Advanced Studies in IT
CT433

Languages for Data Integration of Semi-Structured Data I – XML Basics

Lecture 2.

www.deri.ie

science foundation ireland
fondúireacht eolaíochta éireann

National University of Ireland, Galway
Ollscoil na hÉireann, Gaillimh

Overview

- Introduction and motivation
- Many different formats: documents, databases, semi-structured data.
  Ultimately: integration, mediation

- XML – definition
- XML features, i.e. what is special about XML?
- From SGML to simple HTML, from too simple HTML to XML
- XML syntactic structure
- Well-formed and valid documents: DTDs

- XML companion standards overview
- XML namespaces

Introduction and Motivation

- Information exchange formats
- Web as a large database:
  - Extraction of Data from the web
  - HTML/XML ⇔ human/machine
- increasing quantity of Data with flexible irregular structure:
  - Integration of heterogeneous data.
- Document-view and Database-view become one:
  - Databases: models of (semi-)structured data
  - Documents: XML

Documents

- Intra- und inter-document structure, (e.g. tables, etc.)
- **Common** presentation formats such as HTML
  - reflect only rough structures but mainly restricted to layout information
  - based on SGML
- **Global** infrastructure for document exchange (e.g., Web)
  - But: Web is unstructured, in the best case it is a large graph, links alone don't tell you about the structure of the information
- Mix of documents and databases
- Requirements for **management** of large document collections
- Requirements for **exchange** between heterogeneous sources

(Databases, spreadsheets, Web crawled date, etc.)

This lead to the need for developing of new formats for structured data exchange, in particular XML.

Databases: state of art

- Relational DB, EER for structure description
  - modelled as finite First Order Logic structure
  - In DB theory, Finite Model Theory (FMT) and descriptive complexity theory are important
  - Alternative: OODB-model
- Data models and query languages
- Break between logical view and physical implementation
  - Logical view: what are valid queries,...
  - physical implementation: how to store data, B-Trees, etc. ...
- External view: Views on how each user perceives data, representation
- Storage techniques und techniques for database consistency/integrity (key, integrity constraints, triggers,etc.)

Database architectures

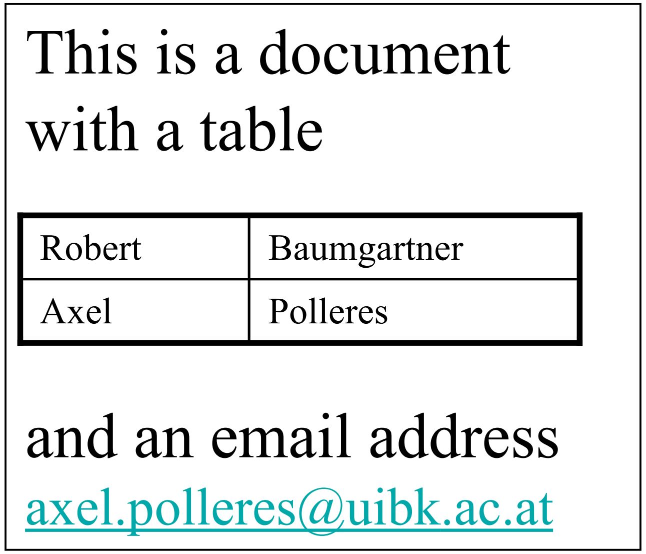
- Databases
  - Traditional **Client/Server architecture**
  - **Warehouses:** intermediate DB imported from other source-DBs; this will be queried upon (problems with updates etc.)
  - **Mediator/Wrapper systems:** queries from clients will be splitted and upon query to the corresponding source-DB translated, the output will be produced on-the-fly by the mediator; especially for heterogeneous data sources
- Web-usage
  - **More layers:** DB-servers, legacy data, transformation components, application servers, etc. (to HTML, only layout, semantics/structure is somehow lost), clients (browser), …

Semistructured data

- The need for models for flexible and irregular structures has lead to models for semi-structured data:
  - When there is no solid known explicit known schema
  - When databases have many null-values (incomplete knowledge, e.g. collecting addresses from Web pages, not all might have a ZIP code, not all might have a FAX number, etc.)
  - When the database schema is large
  - When data is not well-typed (i.e. Can be of different types, text including (marked-up) data, etc.)

- Instead of a table, model your data as a **tree** (XML) or more generally a **graph** (RDF… later on in this lecture)

Example: document as tree… somehow adhoc ;-)

