Cognitive communities using semantic matching: knowledge propagation and human transformation

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Abstract. Individual minds *also* form a collective brain. Its physiology and evolution are based on knowledge wave propagation- using explicative consonances lived by human pairs. The communicational network has a synaptic character. Optimising knowledge streams requires the modelling of the cognitive space to assist, in a "mirror"- usable for sustaining matching, distribution and retrieval mechanisms. A cybernetic loop is closed when the "semantic mirror" is used in the orchestration of the intellective process it models, forming an evolving whole with it. A society equipped this way has a different physiology and evolves towards different individual and collective human conditions. Once aware of this- we are overwhelmed by responsibilities. What can we do so that the "semantic web" drive us away from, not towards the world imagined by Orwell in "1984"? The meta-modelling of the "cognitive reality - semantic mirror" physiology offers instruments for fighting the pathology of the community's cognitive metabolism.

Keywords: distributed cognition, collective brain, explanation, knowledge reproduction, active models, semantic match, responsibility and awareness

1 Distributed meta-brain

1.1 Individual minds *also* form a collective brain

As any term, the notion of "community" integrates a spectrum of acceptations, leaving room to ambiguity. For some, any group of people, cooperating in a given project or meeting in a certain context- forms a community of practice (interests). For instance, efforts are made to observe and to accentuate the manifestation of the "community" of those who shop in a virtual store [1]… For others, only a prolonged cohabitation, sharing a physical space, an historical destiny and some major significations can give birth to an organic community. Technology's role in the equipment of communities is also diverse, depending on each one's position in the progress/conservation dialectic. Some use the Internet to discover or form new communities and rituals ([2], [3]). Others- to observe, preserve or equip the existing ones ([4], [5], [6]).

Also important is the adoption of different philosophical positions regarding the condition of the person integrated in the society- from individualism to sociality. Let us compare the accent put on intellectual individuality- in cognitivism and constructivism ([7])- with the attention conferred to co-existence and relationality- in behaviourism, social cognition and distributed cognition ([8], [9],[10]). This article's position (see also [11]) is dual: individual existence/becoming and collective co-existence/evolution can be bundled in various formulas- on which the saneness and beauty of the human adventure depend. The development of the individual must not be made against that of the humanity. Nor the reverse...

In works dedicated to the essence of living ([12], [13]) Maturana and Varela signal a problem that perplexes biologists: how can the auto-organization logic of a living system co-exist with that of a wider organism, integrating it- as a cell? We find the same mystery observing the "individual cognition/ collective cognition" duality. Each person develops a cognitive universe. The mankind progressively weaves a conceptual space. Neither of the two processes is possible without the other.

1.2 Concept communication, knowledge propagation or consciousness pylogenesis ?

The individual cognitive space, auto-organizing the intelligent living, passes through ontogenesis, development and death. The propagation (perpetuation) of knowledge and the consciousness phylogenesis is accomplished at the community (species) level, through concept reproduction. The research on the collective cognition can reveal the mechanisms of this cultural process.

The physiology of each individual cognitive system is continuously adapted to the one of the global cognitive system and evolves in correlation with it. If we emphasize the individual mental metabolism, we perceive (and instrument) communication between distinct cognitive entities; we seek the organization of "informational environments", offering a variety of services to the "user"; the others- are "resources"… If we perceive the same phenomena at community level- we observe and instrument "knowledge waves"- that flow through the cognitive net and insure spiritual reproduction; we seek optimal conditions for the propagation of those waves *inside* the community's cognitive space; the persons are the "medium"…

The two accents sustain different cultural policies. Dual "illuminist" approaches can aim at the simultaneous emancipation of the person and the society.

The leap from the cognitive destiny of the individual to that of the community is realised by the communicating human pair. A synapse connects two neurones… The explicative relationship is essentially a bipolar phenomenon, based on cognitive consonance and on collaboration between two free-will centres. It exploits the physical interaction through objects and the innate or cultivated sense sharing capacities (language etc.)

