# Postext – A Mind for Society

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**Abstract.** We present Postext (pronounced POS-TEH) - a platform for collective thinking. This generic system was originally created in order to assist the community of complexity research to self-organize (the system is operative and can be found at `http://complexity.huji.ac.il`). In this paper we describe the basic philosophical ideas that promoted its creation, and the circumstances of its specific application to the complexity community.

## 1 Thoughts, Words and Context

Communication is an act of framing - by choosing what will be said, one excludes an infinite amount of information, leaving it to be inferred by the receiving side. Much like foreground and background in visual perception, a message communicated is dependent on the context in which it is embedded. Most of the context is built into the language we use to express it. Yet, if we understand the language (sometimes, in the case of scientific discourse, a language full of specialized words and jargon), we often become blind to the extent in which this contextual frame qualifies the entire message. This is no secret to computer scientists, who have been struggling with natural language processing for decades.

One could say that context is "the stuff meaning is made of". Thoughts are also an object of pure context. They are never abstract - You always think of something, a certain object. However, as the Psychology theorist William James pointed out[1], that object is hard to corner. When we try, it fades into the interconnected concepts, precepts, and sensory inputs that brought it on. We try to grasp the thought by putting it into words, but usually the most we can hope for is 'the crumbs that fall from the feast'. This is mainly because one cannot hope to communicate the entire contextual scope of every thought.

In the realm of linguistics, similar ideas were advanced by Postmodern thinkers like Jacques Derrida[2]. According to this view, a word derives meaning not from

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its own innate value, but rather from all the other words than can be linked to it. Comprehension and ultimate understanding result from this associative power of language, the ability to summon the correct context to support the words back into coherent ideas. A concept, like a word, derives meaning, and especially purpose, from the all the other concepts in relation to it.

The first stage of the elementary writing process exemplifies a natural pattern of thought. In elementary school, children are taught to compose an essay by "clustering" associations, a procedure which usually consists of writing an idea in a bubble and then drawing lines to additional bubbles of supportive or related ideas. The thoughts and connections should be complete before the actual writing starts.

The challenge of expressing and communicating reality was exposed in all its difficulty in Umberto Eco's book "In the Search for the Perfect Language" [3]. Notwithstanding Lao-Tzu's "that which can be named is not Tao", one is forced to accept that in practice, the fundamental and primordial act of "conscious" cognition is one of discretization - an infinite (of continuous cardinality) world is projected into a finite set of categories, which eventually crystallize in our minds into concepts, and cast into words. This is probably unavoidable to all but the true Zen masters.

## 2 The "Classic" Text

The main characteristic of written language is its unavoidable linearity of structure. Elementary-school children, after depicting their thoughts in a graph structure, are instructed to fit their clustered ideas into the linear form of text. This linearity imposes severe restriction on the representation of ideas. Freezing ideas in their tracks, we dissipate the flow that gives them substance, creating in essence a sequence of one-dimensional snapshots of a multi-dimensional object. Thus, the challenge to the reader is often similar to the challenge of the six blind men in the Maharaja's palace[5], trying to reconstruct the concept of an elephant, after each touched a different part and got the impression that it is, respectively, like a snake, a wall, a spear, a tree, a rope, and a large wing.

Academic writing is riddled with transitional phrasing implying causality, e.g., "thus", "therefore", "due to". Linearity forces the purpose of the text to be that of an argument, as conclusions can only be drawn from inferences in a logical sequence. Furthermore, the concepts addressed by the text are limited by the thesis of the argument, its narrative. Any concept or bit of information that is not wholly supportive of the immediate thesis is weeded out, leaving a vast number of related aspects on the cutting room floor. These floating snippets, albeit mere tangents to the "point" of the text, are often valuable. In science and academia, where knowledge is the goal, not politicised argumentation, these snippets should not have to be removed.

**Fig. 1.** A Talmud Page. Note the division of each page in fixed threads that flow (interactively) along the entire opus (approx. 63 volumes)

The Jewish Talmud was one of the first attempts to transcend the problems of text linearity. The solution was to present a stenographic elliptic statement of the main facts in the centre of the page; written around it were various "sub"-texts providing commentary, interpretation, and suggestions of other aspects of the main point - in short, a supply of context (Fig. 1). This style of textual presentation makes additional information available for reading *from within* the original document, like footnotes. This induces mutual context, with the original text suggesting a certain reading of the commentary, and the commentary suggesting a certain reading of the text.

In currently standard scientific texts, the very connection to their multidimensional intellectual neighbourhood is linearized (and laminated) in "the bibliography". This is typically a list of references, where connections to external texts are stacked, as an afterthought, following the actual end of the opus. This list, trailing the text, attempts to fulfil the need for related knowledge or concepts that were left out of the main body, for being only loosely related to the main argument of the text. Usually references serve as a token of authority, exempting the author from tedious elaborations required to back up a certain point. They may also serve as a collection of related works, a set of suggestions for the interested reader who seeks elaboration and extensive context. Unfortunately, bibliography lists stop short of actually making the referenced material available, and so fail to meet their own goal. No wonder that fully referenced material is typical only for professional publications, targeting a very learned audience.

