Education Competence for the Anthropocene Era

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Abstract

"Animals and humans use their finite brains to comprehend and adapt to an infinitely complex environment." The human brain is at least a factor of 1 billion more efficient than our present digital technology, and a factor of 10 million more efficient than the best digital technology that we can imagine today, to create an inner image of the real world. The unavoidable conclusion is that we have something fundamental to learn from the human brain about new and much more effective form of deep learning. Human values express intention and commitment, but they are not merely utopian ideals or ethical principles. They represent the highest abstract mental formulations of life principles and the quintessence of humanity's acquired wisdom, regarding the necessary foundations for human survival, growth, development and evolution. Consciously or unconsciously, the construction of any image of the real world relies on personal beliefs based on social predicative and numerical competence. If some educators are better than others on account of more than the equipment they have access to, it is considered as incidental today. To identify educative talent, dedicated to young brain development, is a function abandoned, since universities and professional schools are not really lacking applications and are able to defend their ROIs quite successfully. The key change performance factor is education competence, distinguishing from classic, contemporary education and a new one, based on a more reliable control of learning uncertainty, disciminating future building on sand from building on rock. Main critical issues are presented and discussed.

Keywords: Education competence, consilient education, transdisciplinary education, transdisciplinarity, multidisciplinarity, interdisciplinarity, deep learning, creativity, innovation, personal-centered education, social change, cybersociety, anticipation, self-organization, Post-Bertalanffy system, CICT, IDB, OUM, Cybernetics**.**

1 Introduction

Skills demands are increasing and changing rapidly everywhere, as advanced economies are in the process to embrace globalisation, technological change and ageing. But higher levels of skills will only contribute to stronger and more sustainable growth and prosperity if firms take action to make full and effective use of the skills that are available to them.

While many, relatively large, companies compete in the global markets successfully, many others have low-skilled managers and workers with relatively low levels of productivity. The low levels of skills of managers and workers are coupled with low investment in productivity-enhancing work practices and in technologies requiring workers to use high-skills. These in turn reduce incentives and capacity to effectively invest in skills and productivity-enhancing work practices and technologies. This dynamic is partly explained by the way work is currently designed and organised, and the way firms are managed.

For instance, in Italy, family-owned business account for more than 85% of all firms and about 70% of employment. But managers of family-owned businesses often lack the skills needed to adopt and manage new, complex technologies. Skill mismatch is quite pervasive in Italy. Bringing skills supply and demand into better balance requires more responsive educational institutions and training providers, more effective labour market policies, better use of skills assessment and anticipation information as well as greater efforts on the part of the private sector to collaborate with these institutions.

Recognising these challenges and the importance of seizing the opportunities of a digital and globally interconnected world, recent governments have introduced a number of ambitious policy reforms of its labour market (2014 Jobs Act), education system (2015 Good School Act) and innovation system (2015 National Plan for Digital Schools and Industry 4.0 National Plan 2017-2020). In Italy, “Industry 4.0” is an important reform to improve the skills system and, in particular, the demand for skills in Italy.

This policy aims to encourage and facilitate the transition to digital technologies among Italian firms so that they can keep pace with their partners and competitors. To help firms, especially SMEs, familiarise themselves with, and take advantage of, the new opportunities provided by digital technology, Industry 4.0 will set up a network of technological hubs including Digital Innovation Hubs, Digital Enterprise Points, and Competence Centres. These entities will be able to engage a broad range of actors including large private players, universities, research centres, SMEs and start-ups to promote the increased adoption of technologies all over the country, and in key industrial sectors. The main challenges faced by these technological hubs will be to actually attract firms in partnerships and effectively promote all the opportunities and incentives provided by Industry 4.0. A strategic framework for tackling Italy’s low-skills equilibrium is based on four pillars: developing relevant skills; activating skills supply; using skills effectively; and strengthening the skills system (OECD, 2017).

Anticipating and addressing the consequences of the Fourth Industrial Revolution, environmental pressures, rising levels of youth unemployment and inequality, globalization and virtualization of business models, the explosive growth of online communications and education, the globalization of education, increasing intercultural contacts and migration will place enormous pressure on educational institutions, students, teachers and researchers.

