

# TARGETED KNOWLEDGE: INTERACTION AND RICH USER EXPERIENCE TOWARDS A SCHOLARLY COMMUNICATION THAT “LETS”

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## **Abstract**

All living systems share many properties, including hardly predictable behaviours, due to the differences between individuals and the chaos in natural environments.

The reductionist approach to the interpretation of these phenomena suffers from the oversimplification of the factors involved in the quest for universal “scientific” explanations. The validation of scientific paradigms is based on the consensus of leading groups who decide what is true and what is not.

This means that all events – not only conflicting opinions but also conflicting raw data – not fitting with the official scientific truth were never published, which indirectly supported the correctness of the experts’ choice.

With the advent of Web 2.0 and the freedom of publishing, the number of these not fitting events has dramatically increased.

Yesterday, data were supplied to the reader with the interpretation. Now the reader has to wade through a huge amount of data and opinions in each field. Extracting the information you need from the garbage requires a strategy.

Strategy is a science by itself. In the specific case of knowledge the first step is to define knowledge. The aim of life sciences, medicine and social sciences is to modify the reality when it is no longer sustainable, whatever it means in every single situation. I have to know how my system works to modify it. Knowledge is the information that allows me to succeed in my tasks.

Tasks must have an assessable target. All information which is useful and therefore processed to attain the target will be “targeted knowledge”. Information

can be selected on the basis of its congruence with the internal rules of the system.

In Web 2.0 we found proper tools to test this approach. We implemented a web application – which aims for easier identification of the molecular basis of diseases – structured in **Rules, Reports, Items, Pathways** and **Tools** referring and linking each other. The use of tags allows and fosters a free and personal use of information to create original knowledge. Users can follow and open innovative paths each time answering a different question, re-combining the fitting information.

Our application is an example of advanced Problem Solving: the patient as a whole, not as a single symptom, has to be understood as a part of the living world (Gaia, with its rules) whose components (Items, Pathways) are described in their multiple roles and connections.

The Web allows easy access to information, the program allows the network creation, the Rules drive the selection of the information and become more and more stable the more they evolutionary adapt to the reality; something like DNA, carrying millions of years old sequences in an ever changing world.

**Keywords:** knowledge; knowledge management; information; rules; scholarly communication; Web 2.0; e-learning.

## 1. Introduction

The contemporary knowledge landscape includes many actors, means and skills: men with their wishes and targets; information in all its forms (books, Web resources, word of mouth, blogs, social networking etc); technologies day by day better exploiting the richness and the potentiality of the Web as a platform of information and a channel of communication; the ability to select the right information matching one's "query".

In seeking to address these largely debated topics from a different point of view, an overview is needed with some view observations on knowledge, access to information, scholarly communication, Web 2.0 new tools, teaching and learning.

### Knowledge

The first step is to define knowledge, notoriously an evanescent concept. Knowledge is a multipurpose word like "mother": anyone has his own, not comparable to the others. However, on the other side, knowledge is required only if you have targets, whether you reach them or not.

The aim of life sciences, medicine and social sciences is to modify the reality

when it is no longer sustainable, whatever it means in every single situation. I have to know how my system works in order to modify it. Knowledge is the information that allows me to succeed in my tasks.

Tasks must have an assessable target: to treat a disease, to increase the food intake of a population, to improve the school performances. All information which is useful, and therefore processed to attain the target, will be "targeted knowledge".

Moreover, in this era of overspecialization, we are facing an over-atomised knowledge, while our aim ought to be for "connected knowledge", a network culture of knowledge in which ideas and knowledge itself are blocks to be connected [1].

### **Access to information**

This idea of an open network of knowledge lies on the concept of the wider possible access to information as an «enabler of innovation» [2]. As Suber puts it in perfect consonance with our idea of targeted knowledge: «Step one is getting access to texts or data, stage two is getting answers to questions» [3]. The Internet gave unprecedented means to reach and share information: it is a formidable «shortcut» both to connect people to information without barriers and to connect people to people and ideas to ideas, revising the Cartesian motto in "We participate, therefore we are" [4] to create a "common intelligence" [5].

Or, better, "distributed intelligence": it became more and more true that as the theory of complexity points out, the whole is greater than the sum of its parts and the real power is that of the connections between the nodes, not of the nodes themselves [6]. Global access to information means also that in the network and within a context of distributed intelligence it is easier to catch the creative momentum that stands at the edge of the chaos, to find a new path, to innovate. But here arises the question of the current paradigms, circuits and behaviours in scholarly communication.