There is no textual structure that can accommodate all the context of a statement. Footnoting and subsectioning are but feeble, incomplete solutions. To avoid confusion, annoyance, and vulgarity, they must be incorporated with caution. Furthermore, the physical confines of the printed page prevent any attempt at presenting a comprehensive network of knowledge.

Providing "complete" context within a printed document is not only impossible but would be counterproductive too. The main concept needs a context; but once the context is supplied, the main idea becomes just one line out of many in the page. We run the risk of losing the diamond in a lingo of gold (rather then exposing it in a fine gold monture). The main idea drowns in the context provided to situate it, lost in the multitude of words that sophisticate it.

The structure of narrative prevents the inclusion of concepts that do not fit into its predestined linearity. An attempt must be made to fully account for as much knowledge as possible, embracing the potential for full implication to exist. Such an attempt would call for a radical new conceptualisation of the cohesiveness of text.

## 3 From Hypertext to Networks

In recent years, networks have become a prominent object of research across many disciplines. From gene regulation to sexual partnerships, it seems like everything is being analysed from this perspective. And indeed, studying the underlying network of social and natural phenomena has proven to be a powerful new way of looking at things.

However, working with networks is still a challenge. A static representation of a large network is often too dense to be easily perceived, especially if the system is heavily connected. Recently, a dynamic and interactive approach to network representation is making great advance, and new tools, such as the "Visual thesaurus" (`http://www.visualthesaurus.com/`), or the "Touchgraph Google browser" (`http://www.touchgraph.com/TGGoogleBrowser.html`), are suggesting new and exciting perspectives on the world of information.

As of now, the most ambitious attempt to solve the problems of textual linearity is Hypertext, an alternative founded upon the tenets of Postmodern linguistics. Independently of its common use in the World Wide Web (WWW), Hypertext has been explored as a new medium for literature. Literary pieces in Hypertext, like Geoff Ryman's novel 253 (`http://www.ryman-novel.com/`), resist closure both in structure and purpose - many links lead to redundancy or dead ends, and all stem from primary branches, which in turn stem from the trunk, or main body of text. In this way, Hypertext attempts to upgrade the text from a line to a network.

Yet, when browsing in Hypertext, one can only experience it at every moment as a tree; a quasi-linear system of pages, with single paths extended and withdrawn. Although we may navigate in a network of links, and even with the aid of the standard "Back" and "Forward" buttons, we still explore only one branch at a time.

Even more problematic is the sensation of disorientation, inherent to this method of traversal. Like driving in Jerusalem without a map, the "reader" will soon get lost in the plethora of splitting paths and overwhelmed by the multitude of histories (and browser windows). Backtracking is often used as a simplification, at the price of losing the backtracked trails, often resulting in further disorientation. Indeed, Hypertext provokes a battle between the viewer and the seemingly limitless number of paths and uncharted (or already frustratingly charted) territory.

Without a sense of "location" in context, the viewer is lost in a sea of unconnected references - although the pages are linked, once the link has been selected, its relationship to previous pages exists only in the memory of the viewer. The navigation (attempted, but impossible) of this endless maze often leads to frustration and ultimately hostility towards the system.

We believe that the network of ideas that underlies every concept should be represented explicitly. What we conceive is a network whose nodes are items of information. These can take any form, be it an equation, a paragraph or a movie. Browsing through its elements, a map of the neighbourhood of the current item is always in view, providing context and facilitating orientation. There is no longer a main body of text, only pieces of information linked in a web of connections. Yet, a coherent picture may naturally emerge in the mind of the "reader", due to the graphic representation of the relationships between the ideas.

In such a setting, ideas are freed from the constraint of linearity, and may relate to each other to form a complex web of interrelated ideas. Such a platform could be nearer in spirit to the true form of human thought, much more so than a logically structured argument. At the same time, the "reader" can maintain orientation in this web of ideas, thanks to the dynamic map that keeps track of his/her wandering, providing the context for every element. Furthermore, such a setting may be extended to allow "readers" to personalize, in an interactive way, the information space, by allowing them to leave marks in the places they visited, or even to extend and contribute to their contents, their connections and their setting.

As soon as information items are allowed to arrange in a graph, richer dynamics may emerge. For instance, the ubiquitous role of transitive connections (diagonal links) in the emergence of creative ideas, new products and story unfolding has been systematically substantiated in a series of quantitative measurements, which could be considered as precursors of the present scheme[6, 7, 8].

