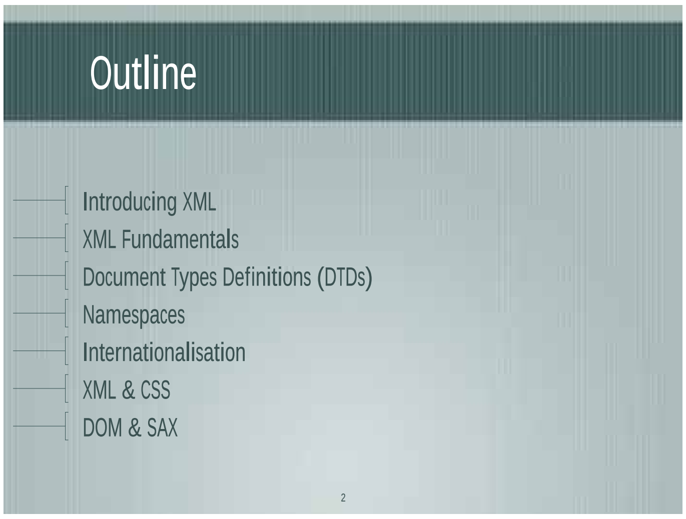
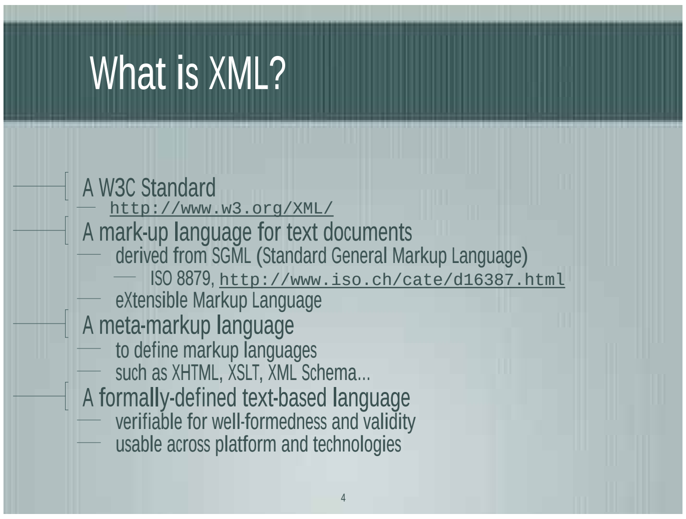
XML Concepts

Prof. **Andrea Omicini**
DEIS, Ingegneria Due
Alma Mater Studiorum, Università di Bologna a Cesena
andrea.omicini@unibo.it



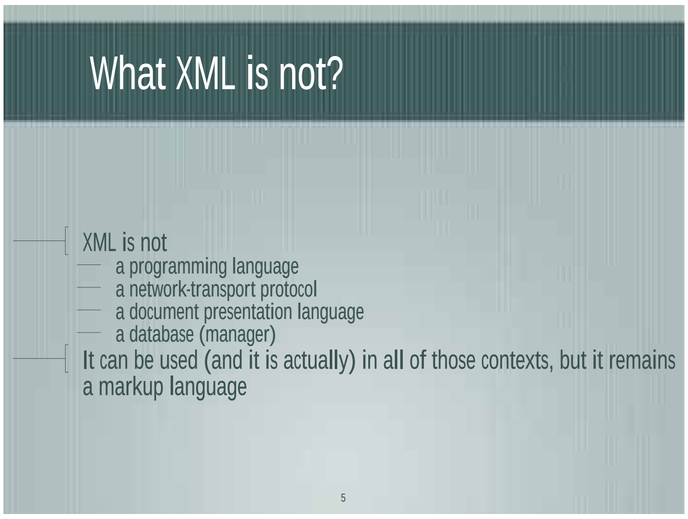
Outline

Introducing XML



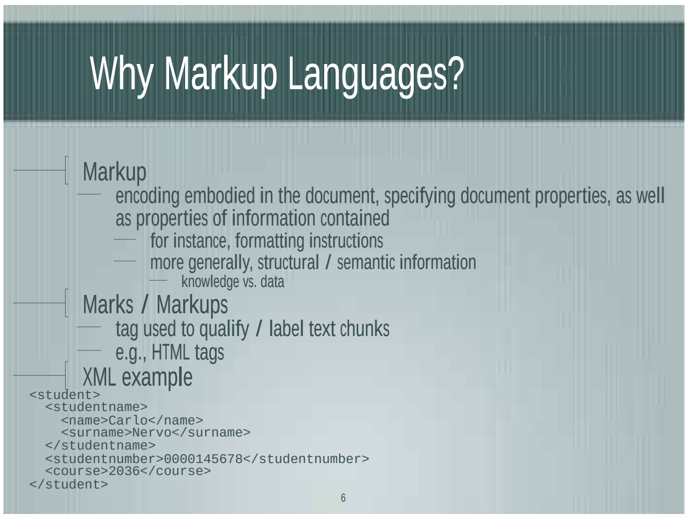
What is XML?

- A W3C Standard
  - http://www.w3.org/XML/
- A mark-up language for text documents
  - derived from SGML (Standard General Markup Language)
    - ISO 8879, http://www.iso.ch/cate/d16387.html
  - eXtensible Markup Language
- A meta-markup language
  - to define markup languages
  - such as XHTML, XSLT, XML Schema...
- A formally-defined text-based language
  - verifiable for well-formedness and validity
  - usable across platform and technologies



What XML is not?

- XML is not
  - a programming language
  - a network-transport protocol
  - a document presentation language
  - a database (manager)
- It can be used (and it is actually) in all of those contexts, but it remains a markup language



Why Markup Languages?

