

PETRI NETS AS AN EFFECTIVE TOOL TO STRUCTURE WEB MULTIMEDIA KNOWLEDGE: THE CASE FOR GIOVANNI DEGLI ANTONI'S SCIENTIFIC AND DOCUMENTARY WORK

Adalberto Sangalli, Rita Pizzi, Adriano Baratè,
Luca A. Ludovico, and Goffredo Haus*

Department of Computer Science, University of Milan, Milan, Italy

ABSTRACT

The complexity of multimedia knowledge requires new methods of representation. This work addresses the problem by proposing the use of Petri nets, a powerful knowledge representation method suitable to manage complex concurrent events. An interactive interface allows the exploration of both the knowledge structure and the multimedia content. We have developed a web application that collects and systematizes Giovanni Degli Antoni's scientific and documentary work, mainly composed of web multimedia contributions, underlining his long-life research in the field of hypermedia world and Petri nets theory and applications.

Keywords: Petri nets, hypermedia, knowledge representation, Giovanni Degli Antoni

INTRODUCTION

Giovanni Degli Antoni (founder and former Director of the Department of Computer Science, University of Milan, one of the pioneers of informatics in Italy) devoted a relevant part of his scientific activity to the investigation of Petri nets theory and applications and of the hypermedia technologies, anticipating their diffusion and exploring their use in often unconventional areas.

His recent death has stimulated the Department of Computer Science of the University of Milan to promote the collection and systematization of his scientific and documentary work, made up of numerous multimedia unstructured contributions, mainly in form of web pages.

* Crema Campus: via Bramante 65, 26013 Crema; Milan headquarters: via Comelico 39/41, 20131 Milan.
E-mail: rita.pizzi@unimi.it

Once identified the material, the problem was to create a tool capable of effectively representing it and consulting it interactively.

We approached the problem by both examining existing methods for hypermedia classification and addressing the investigation into Petri nets [1], which were considered suited to represent the Giovanni Degli Antoni's method of research, often open on several parallel fronts that reveal different approaches and solutions to new problems.

1. MATERIALS AND METHODS

The first phase of the work was the collection and classification of multimedia documents. The material was quite heterogeneous: e-books, presentations, articles, videos, courses, interviews, papers, conference talks, contributions to other authors' works, etc.

Main references were found privileging direct sources, namely:

- in the video portal of the University of Milan ¹;
- in the "Country Code Top Level Domain" website ², dedicated to the Italian top level domain and a witness to the history of Italian informatics. It contains a wealth of articles written by prof. Degli Antoni;
- in the Coobook website ³, founded and managed by prof. Degli Antoni and rich in articles, e-books and presentations that well reflect his thoughts.

For each of the resources under consideration, significant words or phrases were used to classify them. In order to make collection homogeneous and to facilitate subsequent research operations, Dublin Core standard ⁴ [2] has been adopted for metadata of digital resources. This first phase lead to the composition of an index of about 60 contents, divided into three groups broadly similar in size:

- video;
- websites and pictures;
- scientific articles, e-books.

2. PETRI NETS

The particular nature of the documentary material identified, rich in connections among different themes, has directed our research into methods that propose a "hypermedia" interactive fruition.

Throughout his academic life, Giovanni Degli Antoni promoted Petri nets as a first-choice tool for representing knowledge and managing complex concurrent events. He often proposed the use of Petri nets in non-habitual areas such as, for example, for the analysis and re-elaboration in computer music [3] and for the analysis and synthesis of legal texts [4]. The

¹ <http://portalevideo.unimi.it/>

² <http://www.cctld.it>

³ <http://www.coobook.org>

⁴ <http://dublincore.org/documents/dces/>

belief of the Petri nets representative power, together with their self-evident graphic representation, prompted us to evaluate their use for the creation of an interactive fruition tool.

A classical Place-Transition (P/T) Petri net is a class of discrete event dynamic systems represented by a bipartite graph composed by four symbols:

- circles for places;
- rectangles for transitions;
- oriented arcs for connecting places to transitions or vice versa;
- tokens, i.e., dots in the circles or numbers inside them that indicate the dynamical evolution of the net.

It was assumed that the use of graphic symbols would be used to build interactive cognitive pathways. To do this, however, it was necessary to establish some criteria to represent the available material and the relationships that lie among the elements. The following have been identified:

- media are connected to (0 or more) places;
- arcs are associated with information describing the type of relationship that connects a place to a transition;
- transitions, with their trigger, determine the visibility of the media, depending on the number of tokens created in the corresponding output place: if greater than 0, the place is in an 'active' state and the corresponding documents can be viewed.

The transition trigger should also be decided interactively by the user who, clicking on one of the enabled transitions, selects from time to time which one will trigger.