## 4 From Co-authorship to Communal Authorship

Another limitation imposed by "classic" text is the fixedness of printed literature. Books may be revised at later editions and corrections may be published for articles, but these are inefficient exceptions that do little to maintain the relevancy of the text. In the general case, the linear text is frozen forever upon completion. Thus fossilized, the text is unable to undergo significant evolution, in order to remain a living and useful product. This is especially problematic when accounting for academic and scientific material, which can be quickly rendered "out-of-date" by new knowledge.

Paradoxically, irrelevancy is guaranteed especially for those rare occasions of true scientific breakthrough - by definition, groundbreaking ideas generate a new intellectual or factual context that often contradicts previously established modes of thought. After the paradigm shift takes place in practice, the text finds itself outside its original context; surrounded by the ideas it spawned, yet alien to them, since it was composed in another context.

Scientific collaboration (including often very many authors) has become commonplace in the academia, and this has its obvious benefits. However, articles that report such collaborative work are usually co-authored. The need to establish consensus with your co-authors is a challenging task, and one often finds it necessary to compromise. This may not be without consequences - compromises accepted in expressing a reality might compromise the reality of the expression. Moreover, compromise and consensus yields conformity and the exclusion of disputed ideas. Such exclusion, as already mentioned, stunts conceptual growth and limits the spread of knowledge.

Recently, a new form of "massive co-authorship" has gathered popularity - certain websites allow all visitors to take active part in creating the content. Ward Cunnigham devised this approach of *open content* in 1995, when he created the "WikiWikiWeb" (`http://c2.com/cgi/wiki`); today there are thousands of web pages running some sort of Wiki. One direction in which Wiki has developed is the web logs (blogs) and live journals, where visitors may broadcast whatever message they find relevant. This type of site allows for the emergence of a community around it, where people may converse with other people of shared interests, and the entire community accepts responsibility for the relevancy of its site. Of course, relevancy is a relative term, and so its definition is the site's main characteristic - like foreground and background, an infinite amount of potential news are necessarily excluded. Dialogues exist in a well-defined frame of time and mind. The time frame imposes linearity, while the connection of minds between the speakers makes the it dependent on a large volume of perishable

context (which exists only momentarily within the minds of the conversers, and so is implicit to the words actually uttered in the unraveling of the dialogue). while this is beneficial for the transfer of knowledge from one individual to the other, it becomes a liability for a perennial durable repository of information.

At the other end of the Wiki spectrum there are visitor-compounded information repositories, such as Wikipedia (`http://www.wikipedia.org`). In that case, the distributed effort put in by tens of thousands of people from around the world created an online encyclopaedia that contains over 300,000 entries.

The open content paradigm (behind the Wiki ideas) stems from the belief that when releasing the constraints, the system will reach a dynamic equilibrium, rather than mayhem. In practice, open content proves to be very stable in terms of resilience to malicious activity. The community that congregates around these projects has more motivation and more resources to maintain it in good form, than occasional mischievous passer-by would have to damage.

Nevertheless, a major shortcoming of Wiki should be pointed out: a Wiki text is bound to reach a certain equilibrium. This may be the result of a consensus in the participating community, in cases where the subject is not controversial and the community is small enough. In certain cases a dialog may unravel, stemming from a minimal point of agreement. However, in cases of collaboration on larger scale (such as Wikipedia), equilibrium is often reached by means of compromise. Equilibrium is a necessity imposed by the openness of the system: the "edit all" option of Wiki enables an entire community to work together on the same pieces of information, but at the same time it forces the co-authors into compromising their ideas in search of a universally acceptable common denominator.

Thus, Wiki is extremely efficient in creating consensus virtual societies, but it might be less efficient in supporting dissent and revolution within the participating community itself. We must remember that alignment to equilibrium does not equal ongoing Self-Organization, in the same sense that crystallization does not equal (and in fact excludes) complexity emergence. Wikipedia, The last cry of encyclopaedism, shows the inherent problem to the vision of the encyclopaedists: the total sum of human knowledge simply cannot be assembled into a coherent opus, as it necessarily contains contradictions. These cannot fit in a unified encyclopaedia, but without contradictions the encyclopaedia (as in Gödel's theorem[9]) is incomplete. Therefore, an alternative container for the aggregation of human knowledge should be sought.

## 5 Postext – A Platform for the Mind of Society

The platform we suggest is an open content, network-oriented information repository, which we call "Post-text", or Postext in short. It is a distributed system of information items, (self-)organized in a network, created and updated by its authoring community.

