OPN-Ont: Object Petri Nets Ontology Tool

Lynda Dib and Fouad Bousetouane
LASE- LAboratoire des Systèmes Embarqués,
Computer Science Department, Badji Mokhtar University, Annaba, Algeria

Keywords: OPN-Ont System, Ontology, Objects Petri Nets, Requests, Concepts, Relations.

Abstract: Ontologies are being used nowadays in many areas, including software engineering, business, and biology, to evaluate their suitability for representing and simulating domain processes. To assist users in developing and maintaining ontologies a number of tools have been developed. The representation of knowledge bases and conceptual domain models, hierarchical process, the structural components that participate in the process and the roles that they play in a complex domain, is therefore a major challenge for computer scientists for this complex domain. Without aiming at exhaustiveness, our study combining ontology and Petri Nets (PNs) tries to identify some promising tracks in this area, which seems a rather interesting alternative in the optics of the expressive power of the deductive representations. The context of our work consists to develop a graphical knowledge model for complex domain. This paper presents the OPN-Ont (Object Petri Nets Ontology) model. In this system ontology is represented in the PNs format, which allows verification of formal properties and qualitative and quantitative simulation. It leads to represent and exploit the different ontological components: concepts, relations and requests. The illustration of our model is made in biological domain where process supports methods for qualitative and quantitative reasoning.

1 INTRODUCTION

In computer science, ontologies are a technique or technology used to represent and share knowledge about a domain by modelling the concepts in that domain and the relationships between those concepts (Gruber, 1991). These relationships describe the properties of those concepts; in essence, what it is to be one of those concepts in the domain being modelled. Ontology represents a conceptualization of reality or simply reality. Ontology often resorts to various tools of formalization and representation, which taken independently do not lead to the anticipated results. Today, the number of tools for developing ontologies has been increased and diversified. Increasingly, the construction of ontologies is an area of ongoing research. Today, there are a number of models and tools for developing ontologies. We assessed diverse models that were developed in the fields of software engineering, business, and biology, to evaluate their suitability for representing and simulating domain processes. Based on this assessment, we propose an OPN-Ont model that should be mathematically based to allow verification of properties that are desirable in biological system, and simulation of system behaviour. So, we have combined the best aspects of two models 'PN and ontology model' and we have developed OPN-Ont (Objects Petri Nets Ontology). This last has an interactive graphical interface based on Object PN. The illustration of our model is made in biologic process where PNs can represent nesting and ordering of biologic processes, the structural components that participate in the process and the roles that they play. OPN-Ont not only represents hierarchical process knowledge in biology (which is a major challenge for bioinformatics) and structure components but it composed queries to discover relationships among processes and structural components. We used PNs analysis to answer queries about the dynamic aspects of the model. OPN-Ont is tested by representing OntoCell (Dib, 2005), and composed queries to discover relations among processes and structural components. We used reachability analysis to answer queries about the dynamic aspects of the model.

2 RELATED WORK

There are many formalisms and tools to edit, browse

Dib L. and Bousetouane F..
OPN-Ont: Object Petri Nets Ontology Tool.
DOI: 10.5220/0004085301580163
In *Proceedings of the 2nd International Conference on Simulation and Modeling Methodologies, Technologies and Applications* (SIMULTECH-2012), pages 158-163
ISBN: 978-989-8565-20-4

and map ontologies and a few comparative studies of ontology tools have been performed. These tools assist users in developing and maintaining ontologies as: *Workflow* used by Peleg to develop ontology fo biological processes (Peleg, 2002). Other tools are developed to creat, edit and brows ontologies such as: *Protégé-2000*; *Ontolingua* that shows the concepts in a two dimensional tree visualisation (Rice, 1996); *Chimaera* (Chimaera Software Description URL, 2004) which is a web-based ontology system and built on top of the Ontolingua Distributed Collaborative Ontology Environment; *OilEd* which uses the FaCT system (The FaCT System URL, 2004) a description logic system for checking the consequences of the statements in the ontology and which has various types of tabs where each tab shows information on the current ontology component (Habbouche, 2002).

