Chapter 2
Structured Web Documents in XML

Grigoris Antoniou
Frank van Harmelen

An HTML Example

```
<h2>Nonmonotonic Reasoning: Context-
   Dependent Reasoning</h2>
<i>by <b>V. Marek</b> and
   <b>M. Truszczynski</b></i><br>
Springer 1993<br>
ISBN 0387976892
```

The Same Example in XML

```
<book>
    <title>Nonmonotonic Reasoning: Context-
        Dependent Reasoning</title>
    <author>V. Marek</author>
    <author>M. Truszczynski</author>
    <publisher>Springer</publisher>
    <year>1993</year>
    <ISBN>0387976892</ISBN>
</book>
```

HTML versus XML: Similarities

- Both use tags (e.g. <h2> and </year>)
- Tags may be nested (tags within tags)
- Human users can read and interpret both HTML and XML representations quite easily

… But how about machines?

Problems with Automated Interpretation of HTML Documents

An intelligent agent trying to retrieve the names of the authors of the book

- Authors' names could appear immediately after the title
- or immediately after the word by
- Are there two authors?
- Or just one, called "V. Marek and M. Truszczynski"?

HTML vs XML: Structural Information

- HTML documents do not contain structural information: pieces of the document and their relationships.
- XML more easily accessible to machines because
  - Every piece of information is described.
  - Relations are also defined through the nesting structure.
  - E.g., the **<author>** tags appear within the **<book>** tags, so they describe properties of the particular book.

HTML vs XML: Structural Information (2)

- A machine processing the XML document would be able to deduce that
  - the **author** element refers to the enclosing **book** element
  - rather than by proximity considerations
- XML allows the definition of constraints on values
  - E.g. a year must be a number of four digits

HTML vs XML: Formatting

- The HTML representation provides more than the XML representation:
  - The formatting of the document is also described
- The main use of an HTML document is to display information: it must define formatting
- XML: separation of content from display
  - same information can be displayed in different ways

HTML vs XML: Another Example

- In HTML

  <h2>Relationship force-mass</h2>
   F = M × a
- In XML

  <equation>
  <meaning>Relationship force-mass</meaning>
  <leftside> F </leftside>
  <rightside> M × a </rightside>
  </equation>

HTML vs XML: Different Use of Tags

- In both HTML docs same tags
- In XML completely different

- HTML tags define display: color, lists …
- XML tags not fixed: user definable tags
- XML meta markup language: language for defining markup languages

XML Vocabularies

- Web applications must agree on common vocabularies to communicate and collaborate
- Communities and business sectors are defining their specialized vocabularies
  - mathematics (MathML)
  - bioinformatics (BSML)
  - human resources (HRML)
  - …

Lecture Outline

1. Introduction
2. Detailed Description of XML
3. Structuring
   a) DTDs
   b) XML Schema
4. Namespaces
5. Accessing, querying XML documents: XPath
6. Transformations: XSLT

The XML Language

An XML document consists of

- a prolog
- a number of elements
- an optional epilog (not discussed)

Prolog of an XML Document

The prolog consists of

- an XML declaration and
- an optional reference to external structuring documents

<?xml version="1.0" encoding="UTF-16"?>

<!DOCTYPE book SYSTEM "book.dtd">

XML Elements

- The “things” the XML document talks about
  - E.g. books, authors, publishers
- An element consists of:
  - an opening tag
  - the content
  - a closing tag

<lecturer>David Billington</lecturer>

XML Elements (2)

- Tag names can be chosen almost freely.
- The first character must be a letter, an underscore, or a colon
- No name may begin with the string “xml” in any combination of cases
  - E.g. “Xml”, “xML”

Content of XML Elements

- Content may be text, or other elements, or nothing

```
<lecturer>
    <name>David Billington</name>
    <phone> +61 – 7 – 3875 507 </phone>
</lecturer>
```

- If there is no content, then the element is called empty; it is abbreviated as follows:
  <lecturer/> for **<lecturer></lecturer>**

XML Attributes

- An empty element is not necessarily meaningless
  - It may have some properties in terms of attributes
- An attribute is a name-value pair inside the opening tag of an element

  <lecturer name="David Billington" phone="+61 − 7 − 3875 507"/>

XML Attributes: An Example

```
<order orderNo="23456" customer="John Smith"
        date="October 15, 2002">
        <item itemNo="a528" quantity="1"/>
        <item itemNo="c817" quantity="3"/>
</order>
```

The Same Example without Attributes

```
<order>
    <orderNo>23456</orderNo>
    <customer>John Smith</customer>
    <date>October 15, 2002</date>
    <item>
        <itemNo>a528</itemNo>
        <quantity>1</quantity>
    </item>
    <item>
        <itemNo>c817</itemNo>
        <quantity>3</quantity>
        </item>
</order>
```