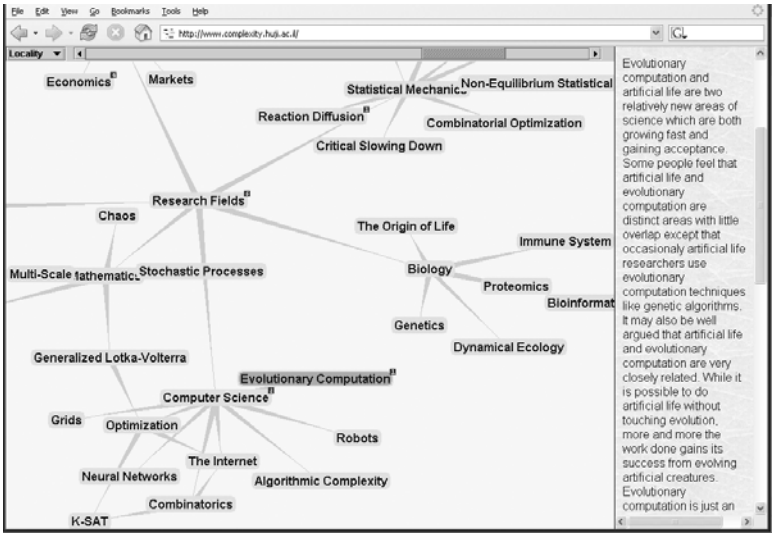


**Fig. 2.** A Screenshot of Postext. The system is focused on the "Evolutionary Computation" post. The left side presents part of the graph that is the neighbourhood of that post, and the right side is (part of) the content of that node

The basic element in Postext is called a "post". It is basically a web page, and so it may contain any type of content (text, figures, movies, equations and so forth). As any web page, the post may contain links to other posts, to downloadable files, or to sites outside Postext. In accordance with the open-content paradigm, posts act as wiki pages - any user may post a new post, or edit the content of existing ones. The Postext system provides the user with a simple interface to create the post, by using techniques inherited from wiki: the content of the page is written as plain text, and the system intelligently deciphers the authors' intentions with regard to the formatting of the page (i.e. transforming named URLs and named posts into hyperlinks, while rendering named images). This is a key point in making the Postext accessible for easy shaping by the entire community. Using the same interface, users can edit existing content as well.

The difference between a post and a regular web page lies in the embedding of the post into the Postext network. In Postext, the network of linked posts is not underlying - it is ever present and under user control. The Postext screen is split in two - the right pane presents the content of the presently selected post, while the left pane presents the post as one node in a graph. This graph shows a small part of the Postext network, the posts as nodes, with edges connecting them to represent a link between the posts. The graph pane shows the neighbourhood

of the active post at a certain radius - for example, if the user chooses to see the neighbourhood of radius one, then all the posts that link to the present one or are linked from it will be visible. a radius of two will show the second order neighbours as well, and so forth (Fig. 2).

The creation, visualization and manipulation of the graph data is realized by an open-content graphic engine called "Touchgraph" (`http://www.touchgraph.com`). The graph is laid out in a way which assures maximum visibility of the nodes, yet maintains the relationships imposed by the links. This is done by simulating a "mechanical system" in which the nodes are subjected to "forces": to ensure the spread, the nodes repel each other, and to enforce the relations, the links act as rubber bands, bringing linked nodes closer together. In order to generate a view of the graph, the nodes are placed in space, and the mechanical system moves realistically across the screen until a dynamic equilibrium of nodes' positions is reached. When the user interacts with the system, the forces of repulsion/attraction are recalculated according to the changes he introduced, and the nodes are freed to accelerate and move around as dictated by the forces. The result resembles a structure of springs and weights, accommodating the pressures set upon it by the structure of the graph and by the demands of the user.

Users may operate on the network, by adding and removing posts and links between posts. Properties of the presented graph can also be changed - the user can hide a node or a link from view. More subtle manipulations to the graph representation are also possible - nodes can be dragged and repositioned. Every such change would affect the entire graph on display, because the applied forces that determine the view will have changed.

The visual presence of the map serves two main causes: the map orientates the reader, and the neighbourhood nodes provide context for the current node. Thus, the node itself may be presented "at net value", without wasting words on introductions.

The difference between the Postext web and the WWW should be stressed: the fact that the underlying network is visually available dramatically changes the user's experience. Moreover the inclusion of a new post is a much lighter task (technically and conceptually) then initiating a new WWW page. In fact our experiments show that the WWW cannot be cast trivially into a Postext format. When one attempts a machine-based projection of a system of WWW sites into a Postext, the resulting network is often too dense, and the nonsense picture it suggests fails to provide the user with the desired orientation. This can be fixed by an informed editor, who may use his/her understanding about the conceptual content of these sites to manually modify the network, and render it comprehensible; in fact, this is quite an easy task. However, the intervention of a human mind seems irreplaceable, because the redundancy in the regular WWW structure, the overlap between pages, and the presence of links of less relevance, pose a challenge that can only be answered by true comprehension of the knowledge represented in these sites. This, we believe, is beyond current abilities in artificial intelligence. This is why we believe Postext can only be

generated and maintained by an entire community of involved authors as a sum of the projections of all users' idiosyncratic opinions and ideas.