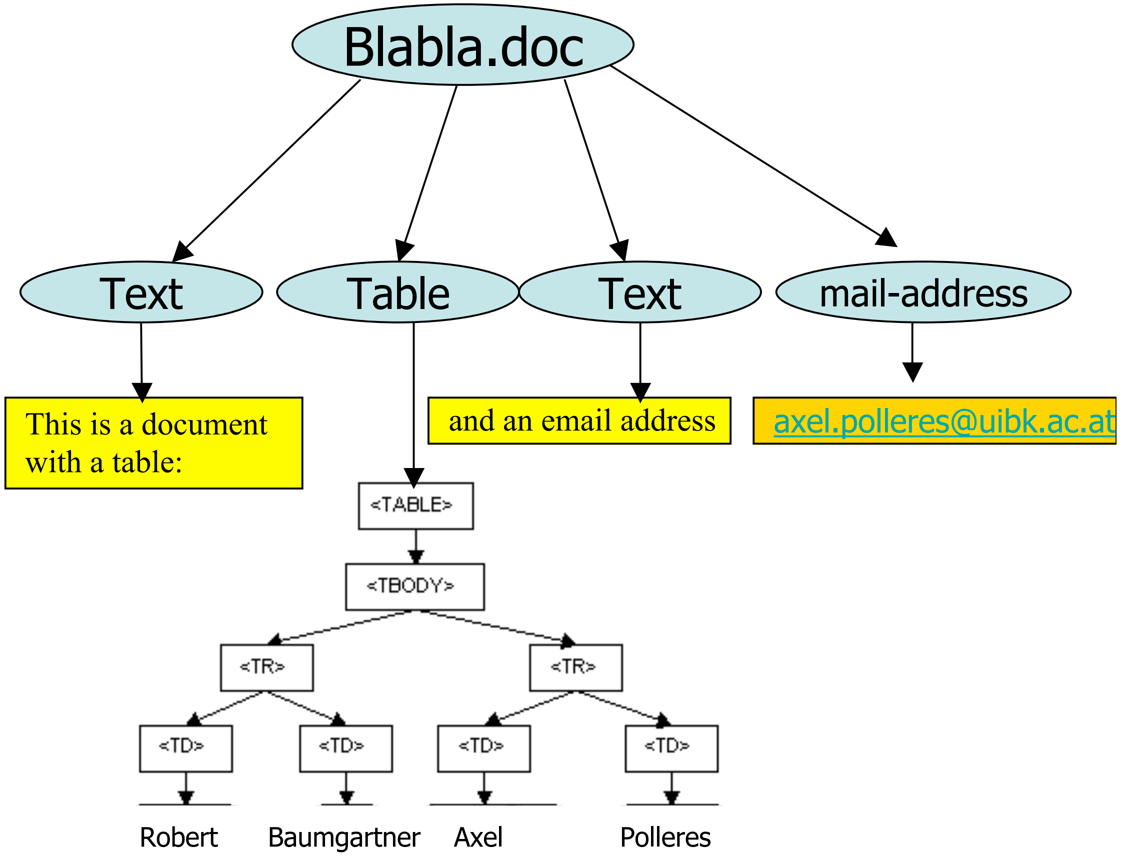


This is a document with a table

Robert	Baumgartner
Axel	Polleres

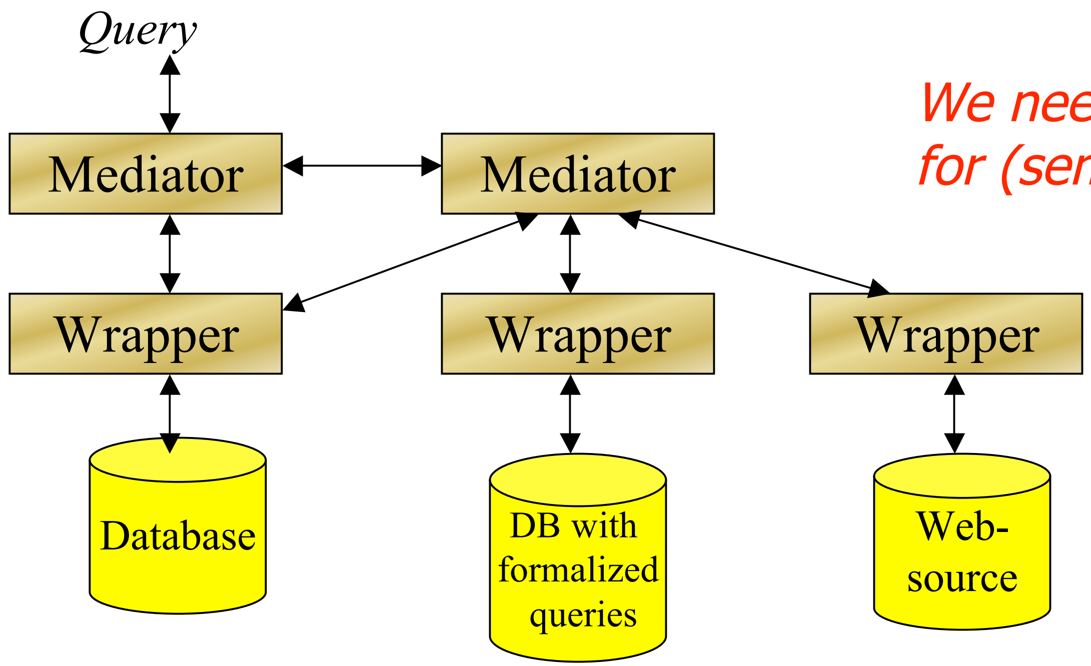
and an email address
axel.polleres@uibk.ac.at

Blabla.doc



Mediators

- Mediator passes data between the user and data resource (Middleware)
- Mediators use wrappers which allow to have homogeneous access to heterogeneous content



We need a uniform data format for (semi-)structured Data → XML

XML

What is XML? XML in 10 points:

1. XML is a standard exchange format for semi-structured Data
2. XML looks a bit like HTML
3. XML is plain text, but not for the human reader
4. XML representation is not necessary concise
5. XML is a family of technologies (XML, Xpath, XSL, XQuery, XLink, DOM, etc.)
6. XML is new but not so new (since 1998 a W3C standard, but SGML already existing since the early 80ies)
7. "HTML in XML" is called XHTML
8. XML is modular (by the use of namespaces)
9. XML is the basis for RDF and for the Semantic Web
10. XML is license free, platform independent and well-supported

In a nutshell:

- XML provides a standardized syntax for markup languages
- XML uses elements and attributes to define a tree structure
- An XML document can have a tree structure of arbitrary level of complexity

What is XML? More abstract:

- XML (e**X**stensible **M**arkup **L**anguage) is a framework for defining markup languages
- XML derives from SGML (**S**tandard **G**eneralized **M**arkup **L**anguage), and conforms to ISO 8879 (SGML)
- XML is a standardization effort by W3C
- XML is more a syntax than a language i.e. there is no fixed set of markup tags (as opposed to e.g. HTML)
  - BUT: you can DEFINE XML languages, using DTDs and XML Schema… ore on that later

Preconditions for XML appearance

- Limitations of HTML
  - Separating layout from structure, no possibilities of reuse
  - Structure/Layout description only
- Complexity of SGML
  - Unsuitable for Web-applications, SGML more flexible, but more complex than XML
- Other flexible markup languages needed
  - Scientific Markup
  - Handies (WML), Palmtops
  - Document type/usage built-in core architecture
- Information representation, e-commerce
- XML simplifies electronic data interchange

What was XML designed for?

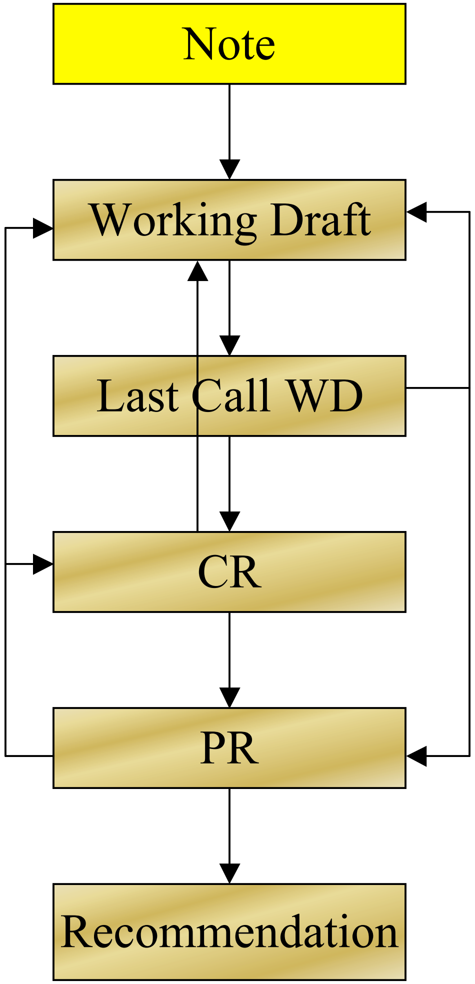
- To separate **syntax** from **semantics** to provide a common framework for structuring information syntactically
- To allow **tailor-made markup** for any possibly application domain
- To support **internationalization** and **platform independence**
- To be the future standard of structured information
- Easy of transformation/exchange, **ASCII/Unicode** based.

