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PARAMETRICS EDITORS FOR STRUCTURED DOCUMENTS

Tesi di Laurea in Interazione Persona Computer

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To my parents, CARMELA *and* EMANUELE, *and to my*
childhood town SANNICANDRO GARGANICO,
they built my hardware and developed my operating system.

To BOLOGNA *and the people that I have met here,*
they have fixed so many bugs ...

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Chapter 0

Introduzione

Lo scopo di questa dissertazione è di identificare le tecnologie più appropriate per la creazione di editor parametrici per documenti strutturati e di descrivere LIME, un editor di markup parametrico e indipendente dal linguaggio.

La recente evoluzione delle tecnologie XML ha portato ad un utilizzo sempre più consistente di documenti strutturati. Oggigiorno, questi vengono utilizzati sia per scopi tipografici sia per l'interscambio di dati nella rete internet. Per questa ragione, sempre più persone hanno a che fare con documenti XML nel lavoro quotidiano. Alcuni dialetti XML, tuttavia, non sono semplici da comprendere e da utilizzare e, per questo motivo, si rendono necessari editor XML che possano guidare gli autori di documenti XML durante tutto il processo di markup.

In alcuni contesti, specialmente in quello dell'informatica giuridica, sono stati introdotti i *markup editor*, software *WYSIWYG* che assistono l'utente nella creazione di documenti corretti. Questi editor possono essere utilizzati anche da persone che non conoscono a fondo XML ma, d'altra parte, sono solitamente basati su uno specifico linguaggio XML. Questo significa che sono necessarie molte risorse, in termini di programmazione, per poterli adattare ad altri linguaggi XML o ad altri contesti.

Basando l'architettura degli editor di markup su parametri, è possibile progettare e sviluppare software che non dipendono da uno specifico linguaggio XML e che possono essere personalizzati al fine di utilizzarli in svariati contesti.

A tale scopo è necessario innanzitutto caratterizzare i documenti strutturati. I documenti strutturati sono documenti che contengono altre informazioni in aggiunta al loro contenuto. Queste informazioni supplementari servono per descrivere la struttura logica del documento, ossia gli oggetti che lo compongono, e le relazioni fra questi oggetti.

Esistono diverse tipologie di linguaggi di markup per la marcatura dei documenti strutturati ma i linguaggi più appropriati a questo scopo sono i linguaggi descrittivi e XML è, attualmente, il più completo in questo genere. Negli ultimi dieci anni sono stati sviluppati svariati dialetti XML per la marcatura di documenti testuali appartenenti a molti contesti. Questi linguaggi devono essere specifici ma allo stesso tempo flessibili per permettere di descrivere al meglio tutte le varie tipologie di documento che si possono incontrare in uno specifico contesto.

Uno dei contesti più insidiosi è quello giuridico. I documenti legali e legislativi possono avere strutture molto differenti anche se creati dalla stessa istituzione. Ad esempio la struttura delle leggi italiane può essere differente dalla struttura delle proposte di legge. Per questo sono stati creati negli anni molti linguaggi XML per la marcatura di documenti legali. Attualmente, il più completo è *Akoma Ntoso*, che con la sua architettura basata su *pattern*, può essere utilizzato per la marcatura di documenti provenienti da tutte le istituzioni.

Gli esperti di informatica giuridica sono stati pionieri nella creazione di editor di markup. In questo contesto, infatti, gli autori di documenti debbono concentrarsi sulla struttura dei documenti e non possono essere distratti dalla complessa sintassi XML. Insieme a linguaggi XML specifici sono stati creati anche editor di markup per le varie istituzioni. Solitamente, essi sono sviluppati come plug-in di processori di testo esistenti, come *Microsoft Word* o *apache OpenOffice*. Questo è molto importante in quanto fornisce agli autori un'interfaccia grafica già nota e con la quale si sentono a loro agio. Tuttavia, è molto difficile adattare questi software alla marcatura di documenti provenienti da istituzioni per le quali il software non è stato originariamente pensato. Partendo dall'analisi di questi software è possibile progettare e implementare un editor di markup indipendente dal linguaggio XML utilizzato.

LIME è un editor di markup open-source, parametrico e indipendente da qualsiasi linguaggio XML. La sua architettura è basata sui pattern XML, su alcune linee guida per la creazione di documenti XML e, soprattutto, su parametri inseriti all'interno di file di configurazione JSON. L'idea alla base di LIME è che è possibile astrarre un linguaggio XML assegnando ad ognuno dei suoi content model uno dei pattern utilizzati dal linguaggio Akoma Ntoso. Questa astrazione può essere descritta con parametri (array associativi) all'interno di file di configurazione JSON. In questo modo, in LIME, è possibile abilitare altri linguaggi XML semplicemente scrivendo un insieme di file JSON impacchettati in un modo comprensibile al software. Questo significa anche che ogni eventuale estensione non necessita di competenze specifiche in nessun linguaggio di programmazione.

Altro scopo di questa dissertazione è quello di identificare un test di usabilità adatto agli editor di markup e utilizzarlo per testare LIME. Il test è stato creato al fine di valutare l'efficacia e l'efficienza degli editor di markup e la soddisfazione degli utenti nell'usare le loro funzionalità. Il test è stato sottomesso a dieci utenti per valutare LIME e ha evidenziato l'eccellente usabilità della maggior parte delle sue funzionalità.

Numerose istituzioni parlamentare, politiche e apolitiche, attendono il rilascio della prima versione beta di LIME per il markup dei loro documenti legali e legislativi.

I successivi capitoli di questa dissertazione verranno redatti in lingua inglese per facilitare la comprensione a ricercatori e sviluppatori non italiani.

Chapter 1

Introduction

The purpose of this dissertation is to pinpoint the proper technologies for the development of parametric editors for structured documents and to characterize LIME, a parametric and language independent markup editor.

The recent evolution of XML-related technologies has led to a massive use of structured documents both for typographical and for data interchange purposes and, in the last decade, several XML languages have been developed in order to meet the requirements of an incredibly diverse set of contexts. Due to this, many people, with many different skills, started to handle XML documents in their everyday work. But specific XML dialects can be difficult to understand and to be used properly and, for this reason, XML editors that allow users to markup documents in a proper way are needed.

In specific contexts, especially the legal one, XML drafters find help in *markup editors*. Markup editors are *WYSIWYG* software that assist users in the creation correct XML documents, by driving drafters through the correct workflow of markup. On the one hand, these are powerful tools that can be used even by people that have no knowledge of the XML syntax and XML dialects. But, on the other hand, these software are strictly dependent from the XML language they use to format documents and from the context they belong to. This means that, in order to use these software in other contexts, customization is needed and this can be expensive if the editor was not designed adequately in the first place.

By relying the architecture of markup editors on parameters, it is possible to create markup editors that are independent from any specific XML language and that can be adapted to several contexts with the minimum effort in terms of coding.

In order to create a parametric editor for structured documents, it is important to understand what structured documents are. *Structured documents* are documents that contain other information in addition to their content. This information adds semantic meaning to documents or to fragments of them and describe documents' *logical structure*.

The logical structure is a description of the objects that compose a document and of the relations among them. It is ascribed to documents by using appropriate and standardized *markup languages*. Different kinds of markup languages were developed in the course of time, but *descriptive markup languages* are the most suitable ones for the description of documents' logical structure.

Descriptive markup languages allow authors to describe objects and the relations between them by labeling them with *tags*. In this way, authors can focus on documents' logical structure regardless of any particular treatment of their rendition.

The first really standardized descriptive markup language was the *Standard Generalized Markup Language*, whose purpose was to define a generalized markup language for documents. By using SGML it is possible to markup structured documents according to a *Document Type Declaration*. SGML laid the foundations for the two most common descriptive markup languages: *Hyper Text Markup Language* and *eXtensible Markup Language*.

HTML is currently the most suitable technology to create web pages. Web browsers interpret the HTML tags in the documents and present the whole document in a readable or audible way. HTML and chiefly HTML 5 are good descriptive markup languages, but they are not intended to markup documents that must have their specific in-context semantically relevant elements. In these situations XML must be used.

XML defines a set of rules aimed to produce human-readable and machine-readable documents. It was originally designed to allow a large-scale electronic publishing, but it is currently also used to exchange data on the web.

There are many XML dialects used for the markup of text-based resources. These XML languages must be specific but at the same time they must be as flexible as possible, in order to hit all the peculiarities of the different areas in the same context. For example, a novel has a quite different structure from a scientific paper.

One of the most challenging context is the legal one. Even if legal and legislative documents rely on recurrent structures, they have to meet the requirements of a large set of different traditions, rules and users. Moreover, different kinds of legislative documents of a single country can have different structures. For instance, Italian bills can be quite different from Italian acts.

In the last ten years, many effective XML languages for the legal context were developed. Some of them were designed to meet the requirements of specific countries, like *Norme In Rete*, that was designed for the Italian legislative documents. Other languages, like *CEN/Metalex* and *Akoma Ntoso*, have a more flexible architecture and can describe documents coming from a variety of countries. These languages try to abstract documents' structure by using XML *patterns*.

Like programming languages' patterns, XML patterns describe recurrent markup situations. Akoma Ntoso architecture relies on six XML patterns: *containers*, *hierarchical containers*, *markers*, *blocks*, *inline* and *subflow*. These patterns are the most descriptive and the most common ones and, even if other languages do not have a patternized architecture, it is possible to abstract them and to assign one of these patterns to their content models. XML patterns are the keystone for language independent markup editors.

In legal context, markup editors are widely used and in the last two decades many editors were developed. As a matter of fact, legal informatics' experts were pioneers in the markup editors' field. They immediately understood that XML is a powerful technology to ensure interchange, reusability, and portability of legal and legislative documents. But they also understood that legal and law experts can not rely on pure XML editors because of the difficulty to write a proper XML legal document by using XML syntax. Through legal markup editors, legal drafters are not in charge of checking XML well-form and XML validity. They focus on the structure of the law and the editor drive them to create a correct XML too.

The most common legal markup editors are built as plug-ins of well-known word processors, like *Microsoft Word* or *Apache OpenOffice*. In this way, users are facilitate in their work because they use an interface they are already familiar with. By using macros, legal drafters ascribe the logical structure to legal documents; the legal markup editor prompts them the correct macros to be used and, eventually, it creates the final XML document by transforming the word processors' format into XML.

The other side of the coin is that these software are hardly customizable because of three reasons. Firstly, they are built on the top of other complex software and this means that any attempt to change the business logic or the interface of the software would be very expensive. Secondly, they are built to comply very specific markup workflows that derive from the legal tradition of the country where they are used. Last but not least, they rely on a specific XML language and it is often difficult to adapt them to other XML standards.

Starting from the analysis of legal markup editors, it is possible to design and implement a markup editor whose architecture revolves on parameters, in order to ensure the customizability and the independence from any XML markup language.

LIME (*Language Independent Markup Editor*) is a parametric and language independent markup editor aimed to be used with a wide variety of different XML languages. It relies on a set of parameters that are used to describe the XML languages that must be used and the markup workflow related to the languages. It solves many of the problems of current legal markup editor and aims to be used in any context in which XML can bring innovation.

LIME is an open-source stand-alone web application and its architecture is based on a set of technologies that ensure its independence from any XML language. Firstly and most importantly, LIME relies on *XML patterns*. In order to be used in LIME, XML languages must be analyzed and a pattern must be assigned to each content model. Secondly, LIME follows specific *XML guidelines* in order to create homogeneous XML documents. Thirdly, LIME parameters are specified in JSON configuration files. To create the configuration for a new XML language, a *language plugin* must be written. A language plugin is a set of configuration files packaged in a specific way that LIME can understand. This means that LIME configuration files are independent from the programming language used to develop LIME and it is possible to create a LIME language plugin without any skill in code developing. Lastly, LIME stores files in a native XML database and assigns them URI according to the *Functional Requirements for Bibliographic Records* (FRBR). In this way, produced documents are immediately published on the web and can be accessed by humans and machines by using the Representational State Transfer (REST).

As a markup editor, LIME drives users to create XML files even if they do not have any knowledge of XML, and moreover, even if they do not have any knowledge of the specif XML language they are using to markup documents. Users select the parts of the text they want to markup and the editor displays the elements that they can use to markup these parts. For example, when users are marking up an act in Akoma Ntoso language and they select a text inside an article, the editor allows to markup it as a section and does not allow to create another article inside it.

By creating LIME configuration files it is also possible to define the markup workflow associated to each XML language. This means that it is also possible to modify a part of the LIME business logic without any effort in terms of coding.

The other challenge for LIME is to ensure users a great user experience. Since users are driven by the editor to create a proper XML file, in some situations they may feel frustrated because this can be interpreted as a lack of freedom during the markup workflow. To evaluate the LIME interface's usability a usability test appropriate for markup editors was created.

The usability test was submitted to ten users during a *hackaton* held at *CIRSFID* (*Centro Interdipartimentale di Ricerca in Storia del Diritto, Filosofia e Sociologia del Diritto e Informatica Giuridica*) of the University of Bologna. The hackaton was also intended to find the bugs of the first alpha version of LIME. The test was performed on LIME with its Akoma Ntoso configuration. After a brief introduction to LIME overall features and to the structure of legislative documents, two questionnaires were submitted to the users and they were asked to perform nineteen tasks in order to evaluate the LIME *efficacy*, the LIME *efficiency* and the users' *satisfaction* while they use LIME.

The test' results demonstrate that users are able to easily use the LIME features related to the navigation system, such as import, export files, open files and save them. It also demonstrated that, even if users have no knowledge of legislative documents, they are able to simply markup the main structure of acts and bills, such as their preface, their preamble and their article and sections. The test also highlighted that users are quite satisfied while using LIME. They were asked to foresee the expected effort to complete some tasks and, after the completion, they were asked to indicate the real effort they experienced. The majority of the users found the main part of the tasks as simple as they expected or, in some situations, they found them even simpler.

The test also highlighted some issues related to the LIME usability and some bugs that will be fixed in the next version of the editor.

LIME is currently requested by several parliaments, political and apolitical organizations from overall the world, to markup their legal and legislative documents. It is also requested by history scholars to markup descriptions and transcriptions of ancient manuscripts. Hopefully, after the release of the first beta version, many language plugins will be developed by third parties and that LIME will be widely used both in the legal context and in other contexts.

Chapter 2

The markup of structured documents

The aim of this chapter is to give an introduction about structured documents, about their evolution in time and about the markup languages used to create them.

In the first section I will produce a definition of structured documents. The second section aims to briefly navigate through the history of the markup, exploring the different styles of markup. The third section is about the descriptive markup languages and explores examples of them. Finally, in the fourth section, I will introduce some notions about the markup of text based resources and the currently most used languages to markup them.

2.1 Structured documents

A structured document is an electronic document which embeds other information in addition to its content. This supplementary information is used to give semantic meaning to the whole document or to specific parts of it and is fitted in the document using some kind of embedded coding, such as markup. [1] .

[1]Extracted from the wikipedia's definition of structured document.

Typically, a document contains at least three different conceptual structures [2]. The first one is the *logical structure*, that is a description of the objects that compose the document and the relations among them. Then there is the *layout structure*, that specifies the document's layout, i.e. the pages' format, the elements that must be underlined or the text's parts that must be centered. Last but not least is the *physical structure* that describes, for example, the fact that a book must be divided into pages and that a page must be divided into sections [3]. In any type of document, including paper ones, it is possible to identify these three conceptual frameworks.

In a structured document, the focus is on the logical structure of the document, with no concerns about how it must be printed. For this reason a structured document contains a lot of semantic information about its logical structure, which can be easily interpreted by computers in order to create different kinds of presentations suitable for a variety of devices (computers' screens, mobile phones, paper sheets and so on), or in order to perform complex computations on large sets of documents.

Such structure can be ascribed to the document using appropriate and standardized markup languages that are used to add semantic markup to each section of the document that is relevant to its logical organization.

In the next section I will explain how these languages can be used to create the logical structure of the document and the differences among the most known markup languages used to create structured documents.

[2]Although some studies highlight four conceptual structures, for example the one of Nenad Marovac [Mar92], this research is focused on only three of them.

[3]It is important not to confuse the logical structure, that refers to the organization as it is seen by the author, and the physical structure that is the organization as it is seen by the publisher.

2.2 Markup languages for structured documents

A markup language is a language used to annotate some parts of the text in order to highlight its logical structure and to make this structure understandable both by software and, if the markup language is human readable, by human beings [Gol81].

The term *markup* is derived from the publishing practice of marking-up a manuscript[CRD87] according to which a reviewer adds some instructions, usually with a blue pencil, on the margins and on the text of a paper manuscript to indicate what typeface, style and size should be applied to each part of the text [4]. In electronic markup the blue pencil was replaced by some kind of instructions that are embedded in the text in binary format or surround the text like labels.

There are three categories of electronic markup, the *presentational markup*, the *procedural markup* and the *descriptive markup* [Gol81, CRD87].

The presentational markup is the markup used by traditional words' processing systems (such as Microsoft Word's versions prior to 2002 [5]). These kinds of software embed the markup in the text in binary code. Such markup is intended to be hidden from the author and the editors.

With the procedural markup, the markup is embedded in the text and provides information for programs that need to process the text. The text is marked up in a visible way and directly manipulated by the author and usually, during the compiling phase, the software runs through the text from the beginning to the end following the instruction as encountered. First examples in the history of procedural markup languages can be *roff*, *nroff* and *troff*, all typesetting packages for the UNIX operating system that read a file written with a special syntax and output another file suitable for the presentation. For example, the listing 2.1 shows how to set a line spacing and how

[4]See the markup language page on wikipedia to read more about the history of the markup.

[5]Read more about Microsoft Word on the word web page.

to center the text using *groff*, a Linux porting of nroff and troff [6].

Listing 2.1: An example of groff markup language

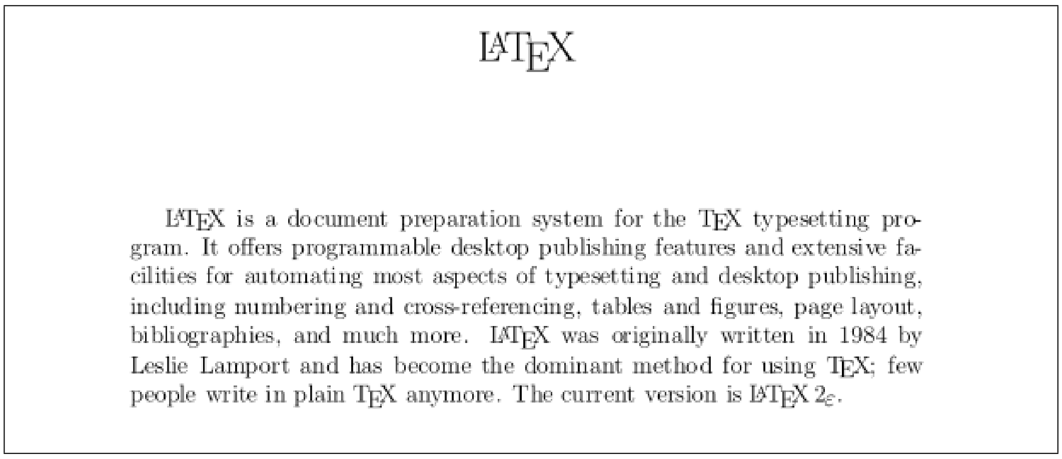
```
.ls 2
.ce 1
Hello world! I'm a centered text in a document
with a specific line spacing
```

Another typesetting program, introduced in 1978, is *TeX*, that uses the metafont language for font description and the modern typefaces to allow the users to produce well formatted documents with a minimum effort. Later in time, in early 1980s, *LaTeX* was introduced, a document markup language for the TeX typesetting program. LaTeX allows to create high-quality documents with a reasonably simple syntax [Lam86]. For instance, the code in listing 2.2 produces the document in figure 2.1 [7].

Procedural markup languages was massively used in the 1980s and 1990s and LaTeX remains till today the most used instrument to edit scientific papers (this dissertation is written in LaTeX too).

Even if both procedural markup languages and presentational markup languages are useful to decouple the logical structure from the document content, this work focuses on the descriptive markup languages that I will extensively explain in the next section.

[6] For more information read the groff's project page.
[7] Courtesy of wikipedia.



LaTeX

LaTeX is a document preparation system for the TeX typesetting program. It offers programmable desktop publishing features and extensive facilities for automating most aspects of typesetting and desktop publishing, including numbering and cross-referencing, tables and figures, page layout, bibliographies, and much more. LaTeX was originally written in 1984 by Leslie Lamport and has become the dominant method for using TeX; few people write in plain TeX anymore. The current version is LaTeX 2_ε.

Figure 2.1: The output generated by the lines of code in the listing 2.2

Listing 2.2: An example of LaTeX markup language

```
\documentclass[12pt]{article}
\usepackage{amsmath}
\title{\LaTeX}
\date{}

\begin{document}

\maketitle
\LaTeX{} is a document preparation system for the \TeX{}
   typesetting program. It offers programmable desktop
   publishing features and extensive
facilities for automating most aspects of typesetting and
   desktop publishing, including numbering and cross-referencing
   , tables and figures,
page layout, bibliographies, and much more. \LaTeX{} was
   originally written in 1984 by Leslie Lamport and has become
   the dominant method for using
\TeX; few people write in plain \TeX{} anymore. The current
   version is \LaTeXe.

\end{document}
```

2.3 Descriptive markup languages

Descriptive markup is used to ascribe a semantic meaning to each part of the document through labels (called tags). In this way, the author can focus on the document's logical structure, regardless of any particular treatment of rendition of it. Unlike the procedural or the presentational markup, the goal of the descriptive markup languages is to institute a one to one mapping between the logical structure of the text and the markup of elements that constitute it [8].

A first attempt of markup standardization for the encoding and analysis of literary texts was made by the *COCOA encoding scheme* [Van04] that was originally developed for the *COCOA* program in the 1960s and 1970s [Rus67], but that was later used as an input standard by the *Oxford Concordance Program* in the 1980s [HM88] and by the *Textual Analysis Computing Tools* in the 1990s [LBM$^+$96]. Another language that reached a certain level of standardization was the *Beta-transcription/encoding system*, that was used to transcript and encode the classical Greek texts [BSJ86].

The first descriptive markup language that was really standardized and that accomplished to the task of formally separating information from metadata, also ensuring interchange, reusability, and portability, was the *Standard Generalized Markup Language*; as I will explain in the next sections, this permitted the creation of the *HyperText Markup Language* and later evolved into the *eXtensible Markup Language.*

2.3.1 The Standard Generalized Markup Language

The Standard Generalized Markup Language [Bry88] (henceforth referred to as SGML) is an ISO-standard technology [9] whose purpose is to define generalized markup languages for documents. It is important to underline that

[8]A more detailed reading about the differences between the procedural and the descriptive markup languages can be found on the TEI's manual page.

[9]ISO 8879:1986, Information processing – Text and office systems – Standard Generalized Markup Language (SGML)

the ISO standard also introduced for the first time a definition of generalized markup. According to the standard, a generalized markup should be declarative, because it must describe the document's structure rather than specify the processing to be performed on it, and it should be rigorous in order to allow computer programs to process the documents in the right way.

SGML descends from the *Generalized Markup Language* that was developed in the 1960s by Charles Goldfarb, Edward Mosher, and Raymond Lorie [Gol91]. It was originally designed to mark up large set of documents in a machine readable format. These documents should be preserved in time and should be easily shared between public offices and industries.

The standard defines that each document intended to be compliant to SGML must be composed of three parts. the SGML declaration, the prologue containing a *DOCTYPE* definition that refers to a *Document Type Definition*, and the content itself, that is composed by a root element containing all the other elements of the document.

The document type declaration defines the rules that the logical structure of the document must follow and other information that is useful for the documents' processors, such as the attribute values and their types. It is used to check one of the two validity kinds of the SGML documents: the so-called *type-validity.* In order to be type-valid, a SGML document must be compliant to its document type declaration. A fragment of a document type declaration is reported in listing 2.3

Although the document can be type-valid, it should also be *tag-valid* in order to be full-valid. To accomplish this, the text in the document must be completely tagged.

It is important to keep in mind that the type validity check is the first one to be performed because a failure means that the document is not syntactically correct, so it is not possible to process it in any way. On the other hand, even if the type validity check can be performed or not, it is the most important one because, if the documents does not follow the rules specified in its document type declaration, it has no semantic meaning.