The dialogue between two persons ([14], [15], [16]) has phenomenological projections in the inner space of each participant, but also represents a manifestation of the collective cognitive physiology. Do we transfer corpuscular concepts between us or are we traversed by concept waves?

In my PhD thesis [17], I have tried to conceive a model for the (instrumented) explanation, integrating the multitude of involved aspects, coagulating the observations extracted from a multitude of domains- each having its own primitives, epistemology, language, paradigms, experience, rituals, models and priorities. The problem complexity forced me to resign myself to elaborate partial models and to enounce some principles that have subsequently guided my research and are at the grounds of this text.

1.3 The communicational network has a synaptic character.

The main problem I tried to tackle in several projects is that of the relationship between the human and the instrumental components of the global knowledge processing system. "Concepts" live in consciousnesses - being "human embodied". But their propagation is done through "signs", "representations", "messages", "documents"- placed on material supports. These externalisations are crucial to insure a consensus regarding the sharing of significations, allowing the objectification of subjective consonances. The communicational semantics is based on human cognitive processes, while the physiology of knowledge "circulation" is determined by the tools and methods used for communication and co-action.

Determining the mechanics of communication and cooperation [18], the instrument space - decisively influences the global cognitive metabolism- that can lead to mutations at the level of semantic processes. Passing from the mechanical synapses of the classical informational tools to the "artificially intelligent" synapses, the possibilities for a metabolic modification grow considerably. Can (must) "computer agents" become replacements for some human cells- leading to hybrid socio-technical organisms [9] or must their role remain that of prostheses, facilitating the human relationship [19] and sustaining new orchestration formulas [20]?

I was confronted to this problem while analysing the "artificial teacher" trend and searching the shift from learning procedures by working in novice-expert pairs to using pedagogical triangulations: novice-computer-expert [21]. My conclusion was that, as co-action and communication partner, the human assistant (appropriate, available and good-willed) has intrinsic qualities - difficult to mechanize. Establishing the optimal presentation order - is the finest part of the didactical expertise. The teacher (author) continuously takes refined decisions to engender his discourse. It is difficult (impossible?) to program an algorithm for taking these decisions. The "reproductive" realizations, seeking "efficiency" - can lower the quality of assistance.

That is why I have delimitate myself [21] from the orientation of the SAFARI project, in which I had involved myself (with the "Meta-demonstrator" project)- to deepen the issue of managing initiative between human and artificial agents. For the efficient adaptation of explanation, following rather the developments in "parallel processing", "distributed systems", "situated action", "social cognition", I orientated myself towards the pragmatic distribution of intelligence between human and artificial agents.

Dialogue requires two persons. Artefacts can facilitate the pertinent encounter, synchronous or asynchronous, of an explicative pair. Even a book simply confronts

the reader to the author's discourse. Instead of degrading the explicative dipole, the synaptic infrastructure based on the computer network can provide contact, contract and management services.

2 Cognitive realities and their active modelling

2.1 Optimising knowledge streams requires the modelling of cognitive spaces…

The community's cognitive reality is created by processes in which persons modifying their knowledge interact through various communication tools (including explicative documents). Regardless if the conservation or the modification of the cognitive physiology is sought, we need a profound understanding of it, shared through explanation. This requires the elaboration of a conceptual frame and of adequate modelling (description) methods.

