Medical Ontology and Virtual Staff
for a Health Network

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Abstract. In the context of a care network, we describe our method for reconstitution of a medical ontology via the translation of a medical database (DB) towards RDF(S) language. Then we show how we extended this ontology, among others through natural language processing of a textual corpus. Then, we present the construction of a Virtual Staff, enabling a cooperative diagnosis by some of the care network actors, by relying on this medical ontology.

Keywords: ontologies, knowledge management, semantic web, cooperation, medical application.

1   Context: Needs in a Care Network

The project *"Ligne de Vie"* (*Life Line*), in collaboration with the Nautilus society and the SPIM laboratory, aims at developing a knowledge management tool for a care network [14]. In order to analyse the concrete needs of care network in general, we had interviews with a physician and with a nurse. Specialised in a particular domain or in a specific pathology, a care network is a health network gathering all the actors intervening in the care or follow-up processes. The objective of the network is to ease (a) communication and collaboration among these actors in spite of their physical distance, (b) the regular follow-up of the patient et (c) the respect of best practices inside the network. The patient must be guided towards relevant medical actors, that must be informed about the patient's state and that may gather (sometimes virtually, through synchronous or asynchronous communication tools) in order to work on the patient's record. For example, cystic fibrosis demands daily cares throughout the patient's life and requires several kinds of professionals : paediatricians, physicians, gastro-enterologists, chest specialists, nurses, physiotherapists, psychologists, dieticians, social workers, as well as the patient, his/her family, the school doctor or the job doctor. The network must ease knowledge sharing about the patient record, among all these actors from various competence domains, with a user-tailored presentation of the information.

The ideas proposed by Nautilus SARL for launching the project Ligne de Vie stem from fifteen years of experiences in health domain and from contacts with a network

dedicated to diabetes: Nautilus offers a software for management of electronic medical record, Episodus, relying on a problem-oriented vision of the patient record sand articulated around the notion of « Life Line » enabling to represent the life of the patient from his/her birth till his/her death with all the health problems encountered by this patient. As long as the patient still suffers from a problem, this problem remains open. When the patient gets completely cured from this problem, the problem is closed.

The technical choices of the project Ligne de Vie are motivated as follows:

- The need to build a *referential common to the network actors* led us naturally to rely on a medical ontology. Moreover, this ontology should help, through inferences, to improve information search on the documents shared or accessible by the network members.
- The need to take into account *actors from various competence domains* incited us to study *viewpoint modelling* [19] in the ontology, in the patient records, or in the presentation of the results to the user after his/her query.
- The need of cooperative work between the actors of a network led to the idea of our partner Nautilus to develop a software called *Virtual Staff* in order to enable the members of the network to *visualise their collective reasoning*: in order to diagnose the pathology of the patient (according to the symptoms expressed by the patient, the observations or analyses of the doctor and the already known health problems of this patient), or in order to determine the best possible therapeutic procedures. This virtual staff should offer to the users *a service of support to cooperative reasoning*, during the phases of elaboration of diagnosis or therapeutic decision and *a service of constitution of an organisational memory* [6] – the memory of decisions of the community constituted by the members of the care network.

This article focuses on the work of the Acacia team on the medical ontology and on the Virtual Staff: we will present our method for reconstituting the Nautilus ontology – this method rests on a translation from a medical DB towards the RDF(S) language; then we will show how we extended this ontology after analysis of a textual corpus. Then, we will describe the Virtual Staff based on this ontology. Last, we will conclude on the interest of this work and on our further work planned.

2 Reconstitution and Extensions of the Medical Ontology Nautilus

2.1 Role of the Ontology

In the project *Ligne de Vie*, the ontology aims at modelling some knowledge on general medicine or specialized medicine, on care networks and their actors : the ontology will represent the conceptual vocabulary common to the actors of a care network, and will be used in the Virtual Staff and for information search. This ontology will be the kernel of a medical *semantic Web dedicated to the care network*.