Listing 2.4 reports a SGML document that is tag valid and type valid according to the document type declaration in listing 2.3 [10].

SGML is still used for small-scale and general purpose applications. One of its derivative is the HyperText Markup Language that is described in the next section.

Listing 2.3: A fragment of a document type declaration

```
        <!ELEMENT anthology  - -  (poem+)>
        <!ELEMENT poem - -  (title?, stanza+)>
        <!ELEMENT title - O (#PCDATA) >
        <!ELEMENT stanza - O  (line+)   >
        <!ELEMENT line O O  (#PCDATA) >
```

Listing 2.4: A type and tag valid SGML document

```
<!DOCTYPE anthology SYSTEM "anthology.dtd">
<anthology>
        <poem>
                <title>The SICK ROSE</title>
                <stanza>
                        <line>O Rose thou art sick.</line>
                        <line>The invisible worm,</line>
                        <line>That flies in the night</line>
                        <line>In the howling storm:</line>
                </stanza>
                <stanza>
                        <line>Has found out thy bed</line>
                        <line>Of crimson joy:</line>
                        <line>And his dark secret love</line>
                        <line>Does thy life destroy.</line>
                </stanza>
        </poem>
        <!-- more poems go here    -->
</anthology>
```

[10]Courtesy of the stanford.edu site

2.3.2 The HyperText Markup Language

The HyperText Markup Language [BLC95] (hereafter HTML) is a *World Wide Web Consortium* recommendation [11] and it is the most used markup language to create web pages. Web browsers interpret the HTML tags in the documents and present the whole document in a readable or audible way.

The history of HTML started in 1980 when Tim Berners-Lee proposed ENRIQUE, a system whose purpose was to allow researchers to share documents. Later, in 1989, Berners-Lee wrote an article where he advanced the idea of an internet based hypertext system [BL89] . In 1990 he designed HTML and developed the language and the first web browser that was able to read HTML documents. The first article related to HTML was published in 1991, it was called "HTML tags" and described eighteen elements and a first simple design of HTLM [BLB]. The first HTML standardized specification was completed in 1995, when HTML 2.0 was released [BLC95]. Since 1996, the HTML specifications have been maintained by the World Wide Web Consortium [12] but in 2000 HTML also became an international standard [13]. The current stable standardized version is HTML 4.01, that was published in 2001. In 2004 development began on HTML 5 [14], that will be officially released in 2014. The design of HTML was inspired by SGML and, still nowadays, it has SGML-based specification. But on January 26, 2000 the World Wide Web Consortium released XHTML 1.0 [P$^+$00], that has XML-based specification. XHTML is intended to be identical to HTML 4.01 except where limitations of XML over the more complex SGML require workarounds.

The content of a HTML document is usually formed by a *head* element and a *body* element. The head contains information abut where to retrieve

[11]See the W3C's page for HTML 4.01 specification

[12]The World Wide Web Consortium (W3C) is an international community that develops open standards to ensure the long-term growth of the Web.

[13]ISO/IEC 15445:2000 Information technology – Document description and processing languages – HyperText Markup Language (HTML).

[14]HTML 5.1 Nightly, A vocabulary and associated APIs for HTML and XHTML, Editor's Draft 23 September 2013.

the files related to the HTML document (like script files and style files), and contains important metadata about the whole document (such as its title and its keywords). The body contains the actual content of the document.

As is it possible to see in listing 2.5, HTML 4.01 is not a pure descriptive markup language, due to the fact that it mixes descriptive markup and presentational markup. Elements like *h1* are used to specify that the inside text represents a heading (in this case a first level heading) and they do not denote a specific markup style, even if most web browsers have a default style in order to format these kind of elements. On the other side of the coin, elements such as *b* and *u* are used to indicate that the devices should render the text in bold face or underlined, respectively. But the use of presentational markup was discouraged in all the HTML versions, it is deprecated in the current versions of HTML and XHTML and it is illegal in HTML 5.

HTML and chiefly HTML 5 are good descriptive markup languages but, as pointed out in the introduction of this paragraph, they are intended to be used to create web pages and not to markup documents that must have their specific in-context semantically relevant elements (for example a cooking recipe or a law). In these cases, as I will explain in the next section, we find solace in the eXtensible Markup Language, that consents to create specialized dialects for different contexts.

Listing 2.5: An sample HTML 4.01 document

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN" "http://www.w3
    .org/TR/html4/strict.dtd">
<html>
        <head>
                <title>HTML example document</title>
                <meta name="keywords" content="HTML, example,
                    paragraph, bold">
        </head>
        <body>
                <h1>Hello wolrd! I'm an HTML document</h1>
                <p>
                        This is my content. I have a paragraph
```

```
                                and a <b>bold face</b> text inside!
                    </p>
          </body>
</html>
```

2.3.3 The eXtensible Markup Language

The eXtensible Markup Language (henceforth referred to as XML) is a simple and flexible descriptive markup language derived from SGML [BB$^+$99]. It defines a set of rules aimed to producing human-readable and machine-readable documents and it was originally designed to allow a large-scale electronic publishing, but it is currently also used to exchange a large variety of data on the web.

The first version of XML (XML 1.0) was defined in 1998 and it is currently in its fifth edition, published on November 26th, 2008. The second version of XML (XML 1.1) was published on February 4th, 2004 and it is currently in its second edition published on August 16th, 2006. Prior to the fifth edition XML 1.0 differed from XML 1.1 because it had stricter requirements for characters used in elements' names, attribute names and unique identifiers. The fifth edition adopted the mechanism of XML 1.1, specifying that only certain characters are forbidden in names and everything else is allowed. Even if no organization has announced plans to work on an hypothetical version 2.0, a skunkworks written by one of the XML developers [15] contains some ideas of what an XML 2.0 could be.

As I said previously, a big part of XML comes from SGML unchanged. XML, like SGML, uses the angle-brackets syntax, it separates the logical and the physical structure of the document, and it supports a grammar-based validity through a document type declaration. It also allows mixed content and processing instructions (used to separate the processing from the representation) and it permits the separation of data and metadata by using elements

[15]Extensible Markup Language - SW (XML-SW), Skunkworks 10 February 2002, Tim Bray.

and attributes. The differences between the two standards regard the SGML declaration, that in XML is substituted by the XML own declaration, and the character set, because XML adopts unicode [US91].

Like SGML, valid XML documents must pass two kinds of validation, the well-formed validation and the schema validation. The well-formed validation is a kind of syntax validation. For example, it ensures that the document has a unique root container and that all elements are formed by an opening tag and a closing tag. The schema validation checks if the document follows the rules that are defined in the schema referred by its document type declaration. The schema of XML documents can be created using different technologies such as DTD, XML Schema [Tho04, BMC$^+$04], RELAX NG [CM01], Schematron [Jel01] and others.

XML is nowadays the most used descriptive markup language and it is used to markup a large variety of documents ranging from the documents that describe user interfaces [16] to the documents that express actions within business processes [17], but it is especially suitable for the markup of text-based resources.

2.4 XML for the markup of text-based resources

In this chapter we have seen that a structured document, both a procedural one and a text-based one, is a resource formed at least by a logical structure, a human readable content and some other background information usually referred as metadata. Earlier in section 2.1 I gave a definition of logical structure, that must be intended as the description of the objects forming the document and the relations between them. The content of a textual resource is obviously the readable text inside it and the metadata are

[16]The *XML User Interface Language*, is a markup language developed by Mozilla, whose aim is creating user interfaces of applications like the Firefox web browser.

[17]The *Business Process Execution Language* is an OASIS standard executable language that enables users to describe business process activities.

data that describe other data. In some situations metadata can be mixed in the content of the document but they are often peripheral data contained in resources related to the main one, for example a book's cover, or in a specific part of the document that, if missing, does not jeopardize the actual readability of the document.

For instance, a book is constituted by chapters, sections, the actual text of the chapters and of the sections and by other relevant information like its author, the publication date and the publisher's name. On the other hand, a law is made by sections and their text, pointed lists and their text, and by a lot of legal info such as the efficacy date, the number of the law and the law's proponent.

In section 2.2 I described three different families of markup languages and in section 2.3 I explained thoroughly the descriptive markup languages that are the currently most adopted languages for the markup of structured documents.

The rest of this research is focused on XML and on the textual resources. XML, due to its intrinsic nature and syntax, is the best suitable choice for the markup of text-based documents. It allows to characterize their structure by using elements, it enables the creation of metadata by using elements' attributes and, last but not least, thanks to XML it is possible to evidence the document's structure without changing or disassembling the textual content of the document.

In chapter 3 I will explore various XML dialects in order to highlight differences and similarities between them.

Chapter 3

Structural differences in XML dialects

In this chapter I will deeply explore the use of XML to markup textual resources. In the first section I will give an introduction about the differences among the XML dialects that are used for documents belonging to different contexts. In the second section I will examine some examples of dialects that are used for the markup of generic textual resources and then, in the third section, I will show the most popular XML dialects that are used to create structured laws. In section 3.4 I will the describe how it is possible to abstract the logical structure of the documents using patterns. I will conclude this chapter examining the possibility to identify a generic markup process that can be used for the markup of all the textual based resources.

3.1 Different dialects for different contexts

Currently, there are a lot of XML [1] dialects used in a large variety of contexts.

Many of them are used for the markup of text-based resources. There

[1]At the time of writing, it is possible to count two hundred twenty-two languages in the wikipidia's page, that lists the most known XML dialects.

are XML used for the markup of medical resources [GNK$^+$99] (that enable, for example, predictive medicine) [TDK$^+$99], there are XML dialects used for markup recipes [2] (that are useful for the creation of internationalized cookbooks) [Raa03], and there are even languages used for the markup of theological texts [Cov00] (that should be suitable for online sharing of sermons).

Some of these languages are really specific for the context they belong to and, for this reason, are composed by elements and attributes that describe exactly the items of their framework. Other languages need to be more generic because, even if they are intended for the markup of textual resources residing in a clear-cut area, they have to face up a big set of differences, due, for instance, to the diversity of the traditions of the documents' creators or to the laws that regulate that kind of documents in the country of the documents' writers'.

In the next sections I will show some examples of XML languages that are used for the markup of generic textual resources and for the markup of legal resources.

3.2 Examples of dialects for textual resources

A book, a technical manual, or a description of an ancient manuscript are all examples of textual resources. For the markup of these documents XML languages are needed. These must be specific but at same time as flexible as possible, in order to hit all the peculiarities of the different areas in the same context.

For example, a book about Oscar Wilde's aphorisms [Wil98] has a quite different structure from a novel regarding a pseudoscientific book that promises everlasting life [Tho10]. Similarly the structure of a technical manual about

[2]RecipeML, also known as DESSERT (Document Encoding and Structuring Specification for Electronic Recipe Transfer), is an XML language created in 2000 by the company FormatData and provides detailed markup for ingredients, cooking time and so on.

a programming language [3] is completely different from the structure of a manual about an airplane made with LEGO$^{(TM)}$ construction toys. Differences can also be identified in ancient manuscripts and for this reason, using a specific XML dialect that I will describe in the next section, it is possible to markup the description of extremely different manuscripts, i.e the description of the Voynich manuscript [D'I78] and the description of a legal ancient manuscript [PC13].

3.2.1 Text Encoding Initiative

The Text Encoding Initiative [IV95] (hereafter TEI) is a community created in the 1980s that aims to support the digitization of texts, chiefly in the humanities, social sciences and linguistics. The result of the collaboration is an XML standard [Prz09] and a set of guidelines [SMB$^+$94] for the creation of digital text.

The first version of the TEI guidelines was released in 1990, but the third version of the guidelines (P3), released in 1994, was the first to be widely used. XML was introduced in 2001 with the release of the fourth version of the standard (P5). The latest version (P5) was published in 2001.

The task of flexibility is achieved by TEI standard because it does not specify a fixed set of rules but it is intended to be customized both for the users that need to select subsets of TEI's elements, and for users that have to add elements for the particular features that they need in order to markup their texts. TEI permits local variation of usage and it is not different human languages; it supports idiomatic usage, dialects and local usage.

TEI is extensively used to markup detailed descriptive information about ancient manuscripts because it supplies a specific module that is generic enough to permit to describe any kind of handwritten resource [4]. The standard also permits to create electronic documents for different purposes; for

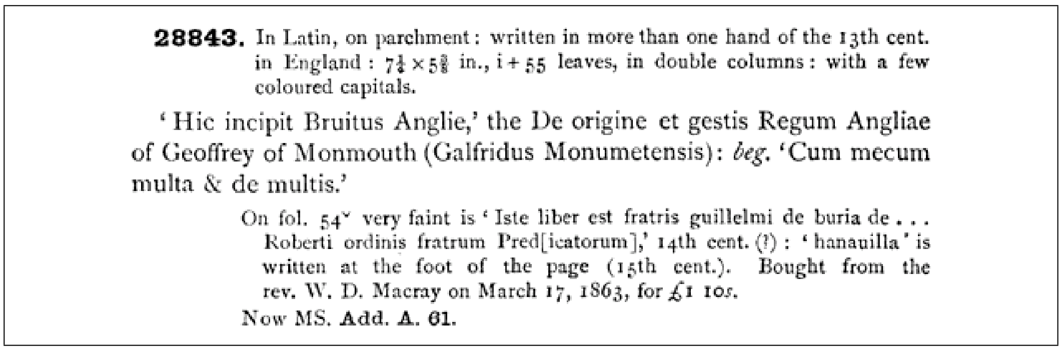
[3]See the PHP's documentation page to have an idea of how programming language's documentation are written.

[4]See the TEI's module's documentation page to read more about this module and its usage.

example, it is suitable both for those projects that may simply wish to translate an existing catalogue into a format that can be displayed on the web, and for the projects whose aim is to create detailed databases of highly structured information that are useful for the *quantitative codicology* [5]

A TEI P5 document contains a *msDesc* root element in which it is possible to specify information like its cataloging (with the *msIdentifier* element), its content (using *msContents* elements) and its history (marked up whit the *physDesc* element). Listing 3.1 shows the markup of the sample manuscript's description in figure 3.1 [6].

The TEI standard is approved by a lot of organizations like the *National Endowment for the Humanities* [7] and the *Modern Language Association* [8] and should be used in the future to create a big standardized online digital library.


28843. In Latin, on parchment: written in more than one hand of the 13th cent. in England: $7\frac{1}{4} \times 5\frac{3}{8}$ in., i + 55 leaves, in double columns: with a few coloured capitals.

'Hic incipit Bruitus Anglie,' the De origine et gestis Regum Angliae of Geoffrey of Monmouth (Galfridus Monumetensis): *beg.* 'Cum mecum multa & de multis.'

On fol. 54^{v} very faint is 'Iste liber est fratris guillelmi de buria de . . . Roberti ordinis fratrum Pred[icatorum],' 14th cent. (?): 'hanauilla' is written at the foot of the page (15th cent.). Bought from the rev. W. D. Macray on March 17, 1863, for £1 10*s*.

Now MS. **Add. A. 61.**

Figure 3.1: A sample of a manuscript's description

Listing 3.1: A TEI document describing the source in figure 3.1

```
<msDesc>
 <msIdentifier>
```

[5]The quantitative codicology is the ability to make complex queries on large sets of manuscripts' description such as: "Find all manuscripts that have the same distribution of jer letters and the same watermarks", "Find all manuscripts that share at least three descriptive features with one another" and so on.

[6]Courtesy of the Text Encoding Initiative

[7]The National Endowment for the Humanities is an independent federal agency and is one of the largest funders of humanity programs in the United States.

[8]The Modern Language Association is an association founded in 1983 by teachers and scholars that promotes the study and the teaching of languages.

```
  <settlement>Oxford</settlement>
  <repository>Bodleian Library</repository>
  <idno>MS. Add. A. 61</idno>
  <altIdentifier type="SC">
   <idno>28843</idno>
  </altIdentifier>
 </msIdentifier>
 <msContents>
  <p>
   <quote>Hic incipit Bruitus Anglie,</quote> the
  <title>De origine et gestis Regum Angliae</title>
     of Geoffrey of Monmouth (Galfridus Monumetensis):
     beg. <quote>Cum mecum multa &amp; de multis.</quote>
     In Latin.</p>
 </msContents>
 <physDesc>
  <p>
   <material>Parchment</material>: written in
     more than one hand: 7 1/4 x 5 3/8 in., i + 55 leaves, in
        double
     columns: with a few coloured capitals.</p>
 </physDesc>
 <history>
  <p>Written in
  <origPlace>England</origPlace> in the
  <origDate>13th cent.</origDate> On fol. 54v very faint is
  <quote>Iste liber est fratris guillelmi de buria de ...
     Roberti
       ordinis fratrum Pred[icatorum],</quote> 14th cent. (?):
  <quote>hanauilla</quote> is written at the foot of the page
     (15th cent.). Bought from the rev. W. D. Macray on March
        17, 1863, for
     L 1 10s.</p>
 </history>
</msDesc>
```

3.2.2 DocBook

DocBook [Wal99] is a descriptive and semantic markup language that aims to allow the creation of technical documentations. Originally it was intended for the markup of programming languages' documentation but, currently, it can be used for any kind of technical documentation or also for other purposes, such as the markup of e-learning materials [MOMGSFM06].

O' Reilly [9] and *HaL Computer Systems* [10] started the developing of DocBook in 1991 in a discussion group on Usenet [11] and moved in 1998 to the *SGML Open Consortium* which is now known as OASIS. DocBook started as a SGML application but, later, an equivalent version in XML (that now has replaced the SGML one for the majority of the uses) was developed. The latest version of DocBook is the 5.1 and it is still maintained by OASIS [12].

The DocBook language is defined by a RELAX-NG schema and by a set of Schematron rules that are integrated in the main schema. Like the other descriptive markup languages, its aim is to give tools to describe the meaning of the content rather than the way in which it should be presented. DocBook's elements can be clustered in three main groups: the *structural-level elements*, the *block-level elements*, and the *inline-level elements*.

The structural-level elements are those ones that are used to describe the logical structure of the document. To this category belong elements like *article* that is used to markup unnumbered collections of block-level elements, *chapter*, that is used to define numbered collections of block-level elements, and *part*, that is used to markup a titled collection of chapters.

Block-level elements are used to markup sequential parts of the content but they can or they can not contain text. Paragraphs, lists and titles are

[9]O'Reilly is an American media company that publishes books and web sites and produces technical conferences regarding computer technology.

[10]HaL Computer Systems is a Californian computer company funded in 1990 by Andrew Heller whose goal was to build computers for the commercial market.

[11]Usenet is a worldwide distributed discussion system that enables users to create and follow discussions about new technologies, reading and posting messages on the system.

[12]At write moment, the technical committee is discussing the version 5.1b2 of the standard.

samples of block-level elements. These elements cause a vertical break of the text in the position they are fitted in.

The inline-level elements are used to wrap a part of the text and to give to it some kind of different presentational rules or semantic meaning. Unlike block-level elements they do not split the text.

Listing 3.2 reports an example of a simple resource marked up using DocBook [13].

The DocBook's distinction among different clusters of elements is really important because, as I will discuss in section 3.4 and later in chapter 5, the languages based on this kind of element's abstraction lay the foundations for a definition of a generic markup process.

Listing 3.2: An example of DocBook markup language

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE article PUBLIC "-//OASIS//DTD Simplified DocBook XML
   V1.0//EN"
"http://www.oasis-open.org/docbook/xml/simple/1.0/sdocbook.dtd">
<article>
  <title>DocBook Tutorial</title>
  <articleinfo>
    <author>
      <firstname>Adrian</firstname>
      <surname>Giurca</surname>
    </author>
    <date>April 5, 2005</date>
  </articleinfo>
  <section>
    <title>What is DocBook ?</title>
    <para>DocBook is an SGML dialect developed by O'Reilly and
       HaL Computer
    Systems in 1991. It is currently maintained by the
       Organization for the
    Advancement of Structured Information Standards (OASIS).
       DocBook describes
```

[13]Courtesy of www.informatik.tu-cottbus.de

```
    the content of articles, books, technical manuals, and other
         documents.
    Although DocBook is focused on technical writing styles, it
       is general
    enough to describe most prose writing. In this article, I'll
         discuss an
    XML variant of the DocBook DTD that is also available.
    </para>
  </section>
</article>
```

3.3 Examples of dialects used in the legal context

Laws, judgments, amendments and all the documents that belong to the legal context are resources whose logical structure is really difficult to markup with a generic markup language. Due to the fact that parliamentary workflows can be completely different among different countries, the laws should be written in different ways and should follow formal or informal rules dictated by the country's legal system. Moreover, even in the same country, it is possible to find different kinds of laws that should be written in different ways, for example a bill can follow determinate drafting rules and an act can follow other rules.

In the last two decades a large community of scholar worked to accomplish this task and they produced four generations of legal documents' XML standards [PCR09]. For the aim of this dissertation I consider two of these generations.

The *second generation* of legal XML languages (i.e. *Norme In Rete* described in the next section) is focused on the document's modelling and on the description of the text, but it does not contemplate a previous abstraction of the classes of the elements in the legal documents.

The *third generation* of legal XML standards includes languages like

CEN/Metalex and *Akoma Ntoso* (described in section 3.3.2 and 3.3.3 respectively), that are based on *patterns*. This means that all the elements that belong to the standard are grouped in classes (henceforth referred to as patterns). Each of these patterns has its own semantic meaning, behavior and hierarchy in respect to the other classes.

The XML dialects that belong to the third generation are the perfect test case for the purpose of this research. Indeed, a legal XML standard that hopes to be widely used in the world must be very flexible and extensible to hit all the countries' needs and should also be able to abstract a generic logical structure of the laws. This inspires the design of a generic markup process for all the laws and legal resources.

3.3.1 Norme In Rete

Norma In Rete (hereafter NIR) is an XML standard, created in 1999, financed by the *Italian Authority for Information Technology in the Public Administration* [14] and it was coordinated in conjunction with the *Italian Ministry of Justice* [BFST03].

The NIR standard was designed around the Italian legislative system and its schema is specified using DTD. NIR supplies three different schemata that are used for specific purposes. The flexible DTD (*nirloose*) does not specify any mandatory rule and is used for those documents that do not have to follow drafting rules. The basic DTD (*nirlight*) is a subset of the complete schema and is used for purposes other than the legal drafting, for example for teaching purposes. The complete DTD (*nirstrict*) contains about one hundred and eighty elements, specifies a lot of mandatory legal drafting rules, and permits to completely markup the Italian laws.

As a second-generation legal XML standard, NIR does not try to abstract the logical structure of the laws in order to be reused. I have to point out

[14]AIPA, *Autorità per l'informatica nella pubblica amministrazione* . Currently it is known as CNIPA, Centro nazionale per l'informatica nella pubblica amministrazione (National Center For The Information Technology in the Public Administration).

that this does not mean that NIR is not able to markup the structure of the document: of course it can, because it is a descriptive markup language. But NIR identifies the logical structure of Italian laws and uses elements that are specific for the Italian legal system. In the example reported in listing 3.3, it is possible to see that the main body of an Italian law is marked up with the element *articolato*, that is basically a container of numbered hierarchical structure.

These kinds of numbered hierarchical structure are used all over the world for drafting laws, even if other terms are used. For this reason it is possible to generalize the schema and the legal XML standards of the third generation try to introduce an abstraction layer in order to guarantee the reusability of the standard.