On the other hand, Japan has its own specific challenges and just as "Industry 4.0" is the European digital transformation of manufacturing, Japanese "Society 5.0" aims to tackle several challenges by going far beyond just the digitalization of the economy, towards the digitalization across all levels of the Japanese society and the (digital) transformation of society itself. What Japanese aim to build is a nation of "Sanpo-yoshi" (En. Tr., all right on three sides) where three fundamental factors, that is, economy, environment, and society, work to improve one another and thereby contribute to increasing the wellbeing of citizens in a super, hyper-smart society.

A super, hyper smart society is characterized as follows: a society where the various needs of society are finely differentiated and met by providing the necessary products and services in the required amounts to the people who need them when they need them, and in which all the people can receive high-quality services and live a comfortable, vigorous life that makes allowances for their various differences such as age, sex, region, or language. Indeed, the notions of, nonlinearity, interactions, impredicativity, self-organization, stability and chaos, unpredictability, sensitivity to initial conditions, bifurcation, etc., are phenomena which also characterize social systems.

We not only need more education but education that is qualitatively different, a new paradigm in education: the “consilient education.” In fact, updating course content is not enough. We need an education that equips youth to adapt to future innovations and challenges that cannot be fully anticipated now. Over the centuries, human worldview about our spacetime universe has been shifting into many evolving scientific paradigms or shared conceptual systems by an accelerating pace. A conceptual system is an integrated system of concepts that supports a coherent vision of some aspect of the world (Byers, 2015). As an example, we found more than twenty proposed and renowned worldview interpretations in the past scientific literature and we grouped them into nine major conceptual, disciplined areas (Fiorini, 2018).

"Consilience" is the term coined by William Whewell in 1840 (Whewell, 1840) and later used by Edward O. Wilson (Wilson, 1998) for the integration of knowledge that involves a continuous remapping of reality. A constant shift of conceptual frames. Improving the consilience between disciplines of knowledge is a worthwhile philosophical aim. Arguably, it makes reality itself more coherent. Because of consilience, the strength of evidence for any particular conclusion is related to how many independent methods are supporting the conclusion, as well as how different these methods are. Those techniques with the fewest (or no) shared characteristics provide the strongest consilience and result in the strongest conclusions. This also means that confidence is usually strongest when considering evidence from different fields, because the techniques are usually very different.

In modern times, specialization has overtaken broader fields of knowledge and multidisciplinary research. The mental world we live in today is infinitely divided into categories, subjects, disciplines, topics, and their more and more specialized subdivisions. Our past knowledge is organized into "silos": good for grain, not for brain. Therefore, their consilience is quite poor. Nevertheless, American universities now offer more than 1000 specialized subdisciplines, and European ones are following them accordingly. Forcing societies to fit their knowledge into boxes with unrelated arbitrary boundaries, without understanding deep reasons for them, may lead to serious consequences, like those we witness in many world affairs today.

Reality is the temporal unfolding of events, and path dependence is a central concept to explain complex emergent phenomena. In modern times, specialization has overtaken broader fields of knowledge and multidisciplinary research. To overcome the missing path dependence problem, interdisciplinary and transdisciplinary education are really the ways society, together with scientists and scholars, must move on. Interdisciplinary education consists, for instance, of a multidisciplinary relational reformulation of problems. On the other hand transdisciplinary education is related to the study of achieving their optimal reformulations to unlock their fundamental properties. We need to recall the dawn of the transdisciplinary thinking from Jean Piaget's words to achieve an effective deep learning (Inhelder & Piaget, 1955). Transdisciplinary education and transdisciplinarity propose the understanding of the present world by providing more unified knowledge to overcome the famous paradoxes of relative knowledge and perfect knowledge and to unfold hidden creativity and innovation.

The domain is then no longer specified only in terms of industrial development and political consequences, but also in terms of the three subdynamics of the evolutionary Triple Helix model (Leydesdorff, 2018): (1) knowledge production, (2) wealth generation, and (3) regulation. Therefore, the "Mindustrial Revolution" (Toht, 2016) has to be a reliable creative thinking transformation process by more and more integration of wellbeing signatories and ratifiers from different cultures and countries. In order to achieve an antifragile behavior, next generation human-made system must have a new fundamental component, able to address and to face effectively the problem of multiscale ontological uncertainty management. Our OUM Model architecture is a solution proposal to this problem, allowing continuous and recursive learning from unespected predictions (Fiorini, 2017a).