The medical community has long been sensitised to the need of modelling its knowledge and of making its terminologies explicit. Therefore, there exists several terminological or ontological resources in medical domain: GALEN [17] [18], MENELAS [23] [24], ON9 Library [8] [16], SNOMED RT [5] [21], UMLS [15] are

ontologies/ontology libraries/thesauri/meta-thesauri that model a part of the medical domain. We could have relied on one of them but for reasons of collaboration, we had to use the Nautilus medical DB developed by our industrial partner.
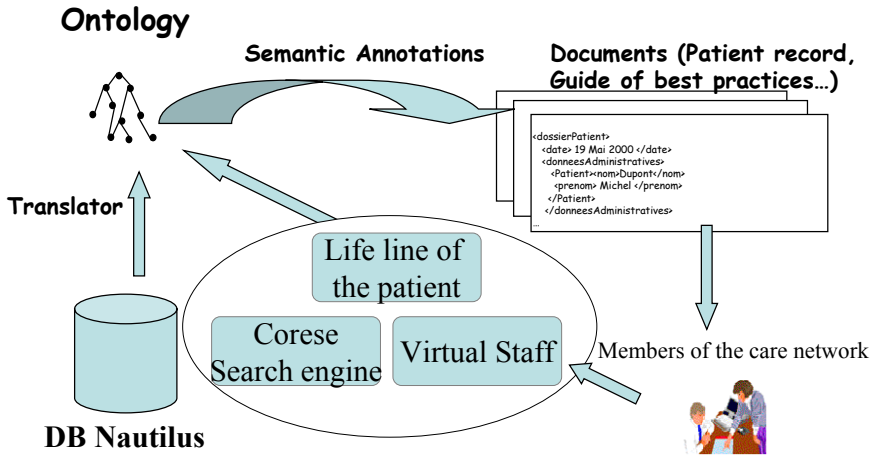

Fig. 1. Architecture of a Medical Semantic Web for a Care Network

In order to make the Nautilus ontology more understandable, it was important to represent it in a standard knowledge representation formalism: we chose RDF(S) [12] to which our semantic search engine CORESE [2] [3] [4] is dedicated. Therefore we developed a translator from the Nautilus DB internal format towards RDF(S) language. Using a « reverse engineering » approach relying on the analysis of this DB coding principle, we decoded this DB in order to reconstitute a Nautilus ontology represented in RDF(S) so as to explore it and validate it via a semantic search engine, to annotate and search documents through this ontology, to guide the Virtual Staff, etc. Figure 1 shows the architecture of the medical semantic Web dedicated to a care network.

2.2   Discussion: DataBase vs Ontology

A preliminary question was the status of the Nautilus DB: could one regard it as an ontology? Some DB researchers assimilate a DB conceptual schema to an ontology. Admittedly, if one has available an explicit principle of how the concepts of an ontology are coded into the internal format of a DB, one can regard this DB as an implementation of the ontology. But it is important to represent the ontology explicitly in a form understandable by a human user, and in a knowledge representation formalism. We thus looked upon Nautilus as a medical ontology encoded in an internal format but without a representation readable by a human user. The reconstitution of the Nautilus ontology thus required the reconstitution of the hierarchy of concepts and of the set of relations implicit in the DB.

Table 1. Examples of characters coding the root concepts in the Nautilus DB

Code	Root Concept	Code	Root Concept	Code	Root Concept	Code	Root Concept
A	*Anatomy*	C	*Foreign body*	D	*Physician*	E	*Patient's state*
G	*Diagnostic/ therapeutic gesture*	N	*Treatment*	O	*Material*	P	*Pathology*
Q	*Physiology*	S	*Symptom*	T	*Labotatory test*	X	*Histology*

2.3   Translation Algorithm

The Nautilus DB is a Paradox database composed of:

- a table **Lexique.db** describing more than 36 000 medical terms,
- a file **Concept.txt** containing the list of the root concepts: **Anatomy, Physiology, Symptom, Pathology, Physician, Laboratory Test**, etc. Table 1 gives examples of characters coding such root concepts.
- a table **Savoir.db** describing the relations between the terms, with four types of relations: the ES specialisation relation (is-a), the E0 relation (non transitive is-a), the AT relation (located-on) and the ME relation (measured-with).

To each term appearing in **Lexique.db** corresponds a single, 6-characters long, code (e.g. **PABCF1**): the first character thus enables to find the associated concept root (for example, the character P corresponds to the root concept **Pathology**). The first 5 characters of the code associated to a term characterise the concept; the sixth character enables to distinguish the synonymous terms. For example, the terms « abcès de derivation » (derivation abscess) and « abcès de fixation » (fixation abscess) coded respectively **PABCF1** and **PABCF2** in the **Lexique.db** table are two synonymous terms naming the same concept, coded **PABCF** (**P** indicating that this concept is attached to the root concept **Pathology**). The translation algorithm enables to reconstitute in the concept hierarchy that the *Pathology* root concept has as direct or indirect subconcept a concept named by the synonymous terms *« derivation abscess »* and *« fixation abscess »*.