History

- Hypertext (1945)
  - Any navigation though documents
- GML (SGML predecessor) (1969)
- SGML ISO Standard (1986)
- HTML Tim Berners-Lee, CERN (1989)
  - Goal: simple documents exchange
- W3C was founded (1994)
- SGML work group (1996)
- XML 1.0 (1998)
- DOM (1998)
- XSLT (1999)
- XML 2nd Edition (2000): small changes and introduction of Namespaces
- XHTML 1.0 (2000, revised 2002)
- XML Schema (2001), at first as WD to XML 1.1 (2001)
- XQuery und XPath 2.0 Working Drafts (2002)
- XMLEvents Recommendation (2003)
- Requirement Definition for XML Schema 1.1 (2003)
- XML 1.1 Recommendation (Feb 2004)

- World Wide Web Consortium
  - Founded by CERN, MIT and others
  - ca. 250 participants (Companies, Academic partners)
  - Function: standardization of web formats
  - Not normative: gives only recommendations, no ISO bearing standards

- Six types of documents
  - **Note**
    - Not a component in the standardization process
    - No declaration that W3C stands behind
  - **Working Draft (WD)**
    - Documentation of a discussion condition
  - **Last Call WD**
    - When the goals are reached
  - **Candidate Recommendation (CR)**
    - Confirmation of success
  - **Proposed Recommendation**
    - Extension; partial implementation
  - **Recommendation**
    - official W3C standard



XML : Now how does XML differ from HTML?

- **New tags and attributes** can be defined
- Document structures can be nested to any level of complexity
- An XML document can contain or refer to optional descriptions of its grammar (DTDs, XSD) for use by applications that need to perform structure validation

- **Strict syntax**: all tags have to be closed! No overlapping tags, etc. (which is tolerated by many web browsers for HTML)

XML : How does XML differ from SGML?

- XML is a **restriction** of the Standard Generalized Markup Language, for instance also HTML is valid **SGML** but XML is more restrictive.

- simplicity, stricter syntax, made it much more successful than original SGML

XML : How does XML differ from HTML?

We can structure the same information in…

HTML *and* XML

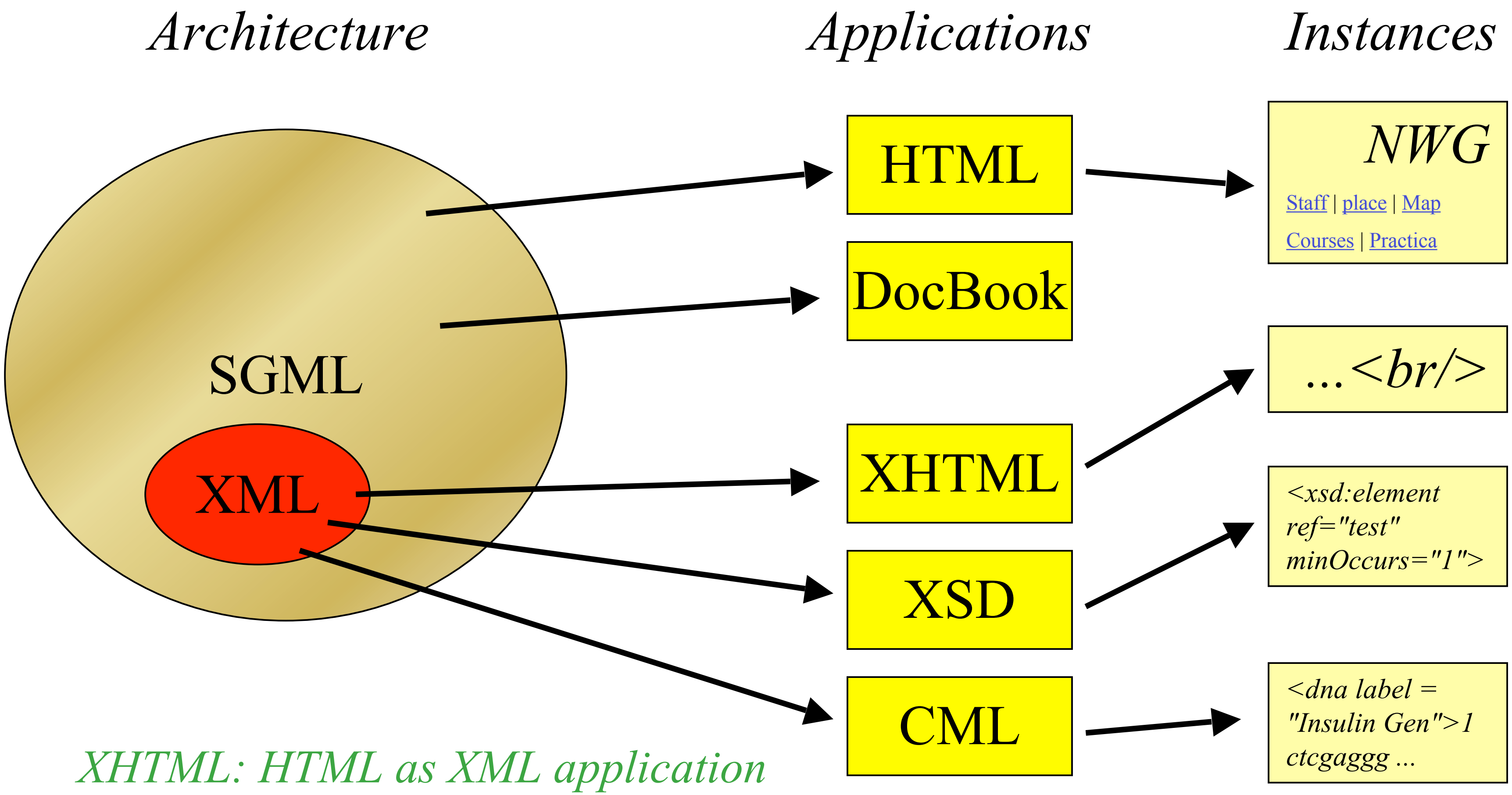
```
<html>
<head>
  <title>Employees</title>
</head>

<body>
  <h1>Marketing</h1>
  <h2>Gustav Sielman (1834)</h2>
  <p>e-mail: gsielmann@Dot.com</p>
  <p>Tel.: +43/0662/723942-124</p>
  <p>Fax.:+43/0662/723942-800</p>
</body>
</html>
```

```
<?xml version=”1.0”?>

<employees>
  <marketing>
    <employee id="1834">
      <name>Gustav Sielmann</name>
      <email>gsielmann@Dot.com</email>
      <tel>+43/0662/723942-124</tel>
      <fax>+43/0662/723942-800</fax>
    </employee>
  </marketing>
</employees>
```