### **Scholarly communication**

Karl Popper stated that «the advance of science depends upon the free competition of thoughts». [7] Is it possible today, when a minority of journals publish the majority of articles and receive the majority of citations? When often publication is synonymous of oblivion and lots of articles are never accessed? [8]. And when the so called "winner's course" – the trend to publish only spectacular results, often severely exaggerated, as demonstrated by further investigations – further on shrinks the already low number of highly visible journals? [9] And when there is no comparison between the huge and even growing availability of raw data coming from the output of research laboratories and the increasingly limited high pres-

tige (and impact) venues for publications, or there is no place and no acceptance for negative results, which, on the contrary, helps foster science if based on rigorous methods? [10] And when a diffuse uncertainty directly stems from the few formal rules of reproducibility in the published studies? [11] And when the abnormal economic returns derived by commercial publishers from the “artificial scarcity” [12], and the claim that selectivity corresponds to quality? The peer-review process, if seriously conducted, is a guarantee of quality, but more and more it has only become the seal of a hyperspecialistic clanic logic and a filter to block new ideas, or at least the “extravagant” ones from the current paradigms. Otherwise, as the case of Scott Reuben – the latest of a long series - demonstrates, peer-review is not a trustworthy index of quality: Reuben was considered an influential researcher in pain management; his studies published since 1996 in the best peer-reviewed journals altered the way millions of patients have been treated for pain during and after orthopaedic surgeries. Reuben has now admitted that he never conducted any of the clinical trials on which his conclusions were based [13]. Such a kind of “blind” peer-review, which sees only what it wants to see, which is more tied to interest –whatever it arises from, economics or prestige - than quality, rather might have fostered the current phenomenon of “herding” – or, as José Saramago said, people flocking under the shadow of an opinion like an umbrella [14] – that has led to a stagnant conformism in science [15].

Moreover, the oversimplification of the factors involved in the interpretation of the “phenomena” led to the quest for universal “scientific” explanations. The validation of “scientific” paradigms is based on the consensus of leading groups that decide what is true and what is not out of an abundance of contradictory results. Official scientific truth comes from a process of validated data selection. That implied that all events not fitting with the prevailing model up to the advent of the Web were never published, and therefore they were not accessible both to researchers and to common people. Not only conflicting opinions but also conflicting raw data were not published; the lack of negative or contrary data indirectly supported the correctness of the experts’ choice.

With the Web 2.0 and the possibility for almost everybody to publish observations and opinions free of charge, the number of events not fitting with the scientific literature has dramatically increased.

Thus, if you are looking for unmediated information, you have to read it in the blogosphere, and this brings us to the Web 2.0.

## Web 2.0

The best thing about Web 2.0 is that... nobody knows what the hell it really means. Even the ones who coined the term are still struggling to

find a compact definition. And this is the true beauty and power of Web 2.0 – it makes people think. [16]

From Tim O'Reilly Web 2.0 Meme map [17] we highlight the facets that are functional to our path:

- importance of the Web as a platform – harnessing collective intelligence
- theory of the Long Tail – lots of contributors for few contributions
- architecture of participation – the user is a content creator, via blogs, wikis and so on
- mutual trust between users – see Wikipedia
- right to remix and reuse
- rich user experience
- tags, comments.

All these attitudes contributed to shaping «Arancia», a Web application, and its instance, «Il Flipper e la Nuvola» [«The Pinball Machine and the Cloud»], the project of knowledge management we are going to discuss [18].

There is only a caveat to stress: it could be true that in the blogosphere you can find more free information – e.g. on the adverse effects of a drug, in a blog written by patients and not by pharmaceutical industries –, but the risk is to cope with a universe expanding to the infinite. Therefore it is important to contextualize this information, to give information a target, i.e. to move from information to knowledge to generate more knowledge [19].

The challenge is to embed the innovative openness of Web 2.0 in a new way of teaching and learning.

## Teaching and learning

As we are presenting an application of a knowledge management tool in its incidental use as a learning tool based upon the Web 2.0 logic, the temptation could be to attribute the tag of “e-learning 2.0”. E-learning 2.0 is definitely more appealing than the mere transposition of a traditional class and the traditional passive way of transmitting knowledge represented by closed Learning Management Systems and static Learning Objects. The underpinning concept of an active learner and the emphasis on content creation [20] might be the same, but actually our conceptual frame is quite different.

Proponents of e-learning 2.0 tend to stress:

- technological aspects: adoption of web 2.0 tools like wikis, blogs, podcasting might enhance the learning experience – but technology itself does not add value to the content: a boring speaker will also be boring on podcast [21],
- social aspects: experiments with the use of Facebook, My Space, or even Second

Life – but it can refer to the sphere of “learning to be”, and might be more useful in higher education [22]

- culture of sharing: the right to remix and reuse is highly agreeable; however, for the vast majority of cases it is referred to in dealing with close, statics, pre-packed Learning Objects, even though delivered by prestigious institutes like MIT (Open Courseware) – a great initiative in terms of openness of education – or Open Educational Resources [23].