Knowledge level. First of all, we must represent live knowledge in symbolic structures that allow us to refer to them. Aware of the principle difficulty of defining "knowledge", I use the following meaning: *cognitive living, reflecting a certain reality (exterior or psychical), perceived in a certain context, expressed by a fragment of language (cultural reference system constructed by coexistence and instruction), understood (shared) by the members of a community – that integrate it in certain "knowledge domains" and decompose it in sub-components.* Through the "word" that represents it, knowledge is reflected in the mirror of its reification. The communication process allows the use of representations, the meaning being recuperated at the time of interpretation. Based on the language's natural reference system, knowledge domains (spaces) K can be built, according to various organization norms N. These systems, establishing relationships between the representations, model (declare) relationships between the represented knowledge (and between the realities that they reflect). Therefore they can enrich (explicit) the "meaning" of knowledge and can be used as reference systems. The utility of such a "reference" depends on the expressiveness of the notion's localization in a domain and on the usage context. The various forms of organization and, consequently, of the indexing and retrieval processes have all their qualities. The best potential of automatic inference (assistance) is obtained when the reference system is organized according to a "computer-comprehensible" logic - hence the interest for ontologies [22].

Person level. Knowledge embodied in persons can be modelled (known exteriorly) only partially, the efforts for its explicitation (through symbols, language, coordinates in given reference systems) depending on the usefulness of the externalisation. In a support (instruction) system, the evolution of the subjects' understanding and the contributions to this evolution must be followed (observed and evaluated). We need [23] qualitative and quantitative descriptions of someone's position relative to a piece of knowledge (concept): defining "*competences*" - managed conforming to a norm C. The cognitive operations (relationships in the person/knowledge pair space) can be evaluated by a "mastering level", measured on a scale M. The competences'

management is confronted to difficult problems such as the calculation of the global competence for K starting from the competences on the sub-knowledge decomposing K, or the negotiation of concurrent evaluations– according to an authority protocol.

Document level. Documents contain externalised messages, in a manner intelligible to the human user, vis-à-vis to whom they represent their author. They intermediate a unidirectional dialogue, their conceiver being able to combine parallel conceptual structures with serial discourses and with limited interactivity elements. Consulting them does not pose problems to those who master the required language (code). However, finding a pertinent document from a vast available document space is problematic. Retrieval can be facilitated through "indexing", a characterization of the semantics comprised in the text, partially analogue to that of referencing person expertises. But the "knowledge references" are a simplistic and equivoque model (the relationship that exists between a document and the referred knowledge is not clear: the document defines it, explains it, signals it, presumes it known by the reader?). The difficulty of modelling documents comes form the complexity of the relationship between a discourse and a "curriculum".

Activity (operation) level. Operations that produce the modification of the participants' knowledge can have various topologies: a person that learns alone by exercising a procedure, someone that consults a support document, a "student" guided by a "teacher", a user disposing of many assistants and documents The explicative process's efficiency depends on the competence detained and sought by the participant, on the pedagogical competences of the assistants, on the pedagogical potential of support documents and ... on the concrete performance of each person in a given instructional session. In order to observe the "competence equilibrium" around pedagogical operations, explicative competences ("*pedagogical postures*") may be introduced [24] characterising a participant P (or a support document D composed by him) Using the competence equations, explicative matching services can be organized: availability analysis, resource planning, support tool selection, participant alerting etc.

Complex processes level. (see figure 1) The models of procedures involving cognitive entities can represent phenomena that have already taken place and are worth memorizing (understood, analysed, used as inspiration sources) or "scenarios" for processes that must be realised in the future. Some represent mental procedures, others exterior procedures with mental effect. Some illustrate operation chains executed by a single actor, signalling or interfacing the involved resources; others can define the "flow-control" between the elements that intervene concurrently in operations; others can manage complex scores for "man-machine orchestras"- combining resource connection, operation sequencing and participant coordination. The procedures' modelling must express the "structures-in process" duality, decomposing the procedure structurally (in *persons*- the actions' executants and their assistants and *objects*- to be produced or used) and processually (in *operations*- the actions executed or planned). *The model of a procedure* that I have used in the GEFO prototype [25] (an adaptation of that proposed in MOT [26]) uses representations for the components reflected in its "mirror": actors (hexagons) - which can designate generic participant categories or specified persons, instruments (rectangles) - which can designate concrete resources or generic classes, operations (ovals) - designating

particular or generic processes, realized or to be realized. All the elements are indexed to the same reference system [K, C]- in order to obtain a semantic aggregation and to allow the intervention of explicative matching services [27].