XML Elements vs Attributes

- Attributes can be replaced by elements
- When to use elements and when attributes is a matter of taste
- But attributes **cannot** be nested

Further Components of XML Docs

- Comments
  - A piece of text that is to be ignored by parser
  - **<!-- This is a comment -->**
- Processing Instructions (PIs)
  - Define procedural attachments
  - **<?stylesheet type="text/css" href="mystyle.css"?>**

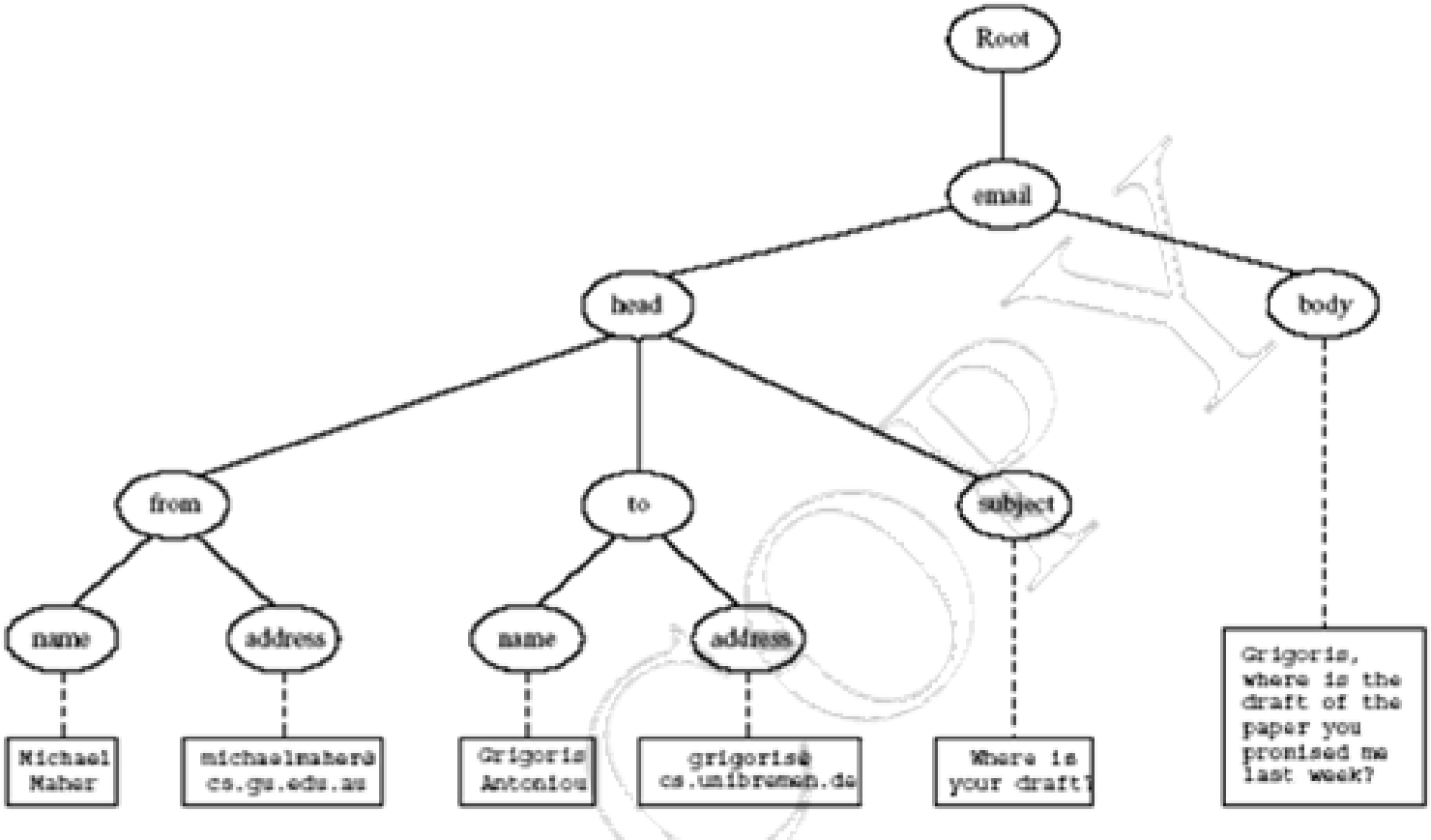
Well-Formed XML Documents

- Syntactically correct documents
- Some syntactic rules:
  - Only one outermost element (called root element)
  - Each element contains an opening and a corresponding closing tag
  - Tags may not overlap
    - **<author><name>Lee Hong</author></name>**
  - Attributes within an element have unique names
  - Element and tag names must be permissible

