AIRS – Automatic Intelligent Research System

An Open "Heuristically programmed Algorithmin calculator" for nutrition researches

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Abstract—**An Open Source automated, based on Semantic Web and artificial intelligence is being developed. This tool is expected to aid researchers and statisticians in selecting data sources and indexing mass of data, to manage common problems to be able to monitor food and nutrition habits in the population.**

Keywords-component; semantic web; open source; software; research; automation; food & nutrition;

I. INTRODUCTION

«The Web was designed as an information space, with the goal that it should be useful not only for human-human communication, but also that machines would be able to participate and help.»

Tim Berners-Lee [27]

«The new model is for the data to be captured by instruments or generated by simulations before being processed by software and for the resulting information or knowledge to be stored in computers. Scientists only get to look at their data fairly late in this pipeline. The techniques and technologies for such data-intensive science are so different that it is worth distinguishing data-intensive science from computational science as a new, fourth paradigm for scientific exploration.»

Jim Gray, computer scientist [28]

A. The scientific context

Population studies in the sciences related to nutrition are aimed at the acquisition of information collected through scientific method making it possible to help to improve the health and social well-being, providing indicators that give the opportunity to policy makers and public stakeholders to formulate appropriate food and nutrition policies.

The evolution of study systems, starting from the computerization of data collection and the underpinning databases, made it possible, among other things, to support in 2010 the recognition of the Mediterranean diet as World Heritage and intangible Cultural Heritage, along with dance, music, languages and customs of the area [29].

This achievement has been possible mainly due to studies on the habits and dietary habits of the population already initiated by Ancel Keys in the Seven Countries Study [1]. Monitoring food consumption through nationwide dietary studies carried out for almost ten-years [2][3][4] integrated [5] with estimates derived from studies on food consumption made by the official statistics, delivered by national[30] [31], and international institutes [32], show high potentiality [6] necessary to evaluate the current background for specific research field.

Nowadays, the myriad of information on the network brings many important issues: first, *where* to find the right information, and second, *how* to determine the validity of the source of information against the requirements of the research.

However, the needs for update information mainly of food products [7] is crucial to obtain reliable estimate of food composition data but also to build representative sample of a current dietary profile in a population group [8].

B. Nutritional Database System

The complexity of the phenomenon requires that an information system is available [9] and allows for providing reliable results [10]. Since the 80s this aspect became evident when the international scientific community started to recognize the needs for developing comparable and compatible datasets to exchange data [11][33], implement cross-country dietary studies [12] and build information interchange system [34].

These trends saw the synthesis in the development of generalized tools to formulate Nutritional Recommendations and the establishment of international association like EuroFIR AISBL [35] and NUGO AISBL [36], resulting from the sustainability tasks in European Network of Excellence, financed within the 6th Framework Program of the European Research. Recently the European Commission has started to support, within the 7th Framework Program of the European research, the development of projects aimed to integrate the different systems (food composition data, software developed to manage dietary survey data) [37]. The results achieved are greatly helpful to manage food safety issues. In fact, the European Food Safety Authority has

started to collaborate with the Member States of the European Union in order to build a food consumption database system for safety evaluation [38] [39].

C. Web Data Capturing

The communication experts have estimated that a person receives ten thousand sensory impressions per second. It is obvious that a drastic selection process is necessary to prevent the higher centers of the brain are submerged by information irrelevant. But the decision of what is essential and what is irrelevant necessarily differ from person to person and seems to be determined by criteria which are essentially 'outside' the individual consciousness [13] [14].

In reality we are dealing with a giant oxymoron which sees some exist statements such as "the flood of data makes the scientific method obsolete" [15], but on the other hand the definition of a new paradigm based on the civilization of the petabytes [40].

Abnormal amount of information circulating in the network creates a deafening noisy signal, but the infrastructure capacity that clouds and clouds of computer processors now offer allow us to face it and solve it at least in the projections of the clouds of information for specific sectors. The system therefore need to equip themselves with the capacity of a human brain to filter and organize the information acquired to make them intelligible. This is the traditional role of classification systems, because "in this way the infinite variability of the world is reduced to tolerable dimensions [16]" [17], but the problem today is that we need to extricate ourselves from huge masses of information, not always adequately qualified.

This is how the system architecture based on neural networks managed by complex algorithms flexible and able to read and process the output signals, giving answers, and, finally, also self-organizing maps to read phenomenal reality [18]. This is how the Semantic Web, an electronic environment that is designed to support the creation of those reading maps of reality that allow you to harness the vast amount of information that the researcher network is facing.

The statistics today called "data mining" [19] includes the integrated use of exploratory multivariate techniques to identify structures in the data.