Listing 3.3: A fragment extracted from an Italian law marked up using NIR

```
<?xml version="1.0" encoding="UTF-8"?>
<NIR xmlns="http://www.normeinrete.it/nir/2.2/"
     xmlns:dsp="http://www.normeinrete.it/nir/disposizioni/2.2/"
     xmlns:h="http://www.w3.org/HTML/1998/html4"
     xmlns:xlink="http://www.w3.org/1999/xlink"
     tipo="monovigente">
<Legge>
   <meta>
      <descrittori>
         <pubblicazione norm="20130831" num="204" tipo="  "/>
         <redazione id="13G00144" nome="" norm=""/>
         <urn valore="urn:"/>
      </descrittori>
   </meta>
   <intestazione>
      <tipoDoc>monovigente</tipoDoc>
      <dataDoc norm="20130831">31 agosto 2013</dataDoc>
      <numDoc>101</numDoc>
      <titoloDoc>Disposizioni  urgenti  per   il   perseguimento
            di   obiettivi   di
razionalizzazione nelle pubbliche amministrazioni. (13G00144)
```

```
      </titoloDoc>
   </intestazione>
   <formulainiziale/>
   <articolato>
      <capo id="1">
          <num>
CAPO I Disposizioni urgenti per il perseguimento di obiettivi di
    razionalizzazione della spesa nelle pubbliche
   amministrazioni e nelle societa' partecipate
         </num>
         <articolo id="1">
            <num> Art. 1 .</num>
            <comma id="art1-com1">
               <num>1</num>
              <corpo>
                 <h:p h:style="text-align: center;">IL
                    PRESIDENTE DELLA REPUBBLICA</h:p>
                 <h:br/>
                 <h:p h:style="padding-left:2px;">Visti gli
                    articoli 77 e 87 della Costituzione;</h:p>
                 <h:p h:style="padding-left:2px;">
Ritenuta la straordinaria necessita' ed urgenza di emanare
   disposizioni in materia di pubblico impiego al fine di
   razionalizzare e ottimizzare i meccanismi assunzionali e di
   favorire la mobilita', nonche' di garantire gli standard
   operativi e i livelli di efficienza ed efficacia dell'
   attivita' svolta dal Corpo nazionale dei vigili del fuoco e
   in altri settori della pubblica amministrazione;
                </h:p>
                ... omissis ....
            </comma>
          ... omissis ...
         </articolo>
         ... omissis ...
     </capo>
     ... omissis ...
  </articolato>
 </Legge>
```

```
<NIR>
```

3.3.2 CEN/Metalex

The CEN/Metalex [BHV+08] standard is a standard proposed in 2006 during the *CEN workshop on an Open XML interchange format for legal and legislative resources* [15]. The first version of the standard was released in April 2007 and the final version was released later in January 2010.

Originally, the CEN/Metalex standard was not intended for the actual markup of legal documents, but it aimed to be an interchange format for legal and legislative resources. This is useful when public administrations need to manage sets of documents coming from different countries. For instance, the European Parliament needs to receive documents from all the European countries, that format them with their favorite standard, and needs to translate them into another format, i. e. Akoma Ntoso [PC09].

To accomplish this, CEN/Metalex strongly relies on the concepts of "content models instead of elements". With this approach the elements' names are not semantically-charged (as they have to do according to the descriptive markup philosophy) because they do not exactly specify the elements' role in the logical structure of the document, but they simply are labels that identify the content model they belong to.

Introducing content models like *hierarchical containers*, *containers*, *blocks* and *inlines*, and elements with names that strongly reflect their content model like *hcontainer*, *container*, *block* and *inline*, CEN/Metalex aims to completely separate the descriptive role of the element from its role in the logical structure of the document. It is possible to see an example of CEN/Metalex in listing 3.4.

The CEN/Metalex approach could seem perfect for legal drafting, but

[15]The CEN Workshop on Open XML interchange format for legal documents - (WS/METALEX) officially started on July 7th 2006 and ended in April 2007. The second phase of the meeting started on June the 4th 2008 and ended in January 2010 with the release of the final version of the Metalex standard.

this has a long tradition and countries often have their own standard that has to be strictly followed. On the other hand, there are a lot of exceptions in concrete examples of laws and the possibility to rely on very generic elements would be a real godsend. Akoma Ntoso tries to fill the gap between complete elements' abstraction and strict descriptive markup.

Listing 3.4: A fragment extracted from an Italian law marked up using CEN/Metalex

```
<?xml version="1.0" encoding="utf-8"?>
<root name="NIR" id="metalex_EA" tipo="originale" xmlns="metalex
   " xmlns:xs="http://www.w3.org/2001/XMLSchema-instance" xs:
   schemaLocation="metalex ../../../../DTD/e_fork_four.xsd">
 <container name="DecretoLegislativo" id="1992_01_25_dlgs_84"
    xml:lang="it">
  <container name="meta" id="metalex_EFAA">
   <mcontainer name="descrittori" id="metalex_ECFAA">
    <mcontainer name="pubblicazione" id="metalex_EDCFAA" >
     <meta id="metalex_ACDCFAA" name="pubblicazione-tipo" ></
        meta>
     <meta id="metalex_ABDCFAA" name="pubblicazione-num"></meta>
     <meta id="metalex_AADCFAA" name="pubblicazione-norm"></meta
        >
    </mcontainer>
   </mcontainer>
  </container>
  <basic name="intestazione" id="metalex_EEAA" >
   <htitle name="tipoDoc" id="metalex_EFEAA">DECRETO LEGISLATIVO
      </htitle> 25 gennaio 1992, n.
   <inline name="numDoc" id="metalex_ECEAA">84</inline>
   <milestone name="h:br" id="metalex_EBEAA" xml:lang="it"></
      milestone>
   <htitle name="titoloDoc" id="titolo" xml:lang="it">
     Attuazione delle direttive n. 85/611/CEE e n. 88/220/CEE
     relative agli organismi di investimento collettivo in
        valori mobiliari,
     operanti nella forma di societa’ di investimento a capitale
         variabile (SICAV).
   </htitle>
  </basic>
  ... omissis ...
  <basic name="articolato" id="metalex_ECAA">
   <hcontainer name="articolo">
    <htitle name="num" id="metalex_EEPCAA">Art. 1.</htitle>
     <htitle name="rubrica">
     Societa' di investimento a capitale variabile e
        autorizzazione alla costituzione
     </htitle>
     <hcontainer name="comma">
      <htitle name="num" id="metalex_EBCPCAA">1.</htitle>
      <basic name="corpo" id="metalex_EACPCAA">
       La societa' per azioni costituita ed operante in
          conformita' alle disposizioni
       del presente decreto, che ha per oggetto esclusivo l'
          investimento
       collettivo in valori mobiliari del patrimonio raccolto
          mediante
       l'offerta al pubblico in via continuativa di proprie
          azioni,
       e' denominata societa' di investimento a capitale
          variabile (SICAV).
      </basic>
     </hcontainer>
     ... omissis ...
    </hcontainer>
    ... omissis ...
   </basic>
   ... omissis ...
  </container>
  ... omissis ...
</root>
```

3.3.3 Akoma Ntoso

Akoma Ntoso [16] is an XML standard developed in 2005 under a project of the *United Nations Department for Economics and Social Affairs* [17] whose aim is to aid the African legislatures to better accomplish their democratic functions using the information technologies [VZ07].

The standard went through various versions till today and, nowadays, it is in its third version and is an OASIS' standard. In order to match the naming convention of the OASIS' XML standard, the Akoma Ntoso namespace was renamed in *LegalDocumentML* but it is still referred to as Akoma Ntoso in literature and in technical documentations.

Akoma Ntoso has a lot of features that make it usable in a large variety of countries respecting their specific legal system: it separates the authoritative content from the non-authoritative one, it clearly separates the metadata from the data, and above all it is constituted by simple and reusable pattern-based content models [BPVC11].

The pattern-based design has two purposes. On the one hand, it allows future extensions of the schema to be carried out in a simple and backward-compatible way. On the other hand, it permits to specify a small set of patterns to which all the elements of the schema must belong to in order to define, in a way as simple as possible, how every element interacts with the other. For example, elements that belong to the *block* pattern can contain elements that belong to the *inline* pattern, but can not contain other block elements. I will describe deeply the Akoma Ntoso patterns in the next section.

The Akoma Ntoso standard differs from the CEN/Metalex standard, because it does not supply only very generic elements that reflect the pattern-based content models. It also supplies a full legal vocabulary that can be

[16]Akoma Ntoso means "united hearts" in Akan language of West Africa and it is an acronym for Architecture for Knowledge-Oriented Management of African Normative Texts using Open Standards and Ontologies.

[17]UNDESA, a department of the United Nations that helps countries around the world to meet their economic, social and environmental goals.

used by the majority of legal drafters from all over the world. For instance, Akoma Ntoso supplies elements for the creation of *sections* and *articles* and it provides elements for the markup of the *preamble* and the *preface* of the laws. But, like CEN/Metalex, it also supplies generic elements with the same name of the patterns in order to allow also the markup of elements that are not provided as basic elements by the schema.

For instance, the *comma* element that is largely used in the Italian laws is not supported by Akoma Ntoso but it can be marked up using the line of code in the listing 3.5 that have exactly the same semantic meaning of the markup in listing 3.6.

Listing 3.5: A sample of Akoma Ntoso for the markup of a comma of an Italian law using the hcontainer element

```
<article id="art1">
   <hcontainer name="comma" id="art1_com1">
      <num>comma 1</num>
      <content>A hierarchical container with the name "comma" is
          equivalent to  a "comma" element</content>
   </hcontainer>
</article>
```

Listing 3.6: A sample of Akoma Ntoso for the markup of a comma of an Italian law using the comma element

```
<article id="art1">
   <comma name="comma" id="art1_com1">
      <num>comma 1</num>
      <content>A hierarchical container with the name "comma" is
          equivalent to  a "comma" element</content>
   </comma>
</article>
```

The fragment of document in listing 3.7 is a full example of Akoma Ntoso and it is extracted by a markup of a Swiss law. In this example it is possible to see how the use of patterns in the markup makes immediately identifiable all the hierarchical containers and how it harmonizes the whole markup. In the next section I will explain how to abstract the logical structure of documents starting by the identification of the patterns that they contain.

Listing 3.7: A sample of Akoma Ntoso for the markup of a comma of an Italian law using the comma element

```
<?xml version="1.0" encoding="UTF-8"?>
<akomaNtoso
    xmlns="http://docs.oasis-open.org/legaldocml/ns/akn/3.0/
       CSD05"
    xmlns:html="http://www.w3.org/1999/xhtml">
 <bill>
  <meta>
   <identification source="#somebody">
    <FRBRWork>
     <FRBRthis value="/za/bill/2003-09-04/76/main"/>
     <FRBRuri value="/za/bill/2003-09-04/76"/>
     <FRBRdate name="enactment" date="2003-09-04"/>
     <FRBRauthor as="#author" href="#parliament"/>
     <FRBRcountry value="za"/>
    </FRBRWork>
     ... omissis ...
   </identification>
  </meta>
  <preface id="prfc1">
   <p class="heading">REPUBLIC OF SOUTH AFRICA</p>
   <p class="subheading">
    <docTitle id="prfc1-dcTtl1">TRADITIONAL LEADERSHIP AND
       GOVERNANCE FRAMEWORK BILL</docTitle>
   </p>
   ... omissis ...
  </preface>
  ... omissis ...
  <body id="bdy1">
   <chapter id="cha1">
    <num id="cha1-nm1">CHAPTER 1</num>
    <heading id="cha1-hdng1">INTERPRETATION AND APPLICATION</
       heading>
    <section id="sct1">
     <num id="sct1-nm1">1.</num>
     <heading id="sct1-hdng1">Definitions and application</
        heading>
      <clause id="sct1-cla1">
       <num id="sct1-cla1-nm1">(1)</num>
       <content>
        <blockList id="sct1-cla1-ul1">
         <listIntroduction id="sct1-cla1-ul1-lstntrdctn1">In
            this Act, unless the context indicates otherwise</
            listIntroduction>
         <item id="sct1-cla1-itm1">
          <def id="sct1-cla1-itm1-df1">"area of jurisdiction"</
             def>means the area of jurisdiction designated for
             a traditional community and traditional council
             that have been recognised as provided for in
          ... omissis ...
         </item>
        </blockList>
       </content>
      </clause>
      <clause id="sct1-cla2">
       <num id="sct1-cla2-nm1">(2)</num>
       <content>
        <p>Nothing contained in this Act may be construed as
           precluding members of a traditional community from
           addressing a traditional leader by the traditional
           title accorded to him or her by custom, but such
           traditional title does not derogate from, or add
           anything to, the status, role and functions of a
           traditional leader as provided for in this Act.</p>
       </content>
      </clause>
     </section>
    </chapter>
     ... omissis ...
   </body>
  </bill>
```

```
</akomaNtoso>
```

3.4 Abstraction of the XML dialects

The XML patterns are the key element for the abstraction of documents' logical structure. Indeed, in order to abstract the logical structure of a document, we need to highlight the parts of its structure that recurs several times, and we need to markup them in the same (or in a similar) way. And, identify a pattern means exactly the same think. We find content models that are shared between more elements.

There are a lot of officially recognized patterns [18] that can describe, more or less, all the most used content models. Akoma Ntoso uses six of these patterns that I will describe in the following sections.

3.4.1 Containers

A *container* is an element that contains sequences of specific elements. Each container has its specific list of contained element. For this reason, it is not possible to create a generic content type for all the containers, but they share the same basic characteristics: Some of the elements that they contain can be optional and they can not contain directly text.

An example of container in Akoma Ntoso is the *act* element that is used to markup the main container of an act. Figure 3.2 shows the content model's diagram of the act element as extracted from the Akoma Ntoso schema.

[18]The XML patterns' community currently lists twenty-eight patterns.

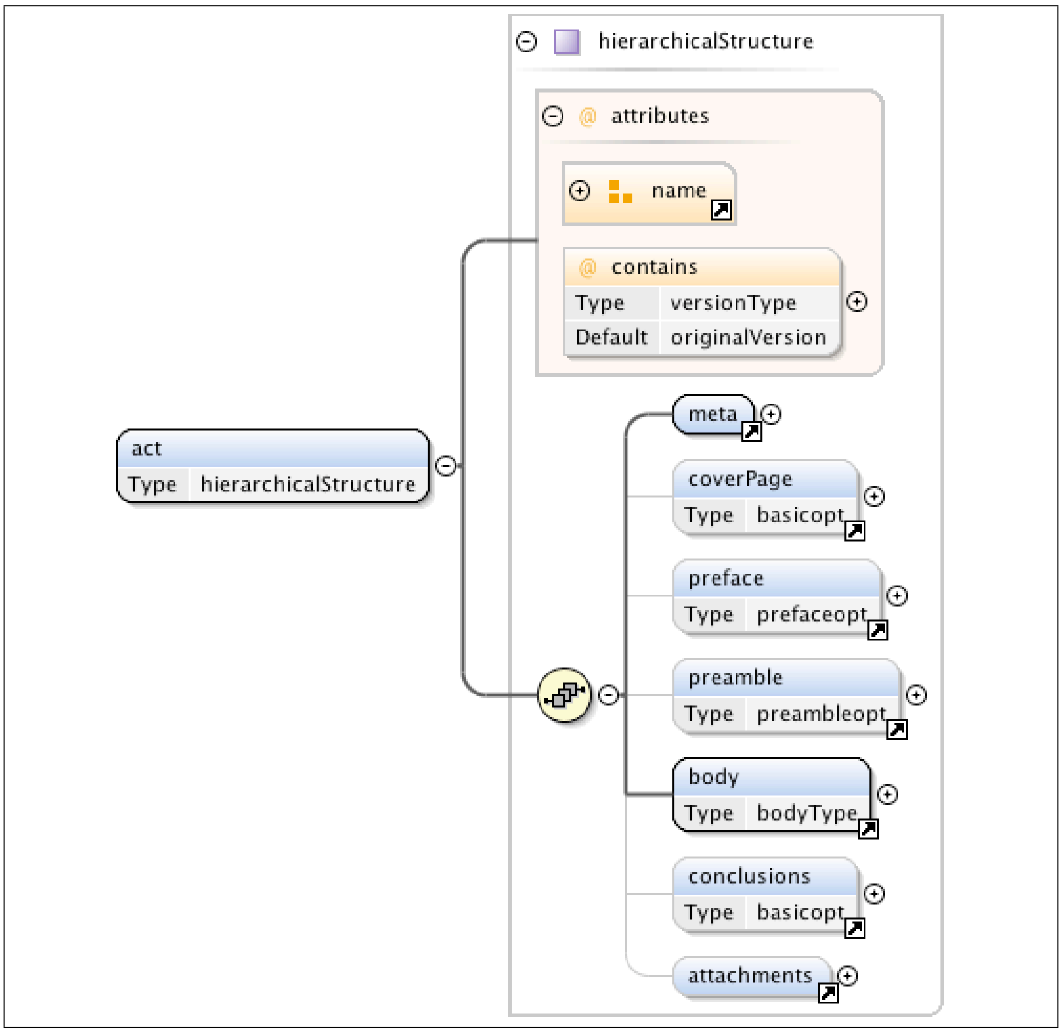


Figure 3.2: The content model of the act element in Akoma Ntoso

3.4.2 Hierarchical containers

A *hierarchical container* is a set of titled and numbered nested sections. Each section can contain other sections or a container (if it is the last in the hierarchy). Like the containers, no text is allowed directly in the hierarchy.

The diagrams in figure 3.3 shows a part of the content model of *article* elements in Akoma Ntoso and the main hierarchical elements allowed inside them.

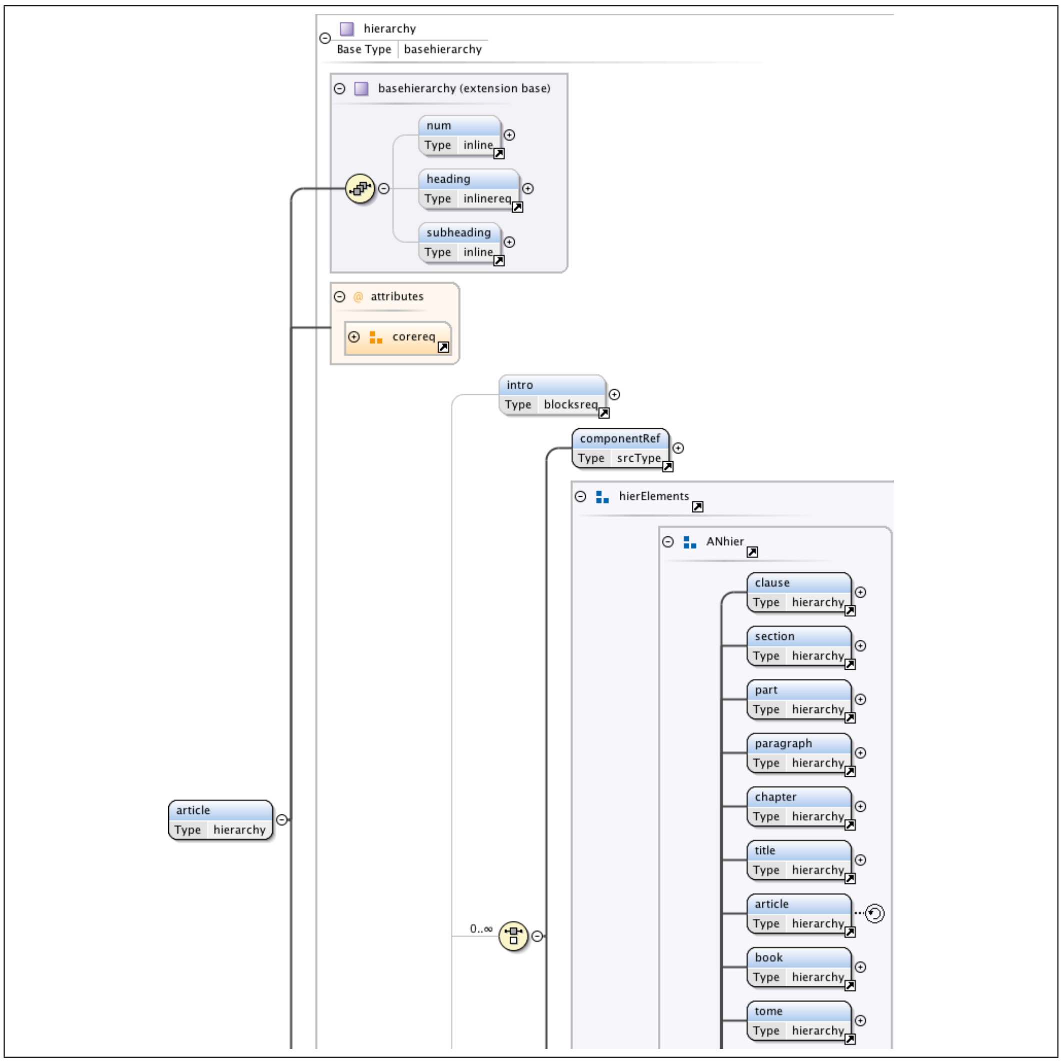


Figure 3.3: The content model of the article elements in Akoma Ntoso

3.4.3 Markers

Markers are elements with empty content model that are meaningful for their name, their attributes, or their position in the text. They are used to insert metadata in the document or to markup placeholders in the text.

The figure 3.4 displays the content model of the Akoma Ntoso *noteRef* element that is used to markup a reference to a note.

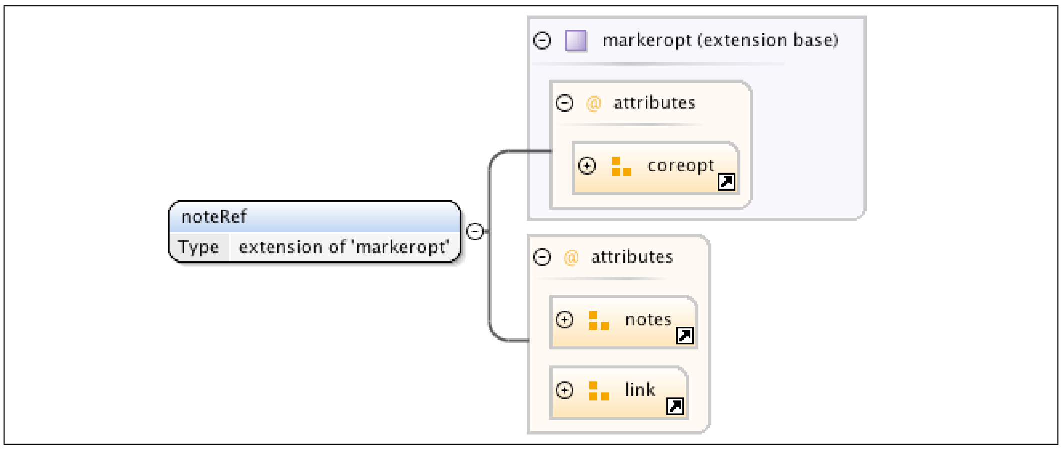


Figure 3.4: The content model of the noteRef elements in Akoma Ntoso

3.4.4 Blocks

Blocks are elements that splits vertically the text and that can contains text, inline elements or markers. Usually there is only one content model shared by all the blocks. This means that wherever any block is allowed, all blocks are allowed too.

The *p* elements in the listing 3.8 are examples of blocks elements.

Listing 3.8: A fragment of an Akoma Notoso document showing the usage of blocks and inline elements

```
<?xml version="1.0" encoding="UTF-8"?>
<akomaNtoso xmlns="http://docs.oasis-open.org/legaldocml/ns/akn
   /3.0/CSD05" xmlns:html="http://www.w3.org/1999/xhtml">
    ... omissis ...

 <preface id="prfc1">
   <p class="heading">REPUBLIC OF SOUTH AFRICA</p>
   <p class="subheading">
    <docTitle id="prfc1-dcTtl1">TRADITIONAL <b>LEADERSHIP</b>
       AND <br/> GOVERNANCE FRAMEWORK BILL</docTitle>
   </p>
 </preface>

  ... omissis ...
```

```
</akomaNtoso>
```

3.4.5 Inline

Inline elements are similar to blocks elements because they can contain other inline, text and markers. Unlike block elements they do not split the text but are used to add presentational markup to the document or to give specific semantic meaning to specific parts of text.

The *docTitle* element and the *b* element in the listing 3.8 are examples of inline elements.

3.4.6 Subflow

Subflow elements are containers appearing in the middle of sentences but containing full structures. They are used when a foreign structured text, with its own markup rules, must be inserted in the middle of the text of the document.

The fragment of markup in listing 3.9 shows the usage of the Akoma Ntoso *mod* element.