One affinity could be recognized in the user-centric infrastructure that ought to emphasize participation, but one can discuss which kind of participation we are talking about: in the JISC funded CeLLS programme for collaborative e-learning in the Life Sciences, within an advanced scenario you can find again the idea of a structured Learning Object edited by an expert [24].

Interesting, in a sense like-minded projects from different fields are Flatworld knowledge and TALIA. Flatworld knowledge is a free online collection of textbooks, released under a Creative Commons license. A professor can adopt his/her textbook in the sense that he/she can edit a chapter, reuse the content, and also create a new book as a specific tool for his/her class. Learners can freely read online – print edition is by fee – and participate in the social network, posting comments, editing texts, rating contents edited by other users, or simply looking for other students connected at the same time to ask questions, to learn together [25]. TALIA is an open source software developed to integrate distributed digital semantic libraries in the Humanities. It works within the Semantic Web framework – in order to ensure interoperability e.g. adopting RDF and OWL – and relies upon a relation-centric vision more than an item-centric one: by creating semantic links between digital objects, the system displays information using metadata and ontologies, each time following the different path set by the user [26].

Actually, in a conceptual frame, the shift ought to be from passive teaching as the delivery of the substance “content” from teachers to students to an active involvement of the learner, in a constructivist approach. The connectivist approach of George Siemens, cited by Stephen Downes – the father of e-learning 2.0 – sounds consistent with our idea of teaching:

Unlike constructivism, which states that learners attempt to foster understanding by meaning making tasks, chaos states that the meaning exists – the learner’s challenge is to recognize the patterns which appear to be hidden. [...].

Connectivism is the integration of principles explored by chaos, network, and complexity and self-organization theories. Learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. Learning (defined as actionable knowledge) can reside outside of ourselves (within an organi-

zation or a database), is focused on connecting specialized information sets, and the connections that enable us to learn more are more important than our current state of knowing. [...]

New information is continually being acquired. The ability to draw distinctions between important and unimportant information is vital. The ability to recognize when new information alters the landscape based on decisions made yesterday is also critical [27].

Moreover, in 2009 one has to also take into considerations the “net-gen” keywords: connection, multitasking, visual, fast, immediate, experimental, inductive, wired [28].

Christian Dalsgaard’s vision, based upon social constructivism, also has to be considered: individuals are encouraged to learn together via social software networked tools, starting from a problem to solve [29]. The most various resources are not integrated in a LMS but only offered in an open environment as tools from which a learner chooses the most adapted to his/her purposes to solve the problem, alone or in collaboration. The idea of «loosely joined technologies» [30] as a tool box for further independent construction is very attractive, as well as the concept that learning activities cannot be structured or pre-determined. This meets our vision of an empowering environment where learning cannot be managed but can be facilitated: an environment in which knowledge, through a rich user experience, «lets». The technology being just the enabler, the real driver is the method.

## 2. Methodology

Think globally, act locally is a famous sentence almost one hundred years old; [31] it has been used in various contexts and perfectly describes how operators in the field of Medicine, Economy or Social Sciences should act.

A complex organism (a cell, a human body, a class, a country) has specific properties that it shares with the other member of its class, but its behaviour may be different in different local situations or environments. To be able to interact with complex systems we have to be able either to know the general properties of the classes (Think Global) or to modify the local conditions (Act Local).

In our finite world every organism is the result of an evolutionary adaptation to the environment with its spatial and energetic limits. Identification of the basic rules governing the organism is the first mandatory step on the path to its knowledge: e.g. what is a country, what is a human body, what is a virus; how they act according to the environment...

As they share the same environment, they are supposed to live together as a super-organism called Gaia [32], which behaves like a single, self-regulating sys-

tem comprised of physical, chemical, biological and human components. The interactions and feedbacks between the component parts are complex and exhibit multi-scale temporal and spatial variability.

Affording the description of such interconnected systems on the basis of relatively simple and universal “scientific” paradigms may be misleading, as they force the researcher to “select” the data. As the data selection takes place, at any step (technician → PhD student → Assistant Professor → Principal Investigator → Journal Referee) having in mind the prevailing paradigm to conform to, the published data represent only a small percentage of the whole.