The literature search has been the first to give rise to searchable databases and to create a method of systematic research [20], but those who have to deal with phenomena such as food that has a strong social-cultural needs also to analyze what is a generic "food environment" and the mere scientific information does not allow to have a complete picture of information assets, which determines the adoption of behaviors and that at the same time is a powerful feedback channel that returns correct information. if delivered by competent bodies (as an example for Italy see [41]). The systematic literature review (SLR) [21, 22] is very often done to perform meta-analyses[42] and, more in general, when having scientific sound information, is necessary to evaluate the current background for specific research fields [23]. Internationally validated bibliographic datasets like PUBMED [43] and Cochran Library [44], are used for research based on white literature, the project Greynet [45].

Now-a-day, thanks to the Internet, the retrieval of unstructured information can greatly increase the efficiency, performance and quality of the results of an information system that needs not only to find information purely scientific, but all that is needed to evaluate the variables that determine the choices and stimuli coming from different subjects acting "in" (producers, distributors, vendors, advertisers, private organizations variously involved in complementary sectors) and inter-acting "with" (policy makers, public operators), of the world food production.

Scientific information and scientific visual information freely circulating encountered in the design of research infrastructures, taking into account a fundamental research is an ongoing activity in the brain of the researcher maintains all active receive channels to allow always learning new information. An internationally recognized Italian experience in developing ontologies is from the Artificial intelligence Research at Torvergata (ART) group that developed the Semantic Turkey tool for ontologies and is currently working on suite of semantic web tools supporting the development of multilingual ontologies [24].

D. What is "microdata"

Currently the web allows for storing a huge amount of information to result as a *formless mass* composed of losing unstructured items [25]. In the absence of adequate forms of annotation, extracting and decoding data by automated systems should be too expensive and unsustainable for its complexity.

In this regard, bodies such as W3C - the consortium that sets the Web Standards - are developing the necessary guidelines to support this "silent revolution" of information: new meta-languages and specific formats (for example like HTML5, SPARQL and RDF) have already been produced and released to common use [46].

Taking as reference the paragraph of a blog article, its current language (HTML) will be roughly as follows:

```
<p>
  Emilian chef Mario Rossi, known for its top quality recipes, has
  created a variant of tortellini, which have cream sauce as a main
  ingredient instead of bechamel...
</p>
```

Figure 1. Example of a current paragraph structure. (current structure)

Unfortunately, in this way it is possible to access to the *paragraph* item, but not to its undefined data. See an illustrative example of relevant data:

```
<p>
  Chef Mario Rossi, from Emilia, known for its top quality recipes, has
  created a variant of tortellini, which use cream sauce as a main
  ingredient instead of bechamel...
</p>
```

Figure 2. Highlighted identified data in previous paragraph structure. (identified data)

```
<p>
  <span itemprop="origin">Emilia</span> <span itemprop="employ">chef</span>
  <span itemprop="nome">Mario Rossi</span>, known for its top quality
  <span itemprop="subject">recipes</span>, has created a variant of
  <span itemprop="dish">tortellini</span>, which uses
  <span itemprop="ingredient">cream sauce</span> as a main ingredient instead of
  <span itemprop="ingredient">bechamel</span>...
</p>
```

Figure 3. Example of microdata definitions. (microdata definitions)

Therefore, the introduction of microdata provides a better level of declarations that enables the classification of retail data.

In this way, by acquiring information on the page, we could directly access to main information data, which in this case will be: "*Emilia*, *chef*, *Mario Rossi*, *recipes*, *tortellini*, *cream sauce*, *bechamel*"

***

But how to solve the problem about data unreleased through standard parameters? How much work is needed to join the new standards, which means defining the required metadata for each information produced? How can a machine determine, the validity of the sources, in a concrete way?

These questions are the source of many doubts between developers, whereas the technologies needed to solve them are not always available.

The present paper illustrates the adopted solutions to address these difficulties.

E. The project

In this context, the former National Institute of Research on Food and Nutrition (currently C.R.A. ex-INRAN), as a result of the project "SIAGRO - Information System on Italian Food Products: Tables of Composition of Foods", has started the development of a software able to fathom the web and give cyclically systematic acquisition of information aimed at increasing the knowledge base of the phenomena related to the sector. In particular, studies on the diet of the population must cope with the constant changes in the food market, since the analysis of the profiles of diet requires you to know the composition in terms of nutrients and energy.

I. AIRS – DESCRIPTION OF THE SYSTEM

AIRS (Automatic Intelligent Research System) is an Open Source software for searching and web content indexing, focused on automation. The design has been inspired by Isaac Asimov e Arthur Clarke's writings, being at the base of Web 3.0, the latest trend of the web.

