XML and DTD

Mario Alviano

University of Calabria, Italy

A.Y. 2018/2019

Outline

Documents versus Data

- Documents
  - Human-readable
  - Basically unstructured text
  - Markup indicates some structure
- Data
  - Human- and machine-readable
  - Structured text
  - Schema for structure

XML (Extensible Markup Language) unifies these paradigms

XML

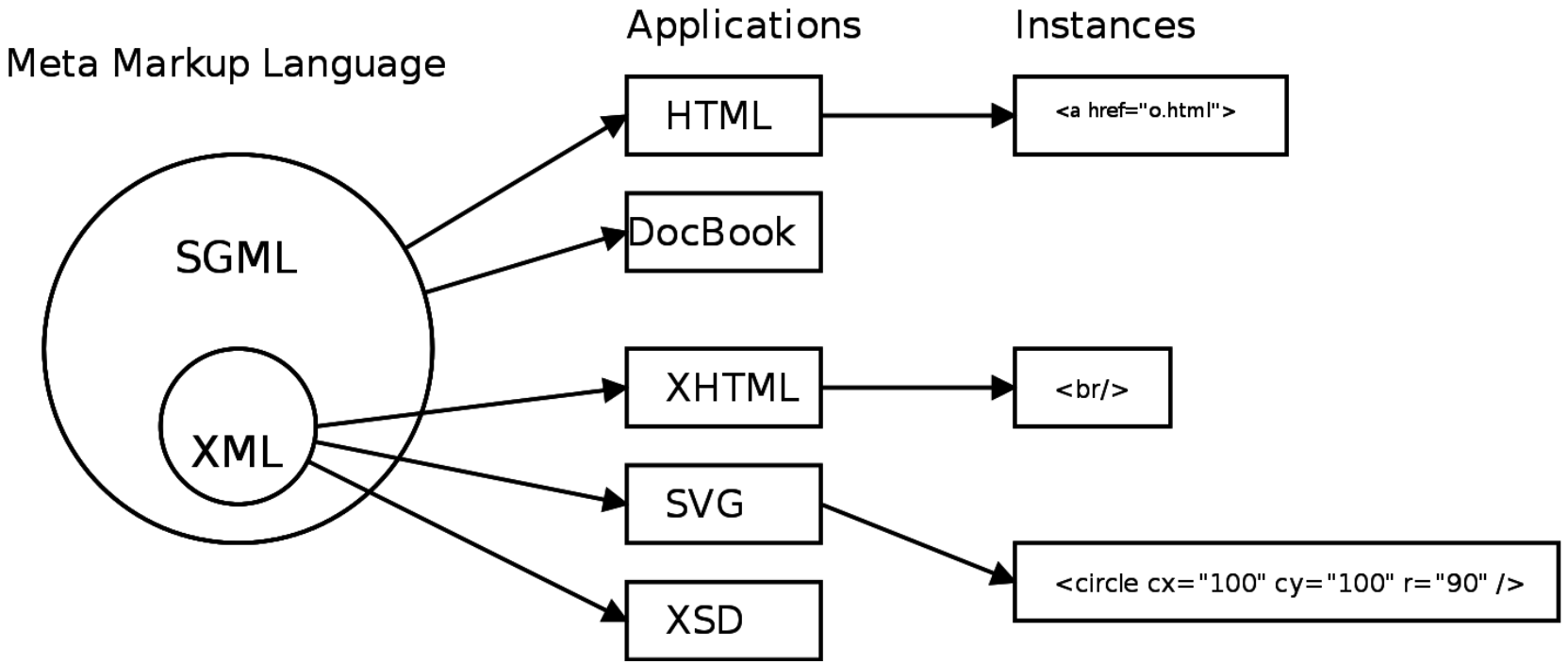
What XML is not

- XML is not a programming language
- XML is not a protocol
- XML is not a database

- XML is a W3C Recommendation
- It is a framework for describing semi-structured data
- Applications specify their own document/data types

> *XML will be the ASCII of the Web – basic, essential, unexciting*
>
> — Tim Bray, 1997

XML versus HTML



- HTML is an application of SGML
  - Around 100 fixed tags
  - Used mostly for presentation and layout
  - Proprietary extensions and variations
  - Error-tolerant browsers
- XML is subset of SGML
  - Meta-language
  - No fixed tags
  - Applications specify their own document/data types
  - Strict syntax

Why XML? (1)

- How to represent data?