One of the possible approaches to overcome this difficulty is to use robust models to simulate the behaviour of living systems at different levels of complexity. The model is interactive: data fitting the model validate it; non fitting data are used to modify the model interactively. The model does not select the data, it learns from the data, and becomes more and more robust. The model proposed in our application is based on some very basic features shared by all living systems.

They are dissipative systems that do not conform to the second law of classical thermodynamics because they are not closed systems, but they continuously receive energy from the outside [33].

On the Earth’s crust excess energy comes from sunlight. Photosynthetic organisms (plants, bacteria, algae) use radiant energy to move electrons from more to less electronegative elements leading to the present atmosphere, which is completely different from the original one surrounding the Earth before life. The most striking difference is the continuous increase of gaseous N<sub>2</sub> and O<sub>2</sub> in the atmosphere over the past 4 billion years. The large availability of a strong oxidant like O<sub>2</sub> allows the survival of all the forms of life which depend on respiration for energy production.

The complex interactions between different organisms in the Earth’s system may be represented by a network of objects and interactions of extreme complexity. Applicative examples of such an approach are common in the description of biochemical pathways [34] but any kind of interaction may be described in terms of positive or negative feedback, activation, inhibition and so on and at any level from molecules to populations. Different mathematical approaches have been used to model living systems; one of the most sound ones is the use of Petri Net [35], but others are valid as well [36]

In this world people live and sometimes they become ill. Physicians are expected to heal them, here and now. They have to act locally, they should think globally. Making a diagnosis of diabetes or hypertension and prescribing the corresponding drug can be really envisaged as global thinking? Or more probably, is it a simple one-to-one connection?

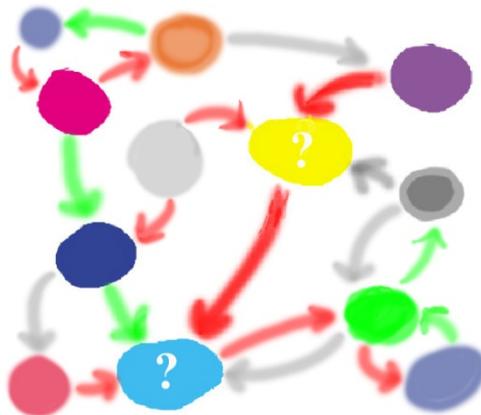


Figure 1: Any living and evolutionary system in a finite environment can be described as a set of nodes and interactions.

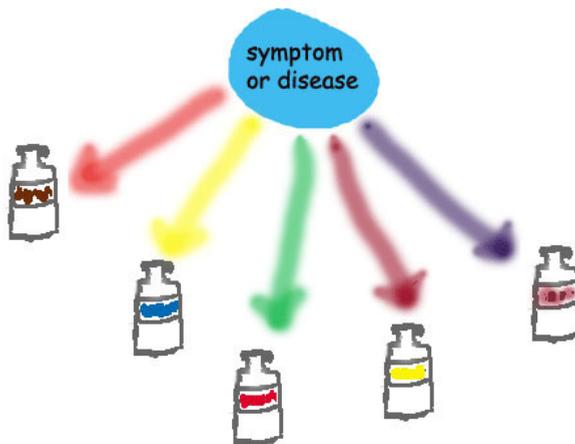


Figure 2: The usual steps of medical practice are: 1) identification of symptom or disease 2) prescription of a drug according to the suggestions of EBM.

The choice of the drug is no longer so dependent on the physician's choice on the basis of his personal experience, but it is strongly suggested or even imposed by Health Services on the basis of the results of specific trials performed according to the rules of the Evidence Based Medicine. According to this practice, patients not responding to or even worsening with the standard treatment (often a significant percentage) are simply labelled as non-responders. Evidence Based Medicine means

the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise

with the best available external clinical evidence from systematic research. By individual clinical expertise we mean the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice [...] By best available external clinical evidence we mean clinically relevant research, often from the basic sciences of medicine, but especially from patient centred clinical [...] Without clinical expertise, practice risks becoming tyrannised by evidence, for even excellent external evidence may be inapplicable to or inappropriate for an individual patient.[37].

Clinical researches – even randomized clinical trials – tend to flatten differences between individuals, as they evaluate an average effect of a therapy on a selected population

Even though Sackett himself noticed that the risk of EBM was to be a “cook-book” medicine, and obviously rejected it; in many instances it is just this. Our logic is the opposite: one cannot rely on statistical data referring to a “normal” patient because who is the “normal” patient?

Patients – as individuals, in their unique evolution – cannot be described by a simple label like “diabetes” or “hypertension” but by a set of links to aging, sex, diet, life style, obesity and by their former history. Every patient is a question mark in the spatio-temporal network of life on Earth (Fig.1).