Every post can also serve as a "place", where interaction between members of the community may take place. Every post, apart from its content, may contain "discourses": like forums or chat rooms, a discourse is a container of conversations. The discourse in a certain post would naturally concern itself with the content of that post, and with the context found in the neighbouring posts. Thus, discourses may split, or migrate from post to post, according to the subject. Discourses might mature into an independent post, and ideas spawned by the discourse may find their way to the content of neighbouring posts. Content posts and relevant discourses are linked on the Postext map, yet exist as separate entities, due to their diverse nature: discourses are an essentially temporal experience of the participants, embedded in a specific mind- and time-frame, while content posts are in nature a more perennial information repository.

Furthermore, the authors themselves are represented as posts in the system, and links connect an author with the posts to which s/he had contributed. This subtle alteration introduces a meaningful modification of the topology. It brings closer together items that have the same author, and authors that share a similar area of interest (note how the spatial meaning of the word "area" is well-defined in Postext). There is no essential difference between a "content" post and an "ego" post. As in the "content" posts, the context in which each author resides defines his/her place in the network, and vice versa - the (identities of the) contributors to a subject become part of its context.

Filters may be applied to the graph view, to project certain aspects of the Postext. The links that represent contribution maybe filtered on a temporal basis, or the nodes representing authors may be hidden altogether. The entire system can be searched, and a mechanism of personal bookmarks exists to facilitate navigation.

So, for example, filtering the results to show contributions in the past 24 hours, will show the hottest topics, and the most prolific authors in the past day. But the picture that emerges is much more informative than the "top ten list". The combined picture of authors that took part in the changes to a post within a limited time frame implies that the authors were engaged in a conversation. Conversely, an author that made a contribution to several subjects in a limited time frame must have had them all on his/her mind simultaneously. This not only elucidates the active interests of the author better than any autobiographical notes could, but illustrates a contemporary picture, detailing the mind of the community, and the 'thoughts' that occupy it. In fact, the deformations induced in Postext by the "active browsing" of a notable individual contain valuable information, and may be made available to other interested users (his/her pupils, disciples, followers).

The challenge faced by Wikis, of adherence to a consensus, is transcended when ideas are merely placed in a network. In a graph, complementary, orthog-

onal, alternative or opposite views may be expressed without compromises and without quarrel in different posts (connected or not, neighboring or not, addressing one-another or not).

The community that is established around open-content sites plays a broader role than simply "feeding" the site with new information. Each member of the community, who frequents the "places" that are of interest to him, will naturally take care to weed out off-topic remarks and other disturbances. The joint force of a community was shown (by many sites that have formed such communities) to be stronger than any malicious passers-by. The ability of a community to heal the occasional damages stems both from its number (which by definition is larger than any lone-gunman) and from the frequent interactions with the system. Thus, we hope that Postext will require no maintenance by designated moderators.

## 6 Implications and Ramifications

Postext transcends the dilemma of artificial consensus vs. destructive arguing, due to its anti-narrative structure. By relaxing the need for classic argumentation, it allows the community the freedom to differ without compromise or quarrel. It transcends the problem of Hypertext, since the ever-present map facilitates orientation interactively.

Thanks to the improved sense of orientation, massive collaboration is greatly facilitated; at the same time, it allows intimate expression of thoughts in their finest detail, uncompromised by the need to fit in an argument. Since the network representation is closer in nature to human thinking than a text, the strenuous linguistic effort of sharing thoughts is simplified. In every instance, different points of view are not merged, but rather juxtaposed in a symbolic relationship that mirrors their divergence in real life. The distributed branching format of Postext allows the introduction of an arbitrary level of technical detail and rigorous scientific proof, without affecting or cluttering the main points and the broad brushes.

Postext is adequate for communal authorship, but the complementary is also true - Postext depends on the effort of an entire community. Due to its transparency, any out-datedness in Postext will be immediately recognizable. Any fault in the ideas presented could no longer be hidden behind literary talent.

Beyond the obvious advantages of such a "community mind", we are convinced that the multidimensional, spatially distributed structure of the Postext would lead to fundamental changes in the way a community thinks. In particular a new way for producing and organizing knowledge can emerge. While in standard scientific interactions there is an advantage to forming hierarchical community leadership and forging an "official" community consensus, Postext allows having large volumes of the multidimensional space left open to arbitrary positions. In the case that a participant finds certain areas irrelevant, s/he can

filter them out of the view, or just browse to other places; every newcomer will soon find what zones are of more personal interest than others.

Postext can tolerate anything - the presence of "junk" is not more of a hinderance or of an embarrassment for Postext then the existence of a sewage network is for a city like Paris. If one wishes, one can easily avoid forever regions of the Postext which one considers irrelevant. Yet this Postext freedom allows the equivalent of real-world "fringe" places: avant-garde art schools, Hyde parks, and other means of unconstrained social expression. Postext (as other distributed structures) is reinstating freedom not only from scientific "dictatorships", but also from the more recent forms of mainstream (minimal denominator) cultural totalitarianism.