Evaluation: A number of other ontology tools have been developed and used in bioinformatics. However, only few evaluations of ontology tools using bio-ontologies have been performed. In (Lambrix, 2003), Protégé, Chimaera, and OilEd were evaluated with respect to criteria such as functionality, data model learning and user interface. So, they were evaluated as ontology development tools using GO ontologies as test ontologies. In (Lambrix, 2004) an extension of this evaluation is found, where Protégé-2000 with Chimaera were evaluated against as ontology merging tools. In (Dragan, 2006) the specific graphical user interface provides graphical tools for all PN concepts and in addition, the PN ontology is represented in RDFS, and concrete PN models are represented in RDF. However this solution covers only Time PNs, and no other kinds of PNs. It neither defines PN structuring mechanisms, nor provides precise constraints. Finally, it does not enable using other ontology languages for representing the PN ontology. From this evaluation, no system is preferred but each system has its own strengths and weaknesses. Based on this assessment and on the solution proposed by Perleg in (Pelegl, 2002), we combined ontology, PN and a biological concept model and developed an interactive graphical knowledge model, OPN-Ont, tested in biological processes that supports methods for qualitative and quantitative reasoning.

3 OPN-Ont

OPN-Ont model allows ontologies to be created and explored. It is a computer application for data organization and analysis. The OPN-Ont tool can represent nesting and ordering of processes, the structural components that participate in the processes, and the roles that they play. It has an interactive graphical interface based on high-level PNs an extention of a PNs formalism. So, it maps to PNs which is a graph-theoretical model that allow verification of formal properties and qualitative simulation. OPN-Ont tries to interpret all the changes and states of the ontology being built or operating. The user can interact with the system using menus and graphical representation of concepts and their relationships (in form of objects PNs). Ontology in OPN-Ont system is operating by updates and requests-answers trough queries. The ontology is primarily an evolutes tool and the updates must be performed periodically to adapt it to its ontological function.

4 OPERATING SYSTEM OPN-Ont

OPN-Ont provides both a net-based and a node-based view of an ontology, where the latter displays the selected concept and its entire environment (definition, parents, children, other concepts linked a domain relationship). So it is not limited to only hierarchical link, *is-a* or *part-of*, however, the user can hide links if they choose to. From the main functions menu, the user can choose to: Open/Creat/Save/Queries a ontology or Exit the system. Once Open or New is chosen, the user could introduce all the information (concepts and relations that connect thems) collected and required for the construction of the new ontology or the enrichment of an existing one. At this level (Open/New), the updates could be through a menu (Figure 1).

A-Consult: The system allows user to browse or explore the ontology moving from one concept to another. The marked place will be displayed with its name and its entire environment : generic/specific concepts and concepts that are linked by a domaine relationship (Figure2).

The marked (current) concept can has equivalent terms (called not-concepts or synonym concepts) viewed in a sorted alphabetical list. As the not-concepts are only linked to the current-concept and can not referred to other concepts therefore their representation in the PNs form is not essential and a list of their names is more than sufficient. Only at this level changes in the equivalent concepts can be deleted, renamed or canceled.

b-Create: Through the creation menu the user must specify if the relationship is equivalent, specific, generic, or a domaine link. In the case of:

(a) generic and associative to a domaine links, the name of the concept that the relation will be established, should be included in the ontological base, that means it must have at least one or more generic links with one or more concepts (Figure 3, Figure 4). (b) the specific link, the name of the concept which will be linking may exist or not in the ontology. If this name does not exist, a control ensuring its no duplication is activated. At this stage, the new concept can be added to the ontology (Figure 5). (c) if the introduced name is a not-concepts in the ontology, the system return automatically to the concept which it is equivalent. (d) the creation of a not-concept, the system control ensuring the non membership of this term to the list of concepts or to the list of not-concepts. To add a new link the system always ensures it has not been duplicated. Thus, there will be a base of information that respects the principles of ontology establishment.

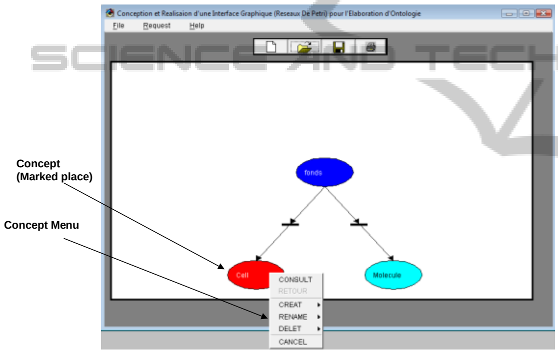


Figure 1: Concept menu: Menu of possible operations associated to a marked place.