To localize properly every patient we need a much deeper insight into mechanisms involved at different levels: molecular, cellular, hormonal, environmental and social. Most of this information is freely accessible on the Web (journal articles, systematic reviews, raw data, genetic sequences, institutional sites, etc.), but often is difficult to reach unless you are an expert in the field. A step by step guided access to these Web resources is one of the major tasks of our application.

The paths leading from the patient observation to the identification of the mechanisms involved have been preliminarily built according to the vision of a complex system of objects and interaction, where you can think of “rules” as the behaviours – inherent to the system itself – adapting and at the same time creating the environment [38].

In such a scenario, information can be selected on the basis of its congruence with the proposed model/rules. The more the information, no matter how “scientific” it is, that fits the model the greater is its reliability. Non fitting information has to be deeply analyzed for the real information content. Bias like advertising, personal interests, strong selection of the cases involved in trials or cohort studies lead to rejection of data that are otherwise accepted and used to modify the original model/rules.

In this perspective, information and rules interact and adapt, bringing to a thorough and dynamic knowledge of the patient, the symptoms, the disease and

their relationship. In the traditional scholarly communication system, governed by the concept of “official scientific truth” as stated by the experts, the reverse is true: the patient, the symptoms, the disease have to be forced into a predefined, rigid schema in which everything must find a standardised collocation.

Techniques typical of Web 2.0 are proper tools to test this different approach to the knowledge. On the basis of our specific field of interest – the identification of the molecular bases of the diseases – we developed a web application that allows easy access, recording and modification of the required information.

«The Pinball Machine and the Cloud» is structured in **Rules, Reports, Items, Pathways** and **Tools** referring and linking each other. The use of tags and/or controlled PubMed MeSH terms to categorize allows and fosters a free and personal use of information to create original knowledge. Users can follow and open innovative paths each time answering a different question, re-combining the existing information.

This is the richness added by users: exploring a tag and its related material can lead to an unexpected point of view on the same symptom, or can change one’s perspective on a disease. A change of point of view also means new targets.

The most striking feature of our site is the **Rules**, where the ontology of the living organisms in health and disease is accurately described. Medical textbooks usually analytically describe specific symptoms, treatments, surgery by organs or class of diseases. However, a robust definition of the disease itself is lacking, although it could help a lot in understanding borderline symptoms, involving more organs and so on. Anytime complexity arises in the reality description, «Think Globally, Act Locally» is more and more true.

The main property of the **Rules** is that they are revisable: they are defined in a way that they can be tested and eventually falsified so that they can always be valid in the context, according to Popper. At the very beginning they can be established by experts, but they will survive only if not demonstrated false by users. The evolution of the rules is very similar to the biological evolution of molecules or whole organisms. Only the fittest of the environment survive; however, if the environment changes, also the pattern of survivors changes. As the pattern of information available changes, also rules and methods of data mining have to change. Only the rules tested daily are good rules and only if they are modified whenever they fail.

According to the same perspective – and to another Web 2.0 suggestion, «trust your users» – the concept of “reliable information” itself changes. Not all the available information has to be validated, just the criteria to accept or reject it, depending on the target: information about adverse effects of a drug might be otherwise assessed by a patient association or a pharmaceutical company.

The underpinned logic is: different queries have different matching informa-

tion sources. No expert can tell “which” source, the only valid criterion being the user’s need and target. Web cataloguing and site classification projects may help and avoid wasted time, but ultimately any target may require a specific pattern of search strategies to retrieve the information useful in a specific ontology.

The reality is represented by **Reports**, descriptions of clinical cases whose fate can be changed by a correct interpretation of symptoms, allowing a validation of the method. Each user edits with a simplified Wiki writing language his/her own Report and links it with the fitting involved **Item** or **Pathway**, and then can tag it or associate it to a MeSH term. That creates a tag cloud which allows unprecedented links and a critical reuse of the content. In the Web 2.0, a controlled vocabulary such as MeSH is no longer a required assumption: folksonomies works as well, and mappings are possible [39].

Comments – both by learners and professor – shape a multi-sided scholarly communication, far away from the traditional one-way descending pattern, both in vertical – teacher/learner – and peer to peer – learner/learner. That also allows shared control of the quality, as the content – edited by a registered user, responsible for his/her contribution – can be revised and commented by each user, in the same winning logic of Wikipedia, in a sort of open, diffuse peer-review (where we intend “peers” as P2P in the Net and not as subject experts).