Unlike Web 2.0, which occurs when two or more people interact, communicate and share information via Internet (Social Networks, blogs, forums, wikis, etc.), by the advent of Web 3.0 we observe the phenomenon of machines interacting with each other in order to improve and simplify the human labor, making in this way the Web itself a huge database.

With a simple graphic interface, AIRS can be used both in the production of defined content according to the new standard 3.0 and to process external sources, either they comply or not. For this task, the System requires the inclusion of resources to be inspected and, subsequently, periodically crawled and *intelligently* parsed.

Through heuristic calculations, this software "surfs" the web and, like Google® crawlers, scans the source of page in order to store and index the contents. Nothing really different from an Index Engine, except for its ability to perform searches in an autonomous way and to acquire information from an increasing number of type of files, being able as well to scan RSS Feeds and to receive and interpret email messages and newsletters.

Across multi-user interface, the user logs to the pages designed for the purpose and starts the procedures following a simple and intuitive path. Then the program will start asynchronous executions, storing the commands and/or running them periodically, according to preferences previously set.

AIRS offers four account levels (*External user*, *Simple user*, *Administrator* and *Developer*) through which the operator will have the rights to access or do not access to individual pages and functionalities.

Interaction with the AIRS System is also possible via electronic mail, being enable to receive e-mail.

Figure 4. AIRS wiki main page

INTELLIGENT RESEARCHES

To perform automated searches, AIRS must know which Search Engine need to interact and secondarily which "keys" (*key ~ value* model) need to use for construct the URL for the GET request.

However, form fields keys are not humanly obtainable by the average user: you have to examine each time the source code of the modules of advanced research and it's an operation that requires a certain level of affinity with codes, so it's not sustainable and non-replicable.

To do this one, AIRS uses "intelligent" highly interactive tool.

When user decides to add a new Search Engine, the system runs silently these processes:

1 From the "Add new Search Engine" page is requested the main address (URI) of service (eg: `http://it.yahoo.com`);

2 Once inserted, using the Ajax protocol, AIRS will check its accessibility and attempt a semantic approach using SPARQL query, otherwise it will scan the page looking for forms fields. If the outcomes are anyway negative, proceeds with the next steps:

2.1 Try to find a link to advanced search pages;

* OR *

2.2 Search on Google the service advanced search page (also thanks by acquired data from its main page);

2.3 Scans each Google research results page, and recursively repeats the routine from step 1

3 Then display to user the service advanced searches, but in filtered mode: through 5 steps structured process, will request you to click on the corresponding field for language, domain, country, document type and time.

Figure 5. Screenshot of the procedure to acquire Search Engine's parameters. Note the simplest interface and the filtered page

Note that some Search Engine inhibit scans from external applications, which are detected by algorithms based on IP address, declared browser type, time display of pages, etc... This problem has been solved by means of the combined use of software TOR [47] and Privoxy, [48] but especially thanks to tricks that emulate human behavior (random waiting time between one page and next, different declared browser for each visits, etc...).

Similar procedures also occur during normal system Web navigation.

II. AIRS MODULES
AN APPROACH TO SOLVE COMMON PROBLEMS

AIRS is an object oriented system, which allows a wide flexibility of use. Each extensible module that composes it has a specific role which doesn't mean that they do not interpenetrate: frequently one uses a class of the other, which makes this system very similar to the Linux/Unix packages and dependencies mechanism.

A. AIR

AIR (Automatic Intelligent Research) is the core module of the System. According to user definitions, it performs multiple searches on a regular cycle, scanning the web, filtering the results and indexing each valid data.

Complex research queries can be formulated and monitoring tools can be harmonized by applying this module.

B. EditoRSS

This module automates the acquisition of RSS feeds and newsletters concerned. In fact, assigning an e-mail address to the System, it is possible to register it in order to receive newsletters: it periodically will read the e-mail messages, and it will scan its contents (using, as already said, the classes of the previous module too).