2 Towards Super Smart Societies

A super smart society is characterized as follows: a society where the various needs of society are finely differentiated and met by providing the necessary products and services in the required amounts to the people who need them when they need them, and in which all the people can receive high-quality services and live a comfortable, vigorous life that makes allowances for their various differences such as age, sex, region, or language.

Our societies are arbitrary complex multiscale system of systems of purposive actors within continuous change. Society is, without any doubt, a complex system and the idea to use the knowledge from the analysis of physical complex systems in the analysis of societal problems is tempting. Indeed, the notions of, nonlinearity, interactions, impredicativity, self-organization, stability and chaos, unpredictability, sensitivity to initial conditions, bifurcation, etc., are phenomena which also characterize social systems. Therefore, the "Mindustrial Revolution" has to be a reliable creative thinking transformation process by more and more integration of wellbeing signatories and ratifiers from different cultures and countries.

In order to achieve an antifragile behavior, next generation human-made system must have a new fundamental component, able to address and to face effectively the problem of multiscale ontological uncertainty management. We need a definitive, antifragile solution to the problem of the logical relationship between human experience and reliable knowledge extraction (Fiorini, 2017a). When uncertainty and ambiguities cannot be avoided, then reliable ontological uncertainty management (OUM) systems are needed and become a must (Fiorini, 2017a). Even in mere terminology, minimizing or avoiding representation uncertainty and ambiguities is mandatory to achieve and keep high quality result and service. As a current, simple example, even understanding the difference between "well-being" and "wellbeing" meaning is mandatory to achieve high quality healthcare informatics and telepractice (Fiorini et al., 2016). The proper use of term and multidimensional conceptual clarity are fundamental to create and boost outstanding performance. One of the fundamental preconditions is to speak in the common language. It is not the problem of cultures only (Leung et al., 2007), it is also a problem of scientific communities (Kagan, 2009; Snow, 1969) and new societal education (Mulder, 2015; UNE, 1997). We deeply share the belief that a better understanding of information is needed to understand anything and everything, hopefully.

It is important to underline that information processing technology can be used also to facilitate the application of pragmatic models to "prescribe" or suggest to participants to improve their attitudes, predicative competence, education and creativity. Science does not exists to enlighten people's minds only. It mainly exists to show the educated way from quanta to qualia. And that way starts from social predicative competence to arrive to computational competence, and to discover that, by the right AI perspective, they are not so different after all (Fiorini, 2017b).

2.1 Social Predicative Competence

Psychologists of reasoning have created algorithmic models of human reasoning and of its fallacies. The "mental models theory of reasoning", developed by Philip Johnson-Laird and Ruth M.J. Byrne in 1991 (Johnson-Laird and Byrne, 1991) is one of the most famous among these theories. Ongoing research on mental models and reasoning has led the theory to be extended to account for counterfactual thinking in 2005 (Byrne, 2005), and probabilistic inference in 2006 (Johnson-Laird , 2006). We follow a different path: it is a new computational approach and so, complementary to previous ones (Fiorini, 2017b).

In fact, according to Swiss clinical psychologist Jean Piaget, human adults normally know how to use properly classical propositional logic. Piaget also held that the integration of algebraic composition and relational ordering in formal logic is realized via the mathematical Klein group structure (Inhelder and Piaget, 1955). In the last fifty years, many experiments made by psychologists of reasoning have often shown most adults commit logical fallacies in propositional inferences. These experimental psychologists have so concluded, relying on many empirical evidences, that Piaget's claim about adults' competence in propositional logic was wrong and much too rationalist. But, doing so, they forgot Piaget's rigorous and important analysis of the Klein group structure at work in logical competence. In other words, according to experimental psychologists, Piaget was overestimating the logical capacities of average human adults in the use of classical propositional logical connectives. As a matter of fact, English speaking people tend to treat conditionals as equivalences and inclusive disjunctions as being exclusive (Robert and Brisson, 2016).