In **Items** and **Pathways** the user generated content – dealing with diseases, drugs, proteins, metabolic paths ... – consists of texts, images, links to scientific literature, links to biomedical websites, in a creative and critical approach as learned during classes. Tag clouds also apply to the most linked and handled Web sites, generating a sort of shared validation. The easiness and readiness both in submitting and in searching and retrieving the content creates such a participative environment that the user experience really is enriched.

The information, or better, an interpreted gateway to the information is collected in **Tools, Items** and **Pathways**, where the link to the contents is categorized with an indexing which is visually very similar to classical textbooks, but structurally based on a relational database and easily modifiable if needed. The database is also searchable via Google, independently from the type of indexing. Indexing itself carries a lot of information, as different branches of learning usually aggregate the same set of contents differently.

On this line, in our application the Web 2.0 logic – the user is no longer simply a content consumer but a content creator - goes further and encompasses some of the Library 2.0 concept; first of all the idea of meeting users’ needs when, where, and how they need it. Useful tips to improve the users’ ability to search and retrieve pertinent information according to their query are presented among the Tools, such as a link to a biomedical gateway which offers selected points of access to the Web. A skilled user will be able not only to retrieve what he/she needs, but

will also be able to select what actually matches his/her question from the “information deluge”. Moreover, services are seamlessly embedded in the context: a dynamic PubMed search is provided for each object, to keep up to date on the subject of interest.

### 3. Results

«The Pinball Machine and the Cloud», in its two years use as a learning tool (and more than 2000 pages published) in the course of Clinical Biochemistry at the University of Turin, also demonstrates its potential as a knowledge management implementation, functional to the systematic approach to medicine as discussed in the Methodology section above.

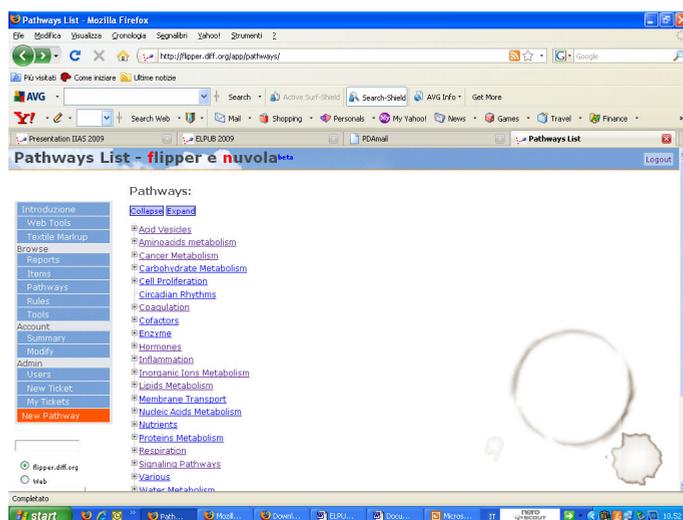


Figure 3: A snapshot of «The Pinball Machine and the Cloud».

A **symptom** (from Greek *σύμπτωμα*, “accident, misfortune, that which befalls”, from *συμπίπτω*, “I befall”, from *συν-* “together, with” + *πίπτω*, “I fall”) is a departure from a normal function or feeling which is noticed by a patient, indicating the presence of disease or abnormality. Physicians are expected to relieve symptoms as soon as possible. Medicine has a long story, thousands of years, and earlier physicians had no knowledge at all of chemistry, biochemistry, molecular biology, pollution etc. They only had symptoms and drugs to counteract the effect of the disease.

The modern physician knows DNA, RNA, ATP, metabolism and in principle

he should be able to understand why the patient suffers. But the old praxis **symptom** → **drug** (Fig. 1) is still the backbone of clinical practice. Drugs are usually very effective against the symptoms, they do not require additional tests for the patient and their administration does not require additional effort from the doctor. The **old paradigm** is still the winner.

But a symptom is also a **sign** [40] of something not working properly in the system: the disease (the question mark in Fig. 2) may depend on either a defect in the patient or a dangerous change in the environment or both.

Today we may measure many parameters of both the patient and the environment and we can match the data with published pathways of the most relevant metabolisms. The environment may be polluted by exhaust gas or pollens; the atmospheric pressure and humidity can change. The patient can be evaluated for either his/her genetic background or his/her metabolic status. And we can access all other information on the Web.

**The new paradigm: we have to know the causes of the symptom before we treat it.**

A simple example – better than a theoretical explanation – will illustrate how this approach works. In the following text the underlined words in the «The Pinball Machine and the Cloud» correspond to a link to an object – **Item, Pathway...** – where the topic is described according to the **Rules**.

The **joint pain** is one of the most frequent symptoms in people over 65.