2.2 … in a "mirror"- usable for sustaining matching, distribution and retrieval

Modelling the cognitive reality (the involved knowledge, the participants' competences, the documents' content, the explicative processes) rarely has a passive (strictly descriptive) objective. The organisation of semantic reference systems allows the indexing of elements. This permits their retrieval- on the grounds of which emergent operational chains may be established. Otherwise, procedural models can be used for the management (orchestration) of new procedure implementations- reproducing the model more or less accurately.

I have encountered the "enactment" problem ([28]) while studying the problem of transforming MOT (LICEF conceived editor for modelling procedural knowledge, pedagogical scenarios and resource diffusion plans [26])- in a collaborative editor for cooperative procedure orchestration scenarios. Working on the Explora2, SavoirNet and TELOS architectures [29] I compared the LICEF pedagogical workflow (learnflow) modelling formulas with similar developments coming from CSCW (or CSCL)- analysing the inter-operability problem sustained by norms like EML or IMS-LD [30]

Then, I have defined the specifications for the "function" concept (model of a procedure used for its orchestration) coordinating the development of a "function manager" (GEFO- [25]). I refined this prototype in the context of the LORNET project [31]- which aims to support the technical and semantic inter-operation between educational service sources and resources repositories, accessible through Internet. The TELOS middleware (similar to others such as Cobl [20]) sustains the coherent management of a global knowledge metabolism: incarnated and evolving in participants, incorporated in explicative resources, referenced in semantic declaration structures.

The use of a functional model (see figure 1) for the execution of the procedure that it represents can mean:

(1) Inspiration. The function is used as a guide for the orientation of the actors involved in actions. The model's interpret observes the operation chain, follows the instructions on the required knowledge and on the criteria that determine the decisions, reads the support documents connected to certain nodes, etc.

(2) Declaration. The user inputs information on the execution (primarily by announcing the realised operations), answers to certain verification questions. The traces of his progress, his annotations and his answers are recorded. The observation of his behaviour can steer automatic assistance.

(3) Facilitation The function allows the launch and manipulation of the connected resources, aggregating them dynamically. It can even launch batches of automatic operations on these resources- if a control agent has been programmed to this end.

(4) Coordination. When the procedure is cooperative, acting as a synchronisation "whiteboard", the function facilitates the coordination of the orchestra composed by human participants and machine agents (via communication, co-action, sharing).

(5) Matching. If the concretization of the participants and resources is not decided prior but during execution, the function can provide filtering, selection, advising, matching and alerting services. The selection of the connected resources aims at the optimisation of the (explicative) competence equilibrium.

As we can see in figure 1, to be used in the ways described above, a "function" must be previously prepared in the edition phase.