Nevertheless, the Klein group structure Piaget used can be reused to help us understand better what happens in spontaneous human reasoning and in the production of fallacies. In fact, in mathematics, the Klein four-group or "Vierergruppe", named by German mathematician Felix Klein in 1884, is a group of four fundamental transformations with four elements (Figure 1). The Klein four-group is the smallest non-cyclic group, and every non-cyclic group of order 4 is isomorphic to the Klein four-group. The cyclic group of order 4 and the Klein four-group are therefore, up to isomorphism, the only groups of order 4. Both are abelian groups in mathematics. Piaget applied the Klein four-group to binary connectives, so that a given connective is associated first with itself (in an identical (I) transformation) and then with its algebraic complement (its inverse (N) transformation), also with its order opposite (its reciprocal (R) transformation) and finally, with the combination of its N and R transformations (that Piaget calls its "correlative" or C transformation) (Inhelder and Piaget, Ch.17). This correlative corresponds to what logicians usually call the "dual" (D) transformation (Robert and Brisson, 2016) (Figure 1).

The Klein group structure generates squares of opposition (SOO), and an important component of human rationality resides in the diagram of the SOO, as formal articulations of logical dependence between connectives. The origin of the SOO can be traced back to Aristotle making the distinction between two oppositions: contradiction and contrariety. But Aristotle did not draw any diagram. This was done several centuries later by Apuleius and Boethius in the second and sixth centuries. SOO are considered as important basic components of logical competence and of human predicative rationality (Béziau and Payette, 2012). Treating conveniently neutral elements (I), algebraic complements (N) and order reciprocals (R) in an integrated structure, by a valid treatment of duals (D), would guarantee people to make logically valid classical inferences on propositions.

But the formal rationality provided by the SOO is not spontaneous and therefore, should not be easy to learn for adults. This is the main reason why we need reliable and effective training tools to achieve full propositional logic proficiency in decision making, like the elementary pragmatic model (EPM) (De Giacomo and Fiorini, 2018). In fact, by an abstract point of view, EPM can be even seen as the logic description of the fundamental interactions of two Klein groups. In other words, EPM can model all the elementary interactions between two rational, interacting subjects. Currently, the notion of reasoning or conscious reason may be interpreted in terms of the reasoning process itself being itself explicitly modeled by the reasoning agent (Gaines, 2010). In this way, we arrive at the core understanding of "the difference that makes a difference" (Bateson, 1972, pp.457-9). Metaphors encompass often our everyday communication and can also be used in explaining the behavior of complex social systems. Such an approach, developed initially by English anthropologist and social scientist Gregory Bateson, is advocated by De Giacomo and Fiorini (2018), and Wheatley (2006) for management and leadership. They do not enter into the technical details of chaos theory and complexity in terms of physical systems, but recommend using these ideas convincingly to the management of social systems and also for educational purposes.

Figure 1. Piaget-Klein Group Cayley Table. The four fundamental transformations of predicative competence: identical transformation (I), inverse transformation (N), reciprocal transformation (R), and finally, the dual transformation (D) (see text)

x	**I**	**N**	**R**	**D**
I	I	N	R	D
N	N	I	D	R
R	R	D	I	N
D	D	R	N	I

As a further, more interesting example, the Piaget-Klein group structure can be even interpreted as the transformation mapping the human perception and representation of our outer and inner universe representation, where the encoding process is carried out by human affectors (our biological sensors) and the decoding process is done by human effectors (our biological actuators) (Figure 2). In this way, the single observer encoding and decoding relationships of the classic Rosen mapping (Rosen, 1991) can be computationally formalized at operative level (De Giacomo and Fiorini, 2018).