The standard therapy is based on aspirin, NSAIDs and COX-2 inhibitors and it is associated with gastric discomfort which requires additional drugs (omeprazole derivative mostly) to protect gastric mucosa. Unfortunately every drug, as a function of its action mechanism, has more or less important side effects.

- **Omeprazole** inhibits the K<sup>+</sup>/H<sup>+</sup> Exchanger responsible for acidity of gastric juice in gastric cells, but also a V-ATPase responsible for acidification of lysosomes.
  - o **Gastric juice** acidity is required for Iron absorption
  - o Lysosome acidity is required for
    - Macrophages killing of bacteria
    - Brain neurons regeneration by autophagy
    - Serum proteins digestion by every cells.

On the basis of the literature the cost of long term gastric protection includes a higher frequency of pneumonia and other infections, neuronal degeneration, heart and skeletal muscle weakness and so on (everything fully predictable on the basis of previous information).

On the basis of this information, we are convinced that perhaps it is worthwhile to understand why we have pain before starting with the therapy.

**Pain** depends on the nerve's ability to pump Sodium and Calcium out of the nerve, an energy consuming process that requires fast ATP synthesis.

**ATP synthesis** requires oxygen and glucose as substrate, cytochrome C, Coenzyme Q, NAD as components of cellular respiration. If any of these elements is lacking or scarce the ATP synthesis will decrease.

**Oxygen** supply will depend on:

- pO<sub>2</sub> in the air, lower in:
  - o high altitude,
  - o low atmospheric pressure,
  - o high humidity,
- asthma,
  - o pollens
  - o iron deficiency
  - o calcium deficiency
  - o Active Vitamin D deficiency
    - iron deficiency
- chronic bronchitis,
- sleep
- anemia
  - o excessive blood losses
  - o lack of
    - iron
    - Vitamin b12
    - FolicAcid

**Glucose availability in blood:**

- Carbohydrates intake
- EXCESS SERUM INSULIN LEADING To prolonged hypoglycaemia
  - o Genetic defects of pancreatic beta cells
  - o Insulin injection in type I diabetes

Components of cellular respiration:

- **cytochrome C**
  - o Iron
  - o Serum Albumin
  - o Thyroid Hormone
- **Coenzyme Q**
  - o Thyroid Hormone
  - o Statins lower cholesterol and Coenzyme Q synthesis to the same extent

- **NAD**

- Can be introduced as a vitamin of group B
  - Vitamins B deficiency after administration of antibiotics
- May be synthesized from tryptophan (Trp)
- High Trp: pork meat, legumes, milk
- Low Trp: beef meat, yoghurt
- It is reduced by activation of indoleamine dioxygenase (IDO) during infections

The written description (even if not exhaustive at all) looks cumbersome, but on «The Pinball Machine and the Cloud» is easy to manage, being each of the underlined words an **Item** – e.g. “Iron” – or a **Pathway** – e.g. “Hormones” –, i.e. independent objects connectable by tags and linkable to one another. Iron deficiency, for instance, is reported more than once, creating a bidirectional connection between pathways apparently distant. Thus, the «Pinball» logic, with its network of links, is functional to a global view of the causes involved in a symptom of a specific patient: a different patient with different symptoms and a different personal history would have depicted a different schema of links.

In conclusion, joint pain may depend on many factors whose relative role may vary from patient to patient. When one single factor is involved it is usually easy to identify it: when lung gas exchange is reduced to less than 60% pain is almost continuous and the patient cannot stay in bed and sleep. But when gas exchange is around 80%, pain may also require a mild anemia or a deep sleep (usually between 2 and 3 am). Alternatively pain may appear when climbing up to 1500m above sea level and will disappear during holidays at the seaside.

Other combinations are possible as well. A mild hypothyroidism (more than 40% of women after menopause) will reduce the Cytochrome C and Coenzyme Q synthesis and hence the ATP synthesis. A simple cold affecting air flow through the nose can be sufficient to trigger joint pain in this situation.

And why is the pain usually localized in the joints? Because joints are very rich in sensitive nerves which are able to detect any small position change to properly control the body position and movement. High sensitivity means high sodium and calcium influx, high ATP consumption and high metabolic rate. Any small metabolic impairment will affect the joints nerves earlier than any other nerves.

In this case the hidden rule is that all cells require ATP synthesis for their functioning. If we list the body cells according to their ATP needs in descending order we could get:

- 1) Joints nerves
- 2) Acoustic nerve
- 3) Brain cells performing cognitive functions
- 4) Thyroid

5) Skeletal Muscle.