Example. Text file

```
Joe Fawcett
Danny Ayers
Mario Alviano
```

Example. XML file

```
<applicationUsers>
    <user firstName="Joe" lastName="Fawcett" />
    <user firstName="Danny" lastName="Ayers" />
    <user firstName="Mario" lastName="Alviano" />
</applicationUsers>
```

Why XML? (2)

- Less ambiguities
- Easily extensible

Example. Text file

```
Joe John Fawcett
Danny John Ayers
Mario Alviano
```

Example. XML file

```
<applicationUsers>
    <user firstName="Joe" middleName="John"
lastName="Fawcett" />
    <user firstName="Danny" middleName="John"
lastName="Ayers" />
    <user firstName="Mario" lastName="Alviano" />
</applicationUsers>
```

Why XML? (3)

- Hierarchical data representation

Example. Text file

```
/
/home
/home/malvi
/proc
/sys
```

Example. XML file

```
<directory>
    <directory name="home" >
        <directory name="malvi" />
    </directory>
    <directory name="proc" />
    <directory name="sys" />
</directory>
```

XML syntax (1)

- First line of an XML file is called **prolog**
  - Must specify XML version (1.0 oppure 1.1)
  - May specify a Unicode encode (UTF-8, UTF-16, etc.)
- Comments use the same syntax of HTML

Example. Prolog

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

Example. Comment

```
<!-- This is a comment -->
```

XML syntax (2)

- An XML file contains a tree of elements
- Elements have the following forms:
  1. Opening tag, content, closing tag:
     `<myElement>Content</myElement>`
  2. Only for elements with no content: `<myElement />`
- Element may have attributes:

```
<myElement myFirstAttribute="One"
           mySecondAttribute="Two" />
```

XML syntax (3)

- Not all characters are valid and escape sequences are used
- Entity references
  - & `&`
  - < `<`
  - > `>`
  - " `"`
  - ' `'`
- Character references
  - E.g., `
` (exadecimal) or ` ` (decimal) add a space
- Contents containing many invalid character can be denoted by **CDATA**

```
<conversionData>
    <![CDATA[
        1 kilometer < 1 mile
        1 pint < 1 liter
        1 pound < 1 kilogram
    ]]>
</conversionData>
```

Namespace (1)

- XML is born for interoperation
- More XML documents must coexist
- How to handle documents using the same names for elements and attributes?

Example. Clash on element names

```
<employee>
   <firstName>Joe</firstName>
   <lastName>Fawcett</lastName>
   <title>Mr</title>
   <biography>
      <html>
         <head><title>Joe's Bio</title></head>
         <body>
            <p>After graduating from...</p>
         </body>
      </html>
   </biography>
</employee>
```

Namespace (2)

- Namespaces allow to avoid clashes
  - URI (Uniform Resource Identifier), i.e.
    URL (Uniform Resourse Locator) +
    URN (Uniform Resource Name)

URL: `[Scheme]://[Domain]:[Port]/[Path]?[QueryString]#[FragmentId]`

```
http://www.wrox.com/remtitle.cgi?isbn=0470114878
```

URN: `urn:[namespace identifier]:[namespace specific string]`

```
urn:isbn:9780470114872
```

Example. Default namespace

```
<applicationUsers
        xmlns="http://alviano.net/km/examples">
    <user firstName="Joe" lastName="Fawcett" />
    <user firstName="Danny" lastName="Ayers" />
    <user firstName="Mario" lastName="Alviano" />
</applicationUsers>
```

Namespace (3)

- Namespaces identified by a **prefix** can be declared in addition to the default namespace

  `xmlns:km="http://alviano.net/km/examples"`

Example. Namespace with prefix

```
<km:applicationUsers
      xmlns:km="http://alviano.net/km/examples">
   <km:user firstName="Joe" lastName="Fawcett" />
   <km:user firstName="Danny" lastName="Ayers" />
   <km:user firstName="Mario" lastName="Alviano" />
</km:applicationUsers>
```

Warning!

- Namespace declarations are inherited
- Attributes are usually associated with no namespace (default namespaces do not apply to attributes)

Document Type Definition (DTD) (1)

- A DTD specifies what data are contained in a XML file (i.e., DTD is a schema for XML)
- The DTD is declared before the root element

```
<!DOCTYPE root-element
      optional-external-reference
      optional-internal-declarations>
```

- Internal declarations are enclosed on brackets and are of the following form

```
<!ELEMENT element-name structure>
```

where “structure” can be

  - `EMPTY`
  - `ANY`
  - `#PCDATA`
  - the name of another element
  - a combination of the previous with `|  ?  ,  *  +`

Document Type Definition (DTD) (2)

Example

```
<?xml version="1.0"?>
<!DOCTYPE name [
    <!ELEMENT name (first, middle, last)>
    <!ELEMENT first (#PCDATA)>
    <!ELEMENT middle (#PCDATA)>
    <!ELEMENT last (#PCDATA)>
]>
<name>
    <given>Joseph</given>
    <middle>John</middle>
    <last>Fawcett</last>
</name>
```

Is the content valid? How to fix it?