- Markup
  - encoding embodied in the document, specifying document properties, as well as properties of information contained
    - for instance, formatting instructions
    - more generally, structural / semantic information
      - knowledge vs. data
- Marks / Markups
  - tag used to qualify / label text chunks
  - e.g., HTML tags
- XML example

```
<student>
  <studentname>
    <name>Carlo</name>
    <surname>Nervo</surname>
  </studentname>
  <studentnumber>0000145678</studentnumber>
  <course>2036</course>
</student>
```

XML: X for eXtensibility

- Basic idea of XML
  - a simple meta-language for humans and automata
  - to build electronic documents
  - allowing users to define ad hoc markup languages
- Then,
  - XML is quite free, in general
  - it can be “extended"
    - actually, specialised
  - to define more specific ad hoc markup languages
- No predefined XML markups, as it happens instead in HTML
  - they need to be defined
    - who does define them?
      - can we do this? how?

Hey, too many Languages already!!

- Application domains are more and more
  - numerous
  - complex
  - specific
- Special / specialised languages as the engineer's tools
  - to represent, denote & express behaviours and computations
- Engineers working with computational / ICT systems will be called to use a number of different artificial languages, but also
  - to know and understand computational models and paradigms
  - to select languages and paradigms
  - to define and build new languages
- Laurea Magistralis ICT
  - “Linguaggi e modelli computazionali”, “Ingegneria del SW”

XML: Applications

- XML per se is “small” & simple
  - languages defined via XML are instead so many and complex
- XML Applications
  - XML-defined markup languages
    - defined through a precise syntax
      - DTD or XML Schema
  - they may be either standard or custom
- Most standard XML applications are W3C
  - such as
    - XSLT
    - XML Schema
    - XHTML

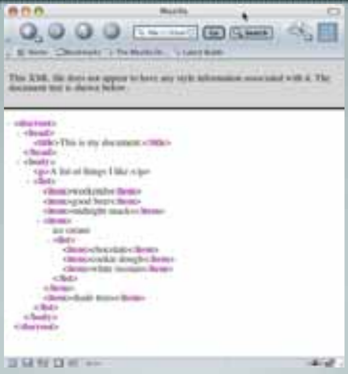
XML for Portable Data

- Cross-platform, long-term data format
  - passing XML data through space and time
  - along with Unicode and text-base standard format
- Text, text, text
  - both data and markup
  - all in the XML file
- XML document structure simple & clear
  - easy to parse
  - well-documented
- That is why XML is already everwhere

How XML Looks like

```
<?xml version="1.0" encoding="utf-8"?>

<docroot>

  <head>
    <title>This is my document.</title>
  </head>

  <body>

    <p>A list of things I like.</p>

  <list>
    <item>weekends</item>
    <item>good beer</item>
    <item>midnight snacks</item>
    <item>ice cream
    <list>
      <item>chocolate</item>
    <item>cookie dough</item>
    <item>white russian</item>
    </list>
    </item>
    <item>shade trees</item>
  </list>

  </body>
</docroot>
```

How XML Looks like from a Browser



This XML file does not appear to have any style information associated with it. The document tree is shown below.

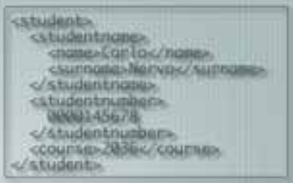
```
- <docroot>
  - <head>
      <title>This is my document.</title>
    </head>
  - <body>
      <p>A list of things I like.</p>
    - <list>
        <item>weekends</item>
        <item>good beer</item>
        <item>midnight snacks</item>
      - <item>
          ice cream
        - <list>
            <item>chocolate</item>
            <item>cookie dough</item>
            <item>white russian</item>
          </list>
        </item>
        <item>shade trees</item>
      </list>
    </body>
  </docroot>
```

How to Work with XML

- XML is text
  - so any text-editor is perfectly fine
- A number of XML editors around
  - but typically, general text editors with some programming / Web-oriented capabilities are good enough, and often even better
- Visualisation is a different matter
  - browsers do something
    - but XML is not a presentation language, so...
  - we need to understand
    - what an XML document is
    - how XML works

What is an XML Document?

- It can be
  - A text file
  - A record in a database
  - A run-time construction in memory
  - ...
- In any case, it can be handled and trasmitted by any system capable of dealing with text documents



```
<student>
  <studentname>
    <name>Carlo</name>
    <surname>Nervo</surname>
  </studentname>
  <studentnumber>
    0000145678
  </studentnumber>
  <course>2036</course>
</student>
```

How does XML Work?

- Who handles XML documents?
  - after it has been produced
  - how / why?
- XML parsers
  - devising out the structure of the XML document
  - verifying well-formedness and basic respect of XML syntax
- XML validating parsers
  - when applicable
    - there is either a DTD or a Schema
  - checking validity
- Examples
  - web brorsers, word processors, database servers, drawing programs, spreadsheets, programs in some language, etc.

Where is XML actually used?

- Everywhere already.

Some History of XML & Related

- Lot to be written, still...
- SGML is where it comes from
  - HTML was the first successful application of SGML
    - but had obvious limitations
  - too complex
    - more than 150 pages
    - never implemented fully
  - too complex for the Internet
- SGML "Lite" (1996, Bosak, Bray et al.)
  - XML 1.0 (February 1998)
- Then, a flow
  - namespaces, XSL (then XSLT + XSL-FO), XHTML, CSS integration, XLink + XPointer, XML Schema, DOM, etc.