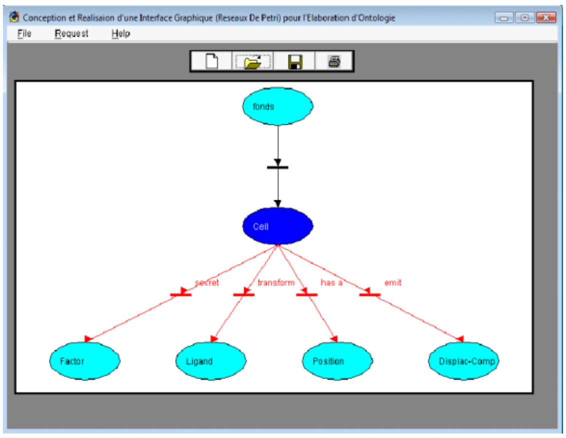


Figure 2: Consultation of the current-concept.

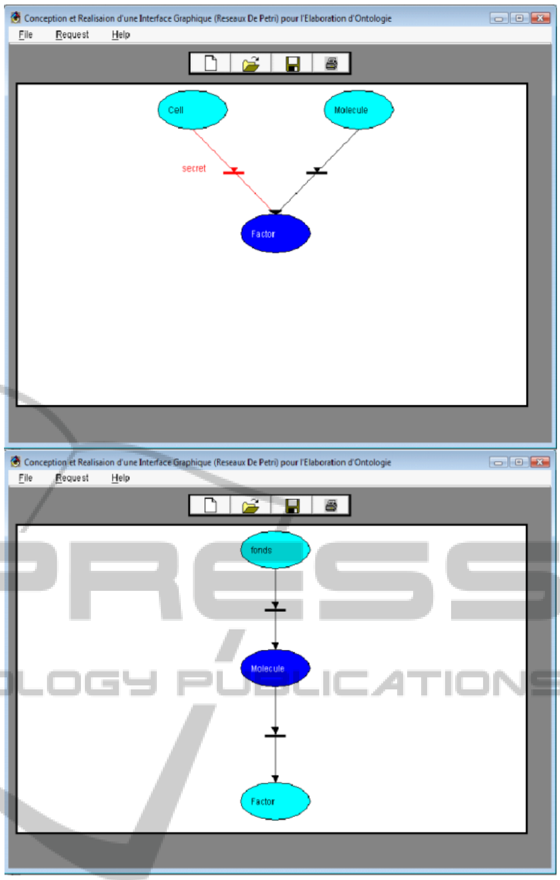


Figure 3: Creation of a generic relationship between 'Molecule' and 'Factor' concepts in OntoCell ontology.

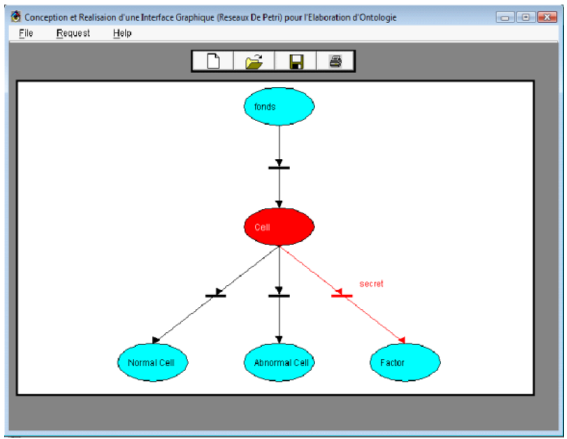


Figure 4: Creation of a domain relationship: Cell 'secret' Factor.

C-Renaming Concept or Relationship

Through the 'Rename Menu' the user can rename a concept or a not-concept but it is necessary to avoid redundancy. He can also renaming a domain relationship among concepts.

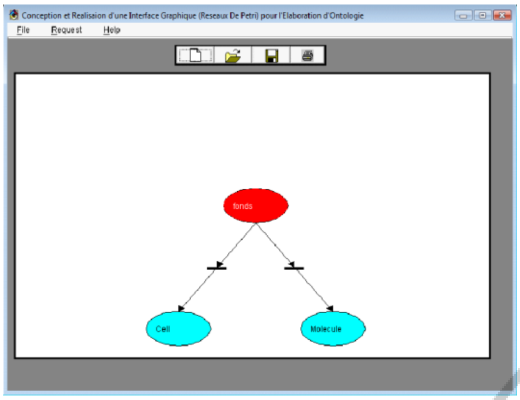


Figure 5: Creation of a specific relationship: Creation of 'Cell & Molecule' concepts in OntoCell ontology.