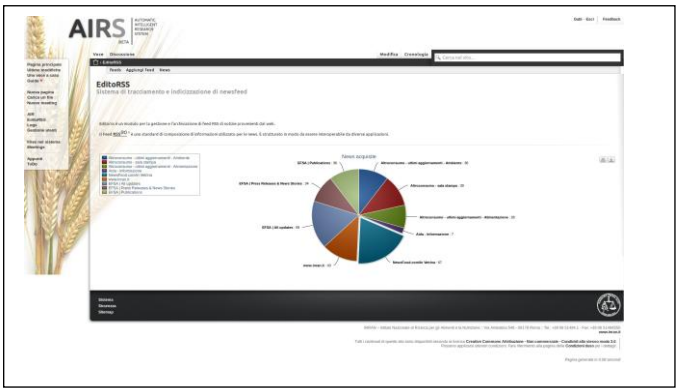

Figure 6. Screenshot of the EditoRSS main page with graph of acquired data

C. Decas

In response to the lack of microdata definitions, and to not force the users to specify the afference of every term, AIRS has a self-learning module: *Decas.*

Decas (in Esperanto: proper, capable, suitable) is an application module that includes a database of terms of the operator registered language [49], through which it is possible to identify individual lemmas and automatically structure a page of content. If these are not in the database, it scans the web in search of satisfactory data, and it acquires all necessary references (grammar values, definition, synonyms, antonyms, etc...).

Overall, *microdata* on one hand, and automation linked to self-learning on the other, crown and satisfy an almost poetic evolution expression of the industrial age.

III. OTHER FEATURES & HIDDEN TECHNOLOGIES

A. OpenPGP and the web of trust

The problem of reliability is the most controversial one. Except for a few rare cases, today there's no way to securely determine the actual validity of data sources. Therefore, it was decided to do not operate by interpretation but by the adoption of a standard, the OpenPGP (Pretty Good Privacy) [50].

OpenPGP is an encryption standard defined by IETF [51] in 1998 (and later). It is an asymmetric cryptographic system of digital signatures and offers a high level of privacy, as well as a system of authenticated signatures.
It has been integrated into AIRS, starting from the login area.

B. Redis Server

The Redis Server [52] has been implemented to speed up several processes, otherwise expensive in terms of resources.

Redis is a database Server that stores data in RAM, which allows a very high performance (roughly 100 thousand query per second).

C. Conference Call

The BigBlueButton [53] software is integrated in the System and enables it to manage VoIP conferences from AIRS graphical interface.

D. PICOL & the graphic communication language

Regarding the design styles, PICOL Project (PIctorial COmmunication Language) [54] was adopted; it works *"to find a standard and reduced sign system for electronic communication"*, which makes the interface simple, but, at the same time, elegant and neat.

E. Internationalization

The language in use is defined by the standard *i18n* [55] and is configurable through a dedicated database table.

F. Semantic features

AIRS tends to have mainly a semantic approach, because data is already filtered and ready, otherwise it tries to parse data heuristically from traditional web.

It has its own FoaF (Friend of a Friend) generator that, better than the most famous foaf-o-matic, generates semantic FoaF data directly from registered users data, limitedly to their permissions: everyone has its own foaf.rdf file, combined with PGP encryption key.

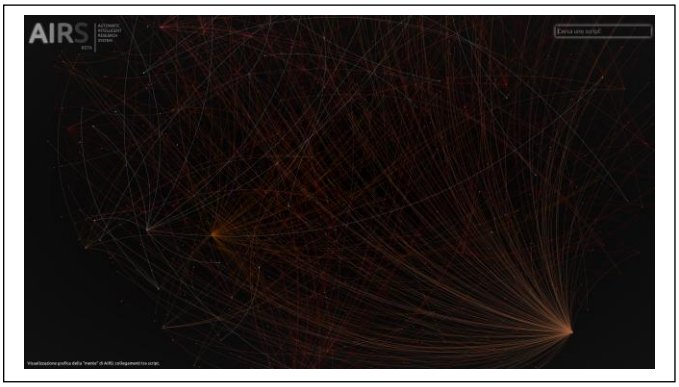

Figure 7. AIRS Development tool for system administrators. In this graphical representation – most interactive on the application - you can analyze the connection between scripts. May be also a poetic vision of "neurons" system.

CONCLUSION

We are living in an era where the technology offers alternative solutions to current problems, making obsolete what has no more *raison d'être*. The Web 3.0, the Semantic Web and the introduction of IPv6 are creating the foundation for the "silent revolution" that surely will change our lifestyles in a close future.

A user-friendly system appreciated for its technological capabilities, and the possibility to manage a huge amount of information is an essential tool to deal with the necessity of capturing, coding and analyzing selected classes of information.

The system here presented will be further enhanced to achieve a complete "semantization" [26] to add further functions specifically related to nutrition themes information Feedbacks will be welcomed once the system will be released.

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[43] http://www.cochrane.org/
[44] Ex 42 http://www.greynet.org/
[45] You can run a compatibility test of your browser with HTML5 at this address: http://html5test.com/
If you are interested in to the source code of the tester, you can find it released in a BSD license at this address:
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[47] https://www.torproject.org/
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