XML Fundamentals

A Simple XML Document

```
<player>
    Carlo Nervo
</player>
```

XML Document & Files

```
<player>
    Carlo Nervo
</player>
```

- This is a complete XML *document*
- It can be stored / recorded / built in the form of a number of different files or even in other forms
  - Carlonervo.xml, player.txt
  - a record in a database
  - a memory area built by a CGI, and then transmitted
  - sent by a Web server, with MIME type application/xml or text/xml

XML Elements & Tags

```
<player>
    Carlo Nervo
</player>
```

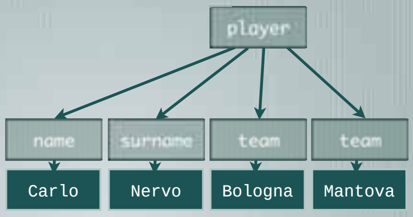
- The document contains a single **element**
  - of type `player`
- Such an element is delimited by the **tag** `player`
  - between **start tag** `<player>` and **end tag** `</player>`
- In between the tags lays the element's **content** `Carlo Nervo`
  - tags are *markup*
    - the most common form of markup, but there are other kinds
  - content is *character data*
    - including the white space between `Carlo` & `Nervo`

Tag Syntax

- Very similar to HTML tags
  - at least superficially
  - `<tag>` for start tags, `</tag>` for end tags
  - `<tag />` for empty tags
    - tags with no content, like `<br />` or `<hr />`
- XML is case sensitive
  - so, `<player>` can not be closed by end tag `</Player>`
  - NOTE: thus, pay attention to non-case sensitive technologies when combined with XML
    - HTML, JavaScript & XHTML, ...

XML Trees: A Simple Example

```
<player>
    <name>Carlo</name>
    <surname>Nervo</surname>
    <team current="yes">Bologna</team>
    <team current="no">Mantova</team>
</player>
```



An XML Document is an XML Tree

```
<player>
    <name>Carlo</name>
    <surname>Nervo</surname>
    <team current="yes">Bologna</team>
    <team current="no">Mantova</team>
</player>
```

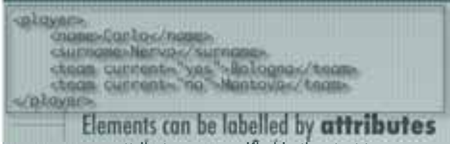
- An XML Document has a tree-like structure
  - one and only one **root**
    - *root element* or *document element*
  - each *node* element can have one or more *child elements*
    - each element has at least one *parent*
    - child elements from the same parent are *siblings*
    - leaves are either content or empty elements
- Well-formedness stems from here
  - `<em><b>Wrong </em> XML</b>` is not permitted
    - nesting need to be perfect, overlapping not allowed

Narrative-Organised XML

```
<biography>
<name><first_name>Carlo</first_name> <last_name>Nervo</last_name></name> was born
somewhere and did nothing really meaningful before becoming a football player.

After playing many years in minor teams, such as <football_team>Mantova</
football_team>, he finally moved to <football_team>Bologna</football_team>, where
he exploded to become one of the most respected leaders of the team, and also a
member of the <football_team>Italian National Team</football_team>.

…

</biography>
```

- XML Documents for written narrative, such as articles, reports, blogs, books, novels
  - elements with *mixed content*
  - not easy for automated processing and exchange

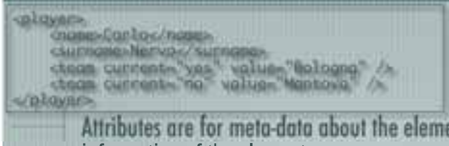
XML Attributes



```
<player>
    <name>Carlo</name>
    <surname>Nervo</surname>
    <team current="yes">Bologna</team>
    <team current="no">Mantova</team>
</player>
```

- Elements can be labelled by **attributes**
  - attributes are specified in the start tag
    - and in the only tag of empty elements
  - any number of attributes can be in principle associated to an element
- An attribute is a name-value pair of the form `name="value"`
  - alternative forms use single quotes instead of double quotes and spaces before / after the "equals" (=) sign
  - only one attribute with a given name allowed per element
- Attributes do not change the tree structures of an XML document
  - but they are qualifiers for the nodes and leaves of the tree

Using Elements or Attributes?



```
<player>
    <name>Carlo</name>
    <surname>Nervo</surname>
    <team current="yes" value="Bologna" />
    <team current="no" value="Mantova" />
</player>
```

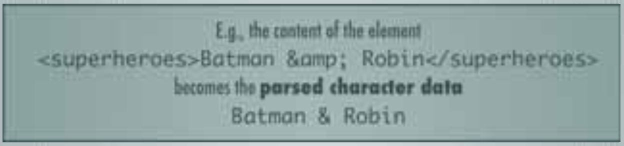
- Attributes are for meta-data about the element, and content is information of the element
  - maybe, but then it is not easy to clearly distinguish between the two
- Element-based structure is more flexible than attribute-based
  - attributes provide for a flat data structure / elements can be nested as needed
  - attributes are unique within an element / any number of elements of the same type can be used within an element
- Attributes are quite useful in narrative-based XML documents
  - where the distinction between elements and attributes is even more blurred
- The answer depends on how data will be accessed and manipulated

XML Names

- XML **Names** are used and are the same for the *names* of *elements*, *attributes* and some other constructs
  - to increase efficiency and abate complexity
- An XML name can include
  - any letter
    - latin or even non-latin, like ideographs
  - any digit
  - underscore, hyphen and period (_, -, .)
  - a colon (:) is reserved to namespaces
- An XML name may not include other punctuation signs, nor any sort of white spaces
  - and can begin only with letters, ideographs or underscore

Parsed Character Data

- An XML Parser interprets the character sequences it is fed with, trying to devise out its tree-like structure
  - so, for instance, '<' always taken as the beginning of a tag
  - what if we need a '<' character in the document, as in a JavaScript code?
- All characters are interpreted as character data to be parsed
  - unless an escape character '&' is encountered
  - character data to parse start again after char ';'