Most importantly, Postext is easily communicable to newcomers and can solve the problems of the modern educational systems. This is a big problem in the realm of "classic" text - even the most complete library is not self-explanatory (Poincare: "facts don't speak"). Thus the increased penury in teachers capable to teach modern knowledge as it is being generated. The self-organized Postext is in principle a stand-alone entity, providing its own context and reference-frame. Postext does not need (and in fact does not admit) a critique, an introduction or a Preface ( where would one place it?!).

The nodes and edges of the Postext are a form of constraint, however it is a fluid and explicit one (not only can posts be created and destroyed but also merge, split, congregate and change character). In this it relates closely to the way we think. Postext should not be regarded as a passive infrastructure. In fact,Postext posses the abilities to infer and extract rich contextual information from the implicit actions of its users. This provides the users the means to move from a binary world, where a connection between different entities either exists or does not exist, to a rainbow of connection strengths, ideas, levels of importance, and persons' significance in the community. On the graph pane, the different posts interact continuously and dynamically. This property of the system introduces casual connectedness of physically-disconnected ideas, as every node in view has the potential to alter the place of every other node in view , thus realizing implicit interconnectedness of concepts - a quality of the continuous mind, rather than the discrete text or Hypertext forms that exist today. This, and other unique properties of Postext, welcome the introduction of innumerable options for extension of the system and its capabilities, and we will name here only a few.

When users interact with Postext, they deepen some links, while weakening others. Thus, they implicitly signal the importance or the controversy of certain claims, while signifying others as outdated. Though Postext has the abilities to extract this implicit knowledge, it remains flexible enough allowing each user to decide on the layers of implicit information s/he deems useful. For example, a researcher might wish to know what are the hot topics of interest and discussion, and Postext will present it to him, for example, through varying the background colour of different nodes (using the standard mapping connecting redder hues to hot and bluer ones to cold), while a novice student would be interested in

the most paved pathways, through which most people have stridden before, like an ant walking on the scent of steps already taken. This framework of flexible inference transforms Postext into an active system, which allows interaction between its users, not only in explicit form (through concept identification or text editing) but also in various implicit manners.

Another possible ramification would be the introduction of link-types. The user may indicate that the link he added between two posts is of a certain type, e.g. extension, contradiction, similar underlying mechanism, and so forth. This will allow advanced filtering of the network - for example, users may choose to show only "derivation" links, and the presented network will become a tree-like system of theorems and proofs.

As described above, exposing the context of thoughts and information, through graph representation, lies in the heart of Postext. Sometimes, the context is embedded in a concrete space which can be identified, rather than in a white canvas. Postext, then, allows the reciprocal embedding to materialize in it. The most vivid example for this is the geographic embedding, where the nodes of the graph are pinned down to various points of an existing map or relationship which relate to them. Imagine a Postext which deals with the history of wars where the various war nodes are embedded on the globe in the points where they occurred. Or, in another extreme example, a Postext which is embedded to an output of the CERN LHC accelerator where nodes relate to the different reactions and particles presented.

Postext is based on peer interaction. Thus, its underlying metaphor should not be of a single central repository, but rather of a loosely coupled, yet tightly integrated consortium. Postext will be the realization of true peer to peer content distribution, where different users host different parts of a Postext, and users move seamlessly from one host to the other. Thus when Postext moves from a metaphor to an uncontrolled, evolving, network of information, it will move at the same time from the current ruling paradigm for presenting information, i.e. the client server paradigm (which lies in the heart of the WWW), to the much more efficient, resilient and natural paradigm of peer to peer distribution. When Postext will be deployed as a peer to peer system, it will naturally possess features which are otherwise quite difficult to maintain, such as load balancing, replication and mirroring, and minimal latency. Popular segments of Postexts will be spread to more physical nodes (hosted by Postext users) than less popular ones. Users will be able to link their home Postexts to other related Postexts. An example which goes towards this future can be found in: `http://www.netDimes.org/shire/dev/`, where the home Postext of one of the authors is connected to the complexity network Postext (see below), a different Postext hosted on a different machine altogether.

We hope that Postext will allow for the emergence of true collective thinking. The various individuals, groups and sub-societies are in a relationship similar to the various modules described in Minsky's "Society of Mind"[10]. As such, one can imagine the way in which their apparently diverging actions can achieve a coherent, positive net result. The modularity of the system should not be

regarded as an obstacle - as Minsky argued well in his book, modularity is an essential property of a functioning mind, intimately linked to the parsing act of perception. Much like a mind, Postext contains more information on the field than the sum of its parts. Presented in the structure itself, ideas that evade phrasing may be communicable in a way that transcends the conventions of usual text.