Using the **Concept.txt** file, the translator translates the root concepts into RDFS classes that are direct subclasses of the *ConceptNautilus* class. The codes of the **Lexique.db** table, without ES relation in the **Savoir.db** table, are also translated into RDFS classes that are direct subclasses the *ConceptNautilus* class.

The use of the **Savoir.db** table enables to gradually reconstitute the concept hierarchy by specifying the specialisation links between the concepts. If the **Savoir.db** table describes a relation ES between Code1 and Code2, the translator generates a *subClassOf* link between the concepts Concept1 and Concept2 (i.e. the RDFS classes generated by translation of Code1 and Code2): Concept1 becomes a subclass of Concept2 in the RDFS class hierarchy.

In the same way, the use of AT relations in the **Savoir.db** table makes it possible to determine the domain and range of the RDF property *« located-on »*, and to generate the RDF triples *Concept1 located-on Concept2*.

Lastly, the use of the **Lexique.db** table which specifies the synonymous terms corresponding to the same code, makes it possible to represent through RDFS labels the various synonymous terms naming the concept associated with this code.

The whole translation algorithm is detailed in [14].

For the previous example, the translator will generate:

```
<lv:Concept rdf:ID="P">
  <rdfs:label xml:lang="fr">Pathologie</rdfs:label>
  <rdfs:subClassOf rdf:resource="#ConceptNautilus"/>
</lv:Concept>

 <lv:Concept rdf:ID="PABCF">
  <rdfs:label xml:lang="fr">abcès de
dérivation</rdfs:label>
    <rdfs:label xml:lang="fr">abcès de
fixation</rdfs:label>
    <rdfs:subClassOf rdf:resource="#P"/>
</lv:Concept>
```

Remark: The translation algorithm depends on the internal format of the Nautilus database but its principle is quite reusable for building an RDF(S) ontology from any DB, provided that the principle of coding of this DB is explicit enough for enabling such a reconstitution.

2.4 Verification and Validation of the Ontology

We distinguish on the one hand, *automatic checking* through automated processing performed by the *translation program*, and on the other hand, *human validation* by the doctors or by the ontologist through *visualisation and navigation in the ontology*.

Checking the Coherence of the Ontology

The translation program carries out some coherence tests, which enabled us to detect various errors in the initial Nautilus database: (a) relations inducing cycles for the specialisation relation; (b) specialisation relations between a concept and itself; (c) redundancies.

Some of these errors were modelling errors and others corresponded to non documented implementation tricks.

Validation of the Ontology with the CORESE Search Engine

The interest of the translation of the Nautilus DB is to enable to check the ontology, once represented in RDF(S). Indeed, the user can browse the ontology using CORESE, our semantic search engine dedicated to RDF(S) [2] [3] [4] Displaying the concepts via their labels instead of their code in the Nautilus DB makes the ontology more understandable for the doctors and its validation more friendly. CORESE

interface could thus allow a team of doctors to visualise the ontology and to validate it by detecting the errors and by suggesting corrections.

By carrying out this validation within the Acacia team and with our Nautilus partner, we could detect several errors in the concept hierarchy. For example, in figure 2, we located several problems in the conceptualisation of pain:

- Problems of redundancy: two concepts represent the concept of *«douleur» (pain)* while one single concept would be sufficient.
- Structuring error: the concepts *douleur abdominale de type biliaire (abdominal pain of biliary type)*, *douleur abdominale de type pancréatique (abdominal pain of pancreatic type), douleur abdominale de type ulcéreux (abdominal pain of ulcerous type)* should have been direct subconcepts of the concept *«douleur abdominale» (abdominal pain)*. It reveals that some ES relations had been forgotten in the **Savoir.db** table of the Nautilus DB.
- Mixture of several points of view in modelling: several viewpoints are mixed in the constitution of the hierarchy: some concepts characterise the pain by the part of the body concerned (e.g. *douleur abdominale (abdominal pain), douleur pelvienne (pelvic pain), douleur rénale (renal pain), douleur thoracique (thoracic pain)*) while others characterise it by its nature (e.g. *douleur exquise (exquisite pain), douleur fulgurante (fulgurating pain)…*).