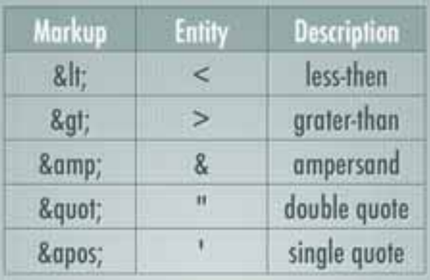


E.g., the content of the element
`<superheroes>Batman &amp; Robin</superheroes>`
becomes the **parsed character data**
`Batman & Robin`

Entity References

- `&entityreference;`
  - an *entity* is something defined outside the normal "flow" of the XML document
    - out of the XML tree
  - used for constants, common values, external values, etc.
    - through an *entity reference*
- Users of any sort may define their own entities
  - we'll see how soon, for instance through DTDs

Pre-defined XML Entities (Pre-defined Entity References)



Markup	Entity	Description
&lt;	<	less-then
&gt;	>	grater-than
&amp;	&	ampersand
&quot;	"	double quote
&apos;	'	single quote

CDATA Sections

- Including code chunks from any language with < or " can be tedious
  - we need to say the parser "do not parse this"
  - good for instance to include segments of XML code to show
- CDATA Section
  - between `<![CDATA[` and `]]>`
  - can contain anything but its own delimiters
- After parsing, no way to tell where a text came from, a CDATA section or not

Comments

- Easy!

```
<!-- Comment -->
```

- It cannot contain `--`, nor it can end with `--->`
- Comments do not affect the document tree-structure
  - they can appear anywhere, even before the root element
  - but not inside a tag or a comment
- Parsers may either drop or keep them at their will
- Comments are meant to improve *human legibility* of XML docs
  - to give info to a computational agents, *processing instructions*

XML Processing Instructions

- Need to pass information for a given application through the parser
  - comments may disappear at any stage of the process
- **Processing instructions** have this very end
  - `<?target … ?>`
- The `target` may be the application that has to handle, or just an identifier for the particular processing instruction
  - `<?php … ?>`
  - `<?xml-stylesheet … ?>`
- A processing instruction is markup, not an element
  - it can appear everywhere out of a tag, even before or after the root

The XML Declaration

- Looks like an XML processing instruction
  - but it is not: just the XML declaration
- It is optional
  - but if there, should be the first thing in the document, absolutely
    - not even comments allowed before

```
<?xml version="1.0" encoding="utf-8" standalone="no"?>
```

- Version is the XML version (1.0, 1.1, ...)
- Encoding is the form of the text (Unicode in the example)
  - optional, default Unicode
- Standalone means that it has no external DTD
  - optional, default "no"

Checking Well-Formedness

- Main rules
  - perfect match between start and end tags
  - no overlapping elements
  - one and only one root elements
  - attribute values are always quoted
  - at most one attribute with a given name per element
  - neither comments nor processing instructions within tags
  - no unescaped > or & signs in the character data of elements or attributes
  - ...
- Tools on the Web
  - Just look around

DTD

Flexibility or Rigidity?

- XML is flexible
  - whatever this means
  - but sometimes flexibility is not a feature within a given application scenario
- Sometimes, some strict rule is required
  - some control over syntax should be enforced
    - like, a football player should have at least one team
- **Document Type Definition** (DTD)
  - to define which XML documents are *valid*
- Validity is not mandatory as well-formedness
  - how to handle errors is optional

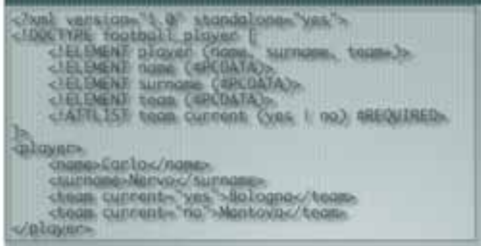
Validation

- A **valid XML Document** includes a DTD the document satisfies
- Main principle
  - everything not permitted is forbitten
    - that is, DTDs specifies *positive* examples
- Everything in the XML document must match a DTD *declaration*
  - then, the document is *valid*
  - otherwise, the document is *invalid*
- Many things a DTD does not say
  - we stick with what we can specify

DTD is...

- SGML-based
  - syntax a bit awkward
  - but after all easy to understand
  - and quite suited for short and expressive descriptions
- It allows XML designers to define a *grammar* for their documents
  - typical syntax-based approach
    - maybe limited, but easy to implement
- Maybe, DTD is not the future of XML document validation
  - XML Schema should be that
  - but understanding DTDs, how to modify them, how to write your own ones, is likely to be useful or maybe necessary for a while, still

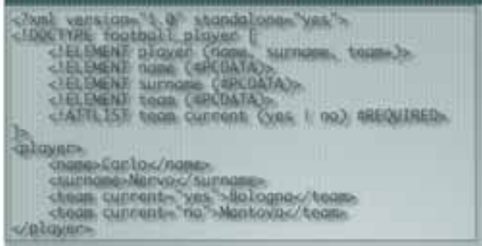
A Simple DTD Example



```
<?xml version="1.0" standalone="yes"?>
<!DOCTYPE football_player [
    <!ELEMENT player (name, surname, team+)>
    <!ELEMENT name (#PCDATA)>
    <!ELEMENT surname (#PCDATA)>
    <!ELEMENT team (#PCDATA)>
    <!ATTLIST team current (yes | no) #REQUIRED>
]>
<player>
    <name>Carlo</name>
    <surname>Nervo</surname>
    <team current="yes">Bologna</team>
    <team current="no">Mantova</team>
</player>
```

- We do not go too deep into DTD syntax
  - we just look at the example above, and comment