The Tree Model of XML Documents: An Example

```
<email>
    <head>
        <from name="Michael Maher"
              address="michaelmaher@cs.gu.edu.au"/>
        <to name="Grigoris Antoniou"
              address="grigoris@cs.unibremen.de"/>
        <subject>Where is your draft?</subject>
    </head>
    <body>
        Grigoris, where is the draft of the paper you promised me
        last week?
    </body>
</email>
```

The Tree Model of XML Documents: An Example (2)



The Tree Model of XML Docs

- The tree representation of an XML document is an ordered labeled tree:
  - There is exactly one root
  - There are no cycles
  - Each non-root node has exactly one parent
  - Each node has a label.
  - The order of elements is important
  - … but the order of attributes is not important

Lecture Outline

1. Introduction
2. Detailed Description of XML
3. Structuring
   a) DTDs
   b) XML Schema
4. Namespaces
5. Accessing, querying XML documents: XPath
6. Transformations: XSLT

Structuring XML Documents

- Define all the element and attribute names that may be used
- Define the structure
  - what values an attribute may take
  - which elements may or must occur within other elements, etc.
- If such structuring information exists, the document can be **validated**

Structuring XML Dcuments (2)

- An XML document is valid if
  - it is well-formed
  - respects the structuring information it uses
- There are two ways of defining the structure of XML documents:
  - DTDs (the older and more restricted way)
  - XML Schema (offers extended possibilities)

DTD: Element Type Definition

```
<lecturer>
    <name>David Billington</name>
    <phone> +61 – 7 – 3875 507 </phone>
</lecturer>
```

DTD for above element (and all **lecturer** elements):

```
<!ELEMENT lecturer (name,phone)>
<!ELEMENT name (#PCDATA)>
<!ELEMENT phone (#PCDATA)>
```

The Meaning of the DTD

- The element types **lecturer**, **name**, and **phone** may be used in the document
- A **lecturer** element contains a **name** element and a **phone** element, in that order (*sequence*)
- A **name** element and a **phone** element may have any content
- In DTDs, **#PCDATA** is the only atomic type for elements

DTD: Disjunction in Element Type Definitions

- We express that a **lecturer** element contains *either* a **name** element *or* a **phone** element as follows:

  <!ELEMENT lecturer (name|phone)>

- A **lecturer** element contains a **name** element and a **phone** element in *any order*.

  <!ELEMENT lecturer((name,phone)|(phone,name))>

Example of an XML Element

```
<order orderNo="23456"
                    customer="John Smith"
                    date="October 15, 2002">
      <item itemNo="a528" quantity="1"/>
      <item itemNo="c817" quantity="3"/>
</order>
```

The Corresponding DTD

```
<!ELEMENT order (item+)>
<!ATTLIST order     orderNo     ID      #REQUIRED
                    customer    CDATA   #REQUIRED
                    date        CDATA   #REQUIRED>

<!ELEMENT item EMPTY>
<!ATTLIST item      itemNo      ID      #REQUIRED
                    quantity    CDATA   #REQUIRED
                    comments    CDATA   #IMPLIED>
```

Comments on the DTD

- The **item** element type is defined to be empty
- **+** (after **item)** is a cardinality operator:
  - **?**: appears zero times or once
  - ***:** appears zero or more times
  - **+**: appears one or more times
  - No cardinality operator means exactly once

Comments on the DTD (2)

- In addition to defining elements, we define attributes
- This is done in an attribute list containing:
  - Name of the element type to which the list applies
  - A list of triplets of attribute name, attribute type, and value type
- *Attribute name*: A name that may be used in an XML document using a DTD

DTD: Attribute Types

- Similar to predefined data types, but limited selection
- The most important types are
  - **CDATA**, a string (sequence of characters)
  - **ID**, a name that is unique across the entire XML document
  - **IDREF**, a reference to another element with an ID attribute carrying the same value as the IDREF attribute
  - **IDREFS**, a series of IDREFs
  - **(v1| . . . |vn)**, an enumeration of all possible values
- Limitations: no dates, number ranges etc.

DTD: Attribute Value Types

- **#REQUIRED**
  - Attribute must appear in every occurrence of the element type in the XML document
- **#IMPLIED**
  - The appearance of the attribute is optional
- **#FIXED "value"**
  - Every element must have this attribute
- **"value"**
  - This specifies the default value for the attribute

Referencing with IDREF and IDREFS

```
<!ELEMENT family (person*)>
<!ELEMENT person (name)>
<!ELEMENT name (#PCDATA)>
<!ATTLIST person   id        ID        #REQUIRED
                   mother    IDREF     #IMPLIED
                   father    IDREF     #IMPLIED
                   children  IDREFS    #IMPLIED>
```