Another advantage of CORESE search engine is to provide an environment to answer requests on the ontology - requests useful for the validation: since some concepts of the Nautilus ontology describe the anatomy, CORESE - which can find concepts via the terminology - can answer requests such as *« Which are the concepts having in their labels the word " abdominal " ? »*.

According to our partner, apart from the ontology validation, the queries of a doctor will rather relate to the ontology-based annotations on some medical documents or to the instances: e.g. *« Who are the patients whose medical record is annotated by a surgery for curing a pathology located on stomach? »*. The inferences of CORESE based on the ontology Nautilus will enable to find the record of a patient that were operated for a stomach cancer.

2.5   Extensions of the Nautilus Ontology

The Nautilus DB is used in the Episodus software for creating and editing the patient medical record. The concepts allowing to describe this patient record are thus useful when reasoning for diagnosis or for choice of the treatment. In the context of a tool aimed at supporting a care network, it seems interesting to extend the Nautilus ontology by concepts enabling to describe a care network and its actors, etc. For building these extensions, we rested on a corpus-based knowledge acquisition methodology [1] for semi-automatic acquisition relying on linguistic tools while being controlled by the expert and the knowledge engineer.

We thus constituted a corpus of documents on health networks: documents used for the preparation of the project *"Ligne de vie",* documents found on the Web about health networks. Because of the disparate nature of these documents (scientific
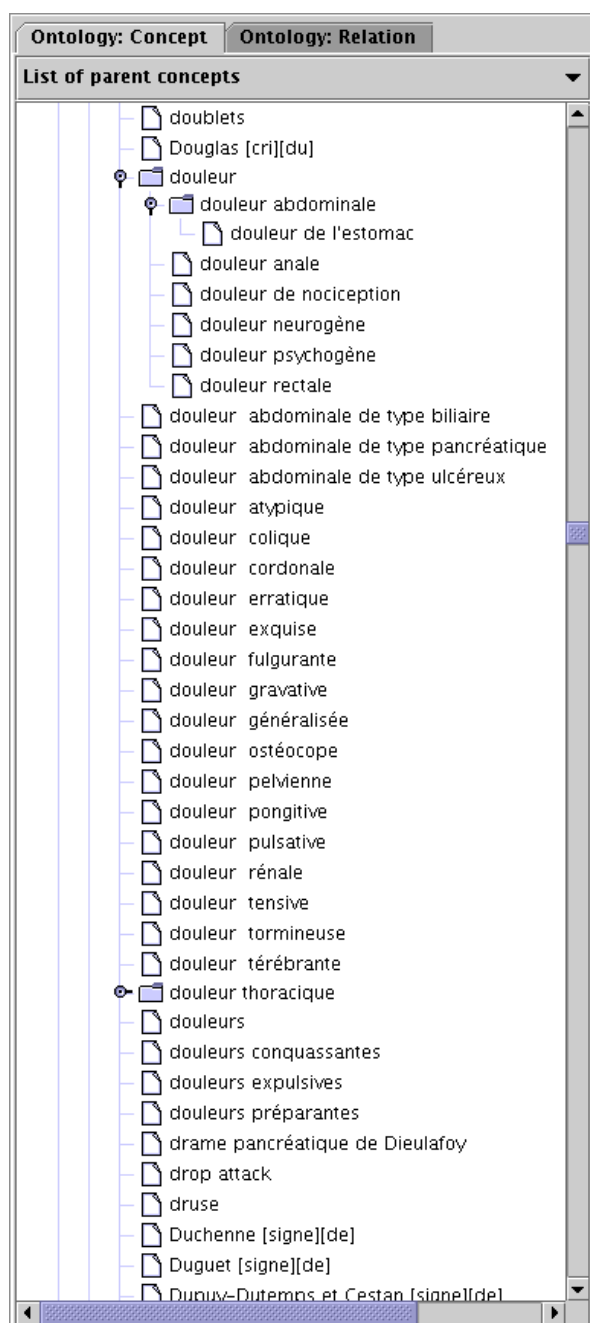
Fig. 2. Ill- formed hierarchy of *"douleur"* (pain)