DTD Declaration



```
<?xml version="1.0" standalone="yes"?>
<!DOCTYPE football_player [
    <!ELEMENT player (name, surname, team+)>
    <!ELEMENT name (#PCDATA)>
    <!ELEMENT surname (#PCDATA)>
    <!ELEMENT team (#PCDATA)>
    <!ATTLIST team current (yes | no) #REQUIRED>
]>
<player>
    <name>Carlo</name>
    <surname>Nervo</surname>
    <team current="yes">Bologna</team>
    <team current="no">Mantova</team>
</player>
```

- DTD is declared here as internal
  - but could be declared separately

`<!DOCTYPE football_player SYSTEM "football_player.dtd">`

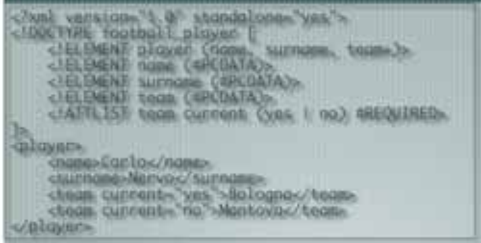
  - even referring to an external / shared resource

`<!DOCTYPE football_player SYSTEM "http://…">`

DTD Declarations: Define or Use?

- So, you may
  - define your own DTD, and
    - either include it in your XML document
    - or save it as an independent document, and refer from one or more XML docs
  - or use an external DTD defined by someone else
    - like, a working group you belong to, or a standardisation body of any sort
    - by referring to that externally-defined syntax for your XML docs

Element Declarations



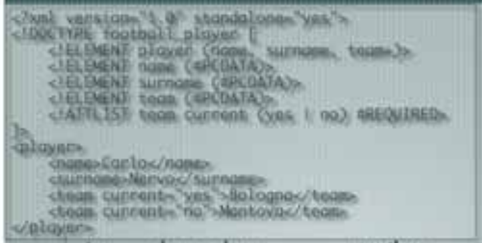
```
<?xml version="1.0" standalone="yes">
<!DOCTYPE football player [
    <!ELEMENT player (name, surname, team+)>
    <!ELEMENT name (#PCDATA)>
    <!ELEMENT surname (#PCDATA)>
    <!ELEMENT team (#PCDATA)>
    <!ATTLIST team current (yes | no) #REQUIRED>
]>
<player>
    <name>Carlo</name>
    <surname>Nervo</surname>
    <team current="yes">Bologna</team>
    <team current="no">Mantova</team>
</player>
```

- A `player` element contain one `name`, one `surname` and one or more `team`S
  - in that precise order
  - and they are just parsed character data (#PCDATA)

Some Syntax for Element Declarations

- "," is for sequence
  - to define ordered lists
- " | " is for choice
  - to provide for alternatives
- suffixes
  - "*" for zero or more occurrences
  - "+" for one or more occurrences
  - "?" for zero or one occurrence
- parenthesis for grouping
  - at any level of indentation
  - operators and suffixes applicable to any level

Attribute Declarations



```
<?xml version="1.0" standalone="yes">
<!DOCTYPE football player [
    <!ELEMENT player (name, surname, team+)>
    <!ELEMENT name (#PCDATA)>
    <!ELEMENT surname (#PCDATA)>
    <!ELEMENT team (#PCDATA)>
    <!ATTLIST team current (yes | no) #REQUIRED>
]>
<player>
    <name>Carlo</name>
    <surname>Nervo</surname>
    <team current="yes">Bologna</team>
    <team current="no">Mantova</team>
</player>
```

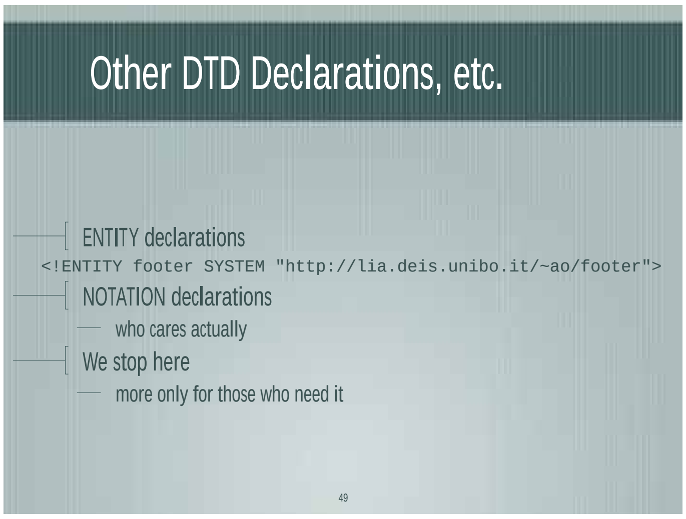
- A `team` element has a `current` attribute
  - which is mandatory
    - `#IMPLIED` would say optional, instead
  - and can be either `yes` or `no`
    - enumeration as an attribute type

Attribute Types

- `CDATA`
  - any string of text acceptable in a well-formed XML attribute value
- `NMTOKEN, NMTOKENS`
  - more than an XML name: anything accepted as the first character
  - the plural form accepts more than one separated by whitespaces
- `ENTITY, ENTITIES`
  - name(s) of unparsed entities declared elsewhere in the document
- `ID`
  - an XML name unique in the document, working as an identifier
- `IDREF, IDREFS`
  - reference(s) to IDs in the documents
- `NOTATION`
  - name of a notation used & defined in the document (rare!!)
- enumeration
  - `(value1 | … | valueN)`

Attribute Defaults

- `#IMPLIED`
  - the attribute is optional
- `#REQUIRED`
  - the attribute is mandatory
- `#FIXED`
  - either it is explicitly specified or not, it has a given value
- `"literal"`
  - the default value is the "literal" quoted string