In a situation like the one shown in Figure 1, for example, the trigger of the T1 transition would enable the fruition of the media m3 and m4, associated with the P3 place, and would disable those associated with the P1 position, whose number of tokens after the trigger would be 0.

The documents associated with the input places of a transition are therefore a pre-condition necessary to access those associated with the output places.

On the basis of this logic, a narrative structure was created to represent the whole material. To do this, we started from the collected documents, locating the individual points of a path – the nodes of the net – to which the media were considered representative. The different nodes are connected to each other through the net arcs that represent the relationship, alternating places to the transitions that have the task of running the net, enabling the view of the specific media.

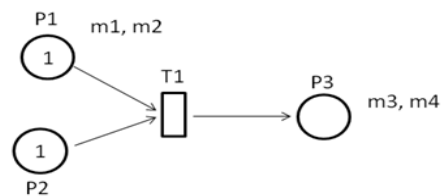


Figure 1. Example of the enabling of documents fruition associated with a place.

3. RESULTS

The implementation of the Petri net and the underlying operational logic were achieved through the creation of a website available at <http://gda-petri.lim.di.unimi.it>. As shown in Figure 2, the graphical interface identifies the net interactive area and a separated descriptive section.

To represent the net, a semaphoric logic was used to differentiate enabled transitions, in green, from disabled transitions, in red. By clicking on an enabled transition it is possible to interact with the net, causing its advancement into a new state. Each configuration represents a possible portion of the knowledge of the entire domain: that determined by the media associated with the places that are active after the last net advancement and are marked by the yellow border.

To improve the graphical interface readability we adopted the symbolism of the Pictomatica codex ⁵, a visual grammar developed by the digital artists G. and R. Carraro with the contribution of Giovanni Degli Antoni. Moving an image from one condition to another occurs through a logical-visual event called “pictomatic operation” that adopts the logic of Petri nets.

The main architecture of the site was realized in HTML5, with the use of CSS technology for graphical layout and JavaScript for client-side interaction. The Petri net was built entirely with JavaScript and Cytoscape.js ⁶[5], a library that allows to easily create and interact with graphical structures.

Designing the net structure, a modular logic was adopted that allows the net itself to be parameterized, thus enabling the tool to be applied to different contexts.

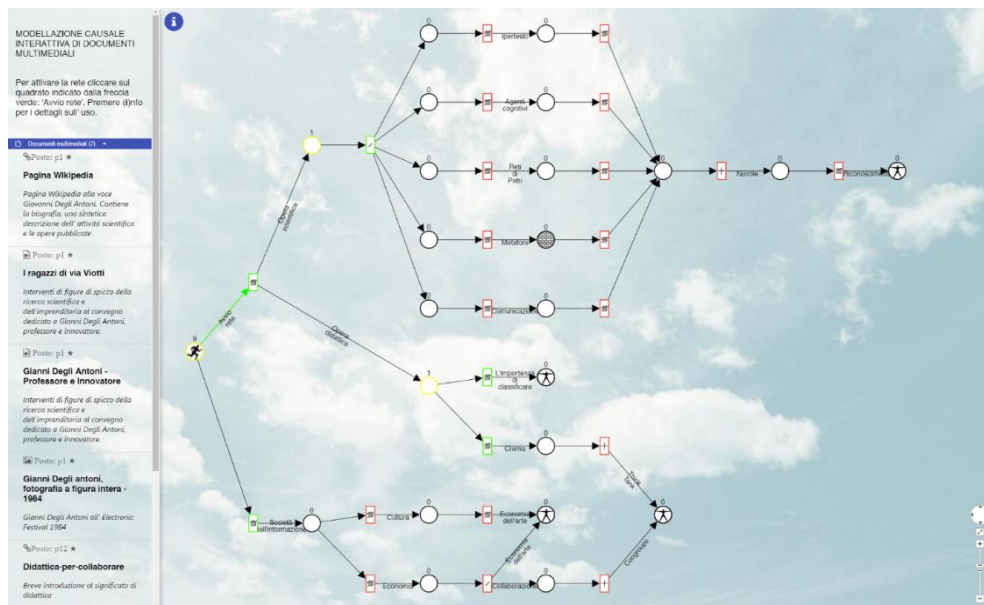


Figure 2. The Petri net interactive interface.

⁵ <http://www.coobook.org/pictomatica>.

⁶ <http://js.cytoscape.org/>.

CONCLUSION AND FUTURE DEVELOPMENTS

We developed a Petri net based knowledge-representation tool, suitable to treat diffuse web multimedia documentation and equipped with an interactive interface. It would be useful to improve engineering in order to get a fully and easily configurable software for different applications.

We are considering to explore the development of a semi-automatic generation of an interactive net from suitable multimedia material structured with the help of descriptive languages such as XML.

The creation of a less technical and more user-friendly interface could enable its use in any professional or recreational context.

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