An XML Document Respecting the DTD

```
<family>
        <person id="bob" mother="mary" father="peter">
                <name>Bob Marley</name>
        </person>
        <person id="bridget" mother="mary">
                <name>Bridget Jones</name>
        </person>
        <person id="mary" children="bob bridget">
                <name>Mary Poppins</name>
        </person>
        <person id="peter" children="bob">
                <name>Peter Marley</name>
        </person>
</family>
```

XML Entities

- An XML entity can play the role of
  - a placeholder for repeatable characters
  - a section of external data
  - a part of a declaration for elements

- We can use the entity reference *&thisyear* instead of the value *" 2007 "*

  <!ENTITY thisyear " 2007 " >

A DTD for an Email Element

```
<!ELEMENT email (head,body)>
<!ELEMENT head (from,to+,cc*,subject)>
<!ELEMENT from EMPTY>
<!ATTLIST from    name    CDATA    #IMPLIED
                  address CDATA    #REQUIRED>
<!ELEMENT to EMPTY>
<!ATTLIST to      name    CDATA    #IMPLIED
                  address CDATA    #REQUIRED>
```

A DTD for an Email Element (2)

```
<!ELEMENT cc EMPTY>
<!ATTLIST cc      name        CDATA     #IMPLIED
                  address     CDATA     #REQUIRED>
<!ELEMENT subject (#PCDATA)>
<!ELEMENT body (text,attachment*)>
<!ELEMENT text (#PCDATA)>
<!ELEMENT attachment EMPTY>
<!ATTLIST attachment
                  encoding    (mime|binhex) "mime"
                  file        CDATA         #REQUIRED>
```

Interesting Parts of the DTD

- A **head** element contains (in that order):
  - a **from** element
  - at least one **to** element
  - zero or more **cc** elements
  - a **subject** element
- In **from**, **to**, and **cc** elements
  - the **name** attribute is not required
  - the **address** attribute is always required

Interesting Parts of the DTD (2)

- A **body** element contains
  - a **text** element
  - possibly followed by a number of **attachment** elements
- The **encoding** attribute of an **attachment** element must have either the value "**mime**" or "**binhex**"
  - "**mime**" is the default value

Remarks on DTDs

- A DTD can be interpreted as an Extended Backus-Naur Form (EBNF)
  - **<!ELEMENT email (head,body)>**
  - is equivalent to **email ::= head body**
- Recursive definitions possible in DTDs
  - **<!ELEMENT bintree**
    ((bintree root bintree)|emptytree)>

Lecture Outline

1. Introduction
2. Detailed Description of XML
3. Structuring
   a) DTDs
   b) XML Schema
4. Namespaces
5. Accessing, querying XML documents: XPath
6. Transformations: XSLT

XML Schema

- Significantly richer language for defining the structure of XML documents
- Tts syntax is based on XML itself
  - not necessary to write separate tools
- Reuse and refinement of schemas
  - Expand or delete already existent schemas
- Sophisticated set of data types, compared to DTDs (which only supports strings)

XML Schema (2)

- An XML schema is an element with an opening tag like

<schema
"http://www.w3.org/2000/10/XMLSchema"
version="1.0">

- Structure of schema elements
  - Element and attribute types using data types

Element Types

```
<element name="email"/>
<element name="head" minOccurs="1"
   maxOccurs="1"/>
<element name="to" minOccurs="1"/>
```

Cardinality constraints:

- **minOccurs="x"** (default value 1)
- **maxOccurs="x"** (default value 1)
- Generalizations of *,?,+ offered by DTDs

Attribute Types

<attribute name="id" type="ID“
use="required"/>

< attribute name="speaks" type="Language"
use="default" value="en"/>

- Existence: **use="x",** where **x** may be **optional** or **required**
- Default value: **use="x" value="..."**, where **x** may be **default** or **fixed**

Data Types

- There is a variety of built-in data types
  - Numerical data types: **integer**, **Short** etc.
  - String types: **string**, **ID**, **IDREF**, **CDATA** etc.
  - Date and time data types: **time**, **Month** etc.
- There are also user-defined data types
  - simple data types, which cannot use elements or attributes
  - complex data types, which can use these

Data Types (2)

- Complex data types are defined from already existing data types by defining some attributes (if any) and using:
  - **sequence**, a sequence of existing data type elements (order is important)
  - **all**, a collection of elements that must appear (order is not important)
  - **choice**, a collection of elements, of which one will be chosen

A Data Type Example

```
<complexType name="lecturerType">
    <sequence>
        <element name="firstname" type="string"
            minOccurs="0“   maxOccurs="unbounded"/>
        <element name="lastname" type="string"/>
    </sequence>
    <attribute name="title" type="string"
        use="optional"/>
</complexType>
```