D-Delete: Through the 'Delete Menu' the user can delete a concept previously introduced (error during the introduction of the concept, ...). After confirmation, the system removes all links that relate the concept on cause to other ones Figure 6.

If further, one of specific concepts (concept2) to the removed concept (concept1) was not attached to any other concept, the elimination of concept1 will cause automatically the deletion of concept2 if the user wants this, otherwise he will relate concept2 to another existing concept in the ontology to avoid any loss of information. This principle will be applied to specific concept of concept2 and so on until to the last specific one. We note that deleting only a relation (with a specific (Figure 7a), generic (Figure 7b), or concept linked by a domain relationship (Figure 7c), between concept2 and concept1 and not a related concept, is possible by selecting the relation in cause and choosing the Delete option. The same verification process described above will be followed if concept2 is not connected to any other concept that concept1.

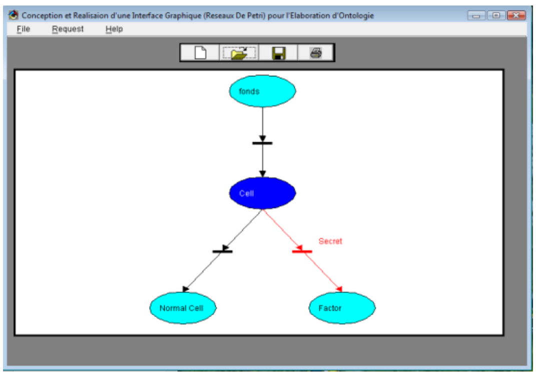
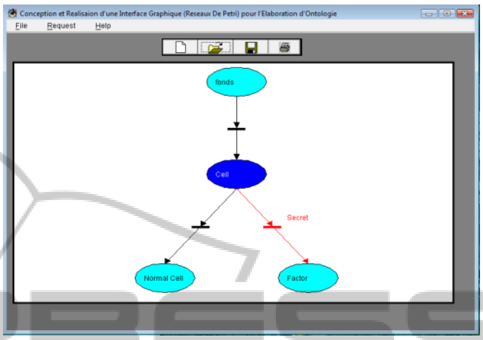
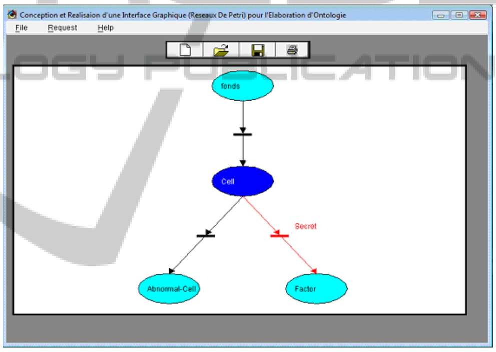


Figure 6: The result after deletion of a concept.

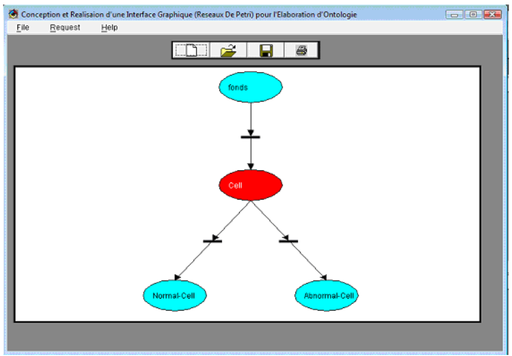
3 - Requests: Once the ontology is built, queries about its contents may be made. Once the user describes this request by entering the operators (OR, AND, EXCEPT) and their inputs, the system uses the appropriate processing with the possibility of combining them. The user structures his query as a PN form starting with the most general operator of the query to the more specific one.



a: Delete a specific link.



b: Delete a generic link.



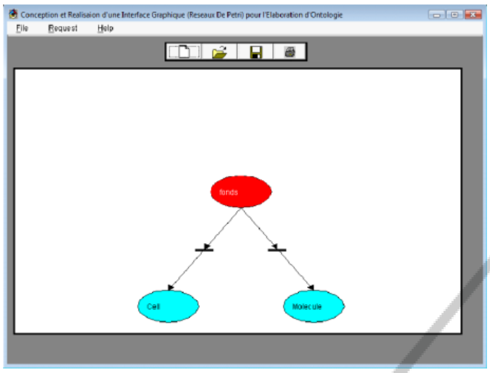
c: Delete a domain link.

Figure 7: Examples of relationship delation.