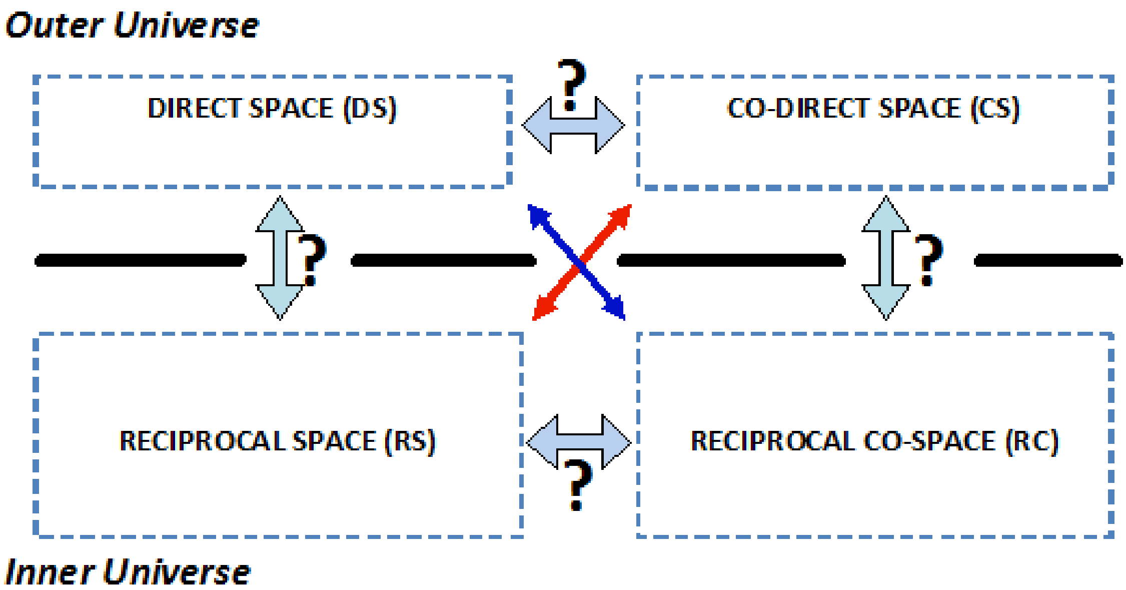
2.2 Computational Competence

From a computational point of view, a current intriguing point is that, although currently there are multiple models for the Integers ***Z***, they all will agree on the definition of computable functions. However, Real Number computation ***R*** does not have these properties. Scientific computation uses specified fixed-length finite representations (related to scientific notation) of real numbers, and so can achieve only limited precision, can make errors in comparisons, and can even be unstable over rounds of conversion to and from corresponding decimal representation. Traditional digital computation must be either approximate or symbolic. Unfortunately, current digital computational resources are unable to capture and to manage not only the full information content of a single Real Number ***R***, but even Rational Number ***Q*** is managed by information dissipation (e.g. finite precision machine, truncating, rounding, etc.). So, paradoxically if you don't know the code used to communicate a message you can't tell the difference between an information-rich message and a random jumble of letters.

This is the information double-bind (IDB) problem in contemporary classic communication theory and in current information science. Scientific community laid itself in this double-bind situation. Even the most sophisticated instrumentation system is completely unable to reliably discriminate so called "random noise" (RN) from any combinatorically optimized encoded message, which computational information conservation theory (*CICT*) named "deterministic noise", DN for short (Fiorini, 2016b). It is a problem to solve clearly and reliably, before taking any huge quantum leap to more competitive and convenient, at first sight, post-human cybernetic approaches in science and technology (Wang et al., 2016).

In the numeric representation of Rational Number ***Q***, rational proper quotient is represented by infinite repetition of a basic digit cycle, called "reptend" (the repeating decimal part) (Weisstein, 1999-2012). According to *CICT* (Fiorini, 2014a), the first repetition of basic digit cycle corresponds to the first full scale interval where number information can be conserved completely, and we call it representation fundamental domain (RFD) (Fiorini and Laguteta, 2013). In this case the new computational representation of rational number ***Q***, is called "OpeRational" (OR) Representation, just to remember that *CICT* is able to conserve Rational Number ***Q*** full information content, much better than previous computational approaches (Young and Gregory, 1973). It is even possible to show a new perspective for number processing, where the complex upper half-plane can naturally emerge by the interplay of the coupled inversion of two counter oriented upper quarter planes. That representation can be even read as the self-reflexion of a reciprocal conformal relation of an "Outer Symbolic Representation" (OSR) to its corresponding reflected fundamental "Inner OpeRational Representation" (IOR) and vice-versa, where *D* in ***Z***, *A* = 1/*D* and *D* = 1/*A*, and *DA* = *AD* = $\bar{0}1.\bar{0}$, for positive oriented upper quarter-space (right upper quarter plane) and *DA* = *AD* = $-\bar{0}1.\bar{0}$, for negative oriented upper quarter-space (left upper quarter plane). The relationship of these two counter-oriented upper quarter-spaces can be thought as a reciprocally projective conformal correspondence to be the first operative example in literature for explicit self-reflexive oriented numeric representation space, which can be used as powerful reference framework to develop OR numerical applications for maximum information conservation (i.e. minimal information entropy generation and information dissipation).