Data Type Extension

- Already existing data types can be extended by new elements or attributes. Example:

```
<complexType name="extendedLecturerType">
    <extension base="lecturerType">
        <sequence>
            <element name="email" type="string"
                minOccurs="0" maxOccurs="1"/>
        </sequence>
        <attribute name="rank" type="string" use="required"/>
    </extension>
</complexType>
```

Resulting Data Type

```
<complexType name="extendedLecturerType">
    <sequence>
        <element name="firstname" type="string"
                 minOccurs="0" maxOccurs="unbounded"/>
        <element name="lastname" type="string"/>
        <element name="email" type="string"
                 minOccurs="0" maxOccurs="1"/>
    </sequence>
    <attribute name="title" type="string" use="optional"/>
    <attribute name="rank" type="string" use="required"/>
</complexType>
```

Data Type Extension (2)

- A hierarchical relationship exists between the original and the extended type
  - Instances of the extended type are also instances of the original type
  - They may contain additional information, but neither less information, nor information of the wrong type

Data Type Restriction

- An existing data type may be restricted by adding constraints on certain values
- Restriction is not the opposite from extension
  - Restriction is not achieved by deleting elements or attributes
- The following hierarchical relationship still holds:
  - Instances of the restricted type are also instances of the original type
  - They satisfy at least the constraints of the original type

Example of Data Type Restriction

```
<complexType name="restrictedLecturerType">
      <restriction base="lecturerType">
            <sequence>
                  <element name="firstname" type="string"
                        minOccurs="1" maxOccurs="2"/>
             </sequence>
             <attribute name="title" type="string"
                  use="required"/>
            </restriction>
</complexType>
```

Restriction of Simple Data Types

```
<simpleType name="dayOfMonth">
        <restriction base="integer">
                <minInclusive value="1"/>
                <maxInclusive value="31"/>
        </restriction>
</simpleType>
```

Data Type Restriction: Enumeration

```
<simpleType name="dayOfWeek">
        <restriction base="string">
                <enumeration value="Mon"/>
                <enumeration value="Tue"/>
                <enumeration value="Wed"/>
                <enumeration value="Thu"/>
                <enumeration value="Fri"/>
                <enumeration value="Sat"/>
                <enumeration value="Sun"/>
        </restriction>
</simpleType>
```

XML Schema: The Email Example

```
<element name="email" type="emailType"/>

<complexType name="emailType">
    <sequence>
        <element name="head" type="headType"/>
        <element name="body" type="bodyType"/>
    </sequence>
</complexType>
```

XML Schema: The Email Example (2)

```
<complexType name="headType">
    <sequence>
        <element name="from" type="nameAddress"/>
        <element name="to" type="nameAddress"
                 minOccurs="1" maxOccurs="unbounded"/>
        <element name="cc" type="nameAddress"
                 minOccurs="0" maxOccurs="unbounded"/>
        <element name="subject" type="string"/>
    </sequence>
</complexType>
```

XML Schema: The Email Example (3)

```
<complexType name="nameAddress">
        <attribute name="name" type="string"
        use="optional"/>
        <attribute name="address"
        type="string" use="required"/>
</complexType>
```

- Similar for **bodyType**

Lecture Outline

1. Introduction
2. Detailed Description of XML
3. Structuring
   a) DTDs
   b) XML Schema
4. Namespaces
5. Accessing, querying XML documents: XPath
6. Transformations: XSLT

Namespaces

- An XML document may use more than one DTD or schema
- Since each structuring document was developed independently, name clashes may appear
- The solution is to use a different prefix for each DTD or schema
  - **prefix:name**

An Example

```
<vu:instructors   xmlns:vu="http://www.vu.com/empDTD"
                  xmlns:gu="http://www.gu.au/empDTD"
                  xmlns:uky="http://www.uky.edu/empDTD">

    <uky:faculty  uky:title="assistant professor"
                  uky:name="John Smith"
                  uky:department="Computer Science"/>

<gu:academicStaff     gu:title="lecturer"
                      gu:name="Mate Jones"
                      gu:school="Information Technology"/>
</vu:instructors>
```

Namespace Declarations

- Namespaces are declared within an element and can be used in that element and any of its children (elements and attributes)
- A namespace declaration has the form:
  - **xmlns:prefix="location"**
  - **location** is the address of the DTD or schema
- If a prefix is not specified: **xmlns="location"** then the **location** is used by default

Lecture Outline

1. Introduction
2. Detailed Description of XML
3. Structuring
   a) DTDs
   b) XML Schema
4. Namespaces
5. Accessing, querying XML documents: XPath
6. Transformations: XSLT

Addressing and Querying XML Documents

- In relational databases, parts of a database can be selected and retrieved using SQL
  - Same necessary for XML documents
  - Query languages: XQuery, XQL, XML-QL
- The central concept of XML query languages is a path expression
  - Specifies how a node or a set of nodes, in the tree representation of the XML document can be reached