articles, vulgarisation articles, etc, and either in French or in English), the discourse structuring and the linguistic quality of the corpus were heterogeneous. Terminological extraction with a linguistic tool, Nomino [7], allowed to extract noun syntagms constituting candidate terms that we analysed, filtered, structured or gathered together. We thus built concept hierarchies on health networks, on health centres and on the patient record. For example, for building the *Network* hierarchy obtained from these candidate terms, we tried to find some similarities between the candidate terms having *"Réseau" (Network)* as head. We could thus notice that some terms corresponded to networks dedicated to a given pathology (e.g. *Réseau de soin diabète (Diabetes care network), Réseau de soin en cancérologie (Care network in oncology), Réseau de soin en cancérologie digestive (Care network in digestive oncology)*, others distinguished the kind of health centres involved *(Réseau hôpital (Hospital network), Réseau libéral (Liberal network), Réseau ville hôpital (City hospital network),* others gathered a given type of actors *(Réseau de médecins (Physician network), Réseau infirmier (Nurse network)...* All these linguistic clues helped us to structure the *Network* hierarchy. Resting on the only terms attested by the corpus, this hierarchy thus depends on the quality and completeness degree of the corpus. Using the same method as [11], this hierarchy is easy to enrich automatically using heuristic rules such as:

```
R1:
If the term X in the list of candidate terms starts
with the expression «Care Network in»
Then suggest to create the concept X as a subconcept of
the concept «Care Network».

R2:
If Y is a subconcept of Pathology in the ontology,
Then suggest to create the concept « Care Network in Y
» as subconcept of the concept « Care Network ».
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Since the term *"Care Network in Oncology"* was extracted by the linguistic tool, the rule R1 enables to create the concept *"Care Network in Oncology"* as a subconcept of *"Care Network"*.

In the same way, the rule R2 would enable to create the concept *"Care Network in Cystic Fibrosis"* as subconcept of *"Care Network",* since the Nautilus ontology includes the concept *"Cystic Fibrosis"* as a subconcept of *Pathology.*

Lastly, to describe the hierarchy of the health actors, we integrated a part of the Canadian National Classification of the Professions in the Nautilus ontology by relying on the concepts common to this classification and to Nautilus.

As a conclusion, the extended Nautilus ontology was obtained from heterogeneous information sources (a database, a textual corpus, a classification) and by several ontologists, with a risk of non homogeneity in its structuring, and a strong need of a validation by doctors. We will now show how this ontology is used in the Virtual Staff.

3   Representation and Use of the Virtual Staff

3.1   Objectives of the Virtual Staff

In the hospital, the unity of location and of time allows the doctors to meet as a staff in order to discuss about the decisions to take. In a care network, the Virtual Staff aims to be a collaborative work supporting tool, allowing the real time update and history of therapeutic decisions. As an electronic board where each one can note information readable by the other members of the team, it constitutes a discussion support that may be synchronous (if the participants take part to the discussion at the same time or in the same place) or asynchronous (if each one accesses it at the moment appropriate to him/her). Starting from the patient's health problems, the members of the team will formulate diagnostic hypotheses and proposals for a treatment. Via this Virtual Staff, the care team will connect the various elements of the patient record useful for the discussion, and thus will converge in an asynchronous way towards the definition of new health problems and of new therapeutic actions. The formulation of diagnostic hypotheses is a priori reserved to the medical actors, whereas the discussion on the treatment could sometimes imply non medical professionals (for example, a welfare officer could emit arguments against the choice of a heavy treatment incompatible with housing conditions of the patient).