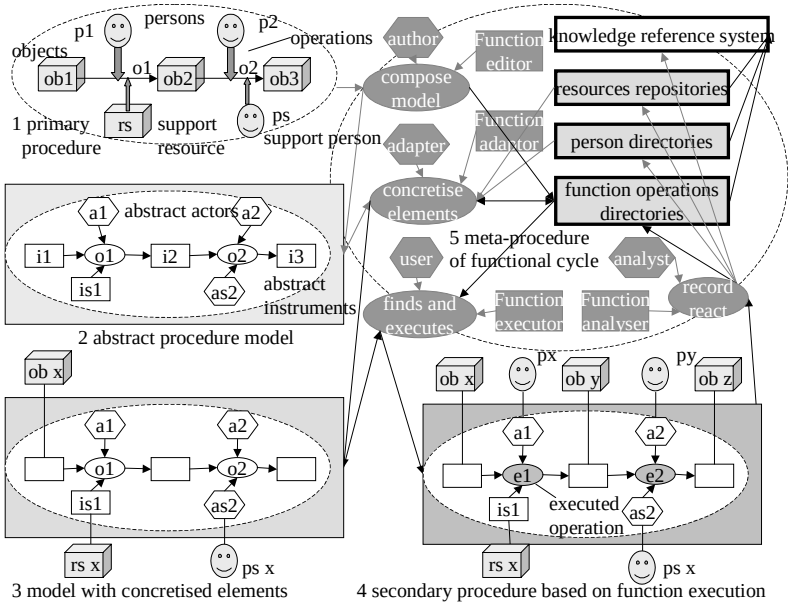

Fig.1: Procedure reproduction with functions

After the definition of a generic model and the particularization of "derivate models" by the concretisation of some appropriate elements- found in the persons or resources directories-, these models can be indexed and published in a repertory, becoming retrievable - as any resource. The users of such "procedural aggregates" take advantage of the assistance facilities prepared during edition: operation guiding, execution supervising, resources manipulation, participant coordination, run-time support connection (matching etc). The transformation cascades operating between a model and the procedural reality that it mirrors and (re)produce (as the one presented in the above figure) can be managed with *meta-functions*.

2.3 A cybernetic loop is closed when the "semantic mirror" is used

The relationship between the cognitive reality C and its model (mirror) is bilateral, dialectic, cybernetic (see figure 2).

In the "use" (execution) phase, the procedure models are used for the orientation of the actors involved in the processes leading to modifications of objects and participants' knowledge). The model's intervention is more or less "active": starting

from the suggestions made to the user, passing to the connection of two or more entities and the intermediation of their communication (coordination) end ending with the piloting of the reality's elements by "agents" installed in the mirror.

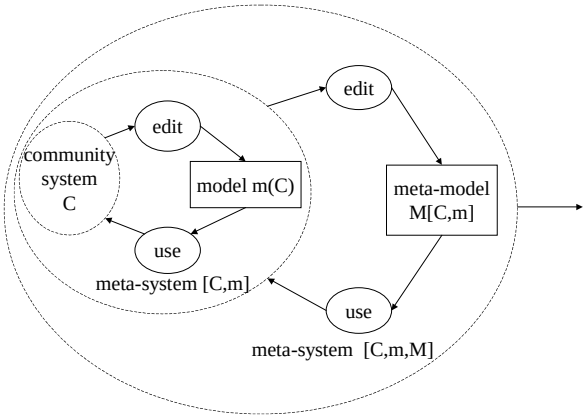

Fig.2. Extension of a community system by active modeling

Other times (in edition phase), the relationship is reversed: the M "mirror" becomes the target of preparatory operations (their influence on the reality being manifested afterwards): modification of knowledge and competence reference systems, edition of a knowledge domain, declaration of new resources and participants, edition and particularisation of operations and functions, insertion of various information on resources, participants and operations (competence indexing), etc. The operation towards the mirror (the organisation of the M structure) can be seen as a means or as a goal in itself (growth of the community's "synaptic capital", emancipation of the collective cognitive physiology).

The reality-mirror relationship defines a global physiology. Apart the initial declaration (at the edition phase), the M model can be modified (by feed-back) during its use, following observations made by users or surveillance persons and agents. An example of a process sweeping between reality and mirror (and determining the "life mode" of a function)- is the progressive concretisation of the model's elements.

In the case of computer resources, the reality - mirror distinction, is not that clear any more. A "text editor" X is part of the C world (as primary instrument), even if it is placed in the computer, beside the C world's model. Through careful management, we can avoid the confusions between the editor X and his representative x in a model M. But paradoxes nock on the door! We can ask ourselves, for instance, if the model must also reflect the reality of its use. If not (in the mirror, the mirror can't be seen, even when we use it to do something in front of it) then... at the moment of the phenomenon model's use, a reality richer then the modelled phenomenon is created...).