Listing 3.9: A fragment of an Akoma Notoso document showing the usage of the mod element

```
<?xml version="1.0" encoding="UTF-8"?>
<akomaNtoso xmlns="http://docs.oasis-open.org/legaldocml/ns/akn
   /3.0/CSD05" xmlns:html="http://www.w3.org/1999/xhtml">
    ... omissis ...

 <body>
  <article id="art1">
   <num> Article 1</num>
   ... omissis ...
   <content>
    <p> by inserting the following new subsection immediately
       after
```

```
      <ref id="ref5" href="/ak/act/2010-08-27/1/main#sec47A-sub3
         ">subsection (3)</ref> --
      <mod id="sec2-lst1-itmb-mod1">
       "<quotedStructure id="sec2-lst1-itmb-mod1-qtd1">
         <section id="sec2-lst1-itmb-mod1-qtdS1-sec47A-sub3">
          <num>(3A) </num>
           <content>
            <p>Notwithstanding the provisions of this section,
               but without prejudice to
             <ref id="ref6" href="/ak/act/2010-08-27/1/main#
                sec47A-sub2-itmb">(2) (b)</ref>, an
Act of Parliament may provide for re-publication of the
draft Constitution and its re-introduction into the
National Assembly for re-consideration.</p>
           </content>
          </section>
         </quotedStructure>'";
        </mod>
       </p>
      </content>
       ... omissis ...
      </article>
      ... omissis ...
   </body>

   ... omissis ...
</akomaNtoso>
```

3.5 A generic markup process for distinct dialects

In this chapter I pointed out differences and similarities among different XML languages. I described examples of dialects used to markup textual resources and examples of standards used for the markup of legal and legislative documents. I ended my XML languages review with Akoma Ntoso that supplies a well pattern-based architecture.

Patterns are really important concepts. If used correctly, they enable a generic markup process for distinct documents marked up with different dialects. The Akoma Ntoso developers are strongly convinced that the logical structure of every kind of document can be described using only six patterns. Nothing more true than this. Even if a schema is not designed to be pattern-based, we can abstract its content models and we can assign one of these six patterns to each element. In chapter 5, section 5.6.1.1 I will explain that exceptions, i.e. elements that do not belong to any pattern, can simply be labeled as *patternless*, and this does not jeopardize a hypothetical generic markup process.

But well-designed schemata are not the only think that we need in order to enable such kind of markup process. We need powerful and usable software that guide us thorough a markup process that results in documents compliant to the specific schema and to the patterns.

As for the legal' standards, in the last two decades, example of software were produced. These software aim to allow the users to markup legal and legislative documents even if they do not know the XML syntax. In the next chapter I will describe some of the legislative markup software and I will compare them to the software used for the pure XML editing.

Chapter 4

Software for XML markup

This chapter aims to introduce the software used for XML markup. Firstly, I will give an introduction about *WYSIWYG* editors. In the second section I will describe generic editors for XML documents. In section 4.3, I will introduce *markup editors* and later, in section 4.4, I will describe the most common markup editors used to markup legal and legislative documents. Lastly, in section 4.5 I will discuss the challenges that markup editors still have to meet in order to be independent from a specific markup language.

4.1 WYSIWYG editors

WYSIWYG (What You See Is What You Get) describes document editors in which the document displayed during the editing mode is quite similar to the one that will be eventually printed on paper.

The first software that incorporated WYSIWYG features was the BRAVO editor [New12] developed in 1974 at Xerox PARC [1]. It was intended to be used with a specific monitor in which users could see a full page of text. Doing so, users can adjust the document's layout while they are editing the page and, then, they can print it out obtaining a similar result that they saw

[1]Xerox PARC is a research and development company located in Palo Alto, California, that is the mind behind a lot of innovative products such as graphical user interfaces, laser printing and object-oriented programming.

on the screen. The phrase WYSIWYG was later coined in 1982 by Larry Sinclair, an engineer at Triple I [2] to express the idea that what users see on the screen is what they finally get on paper.

In the XML context, the WYSIWYG paradigm is used in two different ways. The first type includes the ones that allow users to create XML documents, by directly editing XML elements and attributes. Other editors (*markup editors*) do not allow users to directly manipulate XML code, but they allow users both to describe the logical structure of the document (according to the XML dialect which the document must be compliant to), and to format the document in the exact way they want to present it.

In the next section I will describe an example of generic XML editors belonging to the first category and in section 4.4 I will describe the most common editors that are used in the legal context and that belong to the second category.

4.2 Generic XML editors

Generic XML editors are independent from the XML dialects used for document markup. They let users create any kind of XML document and they can to check the well-formedness and the validity of the document (if a document type declaration is set).

While using this kind of editors, users are focused on the quality of the created XML and not on the final presentation of the document. For this reason, here the WYSIWYG ability indicates that users can directly manipulate the XML code and that the final result will be exactly the XML document that they created.

These editors assume that users have a perfect knowledge of XML and of the XML dialect they are using, but they can supply some kind of tools to help users to create a correct markup. For example, parsing the schema of the XML language, editors are able to give hints about the elements that

[2]Triple-i is a computer company located in Los Angeles, California.

can be inserted in a specific position of the document or they can give the list of the attributes allowed in each element.

Generic XML editors are usually used by XML experts because they are comfortable with the XML syntax. However, the use of these editors is discouraged when a lot of documents must be created. The following section describes the *Oxygen XML editor* that is one of the most used generic XML editors.

4.2.1 oXygen XML editor

The Oxygen XML editor [Sof03] is a multi-platform software written in Java. It runs on Windows, Mac OS X, and Linux as a standalone software or it can be installed as an *Eclipse* IDE's plugin [3]. It is a proprietary software and has been developed since 2002 by *SyncRO Soft* [4]. Oxygen is currently released in its 15.1 version.

Oxygen offers a lot of features for editing XML documents. As a generic XML editor it supplies tools to check the well-formness and to validate them against a schema. Schema compliance can be checked both when the document is completely marked up or while it is being edited. It is also possible to create plug-in software in order to extend the Oxygen's native validation system.

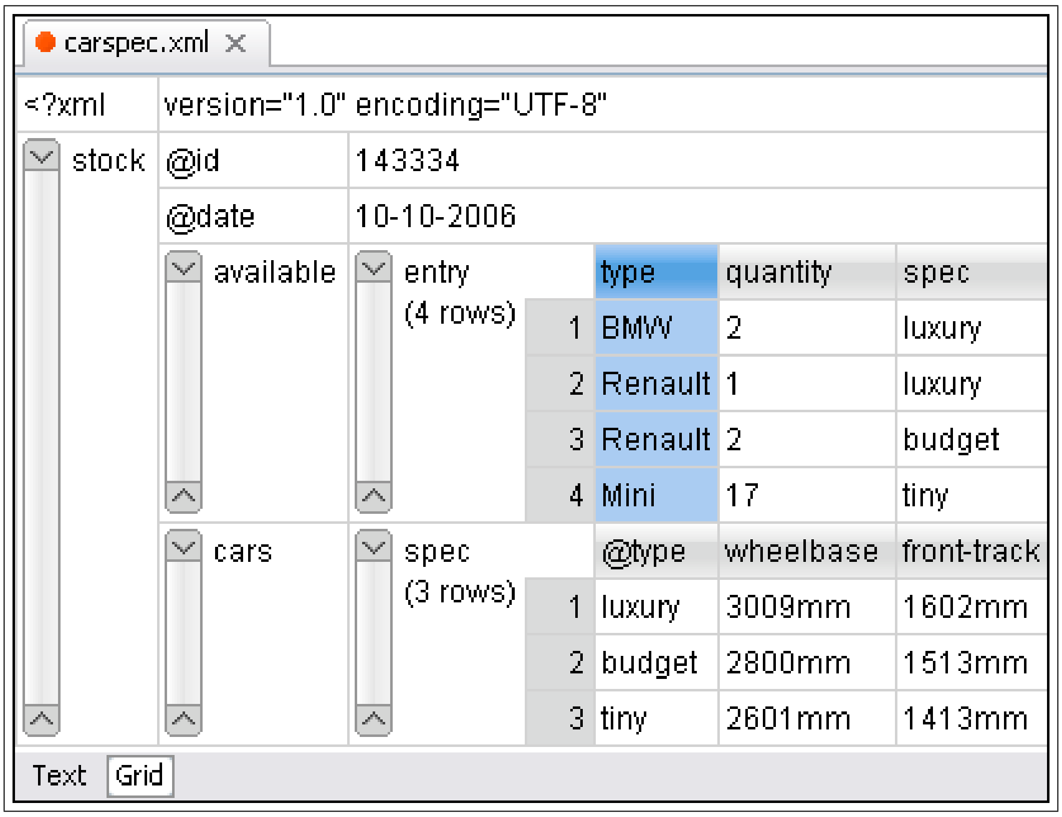
Oxygen supplies three different views that users can exploit to edit XML documents. The first one is the classical *text view*. It simply shows the XML document as text and users can directly manipulate the code finding solace in tags' auto-completion or live validation. The *grid view* displays the document like a spreadsheet. The left column shows the document's elements, while the right column displays a contextual list of the children and the attributes of the element selected in the left column. The *author view* is an intermediate view between the regular text view and a WYSIWYG markup

[3]Eclipse is a free and open source *Integrated Development Environment* (IDE). It supplies a base workspace and can be extended or customized using its plug-in system

[4]Syncro Soft is a software development company located in Craiova, SW of Romania. It is specialized in developing Java-based XML solutions

editor. Indeed, in author view, XML elements are presented in a more human readable way, but the semantic and the nesting of XML documents remain clear and accessible. In figure 4.1 [5] and figure 4.2 [6] it is possible to see the oxygen grid and author view respectively.

Oxygen natively supports the most popular XML dialects (including DocBook, TEI and XHTML) and, currently, it is widely used both by XML experts and by new XML users.



<?xml	version="1.0" encoding="UTF-8"			
stock	@id	143334		
	@date	10-10-2006		
	available	entry (4 rows)		
	cars	spec (3 rows)		

entry (4 rows)

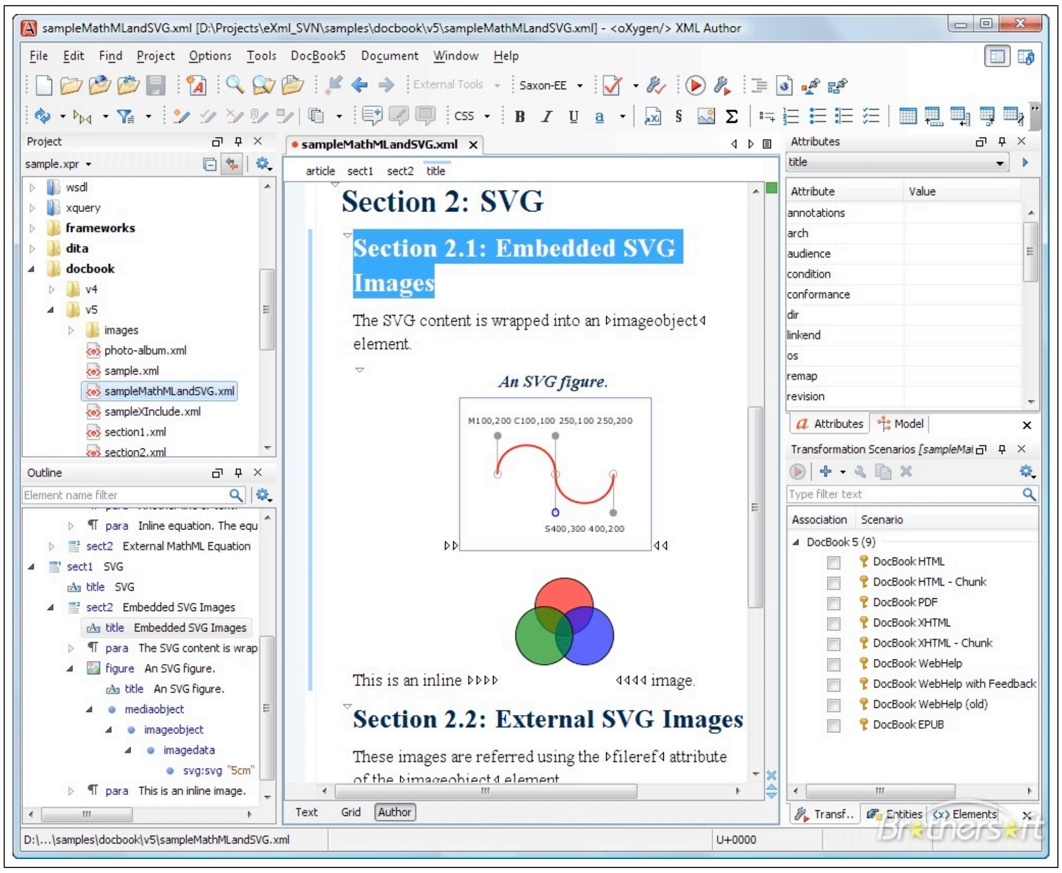
	type	quantity	spec
1	BMW	2	luxury
2	Renault	1	luxury
3	Renault	2	budget
4	Mini	17	tiny

spec (3 rows)

	@type	wheelbase	front-track
1	luxury	3009mm	1602mm
2	budget	2800mm	1513mm
3	tiny	2601mm	1413mm

Figure 4.1: The grid view in Oxygen editor

[5] Courtesy of oxygenxml.com.
[6] Courtesy of brothersoft.com.


sampleMathMLandSVG.xml [D:\Projects\eXml_SVN\samples\docbook\v5\sampleMathMLandSVG.xml] - <oXygen/> XML Author

Section 2: SVG

Section 2.1: Embedded SVG Images

The SVG content is wrapped into an ▸imageobject◂ element.

An SVG figure.

This is an inline ▸▸▸▸ ◂◂◂◂ image.

Section 2.2: External SVG Images

These images are referred using the ▸fileref◂ attribute of the ▸imageobject◂ element.

D:\...\samples\docbook\v5\sampleMathMLandSVG.xml

Figure 4.2: The author view in Oxygen editor

4.3 Markup editors

Markup editors are WYSIWYG editors that do not allow users to directly modify the XML code. On the one hand, markup editors are identical to classical WYSIWYG words' processors because, during the edit mode, documents are displayed in a view that is very similar to the final result. On the other hand, they differ from other WYSIWYG editors because they force users to create documents that are compliant to the XML schema, but they assure at the same time a certain freedom of editing.

The difference between markup editors and the Oxygen's author view is that users are not required to have any knowledge of the rules specified by the document type declaration.

For example, if a user is editing a TEI document, the editor does not allow him to insert a physDesc element inside a msContents element (because the TEI schema does not allow this) but it is the editor's interface itself that guides the user not to do it.

In the same way, markup editors drive users to create documents that are also semantically correct. For instance, the Akoma Ntoso schema allows to insert articles inside paragraphs. This is not semantically correct, but Akoma Ntoso creators allowed it for the sake of modularity, extensibility and customizability. In these situations, inexperienced users can make semantic mistakes and, moreover, if the editor is limited to infer the rules from the schema, it would not be able to report these kinds of errors.

For these reasons it is very difficult to design markup editors that can be used with more than one XML schema or that can be used in different contexts. In the next section I will describe the most used markup editors in the legal context.

4.4 Markup editors for the legal context

In the last two decades, a lot of markup editors for legislative and legal documents were produced. The legal context is one of the most difficult to handle because there are many constraints originated by parliaments and public offices. Moreover, users of legal markup editors have their own traditions and have to follow either stricter or looser workflows. This means, for example, that editors of the Italian *Camera dei Deputati* should use a markup editor in a completely different way from the one of the drafters belonging to the Italian *Senato.*

For these reasons, legal markup editors are usually created to permit the markup of the legislative and legal documents of a specific tradition. In the next sections, I will describe three legal markup editors created for the Italian parliament, the African parliaments, and the United States parliaments respectively.

4.4.1 Norma editor

The Norma editor [PB03] was developed starting by 2002 as a component of the Norma-System project [PB02]. It is built on Microsoft Word and allows the creation of XML documents compliant to the NIR XML standard. The software was intended to be used by the Italian parliament's legal drafters and by legal drafters from many Italian public offices (such as the ones from the Italian *Supreme Court of Cassation*).

The Norma editor can acquire all the unstructured formats that Microsoft Word supports, as well as documents already marked up in Norma format. Users can then markup the document and insert all the elements of the Italian laws' structure. For example they can insert the basic information of the laws such as the opening formula, the closing formula and the main body of the law, and then they can refine the markup by adding more articles and sections to the laws' body.

The editor supports either a manual markup of the law and a semi-automatic markup. Through the manual markup, users select the fragment of the text they need to markup and then they use a toolbar to assign to it the correct label and semantic meaning. They repeat these actions until the document is completely marked up and valid against the NIR schema.

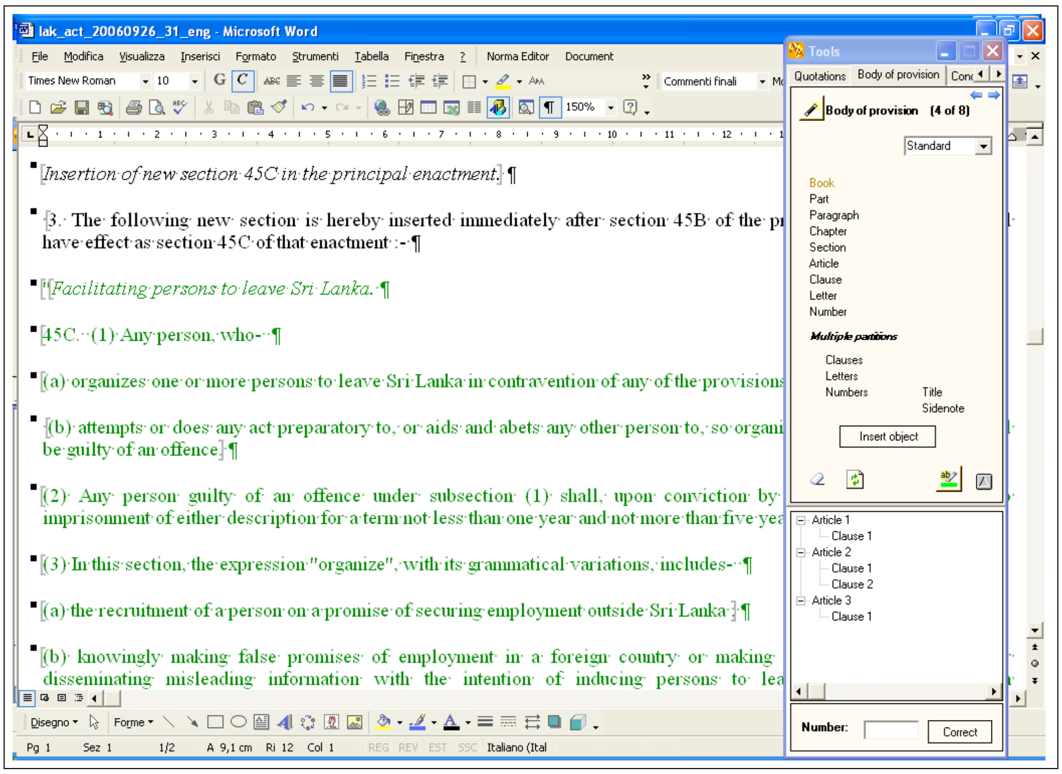
The semi-automatic markup tries to parse the document in order to understand its structure. This is possible because all the Italian laws contain some keywords in specific parts of the document. For example articles start with the word *articolo* and some pointed lists start with the words *i seguenti punti*. After the parser finished their job, the drafter can integrate or modify the inferred markup.

The Norma editor lacks in modularity and portability because it is widely based on Microsoft Word macros and for the same reason it can not be distributed as an open source software [7]. Another problem of the Norma editor is that it does not manage documents using directly the NIR XML. Doc-

[7]The Italian law nr. 4 of 2004 January 9th (also known as *Legge Stanca*) and the European parliament encourage Italian public offices to use open source software.

uments are edited and saved in the Microsoft Word format and only in a second step they are translated to NIR.

However, this editor was the first noteworthy legal markup editor. It is still used in some Italian public offices and some of its ideas (like the use of an interface the users are comfortable with and the legal document parsing) lay the foundations for more recent legal editors.


lak_act_20060926_31_eng - Microsoft Word
File Modifica Visualizza Inserisci Formato Strumenti Tabella Finestra ? Norma Editor Document
Times New Roman 10
Commenti finali
150%
Tools
Quotations Body of provision Conc
Body of provision (4 of 8)
Standard
Book
Part
Paragraph
Chapter
Section
Article
Clause
Letter
Number
Multiple partitions
Clauses
Letters
Numbers
Title
Sidenote
Insert object
Article 1
Clause 1
Article 2
Clause 1
Clause 2
Article 3
Clause 1
Number:
Correct
Disegno Forme
Pg 1 Sez 1 1/2 A 9,1 cm Ri 12 Col 1 REG REV EST SSC Italiano (Ital

Insertion of new section 45C in the principal enactment.

3. The following new section is hereby inserted immediately after section 45B of the pr
have effect as section 45C of that enactment :-

"*Facilitating persons to leave Sri Lanka.*

45C. (1) Any person, who-

(a) organizes one or more persons to leave Sri Lanka in contravention of any of the provisions

(b) attempts or does any act preparatory to, or aids and abets any other person to, so organi
be guilty of an offence.

(2) Any person guilty of an offence under subsection (1) shall, upon conviction by
imprisonment of either description for a term not less than one year and not more than five yea

(3) In this section, the expression "organize", with its grammatical variations, includes-

(a) the recruitment of a person on a promise of securing employment outside Sri Lanka ;

(b) knowingly making false promises of employment in a foreign country or making
disseminating misleading information with the intention of inducing persons to lea

Figure 4.3: A screenshot of the Norma editor

4.4.2 Bungeni Editor

The *Bungeni editor* is the successor of the Norma Editor [BvE11] and it is a markup editor built on the Apache OpenOffice [8] suite. It is a component of the Bungeni project [9] and was developed under the supervision of the

[8]Apache Open Office is an open-source software suite for word processing. It stores the data in an international open standard format called *Open Document Format* (ODF)

[9]Bungeni is a Parliamentary and Legislative Information System that aims to make Parliaments more accessible to citizens

United Nations Department for Economics and Social Affairs.

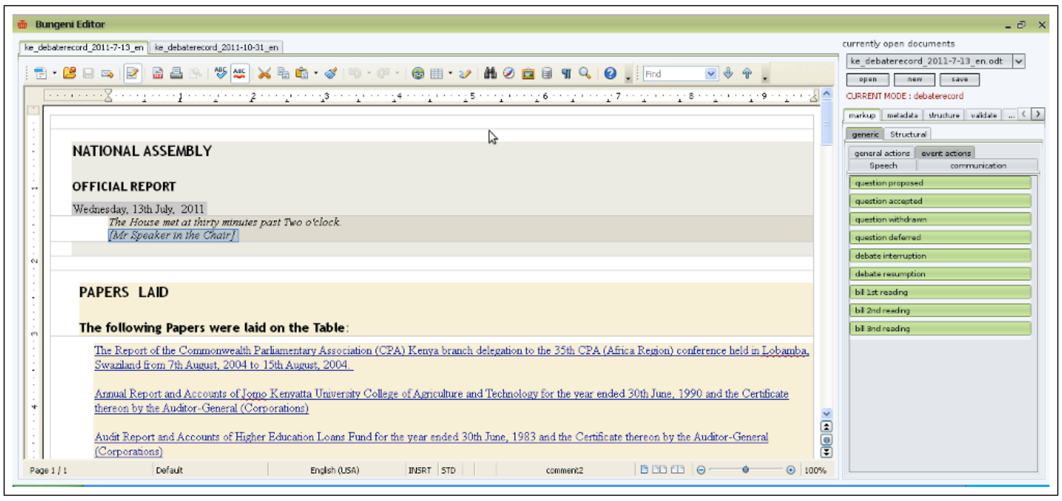
The Bungeni editor solved many problems of the Norma editor. First of all, it was created on the Apache OpenOffice suite. This means that the editor can be released as an open source software because OpenOffice is released under the apache license [Ros04]. This also means that documents are natively stored in an XML format (the ODF format) and this is of great help, because they can be simply translated into any other XML format using XML related technologies, like XSLT [10].

Another improvement in the Bungeni editor is that it is designed around Akoma Ntoso. In this way, the editor can be adapted to a lot of legal tradition simply modifying some of its interface's components and the XSLT that transforms the final document into an Akoma Ntoso document.

The other side of the coin is that the Bungeni editor still carries some problems because it is created as an extension of an existing software, like Norma editor. Its interface is strictly related to the OpenOffice's one. For this reason users can get confused because they can find a lot of tools that are not useful in the legal context. This also forces designers and developers to use the technologies that OpenOffice supports. Last but not least, as a desktop software, it must be installed on the computer it will be used on. In some complex situation, like a parliament, this can be a big problem because it must be installed on hundreds of machines.