3.2   Weed's SOAP Model

In Virtual Staff, the dependencies between the various diagnostic and therapeutic hypotheses can be represented through a graph using the concepts defined in the Nautilus ontology. The doctor will reason by linking the health problems to the symptoms, the clinical signs and the observations in order to propose care procedures.

The Virtual Staff can thus rest on the SOAP model (Subjective, Objective, Assessment, Plan) used by the medical community [22]. In this model:

- the S nodes describe current symptoms and clinical signs of the patient,
- the O nodes describe analyses or observations of the physician,
- the A nodes correspond to the diseases or health problems of the patient,
- and the P nodes correspond to the procedures or action plans set up in order to solve the health problems.

This SOAP model is used in the medical community to structure a patient record. Therefore, its use to structure the doctor's reasoning - that relies on the same concepts - seems natural.

When a patient consults his/her doctor for new symptoms, the physician will create an instance of Virtual Staff. The system will then initialise a SOAP graph with all currently open pathologies and prescriptions for this patient (see fig. 3): the initial A and P nodes automatically added in the graph are the pathologies and the care procedures already existing and open in the patient's life line. The doctor can then reason in order to add, in case of need, new A nodes (i.e. new pathologies diagnosed) or new P nodes (i.e. new action plans) in order to diagnose and treat the new health problem of the patient.
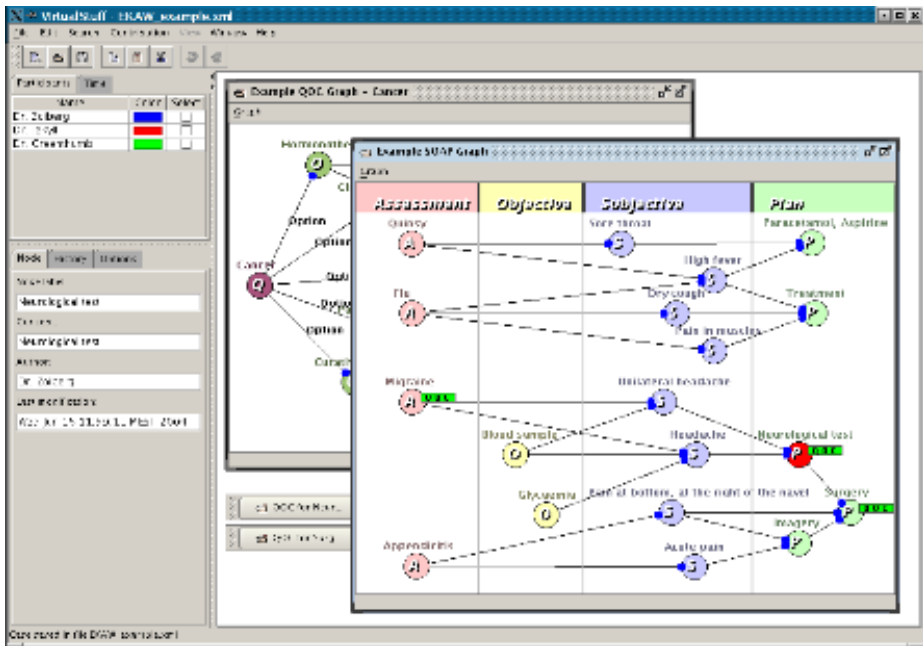
Fig. 3. Example of SOAP graph in the Virtual Staff

3.3 QOC Model (Question-Options-Criteria)

Sometimes, the doctor may need to visualise all the possible solutions and the arguments in their favour or against them. The QOC model (Question Options Criteria) [13], used by CSCW community for support to decision-making or for design rationale in a project, can then be useful. In this model, a question Q corresponds to a problem to solve. To solve the question Q, several Options are thought out, with, for each option, the criteria in its favour and the criteria against it: each option is thus connected positively or negatively to criteria. The QOC graph is reduced to a tree if no criterion is linked to several options.

Two types of questions are possible for the Virtual Staff:

- *Diagnosis of a pathology* (i.e. find the right A in the SOAP model): Which pathology explains the clinical signs of the patient?
- *Search of a prescription* (i.e. find the right P in the SOAP model): Which action plan will enable to treat the diagnosed pathology?

In the Virtual Staff, among the criteria to be satisfied, there are the patient's symptoms and the doctor's observations: for a question about the patient's pathology, each possible option will be linked by a positive influence link to the symptoms and observations compatible with this option, and by a negative link to the symptoms or observations rather incompatible with this pathology. The criteria will thus consist of

S or O nodes of the SOAP model but they may also sometimes correspond to A or P nodes, if some diseases are incompatible or if some care procedures are exclusive.
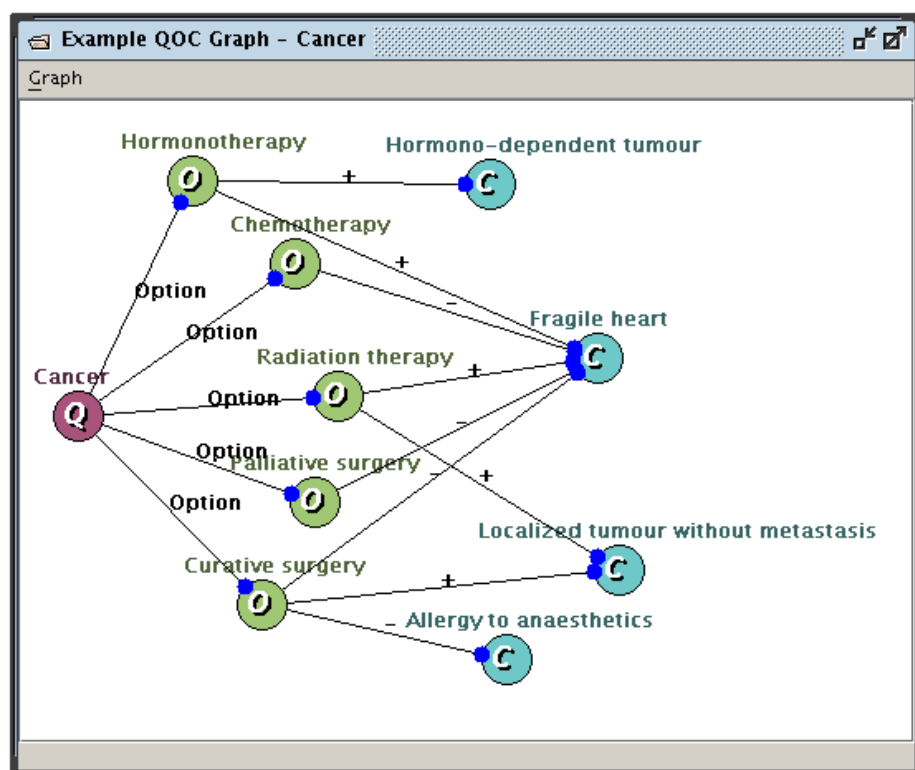

Fig. 4. QOC Graph for choice of a therapeutic protocol a cancer