Applications and instances



XHTML: HTML as XML application

CML: Chemical Markup Language

XSD: XML Schema Definiton

XML : Structure of an XML document

An XML document is composed of:

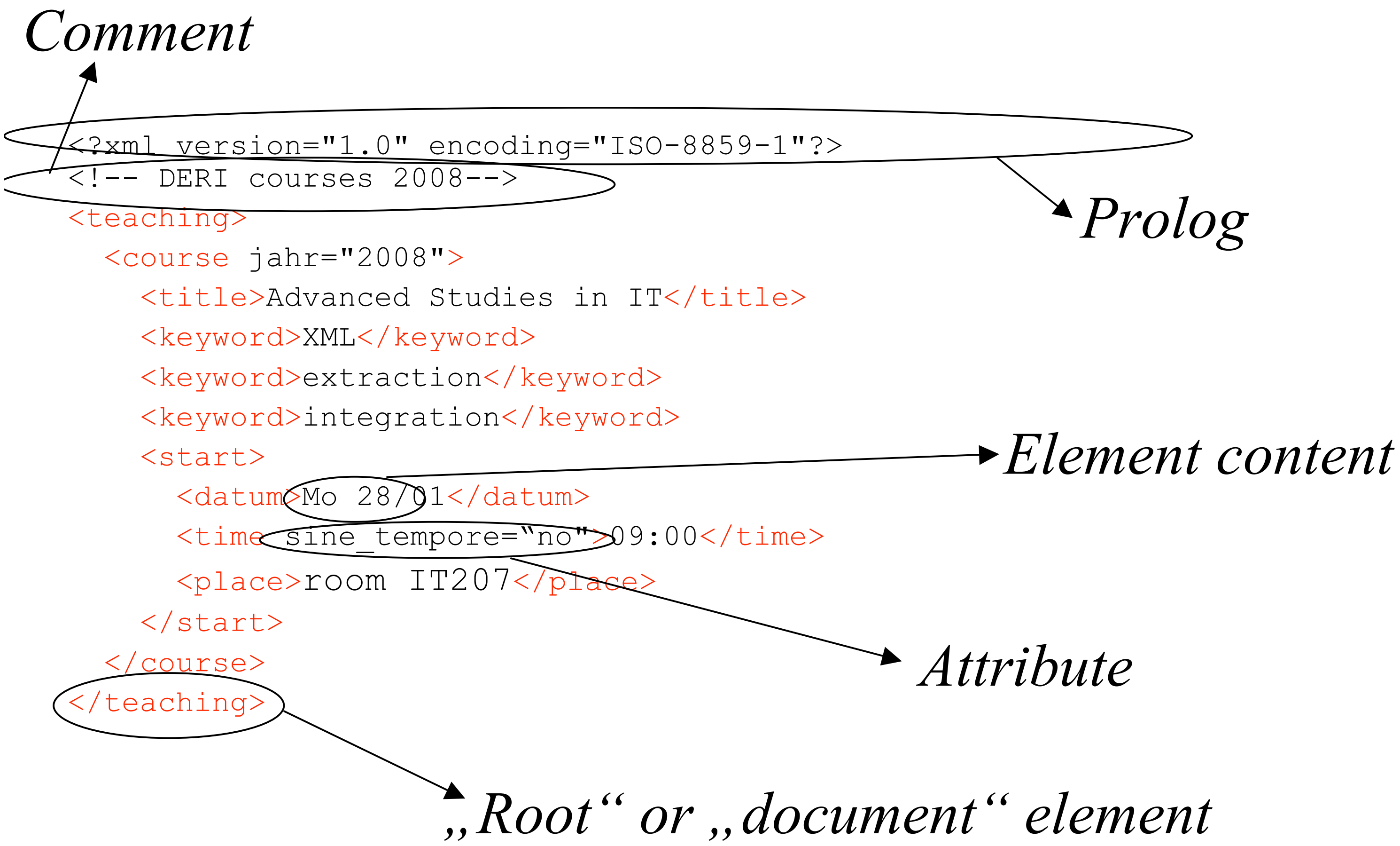
- Prolog
- Elements
- Attributes
- Entity References
- Comments
- Possibly a DTD (Document Type Definition)

How XML looks like

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!-- DERI -->
<teaching>
  <course jahr="2008">
    <title>Advanced Studies in IT</title>
    <keyword>XML</keyword>
    <keyword>extraction</keyword>
    <keyword>integration</keyword>
    <start>
      <date>Mo 28/01</date>
      <time sine_tempore="no">09:00</time>
      <place>HS A</place>
    </start>
  </course>
</teaching>
```

Acknowledgements: R. Baumgartner (thanks for some slides…)

Example of an XML Document



Comment

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!-- DERI courses 2008-->
<teaching>
  <course jahr="2008">
    <title>Advanced Studies in IT</title>
    <keyword>XML</keyword>
    <keyword>extraction</keyword>
    <keyword>integration</keyword>
    <start>
      <datum>Mo 28/01</datum>
      <time sine_tempore=“no”>09:00</time>
      <place>room IT207</place>
    </start>
  </course>
</teaching>
```

Prolog

Element content

Attribute

„Root“ or „document“ element

XML : The Prolog

- The Prolog is the first structural element in the XML document
- It is usually divided into an XML declaration and (optional) a DTD.