XPath

- XPath is core for XML query languages
- Language for addressing parts of an XML document.
  - It operates on the tree data model of XML
  - It has a non-XML syntax

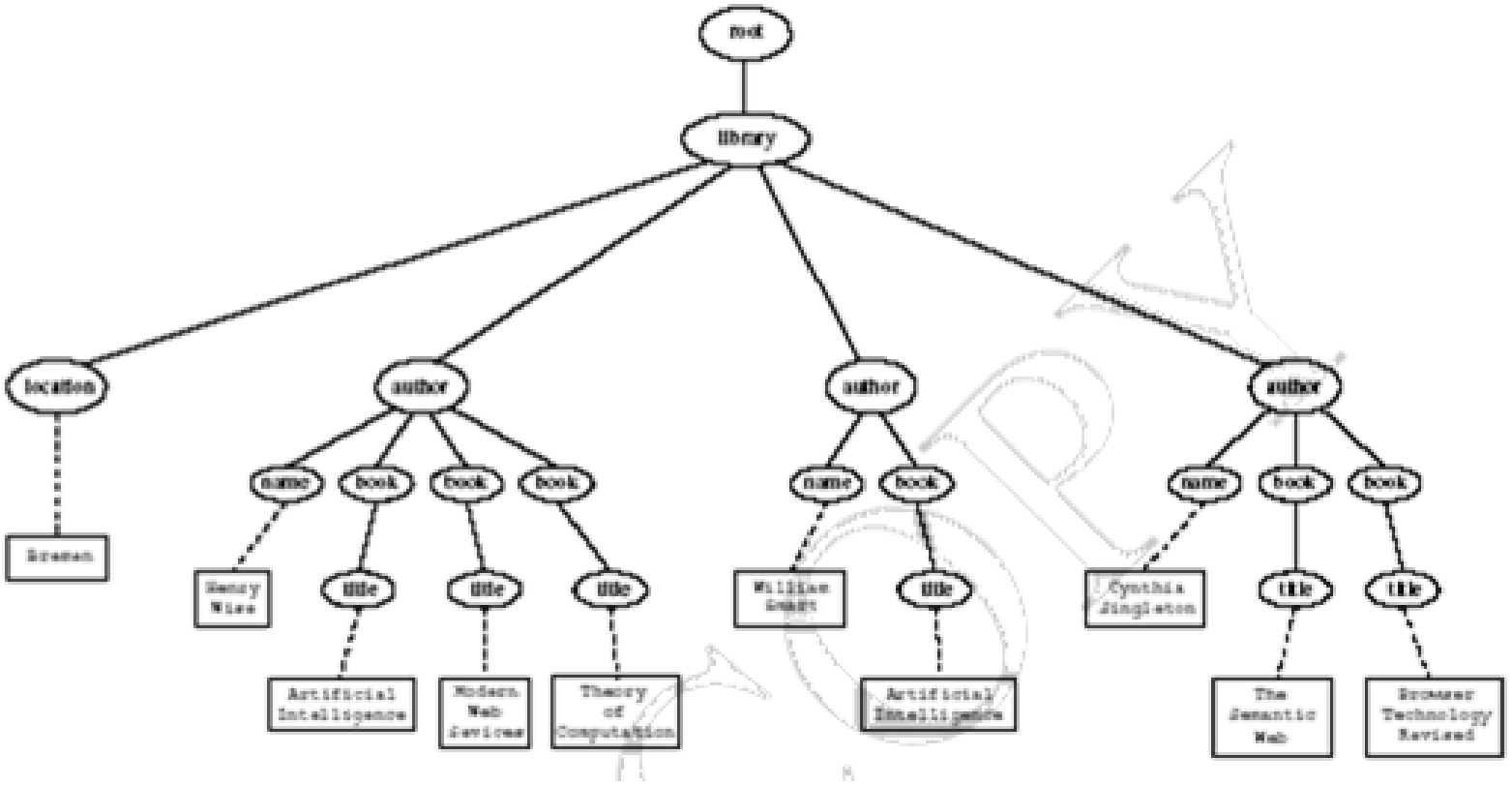
Types of Path Expressions

- **Absolute** (starting at the root of the tree)
  - Syntactically they begin with the symbol ***/***
  - It refers to the root of the document (situated one level above the root element of the document)
- **Relative** to a context node

An XML Example

```
<library location="Bremen">
    <author name="Henry Wise">
        <book title="Artificial Intelligence"/>
        <book title="Modern Web Services"/>
        <book title="Theory of Computation"/>
    </author>
    <author name="William Smart">
        <book title="Artificial Intelligence"/>
    </author>
    <author name="Cynthia Singleton">
        <book title="The Semantic Web"/>
        <book title="Browser Technology Revised"/>
    </author>
</library>
```