The Bungeni editor is used in a lot of African parliaments and its open source-ness makes it the most reliable solution in case a desktop application is strictly needed.

[10]XSLT is a language used to transform document from many formats (XML, plain text, HTML and so on) to any XML dialects.



NATIONAL ASSEMBLY

OFFICIAL REPORT

Wednesday, 13th July, 2011

The House met at thirty minutes past Two o'clock.

[Mr Speaker in the Chair]

PAPERS LAID

The following Papers were laid on the Table:

The Report of the Commonwealth Parliamentary Association (CPA) Kenya branch delegation to the 35th CPA (Africa Region) conference held in Lobamba, Swaziland from 7th August, 2004 to 15th August, 2004.

Annual Report and Accounts of Jomo Kenyatta University College of Agriculture and Technology for the year ended 30th June, 1990 and the Certificate thereon by the Auditor-General (Corporations)

Audit Report and Accounts of Higher Education Loans Fund for the year ended 30th June, 1983 and the Certificate thereon by the Auditor-General (Corporations)

Figure 4.4: A screenshot of the Bungeni editor

4.4.3 LegisPro Web Editor

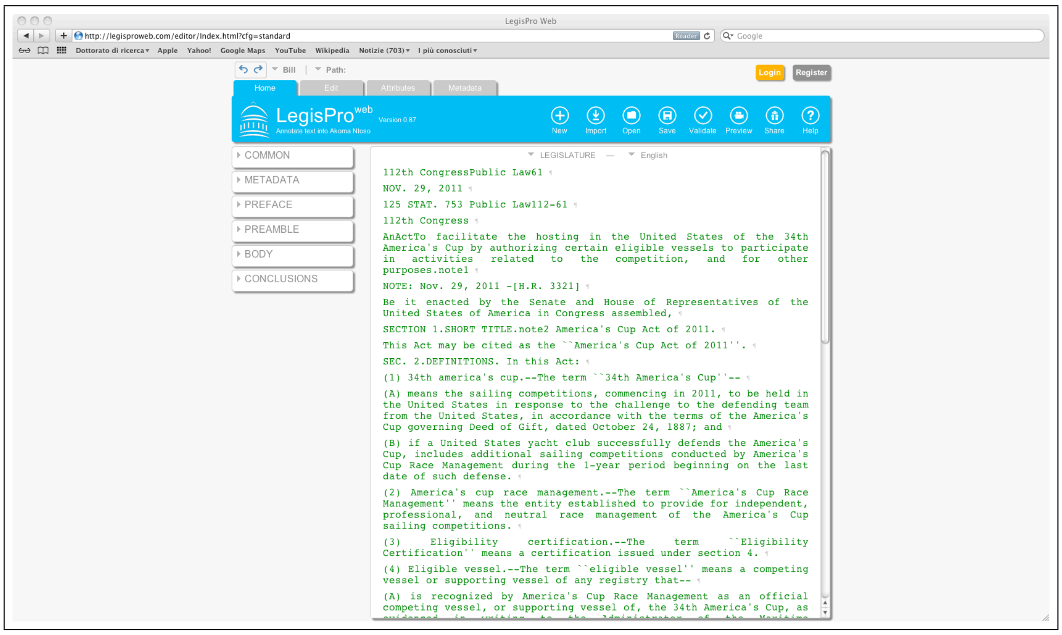
LegisPro - WebAuthor is a in-browser markup editor developed by Xecntial [11]. It is based on *LegisPro - Author*, an XML editing tool used to markup the authoring and amending of local, state and federal government legislation. It has been developed using HTML5, designed to work natively with Akoma Ntoso, and it can run in the most recent web browsers.

On the one hand, LegisPro was the first legal markup editor completely in-browser and resolved the issues of the Norma and the Bungeni editors related to the easiness of customization and portability. Also, its interface was not derived from the one of a word-processor software and, for this reason, it is focused on the legal drafters' needs.

On the other hand, LegisPro is not an open-source software and, as said in section 4.4.1, this is a big problem if the editor aims to be used in European parliaments. Another criticism about LegisPro is that, even if it is based on Akoma Ntoso, it does not exploit the patterns specified by Akoma Notoso and, as I will explain in the next section, this could be the keystone to create a language independent editor.

[11]Xcential is a Californian vendor of legislative products and services to governmental bodies at all levels.

LegisPro is currently used for the bill drafting and publishing system in the State of California and many American and world's parliaments are considering using the software for their drafting purposes.



```
112th CongressPublic Law61

NOV. 29, 2011

125 STAT. 753 Public Law112-61

112th Congress

AnActTo facilitate the hosting in the United States of the 34th
America's Cup by authorizing certain eligible vessels to participate
in activities related to the competition, and for other
purposes.note1

NOTE: Nov. 29, 2011 -[H.R. 3321]

Be it enacted by the Senate and House of Representatives of the
United States of America in Congress assembled,

SECTION 1.SHORT TITLE.note2 America's Cup Act of 2011.

This Act may be cited as the ``America's Cup Act of 2011''.

SEC. 2.DEFINITIONS. In this Act:

(1) 34th america's cup.--The term ``34th America's Cup''--

(A) means the sailing competitions, commencing in 2011, to be held in
the United States in response to the challenge to the defending team
from the United States, in accordance with the terms of the America's
Cup governing Deed of Gift, dated October 24, 1887; and

(B) if a United States yacht club successfully defends the America's
Cup, includes additional sailing competitions conducted by America's
Cup Race Management during the 1-year period beginning on the last
date of such defense.

(2) America's cup race management.--The term ``America's Cup Race
Management'' means the entity established to provide for independent,
professional, and neutral race management of the America's Cup
sailing competitions.

(3) Eligibility certification.--The term ``Eligibility
Certification'' means a certification issued under section 4.

(4) Eligible vessel.--The term ``eligible vessel'' means a competing
vessel or supporting vessel of any registry that--

(A) is recognized by America's Cup Race Management as an official
competing vessel, or supporting vessel of, the 34th America's Cup, as
```

Figure 4.5: A screenshot of the LegisPro Web editor

4.5 Open issues in markup editors

In this chapter I described existing WYSIWYG editors and markup editors. I analyzed some of the most used markup editors for legal and legislative documents.

The legal context is the perfect use case to understand the problems that the markup editors have to face if they aim to be completely customizable and portable. Even if they allow users to markup documents using just one XML language, they need to be extremely modular in order to fit all the specifics needs of the legal traditions.

Current markup editors have some strengths and some weaknesses. Some of them are not open-source software and can not be used in some parliaments in which open-sourceness is required. Others are hardly customizable because they are built on desktop software and are strictly related to a specific XML language. Most recent legal markup editors are based on Akoma Ntoso and this give to them a certain portability and customizability, but their can not be used with other markup languages (maybe not related to the legal context).

My challenge is to create a language independent editor that can be used both in the legal context and in other contexts where XML can bring innovation.

In the next chapter I will explain how, starting by the experience gained in the legal context, we created a parametric editor that is suitable for the creation of structured documents marked up with any XML dialect.

Chapter 5

LIME, a parametric editor for structured documents

In this chapter I will describe LIME, a parametric editor for structured document that is independent from the markup language. In the first section I will describe what I mean for *parametric*. The second section is aimed to describe the technologies that can be used for the development of a parametric editor. Then, in section 5.3, I will deeply describe LIME and its architecture. The last section of this chapter makes a brief introduction about the methodology that should be used to evaluate the usability of markup editors.

5.1 The importance of being parametric

A parametric software is a software that relies on a set of parameters to ensure customization. For example, a software aimed to forecast the sales of a videogame should be built around specific parameters like the videogame type, the area in which it must be sold, the gamers' attitudes of that area and so on. In this way the software can be easily adapted to be used for any videogame.

In the same way, a parametric markup editors must rely on a set of parameters that abstract the structure of XML dialects. Doing so, it is possible to use the same editor with all XML languages without changing its code, but simply modifying its parameters.

There are a lot of technologies suitable for the creation of a language independent markup editor. In the next section I will describe the requirements that these technologies must meet.

5.2 Technologies for parametric markup editors

A good parametric markup editor must meet many requirements.

First of all, It must be an open-source software because it should be used in contexts where open-sourceness is required. It must also be an online in-browser software so that users can avoid installing software on their computers, but at the same time it must run correctly on all the most used browsers. Moreover, the editor must have a Model View Controller (MVC) [KP+88] architecture because its interface must be easily modifiable in order to meet the users' requirements. Furthermore, the software must use an XML storage because it is intended to manage XML files and all the communication with the database must be done using a REST [RR08] style infrastructure. It must also exploit all the XML patterns to abstract XML languages and, last but not least, all of its parameters must be specified in configurations files that must be read and edited also by those who have no knowledge in programming languages.

In the next sections I will describe the technologies that can be used in order to create a markup editor that follows all the above requirements.

5.2.1 Ajax, javascrip and HTLM5 for in-browser software

Ajax [G+05], *javascript* [GME07] and *HTML5* [HH10] are the leading technologies used for developing in-browser software.

Ajax (Asynchronous Javascript and XML) is a programming paradigm according to which a group of interrelated technologies are used to create web applications. By using javascript and HTML5 with the Ajax paradigm, it is possible to create dynamic in-browser applications. Ajax application can send data to or retrieve data from the server without interfering with the behavior of the page displayed on the browser.

HTML5 supplies some interesting features that are useful for creating of in-browser markup editors. For example, HTML5 allows web applications' users to directly modify elements of web pages displayed in the browser and provides some technologies for in-browser storage. Moreover, HTML5 documents are already structured documents compliant to some XML patterns.

Javascript is the most used script language for the developing of dynamic in-browser applications but, because it is an interpreted language, different browsers can execute it in different ways. For this reason it is important to use javascript cross-browser frameworks that ensures the same application's behavior in the most known browsers.

5.2.2 Frameworks for cross-browser software

Javascript syntax can be very verbose and difficult to understand. Moreover, since it is an interpreted language and each browser has its own interpreter, sometimes a javascript code that works on a browser could not work properly on another browser.

Javascript frameworks supply objects and methods that abstract the original javascript's ones and behave in the same way on different browsers.

Most recent frameworks also allow to quickly create animations, visual effects, and to easily communicate with the server side of the software.

Other javascript frameworks, known as *component-based* frameworks [Lew98], allow developers to create, with few lines of code, visual elements that are similar to the ones used in desktop applications. These are the most suitable ones for the creation of a parametric markup editor.

5.2.2.1 ExtJS

ExtJS [OPKJ09] is a component-based javascript framework for building interactive web applications. It allows to create easily the core of the application by following the Model View Controller pattern.

ExtJS comes along with a big range of user interface widgets, but it is possible to extend it by creating new components and these can be combined with the default ones to create rich user interfaces.

ExtJS is completely cross-browser and applications that exploit Ext JS can be used both on all browsers (running on all operating systems), and on modern tablets and smart phones.

5.2.3 TinyMCE

TinyMCE [AH08] is a platform-independent web-based javascript HTML WYSIWYG editor control. It can convert HTML5 text area fields or other HTML5 elements into editor instances.

It relies on an user interface very similar to the one of the most used word processors, like Microsoft Word and Open Office. The editor offers the most common formatting tools, like bold, italic, underline, lists and so on, and can be configured in order to display only subsets of these tools.

TiniMCE is designed to be easily integrated in content management systems, but it is possible to integrate it in ExtJS, by developing a new component. This component preserves all the functionality of TinyMCE editor but the effects of them are intercepted by the core of the ExtJS application.

5.2.4 REST style communication

REST stands for Representational State Transfer and is the foundation of the RESTful architecture [Fie00]. It emphasizes the abstraction of data and services as resources that can be requested by clients, by using the resources' name and address, specified as a Uniform Resource Locator (URL).

It revolves around five fundamental notions: a resource (e.g., a document or image), the representation of a resource, synchronous request-response interaction over HTTP to obtain or modify such representations, a web page as an instance of the application state, and engines (e.g., browser, crawler) to move from one state to the next.

REST specifies a client-stateless-server architecture in which each request is independent from the previous ones, inducing the property of scalability. For example, the following request:

```
DELETE /photos/17
```

will be mapped to the photo whose ID is seventeen, and will perform the desired action, so it will delete that resource.

REST is a natural style for the architecture of web applications.

5.2.5 eXist Database

eXist is a native XML database [Mei03] that is completely built on XML technology.

The database interacts with Ajax applications, by supplying a RESTful interface. A *unique resource locator* (URI) is assigned to each resource in the database, which can be accessed using it. This is important because, by using a standard conceptual schema for the creation of the URI, for instance *FRBR*, it is possible to navigate the storage without using a query language.

The query language must be used to perform more complex actions, for instance to modify specific fragments of documents or to retrieve specific subsets of documents.

Unlike relational database management systems, eXist uses *XQuery* to access and manage the data that are stored in it.

5.2.5.1 FRBR storage

FRBR (*Functional Requirements for Bibliographic Records*) [O'N02] is a conceptual entity-relationship model that allows users, for example, to retrieve and access resources in an online library by using a human-friendly syntax.

FRBR provides hierarchical links to navigate resources that are composed by a specific set of items. The main entities in FRBR are the *work*, the *expression*, the *manifestation* and the *item*.

The work "represents a distinct intellectual or artistic creation" [Pla98]. For example, in video game contexts the concept *The Legend of Zelda*$^{(\mathrm{TM})}$ is a work. In a FRBR URI this concept must be expressed as the following:

```
/jp/zelda/21-02-1986
```

The URI expresses that Zelda is a work, published in Japan on February the 21st, 1986.

The expression is "the specific intellectual or artistic form that a work takes each time it is realized" [Pla98]. In Zelda example, an expression can describe the *Ocarina of the time*$^{(\mathrm{TM})}$ episode of the game released in November 1998 in Japanese. The URI of this expression is the following:

```
/jp/zelda/21-02-1986/ocarina/jp@11-1998
```

The manifestation is "the physical embodiment of an expression of a work. As an entity, manifestation represents all the physical objects that bear the same characteristics, in respect to both intellectual content and physical form." [Pla98]. For the Zelda work, a manifestation can be the Ocarina of the time version stored on *Nintendo Optical Disk*$^{(\mathrm{TM})}$, released for *Nintendo Game Cube*$^{(\mathrm{TM})}$. The URI of this manifestation can be the following:

```
/jp/zelda/21-02-1986/ocarina/jp@11-1998/game.nod
```

The item is "a single exemplar of a manifestation. The entity defined as item is a concrete entity." [Pla98]. For example an item of Zelda Ocarina of the Time$^{(\mathrm{TM})}$, in its Game Cube$^{(\mathrm{TM})}$ version, can be the file *character.png*, describing the physical file that contains the art of the main character of the game. Items can be expressed in URI format as the following:

```
/jp/zelda/21-02-1986/ocarina/jp@11-1998/game.nod/Link.png
```

5.2.5.2 XQuery language and XSLT

XQuery [RCDS] is a functional programming language used to query large sets of structured documents in XML format. It relies on a set of XPath [CD$^+$99] expression used to address specific fragments of XML documents.

XQuery can also be used to create or modify XML documents; indeed, it supplies functions to dynamically or statically create nodes and attributes.

Even if, like XSLT, XQuery can be used to transform XML documents into other XML documents, it is better to rely on XQuery only to query, create and modify documents. This because XSLT is stronger for simple tasks, such as to transform all div elements to span elements. Moreover, the template architecture of XSLT is perfectly suitable for transformations based on patterns.

5.2.6 XML patterns and XML guidelines

As said in section 3.4, XML patterns are powerful instruments that can be used to abstract XML dialects. A parametric markup editor must rely on patterns in order to specify common procedures for elements belonging to the same pattern.

Also XML guidelines are useful in the design and the developing of a parametric markup editor. XML guidelines specify requirements for the usage of XML that are not strictly required by the schema, but that simplify the production of homogeneous documents. A parametric markup editor that aims to be used for the markup of many XML languages must specify and follow some XML guidelines; these are useful, for example, to create generic parser and generic queries for documents retrieval.

5.2.7 JSON

JSON (JavaScript Object Notation) [Cro06] is a text-based and human-readable open standard used for data interchange. It is specifically designed to represent data structures using associative arrays.

Even if JSON is language-independent and there are many parser available for many programming languages, it was derived from Javascript and, for this reason, it is the leading solution used for javasript applications' configurations files.

JSON is also often used in Ajax applications to pass data from the server to the client and viceversa. This is useful for parametric editors because JSON is less verbose than XML and this results in smaller files.

An in-browser parametric markup editor must use XML to describe structured documents and JSON to describe all the configuration files both for the client and the server side of the software and all the applications' data that must be interchanged between the two sides.

5.3 LIME, a Language Independent Markup Editor

LIME is the parametric web-based language independent markup editor that I designed and partially developed to prove my thesis. It drives users through the markup of non-structured documents into well-formed (optionally valid) structured XML documents compliant to the XML language chosen by the user.

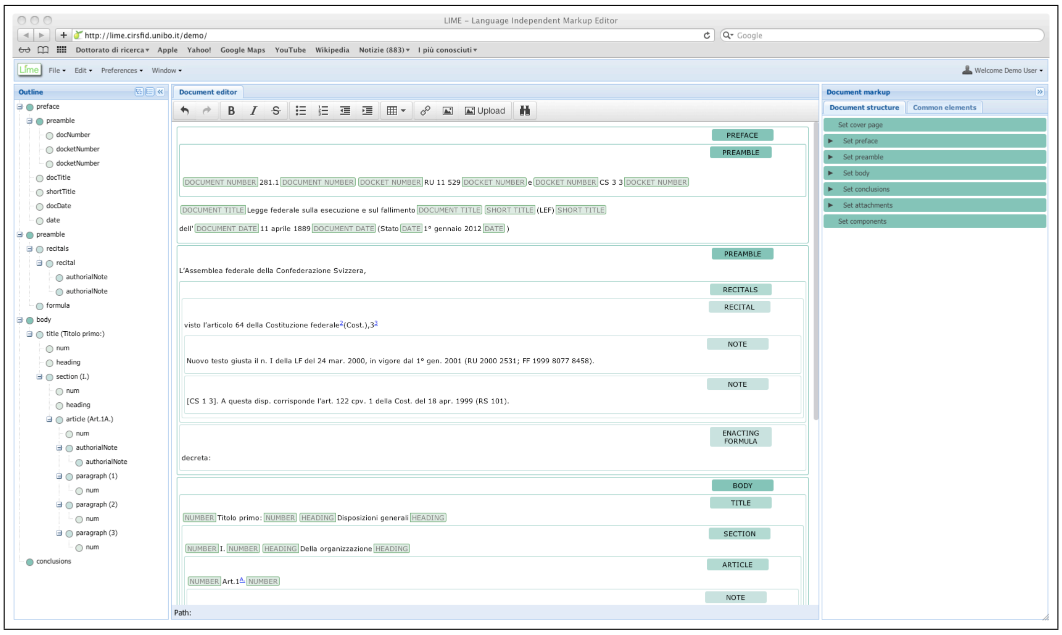
The LIME editor is an open-source software and relies on many open-source technologies. It is currently under development by CIRSFID [1] and the University of Bologna.

Works on LIME started when some parliaments asked professor Monica Palmirani and professor Fabio Vitali to create a web markup editor to markup their legal and legislative documents. At the same time, some scholars of history requested a markup editor that would be able to markup descriptions of ancient manuscripts.

[1]CIRSFID is an inter-departmental research center of the University of Bologna. Its main legal researches are focused on legal informatics, law and philosophy and sociology of law

Even if the two contexts are completely different, by revolving on our experience on XML languages, we started to imagine a markup editor that would be suitable for all XML dialects without the need to modify the code.

We started to focus on the legal context and, by using the technologies reviewed in previous sections, we designed and developed the first parametric and language independent markup editor.



DOCUMENT NUMBER 281.1 DOCUMENT NUMBER DOCKET NUMBER RU 11 529 DOCKET NUMBER e DOCKET NUMBER CS 3 3 DOCKET NUMBER

DOCUMENT TITLE Legge federale sulla esecuzione e sul fallimento DOCUMENT TITLE SHORT TITLE (LEF) SHORT TITLE

dell' DOCUMENT DATE 11 aprile 1889 DOCUMENT DATE (Stato DATE 1° gennaio 2012 DATE)

L'Assemblea federale della Confederazione Svizzera,

visto l'articolo 64 della Costituzione federale2(Cost.),33

Nuovo testo giusta il n. I della LF del 24 mar. 2000, in vigore dal 1° gen. 2001 (RU 2000 2531; FF 1999 8077 8458).

[CS 1 3]. A questa disp. corrisponde l'art. 122 cpv. 1 della Cost. del 18 apr. 1999 (RS 101).

decreta:

NUMBER Titolo primo: NUMBER HEADING Disposizioni generali HEADING

NUMBER I. NUMBER HEADING Della organizzazione HEADING

NUMBER Art.1A. NUMBER

Figure 5.1: A screenshoot of the LIME editor

5.4 Overview of LIME features

The LIME editor permits to markup documents in various XML languages by using an interface that is quite similar to the one of desktop word processors.

LIME allows users to register and to create and save their documents (no matter the language they are marked up) in the cloud. So users can import documents, edit them and save them in their dedicated eXist database space. These functionality are all managed using the top toolbar of LIME that is showed in figure 5.2.