E.g.

```
<?xml version=”1.0” encoding=”UTF-8” standalone=”yes”?>
```

XML : Elements

- All subsequent elements must be within one **document element**
- XML elements must contain a **start tag** and a matching **end tag** prefixed by a slash. E.g. `<YEAR>1976</YEAR>`
- **Empty elements** can be written `<CANCELLED/>` instead of using both tags without content
- XML is case-sensitive! (e.g. <br/> != <BR/>
- Element names must begin with an underscore or a letter. Subsequent letters in the element name may include: letters, digits, underscores, hyphens and periods, (Attention: &, <,> ‘,” are reserved!)

XML : Attributes

- XML attributes are attached to elements
- They are a way of associating values to an element without making them part of the actual content
- Attribute **names** must begin with a letter or an underscore and must not contain any white spaces
- Attribute **values** must be quoted
- An attribute name may occur **only once** per element
- Attributes only **in** the start tag of an element

```
<employee name=”Axel Polleres”>
   axel@polleres.net
</employee>
```

XML : Entity References

- Entity references are used to reference data that is not directly in the structure
- Pre-built entity references are used to represent special characters, such as

  `&  &amp;  <  &lt;  >  &gt;  “  &quot;  ‘  &apos;`

  or character-References: `&#211;` (dezimal), `&#xF3;` (hex)

- New entities can be declared in DTDs (see later slides)

e.g. the string `Peter&Tom(“Don‘t cry for me“)` would be written:

```
Peter&amp;Tom(&quot;Don&apos;t cry for me&quot;)
```

XML : Why use Entitiy References?

We use Entity References …

- …to use symbols we could not use otherwise
- …to make maintenance easy and scalable
- …out of comfort

More about this when we speak about DTDs

XML : Comments

- Comments are a special set of tags that start with `<!--` and end with `-->`
- All data written between these two tags is ignored by the XML processor.
- Comments are usually used to make small notes inside the XML document or to comment out entire sections of XML code

```
<!-- I HAVE TO GET GUSTAVS EMAIL
  <employee name=”Gustav Sielmann” >
    <email/>
  </employee>
-->
```

XML : Well-formedness and Valdity - DTDs

With an XML parser an XML document can be checked for two things:

- **Well-formedness** i.e. if the document obeys the syntactical rules of XML (has a prolog, a document element, all elements closed, no overlaps…)
- **Validity** i.e. if the document obeys the rules in a DTD (or in an XML-Schema, next lecture) – Grammar!

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!-- DBAI -->
<teaching>
  <course jahr="2008">
    <title> Advanced Studies in IT </title>
    <keyword>XML</keyword>
    <keyword>Extraction</keyword>
    <keyword>Integration</keyword>
    <start>
      <date>28/01</date>
      <time sine_tempore="yes">09:00</time>
      <place>room IT207</place>
    </start>
  </course>
</teaching>
```

Questions:

- Which element names should be used?
- Which content models are allowed?
- How elements are connected?
- Which attributes are valid for an element?
- Which data should an attribute contain?

XML : Document Type Definitions

- DTDs (**D**ocument **T**ype **D**efinitions) contain a list of elements (tags), attributes and entity references contained in an XML document and describes their relationships to each other.
- A DTD specifies a set of rules for the structure of a document therefore making it easy to share data with everyone that conforms to the same encoding standard
- DTDs are part of the XML standard, but inherited from SGML

XML : Why use DTDs?

We use DTDs …

- …to define a **grammar** for one of several XML documents
- …to check XML documents against this grammar

XML : DTDs

Document Type Definitions can be:

- **Internal**, i.e. placed in the prolog of an XML document *or*
- **External**, being identified by an URL, thus making it easy to share the same encoding standard with other people

XML : Structure of a DTD

- A DTD always starts with `<!DOCTYPE` and always ends with `>`
- Directly after the `<!DOCTYPE` comes the *name of the document (root) element* followed by a bracket `[`

  or the `SYSTEM` or `PUBLIC` keyword.
- Then comes a list of all elements and attributes contained in the XML file, including the document element or a reference to an external DTD.

DTD external

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE teaching SYSTEM “courses.dtd">
<!-- NUIG -->
<teaching>
  <course jahr="2008">
    <title>Advanced Studies in IT</title>
    <keyword>XML</keyword>
    <keyword>Web Services</keyword>
    <keyword>Integration</keyword>
    <keyword>Semantic Web</keyword>
    <start>
      <date>2008-01-28</date>
      <time timezone=“GMT">09:00:00</time>
      <place>room IT207</place>
    </start>
  </course>
</teaching>
```

DTD internal

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE teaching [
<!ELEMENT teaching (course+)>
<!ELEMENT course …
<!ATTLIST course …
…
]>
<!-- URJC -->
<teaching>
  <course jahr="2007">
    <title>Recuperación de Información</title>
    <keyword>XML</keyword>
    <keyword>Web Services</keyword>
    <keyword>Integration</keyword>
    <keyword>Semantic Web</keyword>
    <start>
      <date>2007-02-22</date>
      <time timezone="CET">15:00:00</time>
      <place>Aulario I, Aula 002</place>
    </start>
  </course>
</teaching>
```

Use of DTD

Embedding in XML
Document-Type-Declaration: `<!DOCTYPE ...>`

```
<!DOCTYPE teaching SYSTEM “asignatras.dtd">
```

Name of the document elements must be "teaching"

Described by DTD data (System) or by public identifiers; when public identifier is given, there exists a SYSTEM identfier, which is used if the public link is can not be identified:

```
<!DOCTYPE teaching PUBLIC "-//Teaching//URJC//ES"
   "http://www.urjc.es/asignaturas.dtd">
```

is not an attribute value!

In an DTD different potential document (root) elements are given, which can be chosen in a document instance.

Public vs. System Identifier

- System identifier is a "local" identifier
  - not necessarily local URLs, e.g.
    `<!DOCTYPE seminar SYSTEM "http://www.seminar.se/se.dtd">`
  - for all non-standard documents
- Public identifier
  - must be known to the used XML Processor
  - for known document types
  - must follow a defined syntax
  - can take another value, in case the SYSTEM identifies that the first value can not be applied:

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.1//EN" "xhtml11-flat.dtd">
```

XML : Example of a DTD

```
<employees>
  <marketing>
    <employee id="1834">
      <name>Gustav Sielmann</name>
      <email>gsielmann@Dot.com</email>
      <tel>+43/0662/723942-124</tel>
      <fax>+43/0662/723942-800</fax>
    </employee>
  </marketing>
</employees>
```