The similarity of the dynamics of Postext to thought, like the blending of text and context, and the multi- (and inter-)scale operations, lead us to hope that technology might eventually allow Postext to start acting like a mind on its own right. Correctly steered over the years, with the natural accumulation of technological advance, Postext may indeed develop collective emergent intelligent behaviour (such as personality,moods, creativity, and will).

As any adaptive complex system, its scope and shape will depend on the fortuitous conditions of its birth, and on the particular chain of events along its history[11]. As such various communities will aggregate or rather co-aggregate intertwined with the aggregation of their Postext representation. The representation will be at the same time the expression, the catalyser and an object of the community works. As the Postext representations of "neighbouring" communities will start cross-linking, there will be practically speaking just a single global Postext.

## 7 The Specific Example of Complexity Science

The present mode for organizing Science took shape after the failure of the attempt by Newton, Descartes and La Metterie to put the human knowledge on a unified basis that today we would call mechanistic. In particular, Descartes' effort to describe life phenomena mechanistically was rendered inoperative by the Darwinian revolution, while La Metterie's claim that mental processes are physical at their basis have definitely failed by the time of Freud, who offered them a dignified burial.

As a consequence, chemistry, biology and psychology, as well as economics and social science, emerged as independent branches of Science. Their ways diverged so much, that by now it often seems to lead towards two separate human cultures: the exact sciences on one side, and every other human endeavour on the other[1]. Within such a framework, the way a young scientist was supposed to contribute to human knowledge was by taking up one of the leaves of Dewey Decimal Classification System, learn it from a specialist, and eventually grow a little new bud (left of Fig. 3).

With the speed-up of fundamental scientific research, following the proven use of nuclear science in real life (and death) in the Second World War, this scientific paradigm has somewhat changed. In fundamental science, a field, rather then

[1] Before accusing the general society of being refractory to exact science, one should remember the quote by Chemistry Nobel laureate Rutherford: "All science is either Physics or stamp collecting."

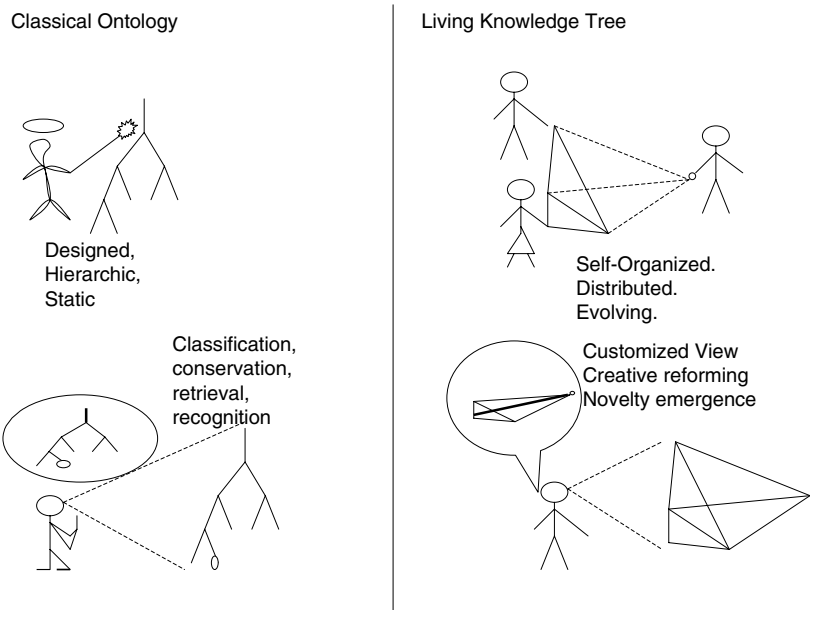


**Fig. 3.** The two ways of organizing scientific knowledge. The left side depicts the standard library classification. On the right side, the novel way of self-organized knowledge is depicted. New knowledge is placed where its creators find it more appropriate. At the "retrieval" stage, one may use one's own preferences and creativity by recognizing new possible connections. The classification scheme is continuously updated by the members of the relevant community, in accordance to the new current understanding of the relevant connections

being defined by its object of research, came to be defined by what its members were doing: the same community of fundamental theoretical physics studied at different times atomic, nuclear, or quark dynamics. Yet, at any given time the definition of such scientific community was quite unambiguous, stemming from the rather internal -if centrifugal- forces governing its evolution. On this background, the appearance of new scientific trans-disciplinary subjects brought a lot of confusion about membership of researchers to a specific scientific community: the speed of scientific progress, and the fractal shape of the forefront of knowledge, rendered the attempt of drawing well defined boundaries impossible, even momentarily. For somebody interested in managing or defining science, this is a major discomfort. On the other hand, for the curious researchers, these unexpected encounters of "remote regions" of knowledge are part of the joy of discovery. In this new format, science-making can be characterized as a self-