We reach, this way, a recursive metamodeling situation. We must model, in a M(C, m(C)) manner, the life of a system C that uses a model m(C) as an instrument of its functioning. The eventual use of the M metamodel in the management of the evolving

relationship between C and m(C)- provides important possibilities of progressive amelioration, but… closes new analysis loops. The occurrence of "vicious circles" can produce a certain epistemological perplexity, but it also opens interesting methodological research tracks.

In practice, it is clear that the apparition of a circular relationship between the (cognitive) processes lived by the C community and their modelling in the M "active - mirror" has major physiological implications. The theory of technical and biological cybernetic systems [32] shows the importance of (positive or negative) reaction loops. The models of community primary cognitive phenomena can influence, manage and orchestrate the production of secondary ones, assuring the reproduction- more or less accurate- of procedures. A community equipped with such active models changes its physiology and can evolve through another phylogenetic chains.

3 Sustaining a healthy knowledge physiology

3.1 Realising our responsibilities…

Humans, along with the instruments they use, determine the global functioning of the society and also are its products. The introduction of writing, printing, television, computer networks- has had profound implications on the informational phenomena, modifying social rituals and- finally- changing the personality of the participating individuals. Becoming aware of this fact, we encounter fundamental problems of social and spiritual ecology. The evolution of the society's and people intellectual physiology, under the pressure of a technological progress (fuelled in its turn by business interests and market speculations)- is it beneficial? Do the triggered mutations really emancipate the individuals and the mankind? According to which values and objectives? Where do they lead us?

It isn't normal to build instrumental worlds before knowing how they will influence the human condition. To shelter humanity from the danger of degenerative adventures, the technical engineering should be accompanied by a social and cognitive one. But, due to the complexity of the socio-technical system, it is extremely difficult to estimate the long-term social and anthropological implications of technological innovations. On the other hand- the rigorous planning of the society's destiny, accomplished according to esoteric agendas, even if possible, is not necessarily desirable.

Collective brain enriched with artificial cells and developed under the control of meta-decision centres? Of course, extremely interesting. But beyond questions like "what" and "how", stands the "why" of responsibility. Equipping society with the semantic web infrastructure can produce, planned or not, major social and anthropological changes. We can imagine a multitude of futuristic scenarios, from the most fascinating to the most frightening ones.

In an optimistic perspective, the semantic mirror will spectacularly increase the possibilities of intellectual collaboration between the members of the community that

uses it. It imagine the individual connecting himself to the synaptic system to get in touch with his potential human or artificial supporters- helping him to find or understand some knowledge; using sophisticated instruments for searching pertinent and accessible material and human resources; resorting to orchestration services as: operation ordering, coordination in collective scenarios, semantic matching and facilitation of resource use; consulting his "personal cognitive agent" to see what interesting elements have appeared in the network: intellectual partners, recommendable activities, contractual possibilities etc.; declaring, at the opportune granulation level, the information necessary to be alerted about some created opportunity or to be called to support another participant; contributing to the propagation of the explicative waves he has subscribed to; evaluating and being evaluated; recompensing and being recompensed; respecting ethical norms and intervention protocols and participating to their elaboration and election; freely choosing his distributed communities; conserving his intellectual autonomy and fulfilling himself - in the context of the collective evolution.

The pessimistic perspective can start from the discrepancy between the feverishness of instrumental progress and the slowness of moral and political emancipation. It foresees the individual, intellectually "satellitised", connected to a system that decreases his autonomy and specificity- in the name of integration and efficiency; progressively diminished as separate and specific entity, simplified (in order to be understood by computers), similar to those he must semantically "inter-operate" with; included in a unique "global" community and functioning according to the Optimal Norm; lacking any real influence over the rules of a game that spiritually models him; continuously exposed to propaganda and marketing; haunted by assistance obligations and rendered hysterical by informational needs growing exponentially; alienated by the artificiality of the condition he is lead to by a cancerous progress, deprived of his privacy- through the obligation of being meticulously and continuously "explicitated" in the synaptic network's mirror; living in the atmosphere imagined by Orwell in "1984"; being cognitively raped- in the name or love… or staying away from cognitive love- fearing rape…