XML Structure

To validate: each used element and attribute have to be defined in the DTD!!!

```
<!DOCTYPE employees [

<!ELEMENT employees (marketing)>
<!ELEMENT marketing (employee+)>
<!ELEMENT employee (name,email+,tel*,fax?)>
<!ATTLIST employee id CDATA #IMPLIED>
<!ELEMENT name (#PCDATA)>
<!ELEMENT email (#PCDATA)>
<!ELEMENT tel (#PCDATA)>
<!ELEMENT fax (#PCDATA)>

]>
```

DTD

Valid Documents: summary

- Well-formed vs. valid
  - Well-formed: following XML syntax
    - XML processor checked only with syntax rules
  - valid: valid in correspondence to DTD (or XML schema)
  - validating Parser
    - validates over DTD (or another language)
- Elements, attributes, entities declaration
  - DTD helps to distinguish desired from undesired elements/attributes/content
- Document structure
  - Needed for a validating XML Processor
  - Instances are filled in document structure
  - XML data can be shortened with different definitions
- External/Internal declaration of DTD
  - directly in document
  - in its own data

DTDs in detail…

- Element declarations
- Attribute declarations
- Internal/external Entity declarations

Element declaration

- An element can contain other elements or only text or a mixed content
- Shortening opportunities in DTDs
  - any element-content
  - empty element-content
  - appearance of inner elements
  - no multiple types, only strings
- Possible content models: only text, only elements, mixed, any, empty.

Element declaration: syntax

- Key words
  - #PCDATA characterizes leaf-elements (parseable character data)
  - EMPTY: empty element
  - ANY: any content (the elements can be defined in DTD, in XML schema or some extent of freedom possible)
- Indicators of appearance
  - Regular expressions +,*,?
  - Without the expressions: precisely one time
  - +: at least one time or possibly any times more
  - *: 0-time or more
  - ?: 0-time or one time
- Grouping
  - With parentheses (...)

Element Declaration: Examples

```
<!ELEMENT teaching ANY>
```

Instance:

```
<teaching>irgend<was>steht</was></teaching>
```

```
<!ELEMENT teaching EMPTY>
```

Instance:

```
<teaching/>
```

```
<!ELEMENT course (name, jahr)>
```

Instance:

```
<course>
    <name>Seminar</name><jahr>2002</jahr>
</course>
```

Not an instance:

~~<course>~~
~~<jahr>2002</jahr><name>Seminar</name><~~
~~</course>~~

```
<!ELEMENT teaching (#PCDATA)>
```

Instance:

```
<teaching>Seminar</teaching>
```

Not an Instance:

~~<teaching>~~
~~<jahr>2002</jahr><name>Seminar</name><~~
~~</teaching>~~

Element declaration: Syntax

- Connection operators: "," (=AND), "|„ (=OR)
- With ",„ element order is important
- "|" means: only one of the following is applied (excluding or)
- "|" repeats with * or + allows thus arbitrary order (and multiple appearance)
- Enclosed bracketing
  - E.g. `(lname, (fname | title))`

Element declaration: mixed content

- Mixed content (elements + character data) vs. Element content
  - Element content: contents only elements
  - Example: `<!ELEMENT start (date, time, place)>`
- mixed content
  - always only separated with | in DTD and * at the end

    Example: `<!ELEMENT name (#PCDATA | fname | lname)*>`
- #PCDATA should be listed firstly
  - and only with | and * if mixed content is located inside!

    `<content>This is <i>my</i> Content</content>`
- #PCDATA can not be used with ","

  `<!ELEMENT teaching (#PCDATA, course)*>`

  - Not valid

Element declaration: further examples

```
<!ELEMENT teaching (course+)>
```

teaching is a list of courses (at least one in this example).

```
<!ELEMENT booktitle (deutsch | english* | italiano)>
```

booktitle consists of a German or several English or an Italian titles.

```
<!ELEMENT name (#PCDATA | fname | lname)*>
```

Name consists of first name, last name or a convenient mixture of text, order doesn’t matter.

```
<!ELEMENT course ((name, year?)+)>
```

List of names and years, setting „year“ is optional.

Attribute declaration

- An attribute has a name, a type and options
- Declared via attribute declaration lists
- All attributes can be in one or more declarations
- Relates to corresponding Element
- Its place does not make any difference

`[Name,Type,[Options]]` List

Attribute declaration: example

```
<!ELEMENT time (#PCDATA)>
<!ATTLIST time sine-tempore (yes|no) "no">
```

„time“ contains an Attribute. The Attribute sine-tempore can have values „yes“ or „no“, and „no“ is a default value.

```
<!ATTLIST test href CDATA #REQUIRED>
```

The href attribute must be defined in test and can contain any string value.

```
<!ATTLIST test lang NMTOKEN #IMPLIED)
```

If this special attribute is defined in a valid document, then it should be described in a defined way (here NMTOKEN (=name token) for attribute xml:lang)

Attribute declaration: syntax

```
<!ELEMENT time (#PCDATA)>
<!ATTLIST time sine-tempore (yes|no) "no">
```

- Element name
  - E.g.. "time"
- Attribute name
  - E.g.: "sine-tempore"
- Type (in principal, only string type)
  - E.g. CDATA, NMTOKEN, ID, …
- Default value (optional)
  - E.g. "no“
- Options

- Attribute values can be more restrictive than element values

Attribute - Limitations

- String-Attribute
  - contains Text

```
<!ATTLIST email href CDATA #REQUIRED>
```

Keyword for String-Attribute

- Tokenized Attribute
  - Content limitations

```
<!ATTLIST entry id ID #IMPLIED>
```

Identifier

- Default value attributes
  - Accept only one value from the list

```
<!ATTLIST entry preferred (true|false) "false">
```

Values for attributes of various types:

- CDATA – Character Data, String
- ENTITY: has a general entity name as a value
- ENTITIES: List of entity names as a value
- NMTOKEN: string – any allowed name in XML (starts with letter or underscore, no special characters, no spaces, etc.)
- NMTOKENS: List of NMTOKENs
  - Separation by spaces
- Lists of NMTOKENS
  - Lists are represented as (RB|GG|CC), (yes|no), etc…
- ID – references (same syntactic restrictions as for NMTOKEN, but unique in the document)
- IDREF, IDREFS – references to IDs
- Default value: optional; is applied when an attribute does not appear

Attribute options:

`#REQUIRED`: There must be a value for this attribute

`#IMPLIED`: optional, no default value

`#FIXED` "Literal": the attribute value in the document is as specified in the DTD (no difference whether you define it in the document or not!)