Document Type Definition (DTD) (3)

- Attributes of an element can be specified as follows

```
<!ATTLIST element-name
    attribute-name type default
    ...
>
```

- The type of an attribute can be `CDATA`, `ID`, `IDREF`, `IDREFS`, `...`
- The default value may also indicate that an attribute is required (`#REQUIRED`) or optional (`#IMPLIED`)

Document Type Definition (DTD) (4)

Example

```
<?xml version="1.0"?>
<!DOCTYPE name [
    <!ELEMENT name EMPTY>
    <!ATTLIST name
        first CDATA #REQUIRED
        middle CDATA #IMPLIED
        last CDATA #REQUIRED>
]>
<name first="Joseph" middle="John"
        last="Fawcett" />
```

Document Type Definition (DTD) (4)

- The external reference allows to reuse an existing DTD
- `SYSTEM` is used for external DTD stored in a local file

```
<!DOCTYPE bibliography SYSTEM "biblio.dtd">
```

- `PUBLIC` is used for DTDs in the catalog of the XML parser

```
<!DOCTYPE HTML PUBLIC
    "-//W3C//DTD HTML 4.01//EN">
```

- Optionally, a file may be specified to be used in case the DTD is not in the catalog

```
<!DOCTYPE HTML PUBLIC
    "-//W3C//DTD HTML 4.01//EN"
    "http://www.w3.org/TR/html4/strict.dtd">
```

Document Type Definition (DTD) (5)

- New entity references may be specified

```
<!ENTITY entity-name definition>
```

```
<!ENTITY author "Mario Alviano">
```

`&author;` can now be used in the XML document

- Entities can be extern (as for `DOCTYPE`, `SYSTEM` and `PUBLIC` are used)
- Parameter entities are similar, but can be used in the DTD (to split it in files)

```
<!ENTITY % entity-name definition>
```

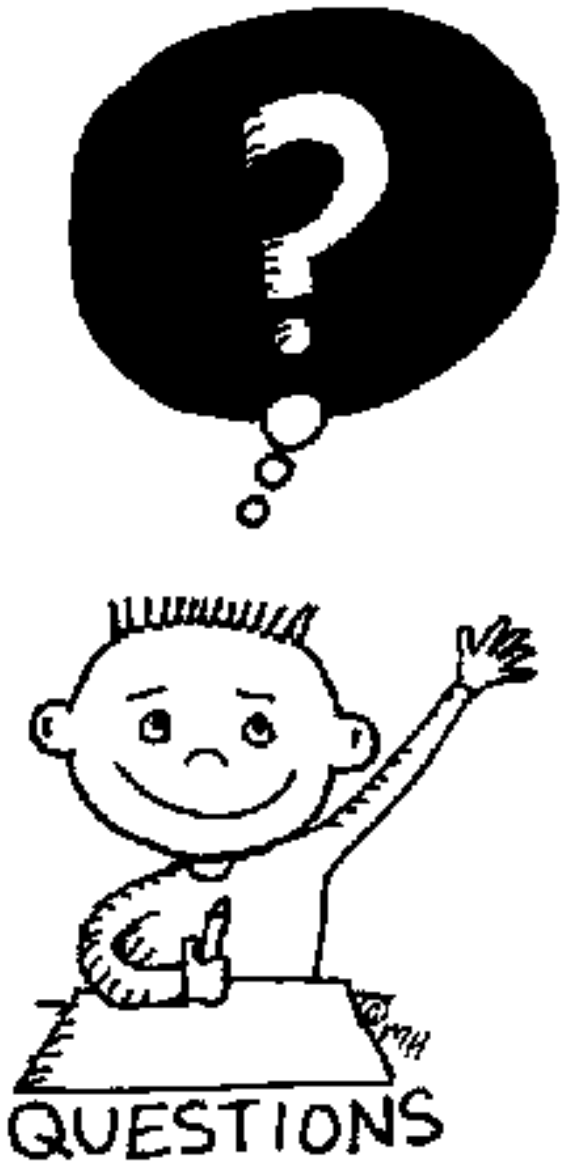
```
<!ENTITY % address SYSTEM "address.dtd">
```

How to validate an XML document against a DTD

- XML validation with libxml
  - `xmllint -valid XMLfile -noout`
  - `xmllint -dtdvalid DTDfile XMLfile -noout`
- XML validation with Eclipse EE
  - Right-click on the file(s) to be validated, then **Validate**

Exercises

1. Given the document **order.xml**, write a DTD that allows its validation
2. Given the document **letter.xml**, write a DTD that allows its validation
3. Given the DTD **mountainRanges.dtd**, write a valid XML document
4. Given the DTD **dealership.dtd**, write a valid XML document
5. Given the description in **football-matches.txt**, write a DTD and a valid XML document



END OF THE LECTURE