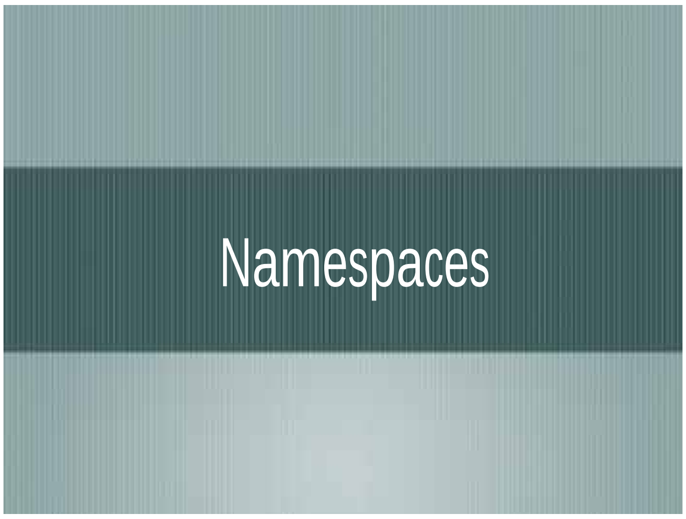


Other DTD Declarations, etc.

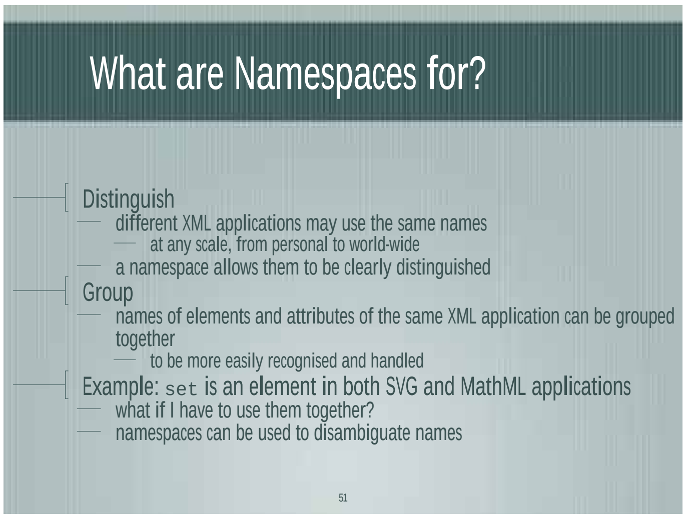
- ENTITY declarations

```
<!ENTITY footer SYSTEM "http://lia.deis.unibo.it/~ao/footer">
```

- NOTATION declarations
  - who cares actually
- We stop here
  - more only for those who need it

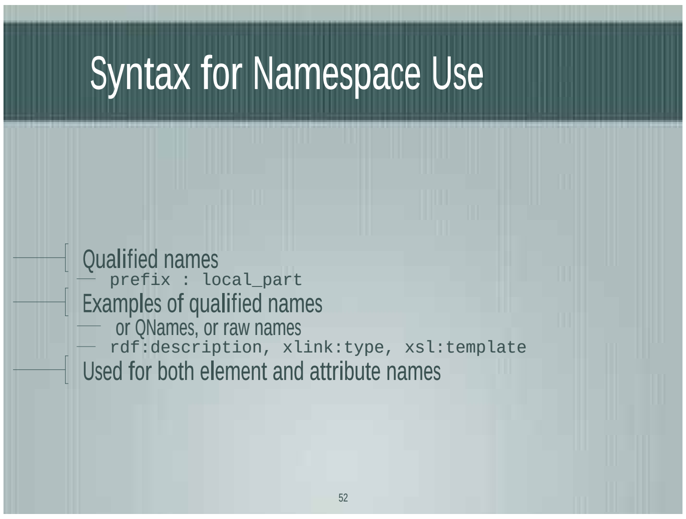


Namespaces



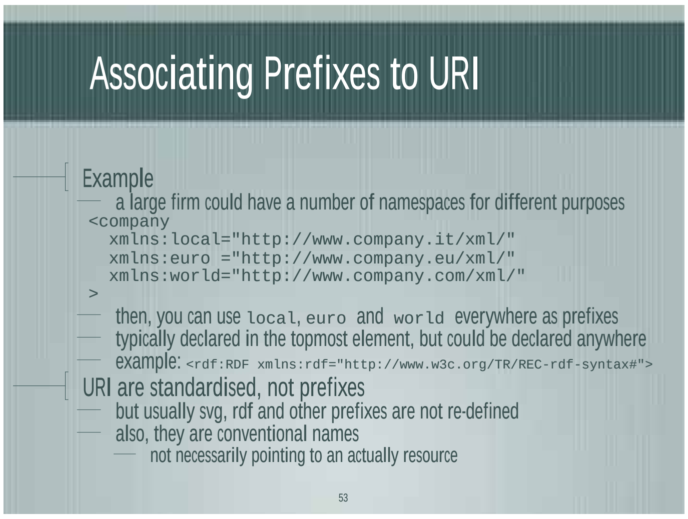
What are Namespaces for?

- Distinguish
  - different XML applications may use the same names
    - at any scale, from personal to world-wide
  - a namespace allows them to be clearly distinguished
- Group
  - names of elements and attributes of the same XML application can be grouped together
    - to be more easily recognised and handled
- Example: `set` is an element in both SVG and MathML applications
  - what if I have to use them together?
  - namespaces can be used to disambiguate names



Syntax for Namespace Use

- Qualified names
  - `prefix : local_part`
- Examples of qualified names
  - or QNames, or raw names
  - `rdf:description, xlink:type, xsl:template`
- Used for both element and attribute names