"Literal": this value will be taken by default

Default- and fixed-attributes add values to a document; make entities

Further Examples

```
<!ATTLIST time sine-tempore (yes|no) "no">
....
<!ATTLIST place building CDATA #IMPLIED>
....
<!ATTLIST course number ID #REQUIRED>
<!ATTLIST time belongsTo IDREFS #REQUIRED>
....
```

ID, IDREF

- ID is an attribute that gives an element a label guaranteed to be unique in the document
- ID must be an NMTOKEN, i.e. a valid XML name
- IDREF is similar to ID, but refers to the ID of another element
- IDREF is used for linking **within** a document
- IDREFS is a list of IDREFs: separated with empty lines
- Consider: XML tree vs. XML graph

```
<course number="_1">
        <place building="Favoritenstrasse">Seminarr.184/2</place>
</course>
....
<time belongsTo="_1" sine-tempore="yes">14:00</time>
```

Entity declarations – **General Entities:**

The GENERAL ENTITY Declaration:

- The types of general entities include:
  - INTERNAL (PARSED)
  - EXTERNAL (PARSED)
  - EXTERNAL (UNPARSED)

INTERNAL (PARSED) GENERAL ENTITY:

```
<!ENTITY name "entity_value">
```

Entity_ value: quoted string not containing special characters

‘&’ ,‘%’,‘“’, ‘;’

Example:

```
<?xml version="1.0‟ ?>
<!DOCTYPE author [
   <!ELEMENT author (#PCDATA)>
  <!ENTITY js "Jo Smith"> ]>
<author>&js;</author>
```

EXTERNAL (PARSED) GENERAL ENTITY:

```
<!ENTITY name SYSTEM "URI">
<!ENTITY name PUBLIC "public_ID" "URI">
```

- URI, public_ID, similar as in external DTD defnition.
- Reference text which is shared among different documents

Example:

```
<?xml version="1.0‟ ?>
<!DOCTYPE copyright [
     <!ELEMENT copyright (#PCDATA)>
     <!ENTITY c SYSTEM "http://www.xmlwriter.net/copyright.xml">
]>
<copyright>&c;</copyright>
```

or:

```
<?xml version="1.0" standalone="no" ?>
<!DOCTYPE copyright [
     <!ELEMENT copyright (#PCDATA)>
     <!ENTITY c PUBLIC "-//W3C//TEXT copyright//EN" "http://www.w3.org/xmlspec/copyright.xml">
]>
<copyright>&c;</copyright>
```

EXTERNAL (UNPARSED) GENERAL ENTITY:

```
<!ENTITY name SYSTEM "URI" NDATA name>
<!ENTITY name PUBLIC "public_ID" "URI" NDATA name>
```

Example:

```
<?xml version="1.0" standalone="no" ?>
<!DOCTYPE img [
  <!ELEMENT img EMPTY>
  <!ATTLIST img src ENTITY #REQUIRED>
  <!ENTITY logo PUBLIC "-//W3C//GIF logo//EN"
  "http://www.w3.org/logo.gif" NDATA gif>
  <!NOTATION gif PUBLIC "gif viewer"> ]>
```

Entity declarations – **Parameter Entities:**

The PARAMETER ENTITY Declaration:

- The types of general entities include:
  - INTERNAL (PARSED)
  - EXTERNAL (PARSED)

These define entities only to be used **within the DTD**.

PARAMETER ENTITIES: %

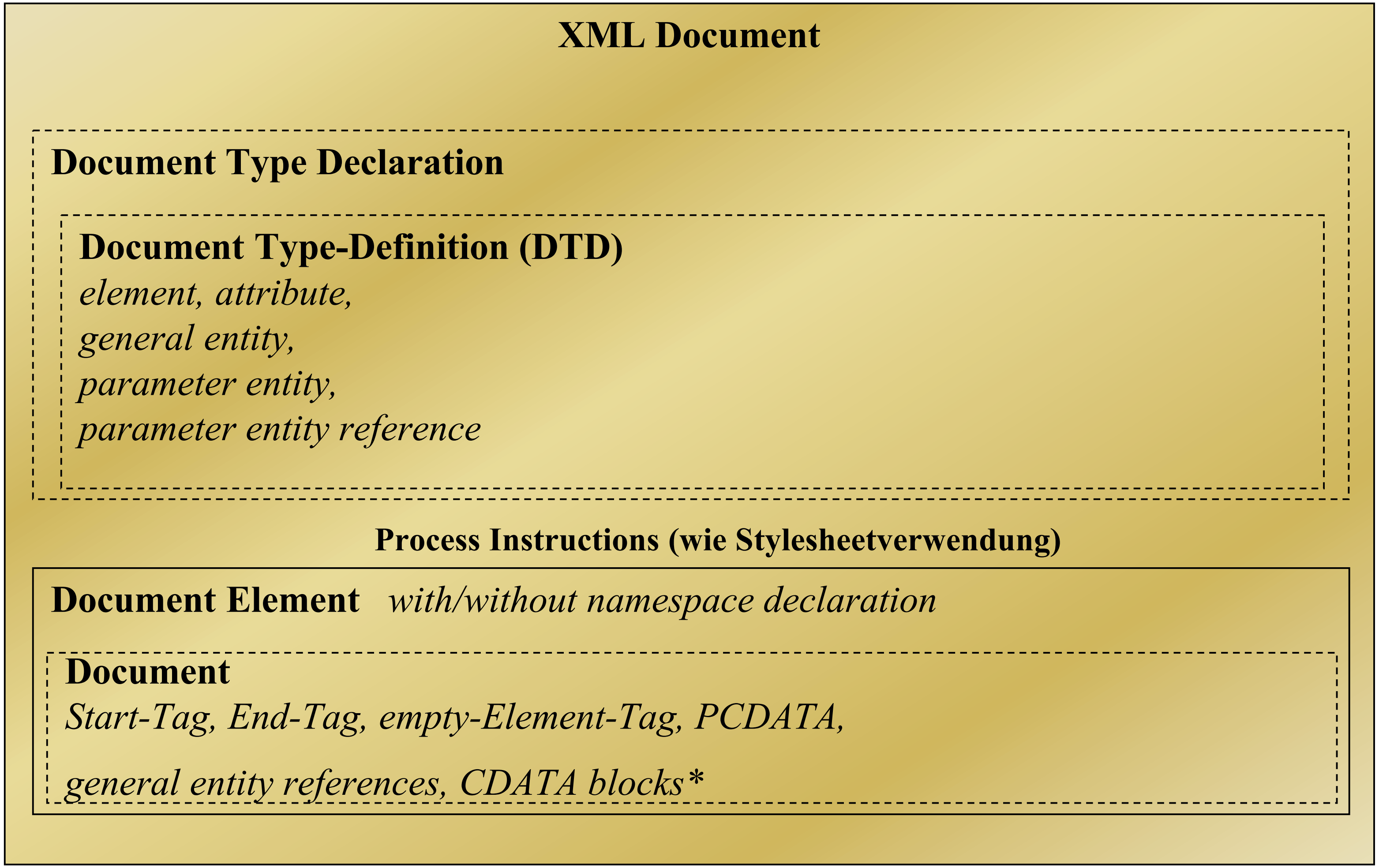
- **Internal** parameter entities define macros WITHIN the DTD, not to be used in the XML markup, e.g.:

```
<!ENTITY % p "(#PCDATA)">
<!ELEMENT student (id,surname,firstname)>
<!ELEMENT id %p;>
<!ELEMENT surname %p;>
<!ELEMENT firstname %p;>
```