Connecting people through semantic web is a critical operation. What can we do to avoid the second scenario and lean towards an optimal realization of the first? How are they interlaced, in a real case? What elements favour the tendency towards one or the other? What symptoms signal the deviation from integration towards cognitive subjugation? These are - I believe - questions that should polarize the research on the pragmatics of the use of semantic web as an instrument for orchestrating the life of cognitive communities.

A levelled approach seams appropriate. At the first level - we analyse the problem of reflecting the knowledge lived by the community in the "semantic mirror" (see as an example the semantic web approach [33]. At the second- we study the way this image is obtained and updated- on one hand- and its influence on the community life- on the other (see the pragmatic web approach -[34]. At the last level, we should observe the logic of the evolution of the global system formed by the cognitive reality and the active mirror that reflects it and influences it. This would allow us to pose and resolve "longitudinally" (throughout the historical evolution) problems such as: autonomy versus cooperation, interoperability versus specificity, coherence versus

variety, awareness versus privacy, descriptive economy versus degrading simplification etc.

3.2 …we can use meta- modelling to fight pathology

We thus reach the necessity of representing processes extended in surface and time such as: the physiology of a complex system involving knowledge, the lifecycles of semantic resources, the evolution process of a system ([35]) and its extension through "phylogenetic" production cascades etc. We intersect here similar preoccupations that come from different directions (software engineering [36], community informatics [37], pragmatic web [38]).

I have already used [39] the GEFO prototype for modelling (see figure 3) the knowledge global metabolism described in paragraph 2.1.