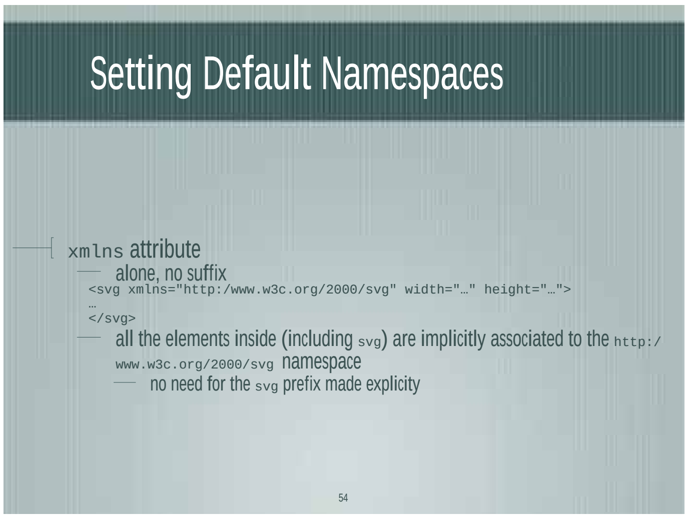


Associating Prefixes to URI

- Example
  - a large firm could have a number of namespaces for different purposes

```
<company
   xmlns:local="http://www.company.it/xml/"
   xmlns:euro ="http://www.company.eu/xml/"
   xmlns:world="http://www.company.com/xml/"
>
```

  - then, you can use `local`, `euro` and `world` everywhere as prefixes
  - typically declared in the topmost element, but could be declared anywhere
  - example: `<rdf:RDF xmlns:rdf="http://www.w3c.org/TR/REC-rdf-syntax#">`
- URI are standardised, not prefixes
  - but usually svg, rdf and other prefixes are not re-defined
  - also, they are conventional names
    - not necessarily pointing to an actually resource



Setting Default Namespaces

- `xmlns` attribute
  - alone, no suffix

```
<svg xmlns="http:/www.w3c.org/2000/svg" width="…" height="…">
…
</svg>
```

  - all the elements inside (including `svg`) are implicitly associated to the `http:/www.w3c.org/2000/svg` namespace
    - no need for the `svg` prefix made explicity

Internationalisation

What does Text Mean?

- "Text" can be encoded according so many different alphabets
  - mapping between characters and integers (*code points*)
    - *character set*
  - ASCII being the most (un)famous, now Unicode
- A *character encoding* determines how code points are mapped onto bytes
  - so, a character set can have multiple encodings
    - UTF-8 and UTF-16 are both Unicode encodings
- Any XML document is a text document
  - so, encoding should be declared

The XML Encoding Declaration

- Part of the XML Declaration
  `<?xml version="1.0" encoding="utf-8" standalone="no"?>`
- Most common values
  - `utf-8`, `utf-16` (Unicode)
  - `ISO-8859-1` (Latin-1)
- See also: XML-Defined Character Sets
  - Unicode and ISO are the most used families
- Used also for external parsed entities
  - like DTD fragments, or XML chunks
  - which may have different encodings
  - there, `version` may be dropped
    - it is a *text declaration*, but no longer a XML declaration

Multi-Lingual Documents

- Example: a spell-checker, or a voice-reader parsing an XML doc
- How to determine the language of a subpart?
  - for multi-lingual docs
- `xml:lang` attribute
  - can be associated to any element
  - determines the language of the element
- Values are to be found in ISO 639
  - standard: two letters for each language known
  - if not there, IANA
    - prefix `i-`
      - such as `i-navajo`, `i-klingon`, ...
  - if not there, too, such as for user-defined tags
    - prefix `x-`
      - such as `x-quenya`

Encoding for Portability

- Working around encoding is not simply an "internationalisation" issue
  - it is also about portability
- When transmitting / communicating through text-based files, many errors typically occur
  - which are often not easy to catch
- XML abilities to
  - handle encoding precisely and accurately
  - embody encoding information within each document
- make it a powerful tool for easy and hassle-free portability
  - across platforms, across applications, across time

XML & CSS

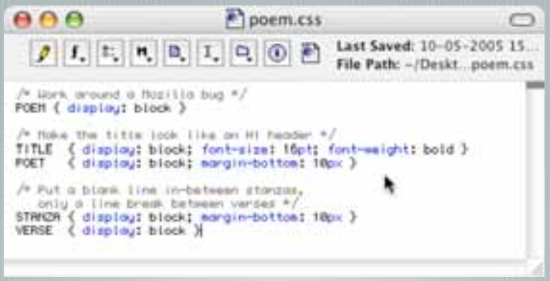
XML on Browsers

- Different experiences with different browsers
  - when trying to visualise an XML document
- XML however can be *transformed*
  - to become easier to handle by standard browsers
- Two main approaches
  - Web-based one: XML + CSS
  - XML-based one: XSL
- In the following we explore the XML + CSS issue

Cascading Style Sheets

- Cascading Style Sheets (CSS)
  - a simple mechanism for adding style (e.g. fonts, colors, spacing) to Web documents
- Standard W3C
  - http://w3c.org/Style/CSS
- Goals
  - describing how to present elements of a document
    - spanning over a range of different media
  - separating style description from content and structure
- In this course we assume that you already know the basics
  - if not, look at http://www.w3.org/Style/CSS/learning

CSS: An Example



```
/* Work around a Mozilla bug */
POEM { display: block }

/* Make the title look like an H1 header */
TITLE  { display: block; font-size: 16pt; font-weight: bold }
POET   { display: block; margin-bottom: 10px }

/* Put a blank line in-between stanzas,
   only a line break between verses */
STANZA { display: block; margin-bottom: 10px }
VERSE  { display: block }
```

XML + CSS

- Any XML documents can be prepared for browser visualisation via CSS
- Two things needed
  - a CSS style sheet referring to the proper elements types of the XML document
  - the association between the XML document and the CSS style sheet
- Processing directive
  - to associate CSS to XML

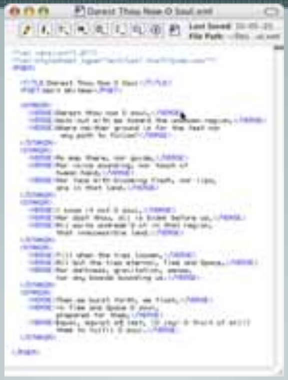
```
<?xml-stylesheet type="text/css" href="nomefile.css" ?>
```

- CSS style sheet defining presentation style for the XML document tags

```
nometag {
  attributo1 : valore1;
  …
}
```

- No need for DTD or Schema
  - even though the browser could anyway complain...