- **External** parameter entity references are used to link external DTDs, e.g.:

```
<?xml version="1.0" ?>
<!DOCTYPE student [
        <!ENTITY % student SYSTEM
"http://www.university.com/student.dtd">
%student; ]>
```

So, we have…



XML Document

Document Type Declaration

Document Type-Definition (DTD)
element, attribute,
general entity,
parameter entity,
parameter entity reference

Process Instructions (wie Stylesheetverwendung)

Document Element *with/without namespace declaration*

Document
Start-Tag, End-Tag, empty-Element-Tag, PCDATA,

*general entity references, CDATA blocks**

[*] e.g.: `<![CDATA tterter& http://xyz.com dasdw]>` not “touched” by the parser

XML : Companion Standards

- **XML Namespaces** allow for modular document definition, multiple inheritance and collision avoidance
- **XPath** or the XML Path Language allows navigation of the document tree
- **XPointer** allows tree components as targets
- The **XML Linking Language** defines linking capability

XML : Companion Standards

- The **XML Style Language** defines presentation capability
- **XSLT** provides for the transformation of documents
- **XQuery** provides a powerful query and transformation language for XML
- **XML Schema** to allow DTDs to be defined as XML documents and to define custom data types in order for content value control

XML : XML Namespaces

- The XML namespaces recommendation defines a way to distinguish between duplicate element type and attribute names.
- An XML namespace is a collection of element type and attribute names. The namespace is identified by a unique name, which is a URI.
- XML namespaces are declared with an xmlns attribute, which can associate a prefix with the namespace.

Why namespaces?

```
<?xml version="1.0"?>
<classes xmlns="http://www.students.info/classes/ns/">
...
 <course>
    <title>Semantic Web</title>
    <type>recommended! :-)</type>

 </course>
...
</classes>
```

```
<?xml version="1.0"?>
<classes xmlns ="http://www.nuigalway.ie/schedule/ns/">
...
 <course>
    <title>Semantic Web</title>
    <type>lecture</type>
 </course>
...
</classes>
```

Same element, different meaning!

Namespaces, scope:

Elements and attributes in the subelements lie in the newly defined default namespace

```
<?xml version="1.0"?>
<teaching xmlns:stu="http://www.students.info/classes/ns/"
       xmlns:nuig="http://www.nuigalway.ie/schedule/ns/"
       xmlns="http://www.polleres.net/ri2007-namespace#">
...

 <course>
   <title>Semantic Web</title>
    <description xmlns="http://www.elsewhere.org/test">
    <title>Informationsverarbeitung</title>
    <topics>XML, Semantic Web, Web Services</topics>
    </ description >
    <stu:type>recommended! :-)</stu:type>
    <nuig:type>lecture</nuig:type>
 </course>
...
</teaching>
```

For XML, this is just the same:

```
<?xml version="1.0"?>
<teaching xmlns:student="http://www.students.info/classes/ns/"
       xmlns:nuig="http://www.nuigalway.ie/schedule/ns/"
       xmlns="http://www.polleres.net/ri2007-namespace#"
       xmlns:xyz="http://www.elsewhere.org/test">
...
 <course>
   <title>Recuperación de Información</title>
    <xyz:description>
    <xyz:title>Informationsverarbeitung</xyz:title>
    <xyz:topics>XML, Semantic Web, Web Services</xyz:topics>
    </xyz:description>
    <student:type>interesante! :-)</student:type>
    <nuig:type>lecture</nuig:type>
 </course>
...
</teaching>
```

Namespaces

- Don’t be confused by the use of URI! This is not necessarily a real resource but just a unique identifier!
  - Imprtant: A URI is not necessarily a document!!!
- ns can be overridden
- Prefixes: A namespace-aware XML application shall only use URI, not the prefix!

  i.e. a:element = b:element if a and b refer to the same URI

Some XML Tools

(many others available of course…)

- XML browsers
  - IE 5 supports XSL incompletely
  - Mozilla (Open Source), Netscape
  - InDelv XML Browser
  - Opera 6.0
  - Amaya (W3C Browser/Editor) (also MathML support!, no XSLT)
- XML editor types
  - Text-based with syntax highlight
  - Tree-based
  - pseudo-wysiwyg (for example, XMetaL uses Stylesheets for displaying)
- XML editors
  - XMLSpy, Oxygen
    - Visual DTD/Schema development
    - very extensive tools;
    - 30 days version available
  - XMetaL and XML Authority
  - Adobe Framemaker (SGML)
  - XML Notepad (simple, MS)
  - Microstar (XML Modelling Tools)

- XML Parser
  - Apache Xerces
- XSLT
  - E.g., Apache Xalan
- Databases
  - Tamino, Poet, Cache, ...
  - native vs. xml-enabled

References

- **XML:** http://www.w3.org/XML/
- **XML and DTD: Learning XML**, O'Reilly, 2001.
- **XML parsers:** http://xml.apache.org/
- Nice Tutorials on XML and related Tehnologies:
  http://ww.brics.dk/~amoeller/XML/
- Lectures by Robert Baumgartner (TU Vienna): http://www.dbai.tuwien.ac.at/staff/baumgart/
- Good Editors with validation: **XMLSpy, oXygen** (unfortunately commercial)
  http://www.xmlspy.com, http://www.oxygenxml.com/
- Quick tutorials on most important W3C standards
  (including XML,and companion standards): http://www.w3schools.com/