For support to decision on a treatment to cure the diagnosed pathology, the options will be the various possible treatments, each one connected by a positive link to the criteria encouraging to choose it and by a negative link to the criteria inciting to reject it. For example, fig. 4 shows a QOC graph for choosing between an hormono-therapy, a chemotherapy, a radiotherapy, a palliative surgery and an eradicating surgery in order to treat a cancerous tumour, taking into account several criteria such as some characteristics of the tumour (e.g. hormono-dependent tumour, localised tumour without metastasis) or of the patient (e.g. fragile heart, allergy to anaesthesia).

3.4 Knowledge Representation for the Virtual Staff

In the Virtual Staff, we thus combine both models: SOAP to visualise the medical record and QOC in phase of decision to choose between pathologies or between action plans.

These graphs can be represented through conceptual graphs [20], built by using the concepts and relations of the Nautilus ontology. Due to the correspondence between

conceptual graphs and RDF(S) language [2] 3] [4], SOAP or QOC graphs can also be represented in RDF(S). Using the Nautilus ontology, the system can propose a list of possible concepts to help the user to build the SOAP and QOC graphs:

- the S nodes will correspond to instances of selected concepts among the subconcepts of *Symptom*,
- the O nodes will be chosen among subconcepts of *Laboratory-Test*,
- the A nodes among those of *Pathology*,
- and the P nodes among those of *Treatment*.

     The arcs between the nodes will correspond to relations among concepts:

- *Symptom has-for-cause Pathology;*
- *Pathology has-for-consequence Symptom;*
- *Pathology confirmed-by Laboratory-Test;*
- *Pathology treated-by Treatment; Symptom treated-by Treatment.*

In the same way, for QOC graphs aimed at determining the right pathology, the Options will be selected among the subconcepts of *Pathology*, and the Criteria among those of *Symptom, Laboratory-Test, Pathology* or *Treatment*.

To determine the right treatment, the Options will be selected among the subconcepts of *Treatment*, and the Criteria among those of *Symptom, Laboratory-Test, Pathology* or *Treatment*.

The arcs between the nodes of a QOC tree can be interpreted by « Question *has-solution* Option » or by « Option *has-argument-for* Criterion » or by « Option *has-argument-against* Criterion ».

To express certainty degrees on a diagnosis of disease or priority degrees between the possible treatments, the physician can indicate weights on some arcs between the nodes of SOAP or QOC graphs [14].

The incremental modifications performed during a Virtual Staff session and the final results of such a session are saved in an XML document in order to be exchanged with the Episodus software of our industrial partner.

Let us note that the Virtual Staff is not at all an expert system. It only allows the care team to visualise the reasoning and the decision-making process; the reasoning is carried out by the members of the network and the inferences based on the ontology enable the system to filter the choices offered to the user. The role of the QOC graph can be compared to a guide of best practices [10]. But the QOC graph relies on the specific data of the concerned patient and not on generic data. To the nodes or arcs of the SOAP and QOC graphs, one could associate medical documents such as guides of best practices: an argument on the choice of a given treatment could be connected by a hypertext link to a guide describing the criteria of selection of this treatment.

Remarks:
- If one integrates in the Nautilus ontology the list of symptoms associated to a pathology, a query to CORESE about all the pathologies possible for a given symptom of the patient could be useful for helping in the diagnosis of the disease while building the QOC graph.

- By the same way, if one integrates in Nautilus the possible treatments for each pathology, as described in a guide of best practices, CORESE will be able to suggest the list of the possible prescriptions for the QOC graph.