XML + CSS Example: The XML Doc

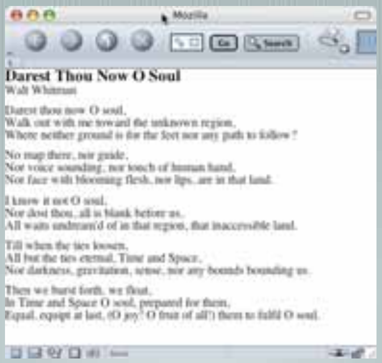


[illegible]

Example: How Mozilla Visualises it [without CSS Style Sheet]

[illegible]

Example: How Mozilla Visualises it [with CSS Style Sheet]



Darest Thou Now O Soul
Walt Whitman

Darest thou now O soul,
Walk out with me toward the unknown region,
Where neither ground is for the feet nor any path to follow?

No map there, nor guide,
Nor voice sounding, nor touch of human hand,
Nor face with blooming flesh, nor lips, are in that land.

I know it not O soul,
Nor dost thou, all is blank before us,
All waits undream'd of in that region, that inaccessible land.

Till when the ties loosen,
All but the ties eternal, Time and Space,
Nor darkness, gravitation, sense, nor any bounds bounding us.

Then we burst forth, we float,
In Time and Space O soul, prepared for them,
Equal, equipt at last, (O joy! O fruit of all!) them to fulfil O soul.

DOM & SAX

Manipulating XML Documents

- Representing information in an XML Document
  - and presenting it somehow
  - is not enough for most non-trivial application scenarios
- Mostly, we often need to *manipulate*
  - access, delete, modify
- parts of an XML *document*
  - which either may or may not be and XML *file*
- This is typically dome through programming language of many sorts
  - through ad hoc API
- The most used / hated / deprecated / widespread are
  - DOM
  - SAX

Document Object Model (DOM)

- http://www.w3.org/DOM/
  - standard W3C, as usual

"The **Document Object Model** is a platform- and language-neutral interface that will allow programs and scripts to dynamically access and update the content, structure and style of documents"

- It applies to HTML as well as XML
- It is essentially an API
  - standardised for Java & ECMAScript
    - but can be extended to other languages
- There is no time here to go deep into DOM
  - we just try to understand its nature, goals and scope

DOM & Levels

- DOM views an XML tree as a data structure
  - similar to the DOM from Javascript
- DOM loads the whole XML document in memory to manipulate it
  - maybe huge memory consumption
- It is quite large and complex...
  - Level 1 Core: W3C Recommendation, October 1998
    - primitive navigation and manipulation of XML trees
    - other Level 1 parts: HTML
  - Level 2 Core: W3C Recommendation, November 2000
    - adds Namespace support and minor new features
    - other Level 2 parts: Events, Views, Style, Traversal and Range
  - Level 3 Core: W3C Working Draft, April 2002
    - adds minor new features
    - other Level 3 parts: Schemas, XPath, Load/Save

DOM Nodes

- An XML document is a tree
- The tree contains **nodes**
  - one of them is a **root** node
  - nodes possibly have **siblings**, **children**, one **parent**, content, tag, etc.
- The DOM specification states that a *node can contain*
  - document, doc. fragment, doc. type, element, attribute, processing instruction, comment, text, CDATA section, entity, notation
- It also defines which kind of child nodes they should / could have

Properties & Methods of DOM Nodes

- Every DOM node has **properties** and **methods** to explore and update the XML tree
- Every DOM node has a **name**, a **value**, a **type**
- There are general properties and methods for all kinds of nodes
  - `attributes` returns all the attributes of the node
  - `appendChild(newChild)` appends `newChild` after the other child nodes
- Then, any specific kind of node has its own specific properties and methods
- These properties and methods are made available by the suitable API for the language of choice
  - many solutions for Java
    - see for instance http://java.sun.com/xml/jaxp/

A Simpe Java DOM Fragment

```
public static void main(String[] args) {
  try {
    DOMParser p = new DOMParser();
    p.parse(args[0]);
    Document doc = p.getDocument();
    Node n = doc.getDocumentElement().getFirstChild();
    while (n!=null && !n.getNodeName().equals("recipe"))
      n = n.getNextSibling();
    PrintStream out = System.out;
    out.println("<?xml version=\"1.0\"?>");
    out.println("<collection>");
    if (n!=null)
      print(n, out);
    out.println("</collection>");
  } catch (Exception e) {e.printStackTrace();}
}
```

Main Problem of DOM

- The XML document is loaded as a whole and handled altogether in memory
  - it might be time-consuming and difficult to manage
  - wouldn't it be better if we could load only the part we are actually manipulating
- This is the motivation behind SAX
  - which is not started as a standard
  - has problems of acceptance
  - but has indeed a long tail of followers
  - and also its good reasons to exist

Simple API for XML (SAX)

- Differently from DOM, SAX is event-based
- It sees the document not as a tree, but as a text doc
  - flowing through the SAX parser
  - and generating events as soon as document started / ended, elements started / ended, character content, etc.
- A very simple model
  - good for simple applications
  - and also to avoid memory abuse
- Not so well-supported as DOM is
  - in terms of standardisation
  - as well as of tools