This would correspond to the appearance of the following symptoms when ATP synthesis is impaired:

- 1) Joint pain
- 2) Tinnitus and Deafness
- 3) Cognitive Impairment
- 4) Hypothyroidism
- 5) Fatigue.

Joint pain and deafness are treated by completely different specialists (who never speak to each other), but they share the same exact causes when they are analyzed as part of a system.

This was just an example out of tens of how it is possible, including all the instances of a symptom in a global discussion, to find most of the possible causes and in some cases also their relative relevance.

#### 4. Discussion

In the last two years about 2000 records were created in «The Pinball Machine and the Cloud». Most of these **Items, Pathways, Reports**, with the exception of the **Rules**, have been created by interactive work of the students with the professor; where “interaction” stands for the real participation of the user/student in the choice of relevant information, creation of content and set of linking and relationships with other records and further adjustments according to the comments of the professor and/or other users.

The most prominent feature of this approach is the creation of a discrete type of knowledge in which every object described in the **Items, Pathways, Reports** (a disease, an enzyme, a drug...) has to be described only once and then linked to all the other pertinent objects. Upgrading the information about an object will automatically also upgrade the information content of the connected object.

Experience has shown that the identification of the object borders is the critical factor. Foreseeing what will happen in an obese or lean child during a Varicella Zoster Virus infection is only possible if I know the viral strategy to survive in the host (essential nutrients requirement), the metabolic features of the obese or lean which are corrected according to age (availability of the nutrients essential for the virus). Nevertheless, the student tends to describe the lean boy with the VZV (Patient 1) and the obese boy with the VZV (Patient 2) as 2 independent objects. According to our model we need more objects (6): boy, obese, lean, VZV, Patient 1, Patient2. Patient 1 description is linked to boy, lean, VZV and his history checked

with the information in the linked records. If the information is sufficient to explain the clinical history we do not need to upgrade it, otherwise we have to search for additional information to record.

The system seems complicated, but with large numbers it allows the automatic creation of a few classes of objects with the same pattern of connections and increases the manageability of large collections of data.

Moreover, the continuous upgrading of the information content of the system may increase its efficiency without affecting its usability as the new information will be connected to the new object requiring it and at the same time to its parent object updating it.

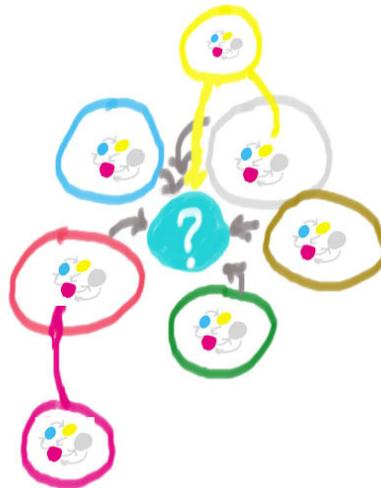


Figure 4: Any new information (yellow circle) incorporated into the system to solve a problem increases the system's global knowledge

The Web allows easy access to information, the «The Pinball Machine and the Cloud» allows the network creation, the **Rules** drive the selection of the information and become more and more stable the more they evolutionary adapt to the reality. Something like DNA, carrying millions of years old sequences in an ever changing world.

## 5. Conclusions

Information versus knowledge was our starting point. Information is growing fast, knowledge in some cases even decreases. Validation of information relies on its capability to improve users' performances. Only a previous definition of a testable target can allow validation.

In the Web 2.0 age a passive scholarly communication which merely transfers information should shift towards a deeper interaction, along with the idea of an academic teaching that “lets”. The premise is a dynamic and not dogmatic concept of knowledge evolving and modifying as the rules or the first hypotheses change. The main actor is a critical user – researcher, student or professor – who finds his/her path according to the target. Learn to know what you want is the first step to getting it.

In our application we have applied these concepts to the patient analysis, as an instance of advanced Problem Solving: the patient as a whole, not as a single symptom, has to be understood as a part of a living world (Gaia) whose components (Items, Pathways) are described in their multiple roles and connections, upgraded anytime additional information is required to solve the problem.

In fact the Problem Solving of any complex system with similar features (Economics, Sociology, Psychology) can be faced with a similar approach, once a sound specific set of Rules is provided and defined from the beginning.

### **Disclaimer**

Be aware that all the medical information and clinical examples quoted here are intended only for illustration of the method and not for discussion of their medical issues. The author is not responsible for any medical use of the information herein supplied without any specific reference.

### **Notes and References**

The text is the result of a long dialogue in which G.P.Pescarmona – creator of the Web application with F. Zamuner of NonSoloSoft – discussed the conceptual frame and the medical expertise, while E.Giglia dealt with the information and knowledge management implications.

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