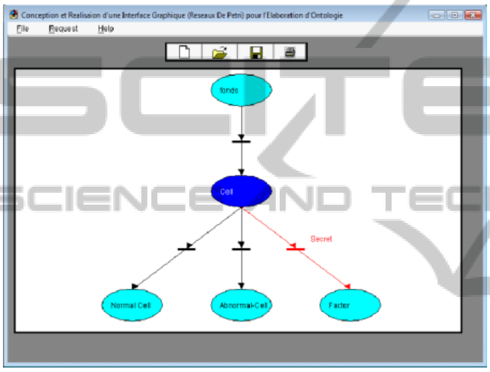
5 RESULTS AND DISCUSSION

Results: A biological OPN-Ont Example

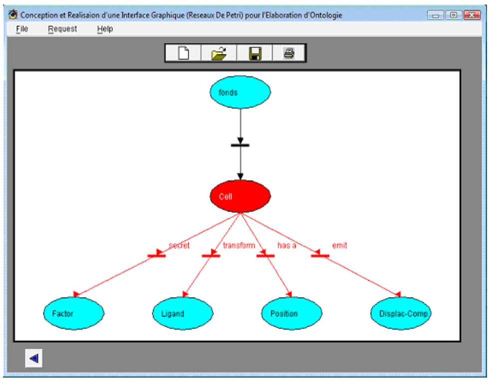
The example represent OntoCell ontology (Dib, 2005). Due to lack of space we only show some concepts of OntoCell diagrams. In the first part of this example we represent OntoCell Concepts. Initially, we represent two concepts (Cell and Molecule) of the first level of OntoCell (Figure 8 a).



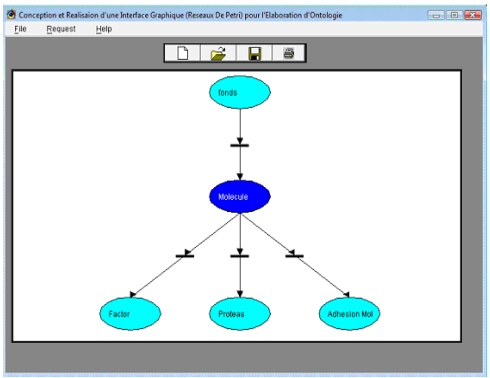
(a)



(b)

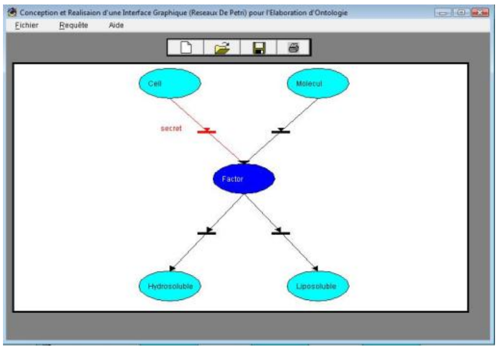


(c)



(d)

Figure 8: Some concepts in OntoCell ontology.



(e)

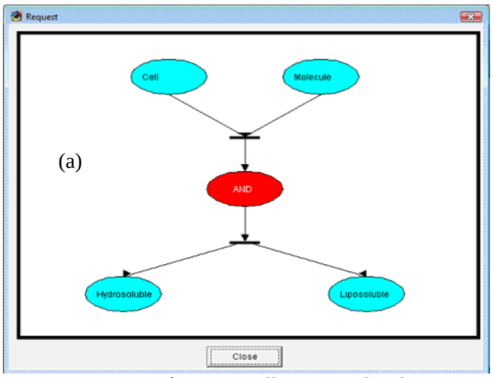
Figure 8: Some concepts in OntoCell ontology(cont.).

After, we represent the second level, where we represent for example the specific (black transition) and associative to a domain (red transtion) links of Cell concept (Figure 8 b,c) and specific Molecule concept (Figure 8 d). At last, in the third level, we represent for example the specific concepts of the concept Factor (Figure 8 e). Factor is linked to Molecule by a specific relation and to Cell by the role ‘Secret’.