Tree Representation



Examples of Path Expressions in XPath

- Address all **author** elements

  /library/author

- Addresses all **author** elements that are children of the **library** element node, which resides immediately below the root
- **/t1/.../tn**, where each **ti+1** is a child node of **ti**, is a path through the tree representation

Examples of Path Expressions in XPath (2)

- Address all **author** elements

  //author

- Here **//** says that we should consider all elements in the document and check whether they are of type **author**
- This path expression addresses all **author** elements anywhere in the document

Examples of Path Expressions in XPath (3)

- Address the location attribute nodes within library element nodes

  /library/@location

- The symbol @ is used to denote attribute nodes

Examples of Path Expressions in XPath (4)

- Address all **title** attribute nodes within **book** elements anywhere in the document, which have the value “Artificial Intelligence”

  //book/@title="Artificial Intelligence"

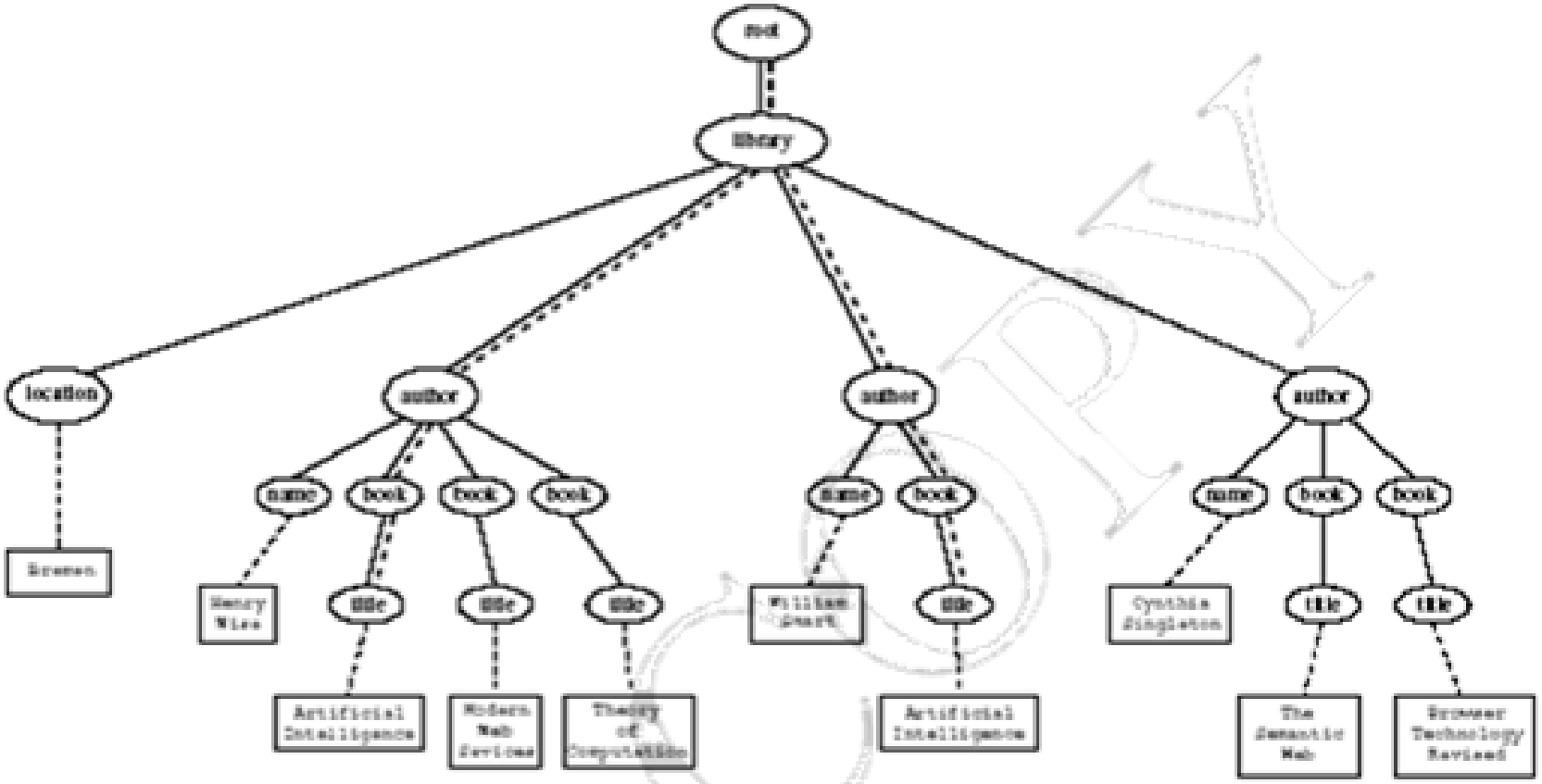
Examples of Path Expressions in XPath (5)