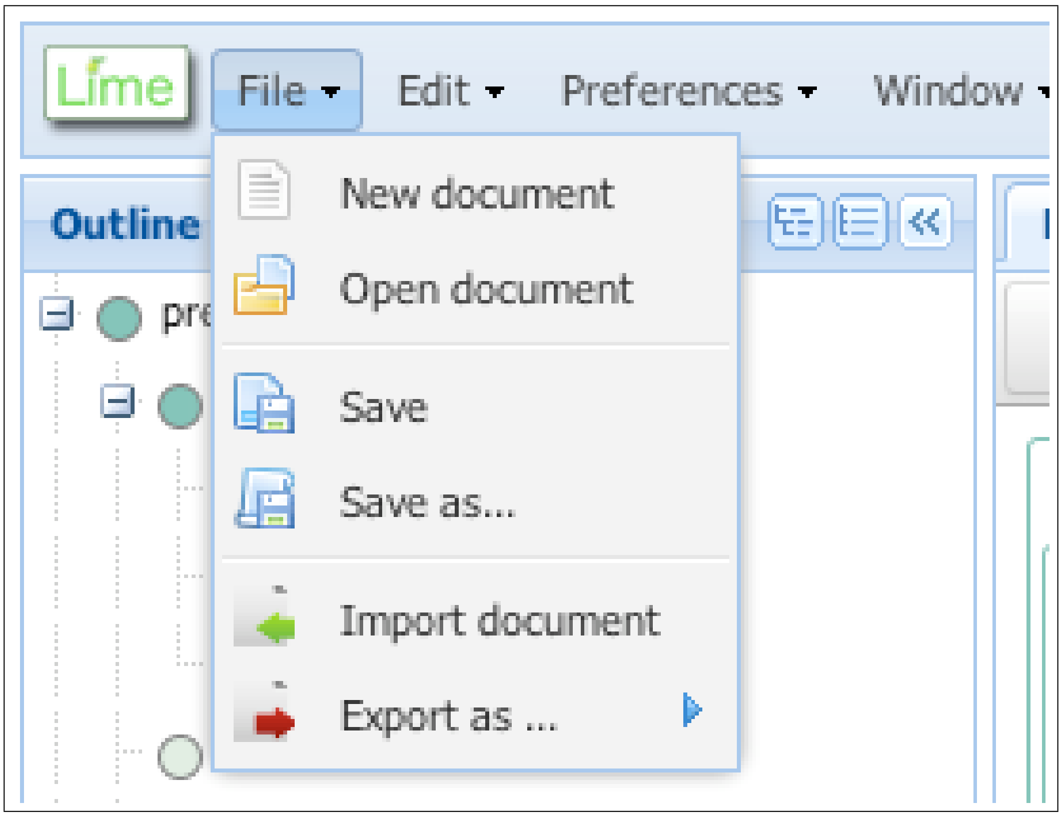
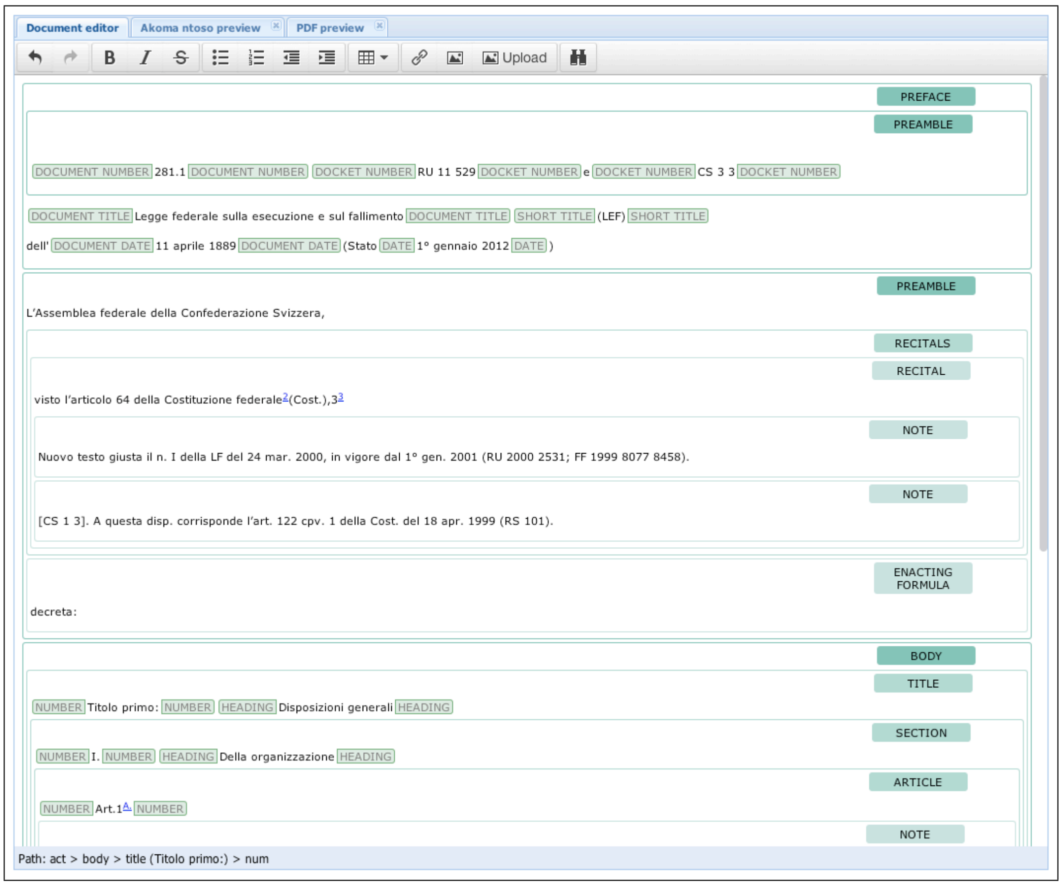


Figure 5.2: A screenshoot of the LIME top bar

In order to enable documents markup and to write new documents, LIME supplies an editor displayed in the center of the application's main window (figure 5.3). This also supplies buttons for cross-language markup features like buttons for bold text, inline text and so on. The document that users see in this editor is formatted in HTML5, because it is currently the best suitable format for the visualization of pages on browsers. When users save documents, they are immediately translated to the markup language users are using.

In this part of the application is it also possible (if enabled in configuration files) to see the preview of the final XML result and the PDF preview of the document.

As said before, LIME does not simply allow users to markup documents, but also drives them to create a correct markup even if they do not have a deep knowledge of the XML language they are using.



DOCUMENT NUMBER 281.1 DOCUMENT NUMBER DOCKET NUMBER RU 11 529 DOCKET NUMBER e DOCKET NUMBER CS 3 3 DOCKET NUMBER

DOCUMENT TITLE Legge federale sulla esecuzione e sul fallimento DOCUMENT TITLE SHORT TITLE (LEF) SHORT TITLE

dell' DOCUMENT DATE 11 aprile 1889 DOCUMENT DATE (Stato DATE 1° gennaio 2012 DATE)

L'Assemblea federale della Confederazione Svizzera,

visto l'articolo 64 della Costituzione federale[2](Cost.),3[3]

Nuovo testo giusta il n. I della LF del 24 mar. 2000, in vigore dal 1° gen. 2001 (RU 2000 2531; FF 1999 8077 8458).

[CS 1 3]. A questa disp. corrisponde l'art. 122 cpv. 1 della Cost. del 18 apr. 1999 (RS 101).

decreta:

NUMBER Titolo primo: NUMBER HEADING Disposizioni generali HEADING

NUMBER I. NUMBER HEADING Della organizzazione HEADING

NUMBER Art.1[A] NUMBER

Path: act > body > title (Titolo primo:) > num

Figure 5.3: A screenshoot of the LIME word processor

In order to allow users to do it, LIME supplies a markup menu in the right side of the interface that is contextual to the part of the document users are editing. For example, if users are marking up an Akoma Ntoso document, in the first step of the markup the menu will display the top level elements made available by Akoma Ntoso. Later, when they have already marked up some chapters or articles, users can position the mouse's cursor inside these elements and the markup menu will display the elements enabled in that position. Figure 5.4 displays the LIME markup menu for Akoma Ntoso documents.

The last part of the LIME editor's interface is the document outline, which is displayed in figure 5.5. It is used to display the outline of the document. This is useful to see the hierarchical nesting of the already marked up document and to quickly navigate among them.

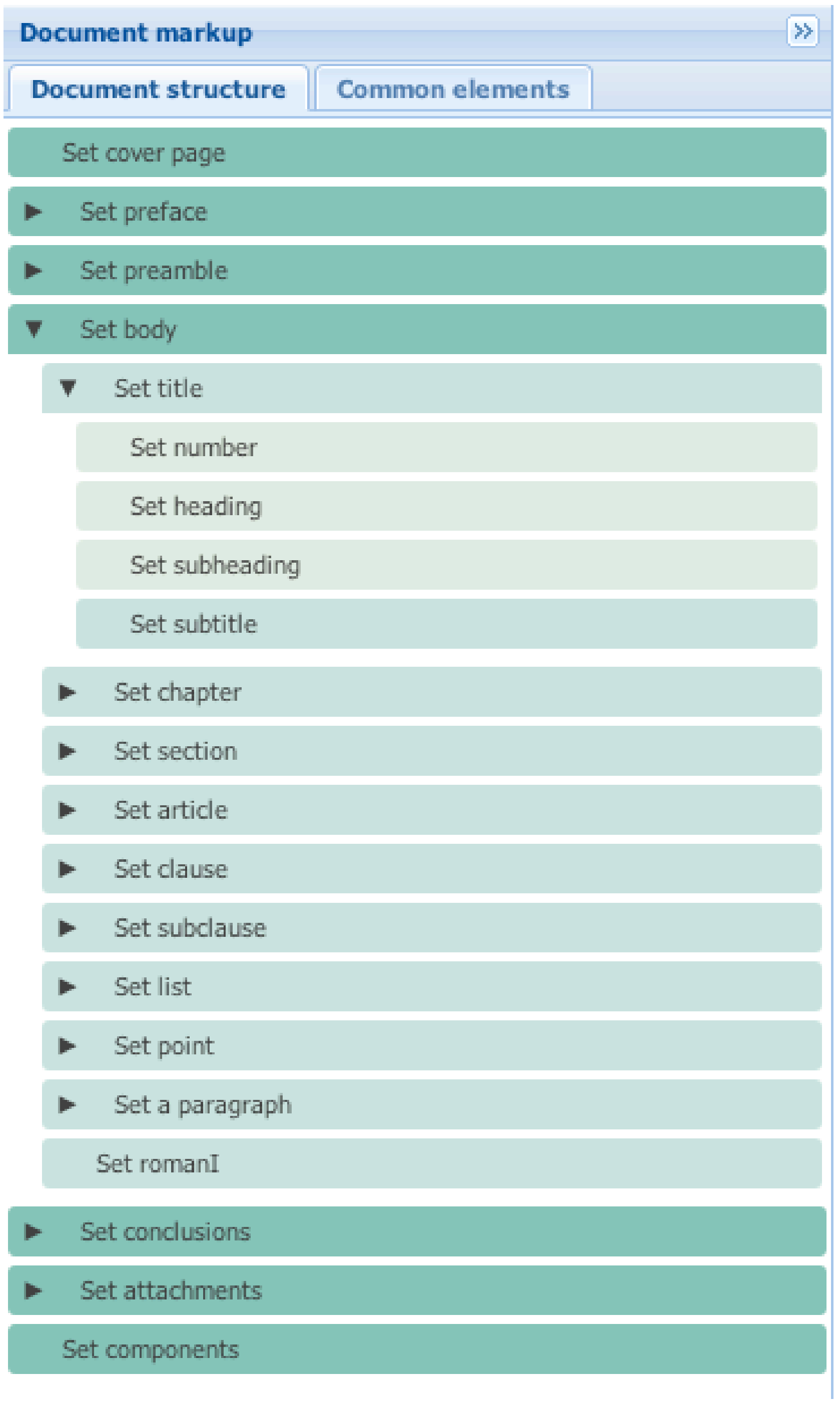


Figure 5.4: A screenshoot of the LIME markup menu

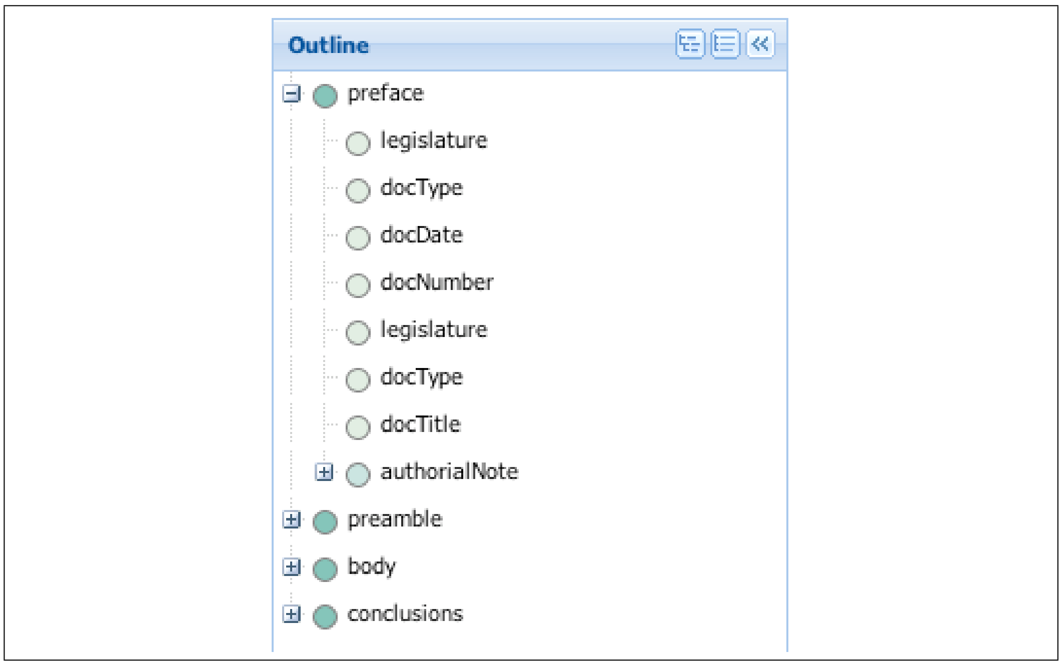


Figure 5.5: A screenshoot of the LIME documents' outline

LIME architecture revolves on the *getting real* method [God06]. For this reason we started from the application interface and created the system architecture on it.

5.5 LIME architecture

LIME is based on a four tier architecture. The application logic of LIME completely relies on its client side components and the server side components are charged to manage documents and database transaction.

LIME uses two database. The first one is a classic relational MySQL database and it stores information related to users and statistic information about the access to the system. The second database is an eXist database instance and is used to store the XML documents marked up through the editor. This database is hosted by a Tomcat Application Server and resides on a separate machine from the one that hosts the server side script of the applications.

The server side components are hosted by an Apache web server and are responsible for the parsing of the documents and act as proxy for the two database of the software.

The client components have in charge the business logic of the system. They draw the user interface, intercept the interaction of the user with it, supply the features for the markup of documents, and interact with the server side components to manage documents and users.

Figure 5.6 shows the LIME architecture. In the next sections I will deeply explain the roles of the client side components and of the server side components

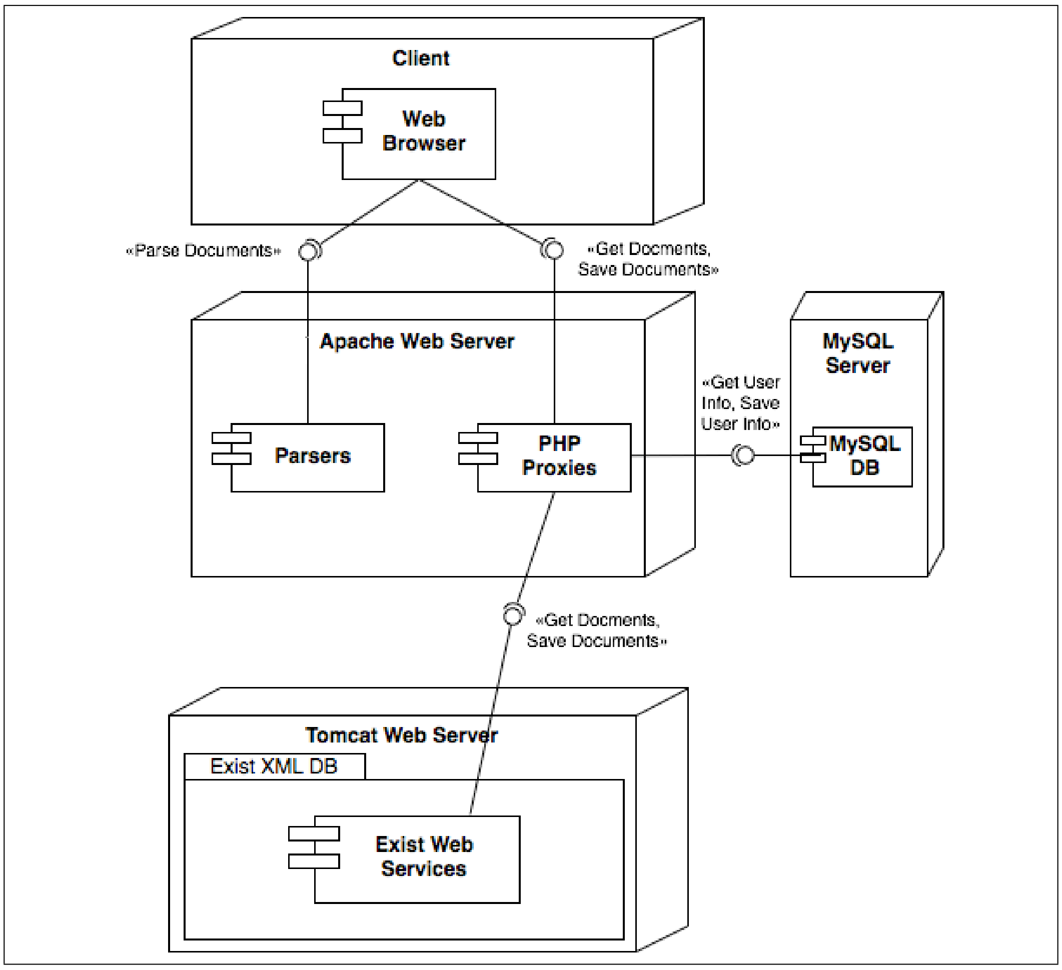


Figure 5.6: The LIME editor architecture

5.5.1 Client side components

The core of the application is constituted by a small set of ExtJS components. When the application starts the main viewport is loaded by the application and the editor, the marking menu, the explorer and the main toolbar are instantiated inside it.

The *editor* is the central part of the application, but when something happens to the document, the editor fires events that are handled by the other components of the application. By doing so, even if the editor is currently based on TinyMCE and is the most important component of the application, it can be easily substituted by other third parts WYSIWYG editors.

The *explorer* is the component of LIME that has in charge to display the hierarchical structure of marked up documents. When a part of the document is marked using the marking menu, the editor also asks the explorer to update itself.

The *marking menu* is the component that creates the buttons used to markup documents. When users click buttons in marking menu, it asks the editor to modify the displayed document and the editor replies updating the marking menu.

The *main toolbar* aims to supply all the common operations of a WYSIWYG editor, such as the operations to load and save files and the operations to change users' preferences.

The JSON configuration files are the client side components of LIME that allow to specify its parameters. I will describe them later in section 5.6.2.

Figure 5.7 shows how the client side components interact among themselves.

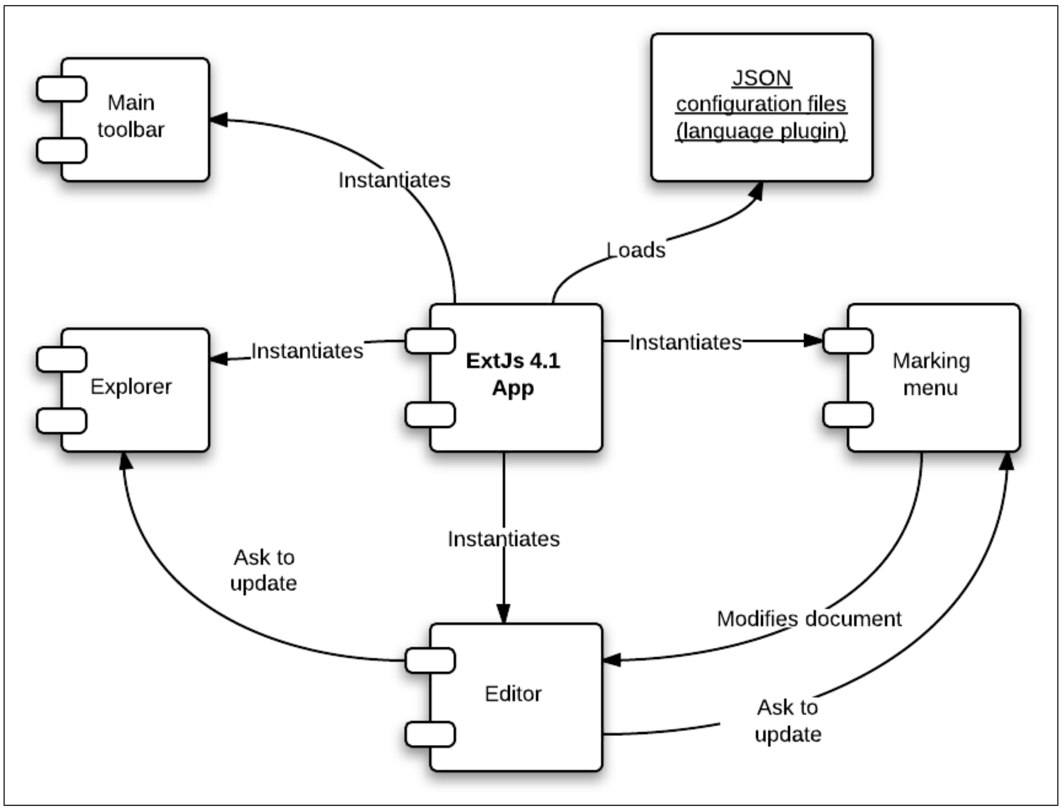


Figure 5.7: The interaction among LIME client side components

5.5.2 Server side components

The server side components have three main tasks; proxying, parsing and translating.

The *requests proxy* is a PHP module that simply dispatches the requests towards the two kinds of database used by the application. When a document is requested (or must be saved), the module retrieves (or sends) the document to the web services built on the top of the eXist database. When users' information must be retrieved (or must be saved) from the MySQL database, it sends the request to the MySQL server and returns the information to the client.

The *document parsing* component is used for the *smart markup* functionality provided by the editor. This permits to parse the document trying to automatically find and markup some parts of the document. For instance, if a law file opened in the editor contains some references to other laws, they will be found and labeled as *ref* elements.

The *document translations* component is the module that translates the document from the HTML version created in the editor into the XML format that users need.

5.6 Three commandments to be parametric and language independent

In order to be parametric and language independent, LIME relies on three main concepts; XML guidelines, XML patterns and JSON configurations files.

Guidelines and patterns are used to abstract XML languages and to allow LIME to markup many of them. When a document is marked up on LIME, a pattern is assigned to each element and its behavior is described by parameters stored in JSON configurations' files.

5.6.1 XML guidelines and patterns used by LIME

The LIME editor relies on six patterns, the same used by Akoma Ntoso. When a LIME configuration for a specific language is created, the contents model of the language are matched with one of the following patterns: inline, block, hierarchical container, container, marker or subflow.

Sometimes a content model can not be abstracted using one of the above patterns. In this situation the elements using that content model are labeled as *patternless* elements.

LIME also follows XML guidelines for the creation of elements' unique identifiers and elements' classes.

5.6.1.1 Patternless, the patterns' wildcard

A patternless element is an element that does not belong to any known markup pattern. Patternless elements are really complicated to manage but are also useful to abstract XML languages that have not a patternized architecture.

An example of patternless elements can be seen in the listing 5.1. In the example the element called *patternlessExample* is obviously a patternless element because it contains text, a block and a hierarchical container and, for this reason, it does not belong to any of the six XML patterns supported by LIME.

LIME manages patternless elements by simply transforming them into structures that are compliant to HTML. So the example in listing 5.1 is translated into the markup in listing 5.2.

In a nutshell, patternless elements are wildcards that can be used everywhere and that do not follow any rule.

Listing 5.1: An example of patternless element

```
<?xml version="1.0" encoding="UTF-8"?>
<root>
   <patternlessExample>
   Hello <block> world!</block>
      <hcontainer>
         <inline>I am</inline>
         <container><block>a patternless element</block></
            container>
      </hcontainer>
   </patternlessExample>
</root>
```

Listing 5.2: A translated patternless element

```
<?xml version="1.0" encoding="UTF-8"?>
<root>
   <div>
   Hello <div> world!</div>
      <div>
         <div>I am</div>
         <div><div>a patternless element</div></div>
      </div>
   </div>
</root>
```

5.6.1.2 Guidelines for elements' unique identifiers

LIME follows guidelines for elements' unique identifiers. Unique identifiers are built in specific ways that allow both to infer some semantic information of the document just looking at them, and to aid automatic processes that have to parse documents.

First of all, all elements in a LIME document have unique identifiers that are composed by three letters of the element's name and by a sequential number. In this way documents parser can analyze the unique identifiers of the element and can immediately understand what is the type of the element and the numbers of the same elements in the document.

The other guideline that LIME follows is the one that specifies that elements must have unique identifiers that explicate their nesting. This allow to understand the nesting of the document and the relations among the elements in the documents.

In listing 5.3 it is possible to see examples of the unique identifiers assigned to elements belonging to an Akoma Ntoso document in editing mode.

5.6.1.3 Guidelines for elements' classes

LIME also relies on guidelines for elements' classes. Classes in LIME documents contain the name of the element that users want to create and the pattern it belongs to.

This is useful because in this way it is possible to create generic XSLT stylesheets to translate the document displayed in edit mode into the final one, independently from the language to which the final document must be compliant to.

In listing 5.3 it is possible to see how LIME assigns classes to documents' elements.

Listing 5.3: A sample of the elements' unique identifiers and elements' classes assigned to a LIME document

```
<div class="akomaNtoso container">
 <div id="bll1" class="bill container">
   ... omissis ...
  <div id="bll1-bdy1" class="body container">
   <div id="bll1-bdy1-cha1" class="chapter hcontainer">
    <span id="bll1-bdy1-cha1-nm1" class="num inline">CHAPTER 1</
       span>
    <span id="bll1-bdy1-cha1-hdng1" class="heading inline">
       INTERPRETATION AND APPLICATION</span>
     <div id="bll1-bdy1-cha1-sct1" class="section inline">
      ... omissis ...
      </div>
      <div id="bll1-bdy1-cha1-sct2" class="section inline">
      ... omissis ...
      </div>
     </div>
     <div id="bll1-bdy1-cha2" class="chapter inline">
      ... omissis ...
     </div>
      ... omissis ...
    </div>
  </div>
</div>
```

5.6.2 JSON configuration files

JSON configuration files are used to specify LIME parameters for each XML language. These files are collected in packages called *language plugins*.