- If the Nautilus ontology is extended by the drugs and their side-effects or contra-indications, CORESE can suggest that a given drug may be cause of a given symptom or indicate a criterion against the choice of a given drug as a treatment of a pathology.

3.5 Virtual Staff Validation

The first version of the Virtual Staff was validated by our industrial partner, from two viewpoints: its functions and its interfaces. This evaluation led to several improvements of the graphical interface of the virtual staff: the new interface (see fig. 3 and 4) helps the user to really follow the reasoning guided by the SOAP model (each part of the graph is dedicated to nodes expressing either an Assessment or an Objective or a Subjective or a Plan) or by the QOC model (Question → Option → Criterion). Moreover, the parts of the SOAP and QOC graphs are visualised differently according to their creators: it is thus possible now to associate a colour to each participant in a given session so as to recognize, directly from the colour of the nodes or of the arcs, which physician or which member of the network argued about a given possible pathology or suggested a given treatment.

Our industrial partner will also ask actual physicians to handle the Virtual Staff in order to evaluate it from the viewpoint of a real end-user.

4   Conclusions

In this paper, we presented a translator of an ontology coded in an internal format of a database towards the RDF(S) language, in order to check and validate the ontology by visualising it via the CORESE engine, in a human-understandable form. The translation algorithm depends on the internal format of the database but the generic idea of building an ontology by decoding a database knowing its principle of coding, and then representing it in a standard formalism, is interesting for companies having DBs from which they wish to reconstitute an ontology.

Moreover this ontology was extended by using a knowledge acquisition method based on corpus analysis through a linguistic tool, as in [11] and by integrating an existing classification. This constitution of an ontology from heterogeneous sources (database, textual corpus, classification) could be compared with approaches such as the ONIONS method [8] [9].

We also specified and developed in JAVA a Virtual Staff, with:

- SOAP graphs describing the links between diagnostic and therapeutic hypotheses, symptoms and observations,
- and QOC graphs for support to decision-making.

The nodes of both kinds of graphs are typed by the concepts of the ontology.

Such a combination of these SOAP and QOC models with an ontology is original and illustrates the interest of an ontology to help the user to visualise a reasoning or a decision-making process.

The ontology and the Virtual Staff were validated by our Nautilus partner. As noticed earlier, the validation of the ontology through CORESE enabled to detect some errors in the initial ontology and the evaluation of the virtual staff led to strong improvements of its interfaces.

Notice that, even though the Virtual Staff was implemented with the Nautilus ontology (for collaboration reasons), it would be possible to adapt the Virtual Staff to another medical ontology such as UMLS meta-thesaurus.

As a further work, we plan several extensions and improvements of the Virtual Staff:

- *Extend the Nautilus ontology* as suggested in section 3.4; provided that such extensions are accepted by the physicians (cf. according to our industrial partner, it seems that some physicians do not appreciate to have "intelligent" suggestions from a system and prefer to choose and decide everything themselves).
- *Improve the cooperation of multiple users* through the Virtual Staff.

Last, our industrial partner will proceed to its evaluation by physicians taking part in an actual network (probably in diabetes).

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