Figure 2. The fundamental blocks of the CICT Inner Universe-Outer Universe Boundary approach for full computational information conservation (CICT IOU Diagram) (Fiorini, 2014b, 2015)



For the sake of simplicity, it is possible to study the main properties of one oriented upper quarter-space only, because the second one is just its reflection with respect a vertical axis, so LTR (Left-To-Right) representation turns into RTL (Right-To-Left) representation and vice-versa. A direct representation turns into additive complemented representation and vice-versa, when needed. In virtue of this relationship, the same information content can get two different numerical representations, in direct space (DS) and reciprocal space (RS), across the outer universe-inner universe (OU-IU) boundary, which can resonate to each other freely, at the same time, with respect to an inversive reference boundary element (i.e., centered unitary segment in 1-d, unitary circumference in 2-d, unitary sphere in 3-d, unitary ipersphere in 4-d, etc.) between an *nth*-dimensional "Outer Space" representation and a correspondent "Inner Space" representation: an n^{th}-dimensional OSR to its resonating IOR and vice-versa (Figure 2).

Therefore, differently to the traditional Peano's arithmetic incomplete approach, according to *CICT*, in Arithmetic the structure of closure spaces is self-defined by Natural Numbers RS representation (Figure 2). By this way, Natural Number can be thought as both structured object and symbol at the same time (and much more!). Linguistic structures do not represent objects but they are symbolic information representation only. They need an appropriate structural description first. Then we can formalize semantics as a relationship between well-defined structures. Therefore, we need an exact arithmetic structural description framework first. So we arrive to the fundamental difference in the ontological status of symbols and object represented by these symbols. To the difference that makes the difference.

Now, it is possible to get the general digit string resonant relationship from equation (1), that ties together numeric body information of divergent (RTL) and convergent (LTR) monotonic power series in any base (in this case decimal, with no loss of generality) of OSR with *D* ending by digit 9:

$$\frac{1}{D} = \sum_{k=0}^{\infty} \frac{1}{10^W} \left(\frac{\overline{D}}{10^W} \right)^k \Rightarrow \ldots \Leftarrow \; Div \left(\frac{1}{D} \right) \sum_{k=0}^{\infty} (D+1)^k \quad . \tag{1}$$

Further generalizations related to *D* ending by digit 1 or 3 or 7 are straightforward (Fiorini, 2015).

Here, our results are presented in term of classical power series to show the close relationships to classical and modern control theory approaches for causal continuous-time and discrete-time linear systems. The difference between the two cases is simply due to the traditional method of plotting continuous time versus discrete time transfer functions. The continuous Laplace transform is in Cartesian coordinates where the *x*-axis is the real axis (Franklin et al., 2010) and the discrete Z-transform is in circular coordinates where the rho-axis is the real axis (Franklin and al., 1998).

As a matter of fact, it can be shown that any Natural number can be thought as symbol, datum or Discrete Laplace operator with peculiar computational properties at the same time. Therefore, all the known properties of the usual Laplace transform complex variable *s* can apply to Natural numbers. They can even be thought as the commuting operators in quantum mechanics. Therefore, it is therefore not necessary to specify the order in which the different observables are measured. Measurement of the complete set of observables constitutes a complete measurement, in the sense that it projects the quantum state of the system onto a unique and known vector in the basis defined by the set of operators. According to *CICT* Infocentric Worldview, traditional elementary arithmetic long division remainder sequences can be interpreted as combinatorically optimized exponential cyclic sequences (OECS) encoding hyperbolic geometric structured information, as points on a discrete Riemannian manifold, under hyperbolic geometry (HG) metric, indistinguishable from traditional random noise sources by classical Shannon entropy computation, and current most advanced instrumentation systems (Fiorini, 2015).

CICT founding principles are the same on which Riemannian manifold theories are founded, principles of relativity and covariance, of optimization (least action and geodesic principles), applied to scale and accuracy relativity transformations of the reference system in HG. *CICT* defines an arbitrary scaling discrete Riemannian manifold uniquely, under HG metric, that, for arbitrary finite point accuracy level L going to infinity under scale relativity invariance, is isomorphic (even better, homeomorphic) to the classic Riemannian manifold (exact solution theoretically) of GSI (geometric science of information) (Fiorini, 2015). In other words, HG describes a projective relativistic geometry directly hardwired into elementary arithmetic long division remainder sequences, offering many competitive computational advantages over traditional primal Direct Space (DS) approach (Euclidean space) only.