A language plugin is a collection of settings regarding both the language used to markup documents and the behavior of the user interface when that language is used. Each element specified in the plugin is connected with one or more buttons and one or more markup elements. Many buttons can be inserted in a single configuration file.

5.6.2.1 LIME language plugins

A language plugin is not made of just one file of configuration. Each plugin provides a set of well-structured directories and JSON files that describe the whole plugin. Each file describes a different layer of the plugin: from the user interface to the patterns mapped to each element and the set of elements specified by the language.

The root directory of all languages' configurations files is *languagesPlugins* in which some directories and one file are stored. The resources contained in the languagesPlugins folders are the following:

- One or more directories having the name of the XML language whose markup must be enabled in the editor. These directories contain two nested folders and a file:
  - **client**: an optional folder containing plugins written in pure javascript.
  - **interface**: the main folder of language configuration.
  - **structure.json**: a JSON file containing the structure of interface folder.
- **default**: this is a directory containing a dummy language which contains some default files that every language can override
- **config.json** A configuration file that contains the list of the languages enabled in the editor.

The *interface* directory contains all the files used to describe the configuration of a specific XML language. It contains the following files:

- **viewConfigs.json**: a file containing configurations about views in the editor, it allows to enable or disable views.
- **markupMenu.json**: in this file all the elements of the language with their patterns are stored.
- **markupMenu_rules.json**: a file that contains the specific configuration for each element and the hierarchy to be used for the buttons in the markup menu.
- **custom_buttons.json**: a file containing custom style rules regarding buttons and elements marked by it. It also contains optional rules regarding the structure of the document.
- **custom_patterns.json**: a file that allows to specify custom patterns and to customize the ones already existing.

All these files can be inserted in nested directories to specify different configurations for different sub-types of documents. For example, Akoma Ntoso allows to create bills, acts, judgments and other document types. The configuration for these documents' types is different from one another and, for this reason, it is possible to create a different folder for each document type inside the interface directory. This folder must contain all the above described configuration files.

System administrators that want to enable LIME to markup other XML languages have simply to write these configuration files and to package them properly inside a language plugin folder. The configuration files are really simple to read and modify but at the same time are very powerful.

In listing 5.4 it is possible to see a fragment of a configuration file used in the Akoma Ntoso language plugin. With few lines of human readable code, the fragment describes a button called *act* that has some children buttons. When these buttons are clicked, the editor must markup the text selected by users with an element having the same name of the button. The other described button is *docTitle* that, when pressed, must markup the selected text with the docTitle element and must display a widget asking for a short title. Then, the text that users input in the widget will be inserted in the docTitle element's attribute called *shortTitle*.

Listing 5.4: Am example of a LIME configuration file

```
"elements": {
   act: {
      "children": [preface, preamble, ..., conclusions]
   },
   ...
   docTitle: {
      "askFor": {
         docTitle: {
           "label": "short title"
           "type": "text"
           "insert": {
              "attribute": {
                  "name": "shortTitle"
              }
           }
       },
    }
  }
}
```

5.7 Evaluating markup editors' usability

In this chapter I described the technologies suitable for the creation of a parametric markup editor and I explained how we used these technologies to design and develop LIME, that is the first in-browser parametric and language independent markup editor.

LIME is not simply a markup editor. It is also supposed to drive the documents' drafters to obtain a correct markup, even if they do not know the XML language they are using. The second challenge of my thesis is to demonstrate that LIME is absolutely suitable for this task because it relies on a usable user interface.

In the next chapter I will describe how I created a usability test for markup editors and I will show the results that I obtained applying it to LIME.

Chapter 6

Evaluation of LIME's user experience

The aim of this chapter is to describe the process for the evaluation of LIME's user experience. In the first section I will synthetically explain what is *user experience* and what are the goals of a generic user experience's test. In the second section I will show the goals of LIME's user experience's test, and in the third section I will deeply describe the methodologies used to develop the test, to submit it, and to collect the data that it produces. In the fourth section I will analyze the results of the test and, eventually, I will point out the strengths and the weaknesses of the LIME editor.

6.1 The study of the user experience

Even if many scholars gave their own definition of user experience (hereafter UX) [LRV$^+$08], the most of them agree that it describes the thoughts, the feelings, and the perceptions that result from an interaction between a human and an artifact (no matter if it is a computer or a corkscrew) [TA08]. For this reason, the aim of a user experience's test is to collect the behaviors, the attitudes, and the emotions that emerge from an interaction with a system.

For example, if we are analyzing the user experience of a person who wants to bake *parmigiana*, we will count how many movements he performs in order to open the oven, put the dish inside it, and set the oven to one hundred seventy degrees. We will also check if he expected the oven handle on the right side and his feelings during the whole process (for example we check if he feels frustrated because he can not figure out how to set the alarm clock of the oven).

In the same way, the aim of a user experience's test on a markup editor, is, generally speaking, to check three different things. Firstly, we need to examine the actions that the user performs in order to open, save and close files; secondly, his behavior in documents' markup; and last but not least, his feelings during the overall process.

This test must then be refined for specific editors in order to identify the issues related to their specific context. In the next section I will explain the goals of the user experience's test created to evaluate LIME editor.

6.2 Goals of the test

The aim of this test is to evaluate the usability of LIME. The test is structured as a *summative usability* test [TA08]. Therefore, it is created to examine how well the editor and its functionality meet their objectives. In order to do this, the *efficacy* and the *efficiency* of the editor, and the *satisfaction* of the users will be evaluated [Sha91].

Efficacy and efficiency are about what users actually do when they interact with the editor, trying to accomplish a task. In the sections 6.2.1 and 6.2.2 I will explain the tasks that where chosen to examine these characteristics.

Satisfaction is about the users' feelings while they interact with the editor or when they are performing tasks. In section 6.2.3 I will explain how I examined users' satisfaction.

6.2.1 Examining the efficacy

The aim of this part of the test is to evaluate the editor's navigation system that should be used to navigate and manage files and to handle the editor's interface. The navigation system is the very first part of the software to which the users are exposed.

To evaluate this part of the software I have chosen to submit to users nine tasks that are fairly representative of the interaction with the navigation system. The nine tasks are listed below:

- *Can you sign up to the system?*
- *Can you log in with your account?*
- *Can you change the editor's language to your preferred one?*
- *Can you import a Microsoft word's file from your desktop?*
- *Can you open one of the examples supplied by the editor?*
- *Can you save the file under a different name?*
- *Can you open the XML preview of the example you are looking at?*
- *Can you save the XML version of the document on your desktop?*
- *Can you log out?*

These are critical tasks that users must complete successfully. Therefore it is important to check both that the user can complete the tasks (because a negative response results in a fatal interaction's issue), and the ease of the interaction (because an uneasy interaction with the navigation system can lead the user to think that the editor is not working properly).

6.2.2 Examining the efficiency

This part of the test is intended to evaluate how much effort users make when they use the editor to markup a legislative document. In order to markup a legislative document, users must identify the legal parts of the document and must assign to each of them the correct label. On the one hand, the markup's tasks are secondary because the users start to use them only after they feel comfortable with the navigation system. On the other hand, they are fundamental tasks because they are performed to accomplish the editor's main objective.

In order to evaluate the markup features of the editor, I asked the testers to perform the following tasks:

- After a partially marked-up document was opened:
  - *Can you set the preface of this document?*
  - *Can you set the document date?*
  - *Can you set the main body of the document?*
  - *Can you set an article, its number, and its heading?*
  - *Can you markup a bold text in the article that you created?*
  - *Can you create a table in the article that you created?*
  - *Can you set a quoted structure in the article that you created?*
- After a complete marked-up example was opened:
  - *Can you show me the subsection 2 of the section 3 of this document?*
  - *Can you un-mark the preface of this document and all the elements that it contains?*
  - *Can you save this document as a new expression in the same work?*

In order to evaluate the efficiency, it is important to check how much time users need to complete these tasks and the actions that they perform in order to do that. It is important to underline that a failure in these tasks is admissible because it should not result in user's frustration, but leads the user to find a different way to markup the document. For example, if users are not able to markup bold text, they can simply decide to skip it (maybe because they think that the editor does not supply this feature), or they can try other strategies to achieve a similar result (for example using a generic inline and setting its class to bold).

This does not mean that failures must be ignored, indeed a lot of failures can make the user to feel frustrated and abandon the system. Therefore, in this part of the test, it is important to check the number of successes, the number of failures, and the users' behavior while they perform the tasks.

6.2.3 Examining the users' satisfaction

Satisfaction is evaluated collecting a set of users' *self-reported data*. Self-reported data are really important because they capture users' actual feelings while they are using the system. Indeed, the data that come out of a summative usability test can be very different from the data that come out of users' self-reported data, and in some situations the latter can be more significant. For example, a task can be rated as dreadful by the usability expert because it takes five minutes rather than the expected one minute. But then the users can rate the same task as amazing because they had a lot of fun while performing it and, as said before, in some situations this can be the only thing that matters.

The testers where asked to answer two sets of questions. The first questionnaire was completed before they performed the tasks listed in section 6.2.1 and section 6.2.2. The second one was compiled after they have completed the tasks. The following are two examples of questions asked before and after the task completion respectively:

An example of a question submitted before the users completed the task

1a. How difficult do you expect it will be to sign up to the system?
Very difficult ○—○—○—○—○—○—○ Very easy

An example of a question submitted after the users completed the task

1c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

After each task was completed, users were asked to indicate the degree of difficulty they found in the task's completion using the same scale they used in foreseeing their effort for the same task. The complete questionnaire is reported in section 6.3.3.

Thanks to this kind of tests it is possible to compare the *expectation rating* and the *experience rating* [TA08]; this can be used to improve the user experience.

6.3 The LIME's user experience test

The LIME's user experience test was built on Akoma Ntoso markup language and was intended to capture both users' performance and satisfaction. For these reasons it was submitted using specific methodologies and users were chosen in order to meet specific requirements. In this section I will explain the methodologies that I used to submit the tests, how I chose the testers and, eventually, I will report the complete questionnaires submitted to the subjects.

6.3.1 Methodology

The user experience's test was divided in four sessions: A *registration session*, a *presentation session*, an *effort foresee session* and a *task performing session*. All the subjects were volunteers and I will explain in the next section how I recruited them.

For the registration I asked testers their age, their degree of experience in certain fields, and how often they uses some kinds of software. I have chosen not to ask their name and their surname in order to ensure their anonymity during the results' evaluation, and for this reason, I assigned to each of them an individual ID number. The other information were asked in order to make it possible to cluster the results and infer more specific data.

During the presentation session, a teacher in legal informatics and creator of Akoma Ntoso (Monica Palmirani) explained testers the basis of the language and shared all the knowledge needed in order to accomplish the simple test's tasks. This session lasted thirty minutes and was performed in a lab of the University of Bologna.

After the presentation, during the foresee session, users were asked to compile a questionnaire in which they foresaw the effort that they presumed to make to accomplish all the test's tasks. I gave them a copy of the questionnaire and I asked them to sign it with the ID they had previously received. This session had no time limit.

In the last session, I asked the users to individually perform some tasks while I was observing and timing them. For this session I produced my personal sheet in which I reported the information related to users while they were performing the task. I divided the tasks into two groups.

The first group contained the tasks developed to examine the navigation system. Tasks in this group was labeled with a *NS* ID, and was treated as *binary data* [TA08]; for this reason I assigned them a time limit. If users finished the task in time I rated it *as accomplished*, otherwise I rated it as *not accomplished*.

The second group contained the tasks used to examine LIME's efficiency.

Tasks in this group were labeled with a *MU* ID, and were treated as *time tasks* [TA08]. For items in this group I simply reported the time users spent to accomplish the task.

After the completion of each task, I asked the users to report the degree of difficulty they found in accomplishing the task.

In section 6.3.3 I will report the questionnaires and the sheet that I used to collect the information.

6.3.2 Choosing the testers

In order to recruit the testers we, at CIRSFID, organized a *hackaton* [1]. Its objective was to markup, by using Akoma Ntoso, as many documents as possible in five hours.

During the hackaton I asked the users to join me in a separate room to perform the fourth session of the user experience's test.

Ten people joined the hackaton and ten people agreed to do the test. In section 6.4.1 I will summarize the users information.

6.3.3 The complete test

The following are the questionnaires submitted to the users and the sheets that I used to report information.

The questionnaire submitted before the users' performed the tasks

About you

1. **Your ID number**: ____________
2. **How old are you?** I am ________ years old.
3. **What is your knowledge in computer science?**

   None ○—○—○—○—○—○—○ I'm an expert

[1]A hackaton is an event in which individuals are involved to collaboratively contribute to a project. A lot of software or software' functionality were prototyped or implemented during hackatons, for example the Facebook's chat [PL09].

4. **What is your knowledge in law and jurisprudence?**
   None ○—○—○—○—○—○—○ I'm an expert
5. **What is your knowledge in legal informatics?**
   None ○—○—○—○—○—○—○ I'm an expert
6. **How often do you use computers?**
   Never ○—○—○—○—○—○—○ Very often
7. **How often do you navigate the web?**
   Never ○—○—○—○—○—○—○ Very often
8. **How often do you use desktop applications?**
   Never ○—○—○—○—○—○—○ Very often
9. **How often do you use online applications?**
   Never ○—○—○—○—○—○—○ Very often
10. **How often do you use desktop word processors (i.e. word, open office)?**
    Never ○—○—○—○—○—○—○ Very often
11. **How often do you use in browser word processors (i.e. google docs)?**
    Never ○—○—○—○—○—○—○ Very often
12. **How often do you use desktop XML editors (i.e. oxygen XML, altova XML spy)?**
    Never ○—○—○—○—○—○—○ Very often
13. **How often do you use legislative markup editors (i.e. NIR editor, bungeni editor)?**
    Never ○—○—○—○—○—○—○ Very often

Foresee the effort you will make to complete the following tasks

1a. **How difficult do you expect it will be to sign up to the system?**
    Very difficult ○—○—○—○—○—○—○ Very easy

2a. **How difficult do you expect it will be to log in to the system?**
    Very difficult ○—○—○—○—○—○—○ Very easy

3a. How difficult do you expect it will be to change the editor's language to your preferred one?
Very difficult ○—○—○—○—○—○—○ Very easy

4a. How difficult do you expect it will be to import a Microsoft word's file from your desktop?
Very difficult ○—○—○—○—○—○—○ Very easy

5a. How difficult do you expect it will be to open one of the examples supplied by the editor?
Very difficult ○—○—○—○—○—○—○ Very easy

6a. How difficult do you expect it will be to save a file under a different name?
Very difficult ○—○—○—○—○—○—○ Very easy

7a. How difficult do you expect it will be to open the XML preview of a document?
Very difficult ○—○—○—○—○—○—○ Very easy

8a. How difficult do you expect it will be to save the XML version of a document on your desktop?
Very difficult ○—○—○—○—○—○—○ Very easy

9a. How difficult do you expect it will be to log out from the system?
Very difficult ○—○—○—○—○—○—○ Very easy

10a. Having a partially marked-up document, how difficult do you expect it will be to markup its *preface*?
Very difficult ○—○—○—○—○—○—○ Very easy

11a. Having a partially marked-up document, how difficult do you expect it will be to markup its *document date*?
Very difficult ○—○—○—○—○—○—○ Very easy

12a. Having a partially marked-up document, how difficult do you expect it will be to markup its *main body*?
Very difficult ○—○—○—○—○—○—○ Very easy

13a. Having a partially marked-up document, how difficult do you expect it will be to markup one of its *articles* with its *number* and its *heading*?
Very difficult ○—○—○—○—○—○—○ Very easy

14a. Having a marked-up article, how difficult do you expect it will be to markup a *bold text* inside it?
Very difficult ○—○—○—○—○—○—○ Very easy

15a. Having a marked-up article, how difficult do you expect it will be to markup a *table* inside it?
Very difficult ○—○—○—○—○—○—○ Very easy

16a. Having a marked-up article, how difficult do you expect it will be to markup a *quoted structure* inside it?
Very difficult ○—○—○—○—○—○—○ Very easy

17a. How difficult do you expect it will be to find the *subsection 2 of section 3* in a complete marked-up document?
Very difficult ○—○—○—○—○—○—○ Very easy

18a. Having a complete marked-up document, how difficult do you expect it will be to un-mark the *preface* and all the elements inside it?
Very difficult ○—○—○—○—○—○—○ Very easy

19a. Having a complete marked-up document, how difficult do you expect it will be to save it as a new *expression* in the same work?
Very difficult ○—○—○—○—○—○—○ Very easy

The task submitted to users and the questionnaire the compiled after the tasks' completion

1b. Can you sign up to the system?

1c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

2b. Can you log in with your account?

2c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

3b. Can you change the editor's language to your preferred one?

3c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

4b. Can you import a Microsoft word's file from your desktop?

4c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

5b. Can you open one of the examples supplied by the editor?

5c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

6b. Can you save the file under a different name?

6c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

7b. Can you open the XML preview of the example you are looking at?

7c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

8b. Can you save the XML version of the document on your desktop?

8c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

9b. Can you log out?

9c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

10b. Can you set the *preface* of this document?

10c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

11b. Can you set the *document date*?

11c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

12b. Can you set the *main body* of the document?

12c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

13b. Can you set an *article*, its *number*, and its *heading*?

13c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

14b. Can you markup a *bold text* in the article that you created?

14c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

15b. Can you create a *table* in the article that you created?

15c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

16b. Can you set a *quoted structure* in the article that you created?

16c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

17b. Can you show me the *subsection 2 of the section 3* of this document?

17c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

18b. Can you un-mark the *preface* of this document and all the elements that it contains?

18c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

19b. Can you save this document as a *new expression* in the same work?

19c. How difficult was to complete this task?
Very difficult ○—○—○—○—○—○—○ Very easy

Table 6.1: The sheet used to collect user's data

User ID:	Start time:		End time:	
Task number	**Task type**	**Time Limit (sec.)**	**Elapsed time (sec.)**	**Task accomplished (yes or no)**
task 1b	NS	180		
task 2b	NS	30		
task 3b	NS	120		
task 4b	NS	120		
task 5b	NS	60		
task 6b	NS	60		
task 7b	NS	60		
task 8b	NS	60		
task 9b	NS	30		
task 10b	MU	*NA*		
task 11b	MU	*NA*		
task 12b	MU	*NA*		
task 13b	MU	*NA*		
task 14b	MU	*NA*		
task 15b	MU	*NA*		
task 16b	MU	*NA*		
task 17b	MU	*NA*		
task 18b	MU	*NA*		
task 19b	MU	*NA*		

6.4 Analysis of the results

The usability test was successfully completed in six hours and all questionnaires except one were filled in properly. Indeed, an user completely forgot to fill in the questionnaire related to the evaluation of satisfaction and I excluded it in the analysis of the results. So, for the analysis of the results, I used the remaining nine tests.

6.4.1 Summary of the testers

The information about users show that my sample of users was quite representative of the scenario in which a legal markup editor should be used. I expected the users of a new legal markup editor to be professionals and to have a good knowledge of computer science or laws and jurisprudence. I also expected them to be skilled in computers, online and desktop applications, and words processors and that some of them also had some knowledge of legal informatics and XML editors.

Indeed, we can see in table 6.2 that the average age of the users was thirty-three years old. Almost all of them use often computers, web, desktop applications, web applications and desktop words processors. The majority of them have a good experience in computer science or law and use quite often online word processors. The minority of them are experts of legal informatics and use desktop XML editors.

I failed to recruit enough people skilled in other existent legal markup editors. This would have been useful to compare the LIME usability to the one of the other editor. However, as already said, this was intended to be a summative usability test and not a comparative test and for this reason the testers were enough reliable for my purposes.

Table 6.2: The summary of the testers

Question	**p1**	**p2**	**p3**	**p4**	**p5**	**p6**	**p7**	**p8**	**p9**	**Average**
age	37	38	29	30	39	26	25	38	37	**33**
knoweledge in computer science	5	4	4	5	2	7	6	4	7	**4.9**
knoweledge in law and jurisprudence	6	7	7	1	7	1	1	7	3	**4.4**
knoweledge in legal informatics	3	4	5	1	5	1	5	6	4	**3.8**
use of computers	7	7	7	7	7	7	7	7	7	**7**
use of web	7	7	6	7	7	7	7	7	7	**6.9**
use of desktop applications	7	7	6	7	6	7	7	7	7	**6.8**
use of online applications	7	3	5	7	6	7	7	7	6	**6.1**
use of desktop word processors	7	7	6	7	7	5	7	7	5	**6.4**
use of online word processors	5	7	3	2	6	5	7	6	3	**4.9**
use of desktop XML editors	6	3	2	7	2	7	1	1	3	**3.6**
use of legislative markup editors	1	3	1	1	2	1	1	2	3	**1.8**

6.4.2 Analysis of the efficacy

The efficacy of the editor was evaluated asking the users to complete nine binary tasks. These tasks had a time limit and if users did not complete them in time, the task was classified as not completed. Table 6.3 shows the tasks used to evaluate the editor efficacy, their time limit and their code.

Table 6.3: The tasks used to evaluate LIME efficacy

Task	**Task code**	**Time limit (sec)**
Sign up to the system	T1b	180
Log in to the system	T2b	30
Change the editor's language	T3b	30
Import a Microsoft word's file from the user's desktop	T4b	120
Open one of the examples supplied by the editor	T5b	60
Save a file under a different name	T6b	60
Open the XML preview of a file	T7b	60
Save the XML version of a document on the user's desktop	T8b	60
Log out from the system	T9b	30

In table 6.4 and in figure 6.1 the results of the efficacy evaluation are displayed.

Table 6.4: The summary of the tasks completed by users (1 indicates completed tasks, 0 indicates not completed task)

	T1b	**T2b**	**T3b**	**T4b**	**T5b**	**T6b**	**T7b**	**T8b**	**T9b**	**avg**
p1	0	1	1	1	0	1	1	1	1	**78%**
p2	1	1	1	1	0	1	1	1	1	**89%**
p3	1	1	1	1	1	0	1	1	1	**89%**
p4	0	0	1	1	0	1	1	1	1	**67%**
p5	1	1	1	0	1	1	1	1	1	**89%**
p6	1	1	1	1	0	1	1	1	1	**89%**
p7	1	1	1	1	1	1	1	1	1	**100%**
p8	1	1	1	1	0	1	1	0	1	**78%**
9	1	1	1	1	0	0	1	1	1	**78%**
avg	**78%**	**89%**	**100%**	**89%**	**33%**	**78%**	**100%**	**89%**	**100%**	**84%**

The eighty-four percent of the tasks was successfully completed. More than fifty percent of the task was successfully completed by all users.

The only exception was found when the users were asked to open one of the marked-up examples supplied by the editor. The majority of the users were not able to figure out how to do it.

In order to open an example in LIME, users have to click on the file menu and then on the open menu. Examples are stored in a folder called *example* and can be opened like any other file. When I asked the users to open a marked-up example, they seemed puzzled and started to look for the example allover the application, except in the open menu.

Other two tasks were completed only by seventy-eight percent of the users. Some users got confused when they had to sign up to the system and when they had to save the file under a different name. I expected this difficulty because the LIME registration mask is still a prototype and the save functionality needs a certain expertise in FRBR.

Overall, the efficacy evaluation of LIME gave good results. Except for one critical issue and two improvable functionality, I can consider LIME an effective markup editor.