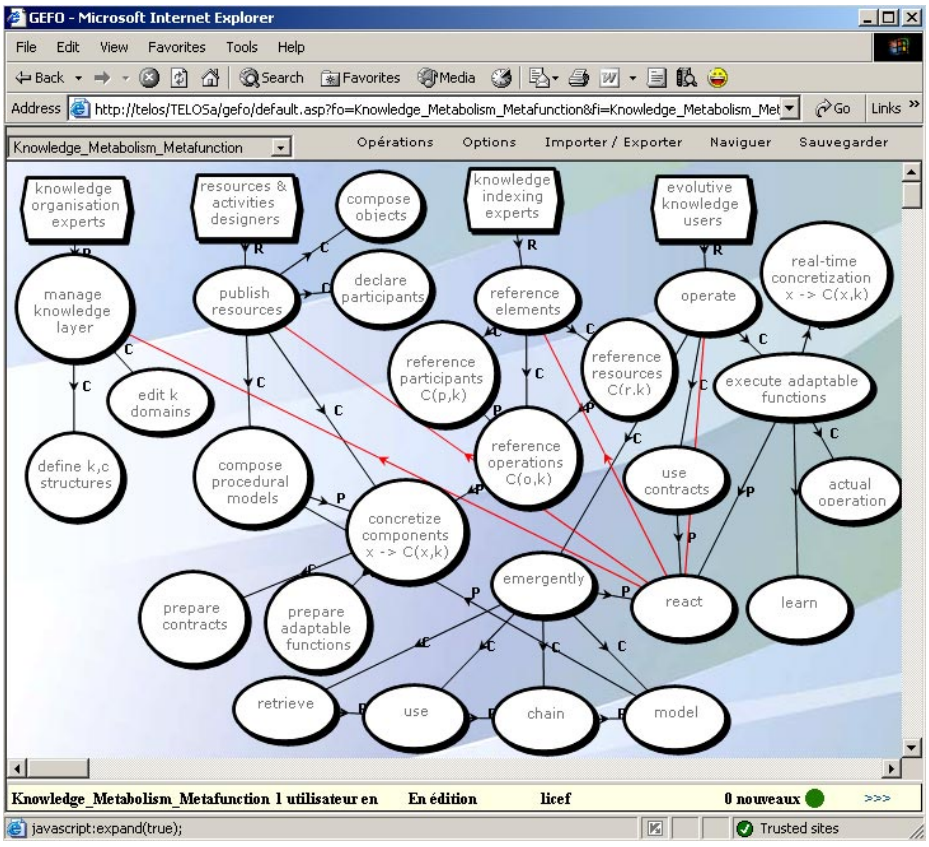

Fig.3. Global physiology of a knowledge system, modelled as a function

Here is a short textual description: 1 A designer defines the organisation structures for knowledge and competences; on their grounds, knowledge domains- usable as

semantic reference systems- are edited. 2 Documentary resources are produced and then declared in repositories; in addition, support persons are declared and scenarios for the explicative activities (operation chaining, their topology, the actors and abstract instruments) are edited. 3 Habilitated experts (in the case of an institution) or members of the community evaluate the persons' competences, index the support documents and declare the explicative competences around the operations. 4 Conceivers create instances of function general models, concretising resources and actors, with the help of support tools that allow them to make the appropriate choices for satisfying competence conditions; rigid "contracts" can thus be reached or concretisation (adaptation) liberties can be kept for the execution phase. 5 Users can operate emergently, chaining freely retrieve-use-react sequences; procedural chains established this way can be an inspiration source for new function models 6 Working in orchestrated mode, users intervene in the instance's execution, taking advantage of the support optimised by the machine agents supervising the competence equilibrium.

7 After operation, regulatory reactions can take place: the learners' competence models are updated, the indexation errors (or even the organisation errors of the K spaces) are corrected (the integrity of the previously edited references being conserved- [39]).

As this example also shows, graphical and narrative representations possess complementary qualities. If the goal would be strictly descriptive, functional modelling would probably not be necessary. But it can become the support for the management of the illustrated phenomena. After the definition of a meta- ontology about knowledge processes and the preparation of functional facilities (chaining, manipulation of system resources, orchestration, matching etc) functions as that of figure 3 can become tools for the meta-management of systems integrating tools for the management of knowledge and for the management of resources, expertise and activities- related to it.

As I have signalled in par 2.2 (figure 1), the use of "metafunctions" correlated with the use of the functions (see a similar approach in [36]) of which they model (manage) the lifecycle- can offer support for the definition of a *system evolution typology* and of *model life modes* - (expressing the relationship between the evolution of the model and of the modelled reality). For instance, the function definition process, starting with the base (class) model (that includes abstract actors, operations and instruments) can be continued by concretising the elements (participants and resources chosen from the accessible repertories)-in many ways. An arborescence of increasingly particular "derivate" models can be obtained this way. The function "life mode" characterizes the liberty space of this derivation process or its effective growth. We can, for instance, establish (observe, coordinate) modes such as: the editor fixes only the topology of the implied operations, leaving the right to fix resources to the administrator, and to find support partners- to the executor. Or: the editor fixes the support resources; the administrator allocates participants etc.

In conclusion, the modelling of complex phenomena could help us perceive the longitudinal evolution tendencies of the community's cognitive system. The observation of the "cognitive reality - semantic mirror" physiology offers possibilities for fighting the pathology of the community's cognitive metabolism. Recalling however the steps described in chapter 2, we realise that the metamodel of a global evolution could also be used for its orchestration (ruling)! These may be steps in the

direction of a meta-intelligent species, capable to understand and influence its own phylogenesis, auto-constructing itself in an emancipating spiral. Or ... powerful instruments usable in destructive meta-scenarios. We run again into the problem of responsibility, one step higher!

It becomes clear that a successful climb on the technological spiral (towards a better man in a better world) depends on the development, in tight correlation with the pragmatics of the WEB, of an adequate socio-politico-moral strategy.

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