organized network of subjects and interconnections, to which new knowledge is added in a way not necessarily determined by the existing elements (right of Fig. 3). At the same time, finding connections between existing elements is at the very heart of the best discoveries therein. Much of this new type of science is done within "classic" disciplines, but it is viewed better at the boundary between fields, and especially in circumstances where intellectual structures created in one field are "exported", and used to understand phenomena from another. One such cross-disciplinary observation is the hallmark of complexity research: "More is Different" (Anderson,1972). A simple, yet profound, observation (often incompatible with previous scientific tenets), stating that a collection of many similar objects can behave very differently from the sum of the characteristics of its components, and have emergent properties. It is when more is different that life emerges from chemistry, social order and revolutions emerge from individual behavior, and market crashes emerge from individual greed. The intimate fusion of intuitions and concepts brings the cross-border scientific interaction into a new dialectic phase: no recognizable border at all. Embarrassed by being left with no recognized "drawer" for their "professional folder" to be stored within, the scientists involved in this revolution invented a name: Complexity[2]. One of the main features of this new science is that instead of occupying itself with self-definition, it started to "self-organize" in a way quite unconscious at the individual participant level. This self-organization was not on the basis of a centrifugal expansion from a central nucleus, but through the convergence (or rather mutual discovery and colonization) of various "islands", who came to recognize un-expected affinities and perform im-probable but briliant syntheses.

As the complexity community started to gain recognition and support from national and international science agencies, the need arouse for its characterization. Soon enough, it became clear that:

- No single person has the expertise to authoritatively present all the field of complexity.
- Even if a person had this expertise, the exposition would present only one possible view of the community.
- Even if the positions about the present facts would be "objective", the statements about the future possible directions will be necessarily tentative, personal and limited.
- In general, the exposition would look more like the "one hour bus tour of London" then like "a map of London".

It was concluded at some stage that what is actually needed is a continuously evolving self-imprinting of the community on a multi-dimensional conceptual "photographic emulsion"; Postext aims at serving that purpose.

[2] In fact, the name was already attributed in the sixties to a different scientific topic, branching from computer science and mathematics; a better name could have been "microscopic representation", "multi-agent systems" or "a-disciplinary study of collective emergent objects", but these proposals were less acceptable by science managers.

In the process of recognizing its own extent and its internal connectivity, the complexity community can use "complexity-specific" methods reflexively. Postext is exactly such kind of "introspective" network-map. It can serve as a major tool for the emergence of a collective mind of the complexity community, but also of any other developing community. As the community evolves, its Postext record will become a visualization of the community thinking effort (with the equivalents of brain phenomena such as epileptic hazards, connectivity and causality relationships, and "hot-spots"). The very building blocks of the community are likely to be redefined by collective features of the map, such as clustering or centrality.

## 8 Conclusions and Outlook

The framework described above is offering an Information-Technology solution to the problem of collective knowledge generation, perception and communication. While we have presented the scaffold for this to take place, the ultimate result will depend on the relationship that the emerging entity develops with the human members of the community. In principle, there are all the "reasons" for a positive and co-operational basis for this relationship. Yet, some of the vitality and energy of the system may also originate in "negative" human traits: self-aggrandizing, envy, and gossip. In fact, the motivation of many of the second wave of contributions to our initial complexity science platform was the feeling that one's brand of science is under-represented or mis-represented by the first wave of contributions. The way the Postext thrives both in the presence of positive and negative emotions makes one optimistic that it is the right structure to self-catalyse its own development. We are left to watch and live together with Postext its first steps in life. Lehaim!

## References

1. James, W.:The Principles of Psychology, Vol. I, Dover (1890). pp. 276
2. Derrida, J.:Writing and Difference, Univ. of Chicago Pr.(1978).
3. Eco, U.:The Search for the Perfect Language, Blackwell (1995).
4. Lao, T.:Tao Te Ching (approx. 600 BCE).
5. Quigley, L.:The Blind Men and the Elephant, Charles Scribner's Sons (1959).
6. Goldenberg J. ,Mazursky D, and Solomon S.:Creative Sparks. Science 285, pp. 1495-1496, 1999.
7. Stolov Y., Idel M., and Solomon S.:What Are Stories Made Of? Quantitative Categorical Deconstruction of Creation. Int. J. Mod. Phys. C, Vol. 11, No. 4, pp. 827-835, 2000 (cond-mat:0008192).
8. Louzon Y., Muchnik L., and Solomon S.:Copying nodes vs. Editing links: The Source of the Difference Between Genetic Networks and the WWW (submitted to Proc. Nat. Acad Sci. USA).
9. Hofstadter D.:Gödel, Escher, Bach: An Eternal Golden Braid,Basic Books (1979).
10. Minsky, M.:Society Of Mind, Simon & Schuster (1988).
11. Gell-Mann, M.: The Quark and the Jaguar, W. H. Freeman and Company (1994).