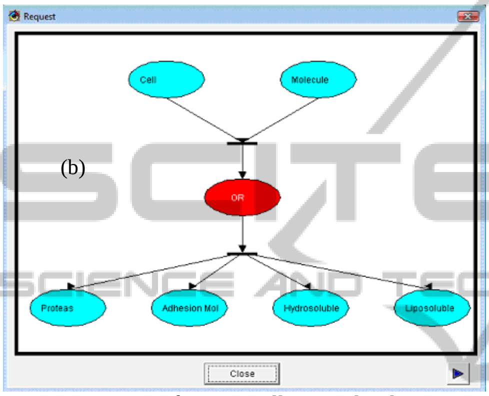
In the second part we identify queries. The results of the three first queries are given by Figure 9: Case a, shows the result generated by the query ‘Cell *AND* Molecule’. Case b, shows the result generated by the query ‘Cell *OR* Molecule’. Case c, shows the result generated by the query ‘Cell *EXCEPT* Molecule’.

Discussion

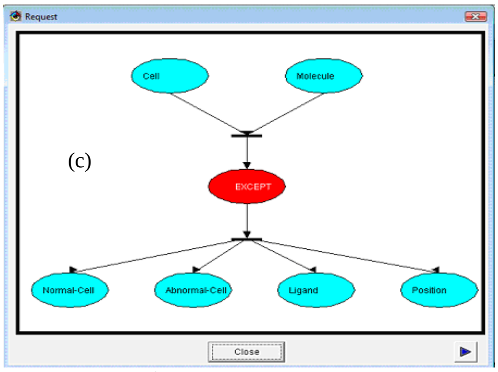
OPN-Ont allows Ontologies to be created and explored. Places represent concepts, and transitions represent relationships (hierarchical links or activities). There are many benefits to use PNs: they have a firm mathematical foundation and they explicitly represent states, which allows for the modeling of milestones and implicit choices. Another benefit is that Hierarchical PNs can control the complexity of the representation of biological systems. And last, Colored PNs can define states and transitions and dynamical behaviours of the systems are indicated by distributions of *tokens* changed progressively along individual fulfilments of conditions at *places* and succeeding firing the events at *transitions*.



Response of query: 'Cell AND Molecule'.



Response of query: 'Cell OR Molecule'.



Response of query: 'Cell EXCEPT Molecule'.

Figure 9: OntoCell in OPN-Ont: functional role, biological reactions, biological process.

6 CONCLUSIONS

The aim of OPN-Ont tool is to allow experts, each in its area, to construct and operate their ontologies. The graphics offers the user ease of handling and understanding the behaviour of the system by the various commands he sends. The search for information thus becomes easy, either by direct access of the system to the information requested through requests or by exploring the ontology while navigating the network that represents it. PNs were chosen to model ontology; indeed, knowledge is clearly represented and easily identified. Also, the dynamic aspect will be present in the activity of conceptual knowledge and in requests where the evolution of marks in places facilitate for the system the search of the requested information, especially in the search for intersection among two distant concepts in the network but that have temporarily dynamic link (with operators) which disappears after reply to the request.

REFERENCES

Chimaera Software Description URL, 2004: www.ksl.stanford.edu/software/chimaera (Acc.25-07).

Dib L., 2005: OntoCell: An ontology of Cellular Biology, *Journal of Computer Science* 1 (3): 445- 449.

Gruber, T. R., 1991: The role of common ontology in achieving sharable, reusable knowledge bases, *in Proceedings of KR'1991: Principles of knowledge representation and reasoning*, p. 601-602.

Habbouche, M. and Pérez, M. 2002: Evaluation of ontology tools for bioinformatics, *LiTH-IDA-Ing-Ex-02/10, Department of computer and information science*, Linköpings universitet. In Swedish.

Lambrix, P., Edberg, A., 2003: Evaluation of ontology merging tools in bioinformatics, *Pacific Symposium on Biocomputing*, 8:589-600, Kauai, Hawaii, USA,

Lambrix, P., Habbouche, M., Pérez, M., 2004: Evaluation of ontology development tools for bioinformatics, *Bioinformatics*, 19(12):1564-1571.

Rice, J., Farquhar, A., Piernot, P.and Gruber, T. 1996: Using the Web Instead of a Window System. *In CHI*, pp.103–110. http://www-ksl-svc.stanford.edu: 5915/ doc/papers/ksl-95-69/index.html.

The FaCT System URL: 2004 www.cs.man.ac.uk/~ horrocks/FaCT. (Acc. 21-07).

Dragan G., Vladan D. 2006: Petri net ontology, in *Knowledge-Based Systems Journal*. 19 220–234

M. Peleg, I. Yeh, R. Altman, 2002: Modeling biological processes using Workflow and Petri net models, in *Bioinformatics Journal* 18 (6) 825–837.