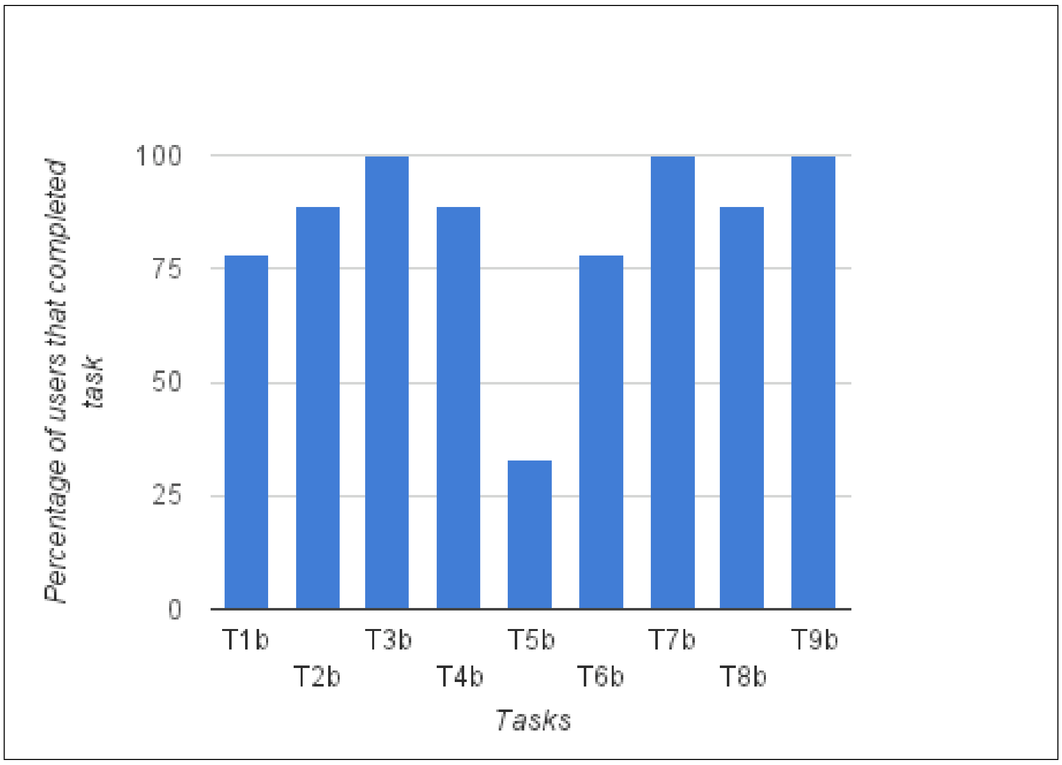


Figure 6.1: The efficacy evaluation by tasks

6.4.3 Analysis of the efficiency

To evaluate the efficiency of LIME I asked the users to complete nineteen tasks. In addition to the tasks described in the previous section, I asked the users to perform ten additional tasks. All tasks were treated as timed task. For this reason, I timed the users and reported the time that it took to complete the tasks. Table 6.5 lists the tasks and their code.

Table 6.5: The tasks used to evaluate the LIME efficiency

Task	**Task code**
Sign up to the system	T1b
Log in to the system	T2b
Change the editor's language	T3b
Import a Microsoft word's file from the user's desktop	T4b
Open one of the examples supplied by the editor	T5b
Save a file under a different name	T6b
Open the XML preview of a file	T7b
Save the XML version of a document on the user's desktop	T8b
Log out from the system	T9b
Markup the preface of a document	T10b
Markup the document's date	T11b
Markup the main body of the document	T12b
Markup an article, its number, and its heading	T13b
Markup a bold text	T14b
Create a table	T15b
Markup a quoted structure	T16b
Find the subsection 2 of the section 3 of a document	T17b
Unmark the preface of a document and all the contained elements	T18b
Save a document as a new expression in the same work	T19b

As said in the previous section, the first nine tasks were considered completed if users respected the time limit. The other tasks did not have a time limit. They were considered completed if users properly finished them independently from the time it took. Tasks were considered not finished if users abandoned them before their completion. Table 6.6 lists the completed and not completed tasks.

Table 6.6: The summary of the tasks performed by users (1 indicates completed tasks, 0 indicates not completed tasks)

	p1	**p2**	**p3**	**p4**	**p5**	**p6**	**p7**	**p8**	**p9**	**avg**
T1b	0	1	1	0	1	1	1	1	1	**78%**
T2b	1	1	1	0	1	1	1	1	1	**89%**
T3b	1	1	1	1	1	1	1	1	1	**100%**
T4b	1	1	1	1	0	1	1	1	1	**89%**
T5b	0	0	1	0	1	0	1	0	0	**33%**
T6b	1	1	0	1	1	1	1	1	0	**78%**
T7b	1	1	1	1	1	1	1	1	1	**100%**
T8b	1	1	1	1	1	1	1	0	1	**89%**
T9b	1	1	1	1	1	1	1	1	1	**100%**
T10b	1	1	1	1	0	1	1	1	1	**89%**
T11b	1	1	1	0	1	1	1	1	1	**89%**
T12b	0	1	1	1	1	1	1	1	1	**89%**
T13b	1	0	1	1	1	0	1	1	1	**78%**
T14b	1	1	1	1	0	1	1	0	1	**78%**
T15b	0	1	1	1	1	1	1	1	1	**89%**
T16b	1	1	1	1	1	0	1	1	0	**78%**
T17b	1	0	1	1	1	1	1	1	1	**89%**
T18b	0	1	1	1	1	1	1	1	1	**89%**
T19b	1	1	1	1	1	1	0	1	0	**78%**

As table 6.7 shows, I took the time each user needed to complete each task and the average time needed by all users.

The average completion time and the task completion rate allow us to measure the efficiency of the editor. The Common Industry Format For Usability Reports specifies that the "core measure of efficiency" is the ratio of the task completion rate to the mean time per task [TA08]. Table 6.8 and figure 6.2 show the efficiency task by task.

Table 6.7: the average time in seconds for completion of tasks (NC indicates the tasks that were not completed)

	p1	**p2**	**p3**	**p4**	**p5**	**p6**	**p7**	**p8**	**p9**	**avg**
T1b	NC	100	87	NC	118	163	65	89	151	**110**
T2b	6	5	12	NC	27	17	11	5	11	**12**
T3b	17	10	8	5	9	15	4	13	4	**10**
T4b	20	14	23	11	NC	12	15	10	16	**15**
T5b	NC	NC	24	NC	48	NC	11	NC	NC	**28**
T6b	13	15	NC	14	17	11	15	14	NC	**14**
T7b	7	8	23	10	15	11	6	16	21	**13**
T8b	12	9	38	6	7	17	8	NC	12	**13**
T9b	6	17	23	22	4	18	15	21	11	**15**
T10b	13	10	14	15	NC	15	12	37	8	**15**
T11b	6	5	33	NC	5	43	13	4	7	**14**
T12b	NC	11	13	13	13	20	16	7	23	**14**
T13b	3	NC	41	19	26	NC	17	20	28	**22**
T14b	10	12	10	5	NC	6	4	NC	50	**14**
T15b	NC	13	10	16	12	13	8	16	16	**13**
T16b	24	12	48	10	18	NC	78	35	NC	**32**
T17b	7	0	11	31	20	11	11	20	17	**14**
T18b	NC	7	30	23	6	10	10	8	19	**14**
T19b	23	17	25	18	15	26	NC	31	NC	**22**

Table 6.8: The evaluation of LIME efficiency

	Task completion rate	**Task time (cs)**	**Efficiency (%)**
T1b	78%	1100	**7**
T2b	89%	120	**74**
T3b	100%	100	**100**
T4b	89%	150	**59**
T5b	33%	280	**11**
T6b	78%	140	**55**
T7b	100%	130	**76**
T8b	89%	130	**68**
T9b	100%	150	**66**
T10b	89%	150	**59**
T11b	89%	140	**63**
T12b	89%	140	**63**
T13b	78%	220	**35**
T14b	78%	140	**55**
T15b	89%	130	**68**
T16b	78%	320	**24**
T17b	89%	140	**63**
T18b	89%	140	**63**
T19b	78%	220	**35**

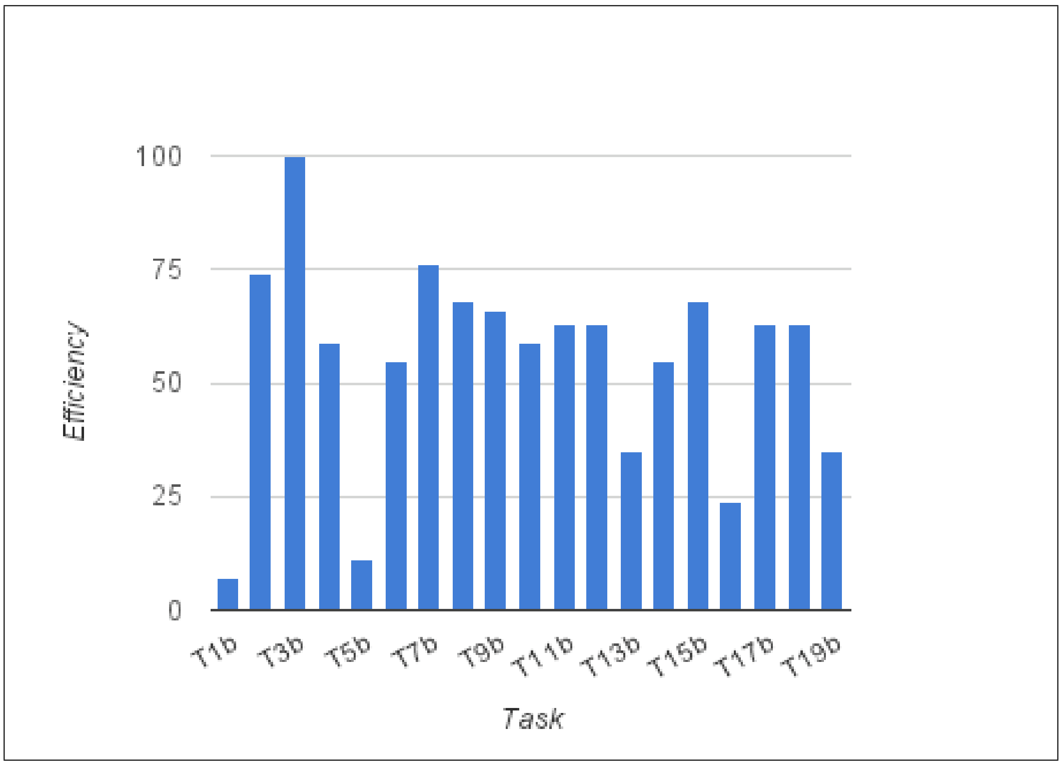


Figure 6.2: The efficiency evaluation by tasks

The evaluation of the LIME efficiency proves that, for the majority of the tasks, LIME is efficient. Only five of the nineteen tasks had an evaluation below fifty percent. The inefficiency (and inefficacy) of two of these tasks (T1b and T5b) was already proved by the LIME efficacy evaluation. This means that the parts of the LIME user interface involved in these tasks must severely be redesigned.

Another task that revealed big issues in usability was the one that involved the user in the creation of a new version (expression) of a document. Like in the efficacy evaluation, users failed again in using the save system of the LIME editor and spent a lot of time to completely save new versions of the document. This is surely related to the complexity of the FRBR notation, but the test proved that this part of the LIME interface must be improved.

The other two tasks that were rated less than fifty percent were the ones that involved the user in the markup of legal elements of documents. I noticed slowdowns when users had to markup an *article* with its *number* and its *heading* and when they had to markup an element called *quoted structure*.

In order to markup an article, its number and its heading, users had to select the text of the article in the document and click the *set article* button on the right. Then they had to select the number of the article and click the button *set num* in the markup toolbar and, again, they had to select the heading of the article and click the button *set heading* in the markup toolbar. The problem in this workflow was that, even if users had no problem marking up the article, they struggled to find the buttons to markup the number and the heading.

In order to markup a quoted structure, users had to select the text that had to be marked up and then they had to click on a toolbar called *common elements*; finally, they had to find and click the button called *set quoted structure*. The common elements' toolbar contains buttons grouped by their thematic area. Users failed to find the button to markup a quoted structure because the majority of them did not know which was the correct thematic area that had to be open and abandoned before they had inspected all the areas.

There are other parts of the interface that must be surely improved, but must not be considered as problematic. These are the ones involved in those tasks that got an efficacy rating barely above fifty-percent.

The test meets my requirements and demonstrates that, overall, LIME is an efficient markup editor specially in the legal context.

6.4.4 Analysis of the users' satisfaction

In order to measure the users' satisfaction, I asked them to foresee the effort needed to complete the nineteen tasks. Then, after they completed each task, I asked them how difficult it had been to complete the task. Table 6.9 lists the average expectation and experience ratings for each task.

Table 6.9: the average expectation rating and the average experience rating

Task	Expectation rating (avg)	Experience rating (avg)
T1b	6.4	3.4
T2b	6.7	6.3
T3b	6.7	6.6
T4b	6.1	3
T5b	6.4	3
T6b	6.6	4.7
T7b	6.3	6.6
T8b	6.8	6.0
T9b	5.2	6.9
T10b	3.2	6.0
T11b	2.7	5.4
T12b	2.8	5.7
T13b	3.3	3.5
T14b	5.7	6.9
T15b	4.7	6.8
T16b	5.4	5.2
T17b	5.8	6.3
T18b	5.4	6.7
T19b	2.7	2.8

After this phase, I inserted the average expectation and average experience ratings in the scatterplot as shown in figure 6.3.

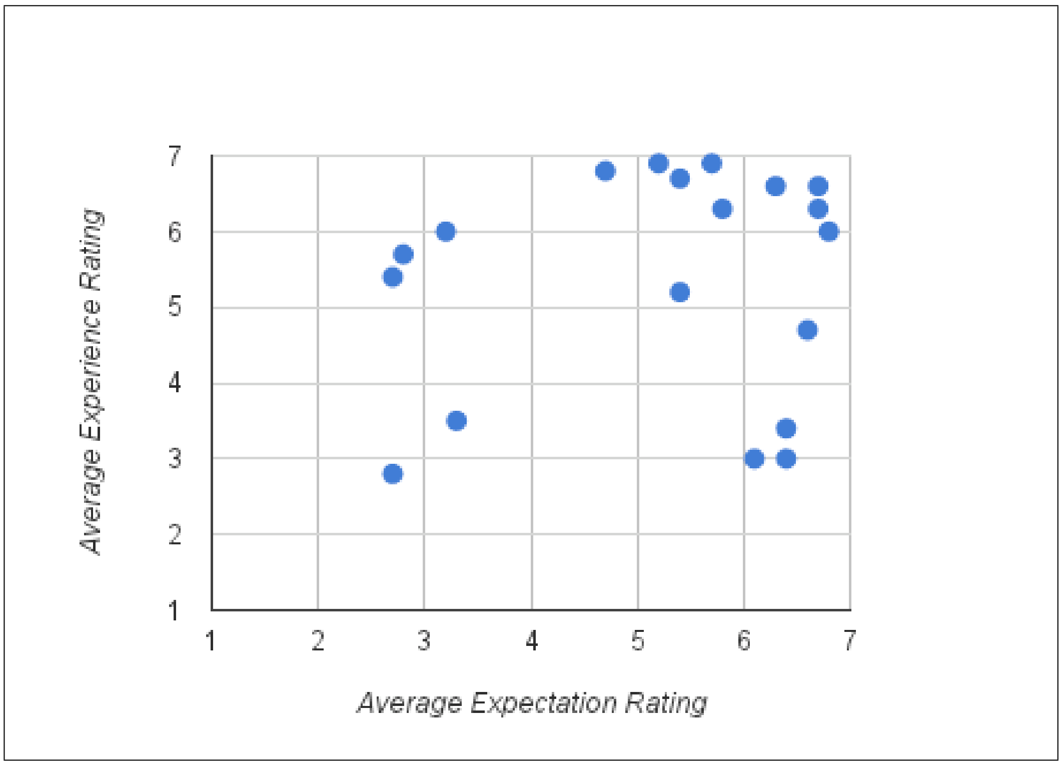


Figure 6.3: Average Expectation and Experience Ratings per Task

The diagram in the figure above must be divided in four sectors in order to be read properly .

In the lower-right sectors, there are the tasks that users thought would be easy but actually turned out to be difficult. These are the problematic tasks already highlighted by the efficacy and efficiency measurements and precisely: the tasks where users were asked to sign up to the system, to open examples and to save documents under a different name. The fact that they are in the lower-right sectors means that they need to be fixed as soon as possible.

In the upper-left sectors there are the tasks that users thought would be difficult and were actually easy. In these tasks users were asked to markup legal parts of documents, such as the preface, the documents data and their main body. This is a very useful data because, even these tasks do not have a very high efficiency score (fifty-nine percent, sixty-three percent and sixty-three percent respectively), the fact that they belong to the upper-left sector of the scatterplot means that they must be promoted and, maybe, improved.

Very difficult tasks to analyze are the ones belonging to the lower-left sector of the diagram. In this sector there are the tasks where users had to markup an article, its number and its heading and the one where users were asked to save documents as new expressions. Users thought that these tasks would be difficult and, indeed, they were so. This data means that there are no big surprises here, although combining this data with the one received in the efficiency evaluation of the same tasks, it is clear that there are many opportunities of improvement.

The last sector is the upper-right one. To this sector belong tasks that users thought would be easy and, indeed, they were. This means that these features of LIME must not be changed and that it is already usable for the completion of those tasks.

Having eleven points in the upper-right sector of the diagram and three points in the upper-left sector, I can conclude that, except for five tasks, users are overall satisfied when they use LIME.

6.5 LIME's strengths and weaknesses

In this chapter I analyzed the LIME usability. Firstly, I described the usability test that I created to evaluate markup editors and then I described the results that I obtained applying it to LIME.

Results demonstrated that LIME is effective and efficient and that users are quite satisfied when they use it. LIME seems to be very usable for markup. Users take advantage of its functionality to quickly mark up the structure of legal documents. Except for some tasks, they feel comfortable with the markup toolbar supplied by the editor. Moreover, they can use easily the interface when they have to navigate through documents and their various views.

However, other tasks, like the save system, frustrated users. This is due both to the particular LIME storage system and to the interface that is probably not simple to understand.

Future versions of LIME will try to fix these issues and to improve the LIME overall usability.

Chapter 7

Conclusions

In this essay I described how to create a parametric editor for structured documents and then I described LIME, a parametric and language independent markup editor.

Currently, there are many software suitable for the creation of structured documents. Some of them are able to markup all XML languages but users need a good knowledge of the XML language they wish to use.These editors are the WYSIWYG editors.

Other editors permit to markup XML documents without a deep knowledge of the XML language, but they are created for only one specific dialect. These are called markup editors and some of these are used in the legal context.

LIME is a mix of these two types of editors. On the one hand, LIME allows users to markup documents through many XML languages and, on the other hand, it drives users to create a correct markup, even if they do not know the XML language.

In order to be independent, LIME relies on parameters. Its architecture is completely based on JSON configuration files and, by creating packages of these files, called language plugins, it is possible to allow LIME users to markup documents through any XML language. Currently LIME supports three XML languages, Akoma Ntoso (in its 2.0 and 3.0 versions), TEI, and legal RuleML. Even if this demonstrates that the requirement of independence was met, LIME could be improved in many ways. For example, two of the most requested features are the possibility not to use the FRBR storage system and the independence of the LIME core from its interface.

The FRBR storage is one of the mandatory LIME requirements because, for example, parliaments' legal drafters want both to markup documents and to easily catalog resources. This is true, but it is also true that, creating a LIME API would enable the creation of plugins. In this way, LIME should continue to use the FRBR storage system but plugins can be created with the purpose to override the LIME default storage system and supply storage system more suitable for other specific contexts.

The independence of the LIME core from its interface is not a trivial task, but it can be achieved because LIME relies on the Model View Controller architectural style. For this reason, it is possible to detach LIME from its interface and to supply a LIME core framework that others can use with their own interface.

However, the current LIME interface is specifically designed to meet the second requirement of a markup editor. A markup editor must drive users to correctly markup XML documents.

To evaluate the LIME interface I designed an usability test for markup editors and applied it to LIME. The test inspected the efficacy and the efficiency of LIME and the satisfaction of users when they were using it.

The test highlighted that for the majority of the tasks LIME is usable. Even if users have no experience in Akoma Ntoso, they were able to markup documents using many of the elements that the standard supplies. This proves that the LIME interface actually guides users through a markup process that results in a complete and, if needed, valid XML document. The usability test also pointed out some LIME weaknesses. Not all users were able to use properly the save functionality and some of them failed to figure out how to markup some elements specifically related to the legal context.

The problems of the storage system, as said before, can technically be solved by enabling plugins. But this would not fix the usability issues related to the interface's parts that allow users to save documents by taking advantage of FRBR notation. It would be ideal if LIME users could properly use the storage system even they are not skilled in FRBR. This can be achieved by improving the save functions' parts of the interface and by making them, in some way, more easily learnable. By doing so, users would spend few minutes to learn the usage of the interface, but then they could take advantage of it. In order to understand how to create a learnable interface, I will organize other hackatons and comparative usability tests in which I will ask users to exploit different interfaces to complete the same task.

Usability issues related to the difficulty of marking up specific legal elements can probably be fixed by observing large sets of legal experts during the markup workflow. Next usability tests can be divided in usability tests with legal drafting experts and usability tests without them. In this way, I will be able to understand what are the issues strictly related to the legal context.

The hackaton during which I proposed the usability test was also the first time in which LIME was massively used. This highlighted many bugs: indeed, over thirty bugs were reported by users. This was expected because the software is in its alpha version but, of course, I cataloged each bug and rated it in a severity scale and scheduled their fix.

Several parliaments and many political and apolitical institutions are currently waiting the first official LIME release to markup their legal and legislative documents. Also some history scholars are waiting a first stable version of LIME to markup ancient manuscripts' descriptions and transcriptions. In the future, I will create language plugins for many common XML languages and I hope that LIME will be used by business and common people to markup all kind of XML documents.

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Special thanks

I apologize to those who do not speak Italian. But what I have to say here must be said in my mother tongue. Anyway, thanks for reading this essay and if you fell in love with me while reading you can give me a call at +39 3482627545.

Tutto cominciò con un *commodore 16*. Ma che bella invenzione! Passavo ore a giocare con quell'artefatto. Io, lui, mio fratello *Angelo* e *scimmia magica* formavamo un quartetto perfetto. Poi arrivarono l'*Amiga 500*, *super frog* e *sensible soccer*. Spettacolo! Ma con l'Amiga non c'erano solo i giochi, c'erano anche *QBasic* e *l'enciclopedia del computer*. Diamine, quei cosi rettangolari non servivano solo per giocare. Si potevano programmare! Ringrazierò per sempre i *miei genitori* per avermeli comperati.

Frequentai le scuole medie e le superiori, arrivò la *playstation* e il mio *486*. Conobbi un losco figuro col *nome francese*, il *fratello di un'amica di famigla* e suo *padre* che mi insegnarono a fare il *vino* (e a berlo), e con alcuni *cugini* e *cugine* imparai che le feste non erano poi così male. E intanto gli anni delle superiori passavano, ero curioso e sperimentavo tutto. Anche le cose più pericolose. Tipo perdere un anno di scuola.

E arrivò la *dreamcast* e la prima connessione *internet*. E arrivò la prima *chat* con una tizia che mi disse: "faccio la *webmaster* a Londra e mi pagano molto bene". La webmaster! Porca paletta, c'è gente che si guadagna da vivere con questa roba. Quel piccolo paesino che tanto mi aveva dato, non poteva insegnarmi a diventare uno scienziato dei computer. Dovevo andare via.

E *Bologna* fu! Bologna, Bologna, Bologna, quanti bei giorni che mi hai regalato! A cominciare da quella prima casa al *Lunetta Gamberini*, con le sue partite di calcio in corridoio, il mio *compagno di stanza* e la *luce rossa* e la *ciabatta*, il *biondo* e la *500* e sempre la *luce rossa* mentre dormiva. E quelle amiche delle *Marche*, e una in particolare, con le *birre* il *venerdì* e far mattina al *sabato*.

E dopo un po' è arrivata anche la laurea triennale. E con essa il lavoro all'università e quei *docenti* che mi hanno insegnato a fare lo *scienziato* anche quando scienziato (certificato) non ero. E sono arrivati quei colleghi e amici che mi hanno ricordato che in fondo se sei *nerd* non conta se fai il *dottorato in Olanda* o la *popstar*. Nerd si nasce. Ed io lo nacqui! Come anche mio *fratello* che mi ha regalato una *giappognata* e un *nippotino* ma sempre nerd rimane.

E intanto è arrivata *un'amica toscana*, la *Toscana*, *l'olio d'oliva* e i *lavoretti in campagna*. Ed è arrivata *Arianna*. É anche grazie a lei se questa dissertazione è scritta in un inglese (spero) perfetto. Mi ha insegnato tanto e non solo della lingua inglese.

Per ora la fine è questa. Ma si sa, *un punto fa morale*, e sono abbastanza sicuro che la storia continuerà. Ma intanto cos'altro potrei dirvi per ringraziarvi tutti di cuore?

"I'm not crazy, my mother had me tested!"

Sheldon Cooper