames) to define new techniques. Further, an open research agenda has been shown to mean future global developments in our organizations. Basically, this agenda suggests how to guide future investigations in Global AI. And a general frame of actions has been presented to deploy our future, global intelligent systems. All these results will contribute to the advancement of the presented Global approach to AI by means of approximating the theoretical and technical details of our intelligent systems in global organizations. Further, some key concepts like global intelligence will be advanced, formally established and supported by empirical data to approximate the systems for global cooperation.

VIII. FUTURE WORK

In the future work, the authors of the paper shall concentrate major efforts in studying and evaluating the intelligence of some governmental organizations and their supporting artificial systems. Some of the proposed foundations, core development elements and general framework of deployment actions will be carefully examined for the proposed Global AI approach. Human/machine aspects of development will be evolved for these organizations. The major issue now is to start making decisions in where and how to improve the artificial intelligence of our platforms and technologies. Perhaps there could be more communication than there really is in the latest AI technology. For example, with Generative AI, this is only question-answer communication. And perhaps the only solution is to continue studying and improving human intelligence, especially when people's rights are in our mind.

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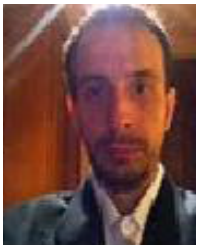

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