According to our analysis, traditional rational number system ***Q*** can offer an arbitrary precision representation framework for universal numeric words that is two-fold with:

1) Revealed front-view (outer or public view) word: you can use word as data given to public use (like generic labels or words already defined);

2) Concealed back-view (inner or private view) word definition: each word is generated by encoded sequence of combined elementary generators, self-defining in turn numerable combinatorial families of related specific universal generators (either one-to-many or many-to-many).

So, we have bijection (one-to-one correspondence) between numeric word generated by the definition of encoded generator sequences and encoded generator sequences defined by simple numeric words. For the ICBS (Institute for Cognitive and Brain Sciences) seminar given September 12, 2008 at UC Berkeley, Lotfi Zadeh concluded that to make significant progress toward achievement of human level machine intelligence a paradigm shift was needed (Zadeh, 2008). More specifically, what is needed is an addition to the armamentarium of AI of two methodologies:

(a) a nontraditional methodology of computing with words (CW); and

(b) a countertraditional methodology which involves a progression from computing with numbers to computing with words. The centerpiece of these methodologies is the concept of precisiation of meaning.

According to *CICT*, arithmetic precision plays the role of precisation of meaning according to Zadeh's point (a) and (b) requirements (Fiorini, 2017b). Thanks to this new computational awareness and following this line of generative thinking, it is possible immediately to realize that traditional ***Q*** Arithmetic can be even interpreted, by new eyes, as a highly sophisticated open logic, powerful and flexible LTR and RTL evolutionary, generative, formal numeric language of languages, with self-defining consistent numeric words and rules, starting from elementary generator and relation (you get your specific formal numeric language by just simply choosing your most convenient numeric base to polynomially structure your information). It is the first, fundamental step to an effective progression from computing with numbers to computing with (numeric) words.

With its potential to equip and better shape our society with new knowledge, services, businesses, social structures, values, and welfare, AI is perceived as a fabulous enabler by Japanese, but its benefits to society will deeply depend on the way it will be implemented and used in real socioeconomic systems. AI services/products work appropriately if users understand their benefits and risks, learn how to identify responsibilities, and operate them perfectly to keep them under control. Significant issues are need to understand the advantages and limits of the current AI technologies, to perfectly utilize AI technologies, and to perform creative activities in collaboration with AI technologies.

3 Conclusion

Facing such challenges as global warming and the aging population with a low birthrate squarely, Japan will become a "model nation" which overcomes these challenges before other countries do so, and create a virtuous cycle of creation of demand and strengthening of supply capability. What Japanese aim to build is a nation of "Sanpo-yoshi" (En. Tr., all right on three sides) where three fundamental factors, that is, economy, environment, and society, work to improve one another and thereby contribute to increasing the wellbeing of citizens. Having experienced the global economic crisis, countries across the world are going deep into a substantial study on how to realize more fair and sustainable capitalism and growth.

In this process, Japanese will promote research and study on new growth and wellbeing in collaboration with foreign governments and international organizations, with a view to developing and upgrading statistics of related indicators. Through these efforts, they will establish a foundation for promoting measures to realize new growth, new environmental policy, and a new concept of public service in an integrated manner. Human reality is multidimensional and integrated. To be effective, knowledge of that reality must be too. It is always shaped by a multitude of aspects, perspectives, and forces. The tendency to condense and compress reality into simplistic formulas is a form of willful ignorance that facilitates quantification, calculation and multiple choice examinations. In the process it conditions the mind to a reductionist mode of thinking, blind to the complexity and integral nature of life, with enormous, useful information dissipation and loss.

New paradigm thinking in the social sciences can no longer deny the central importance of the subjective dimension of reality nor seek to reduce it to its chemical and nervous physiological constituents. The call for new education and new economic theory is based on the premise that the persistence of poverty together with rising levels of unemployment, inequality and ecological degradation reflect the limits of the present conceptual system, rather the practical limits of sustainable human development. A new paradigm in economic thinking is needed to make conscious and explicit the underlying concepts that limit humanity's ability to promote rapid advances in welfare and wellbeing for all human beings.

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