- Address all books with title “Artificial Intelligence”

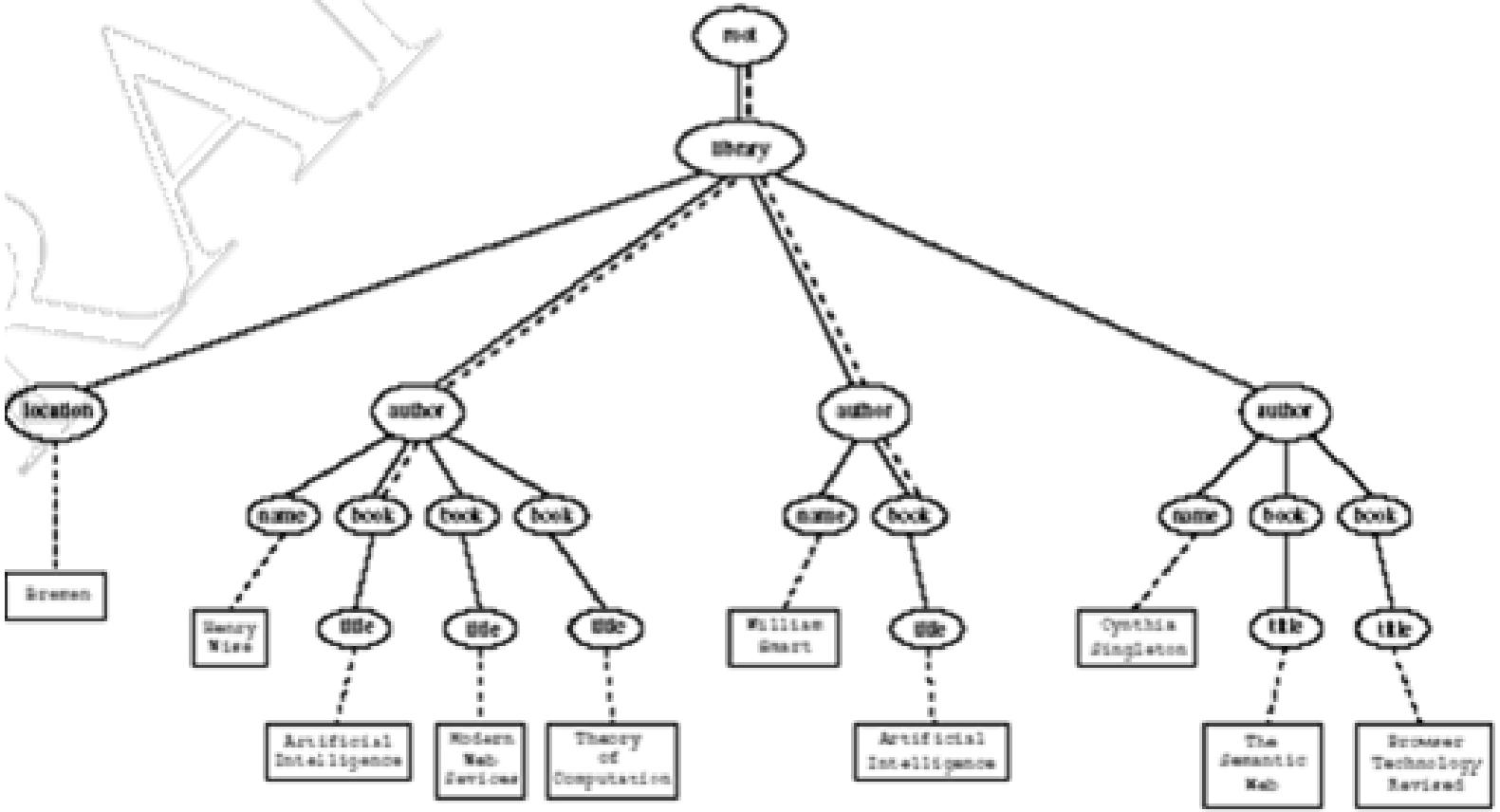
  /book[@title="Artificial Intelligence"]

- Test within square brackets: a filter expression
  - It restricts the set of addressed nodes.
- Difference with query 4.
  - Query 5 addresses **book** elements, the **title** of which satisfies a certain condition.
  - Query 4 collects **title** attribute nodes of **book** elements

Tree Representation of Query 4



Tree Representation of Query 5



Examples of Path Expressions in XPath (6)

- Address the first author element node in the XML document

  //author[1]

- Address the last book element within the first author element node in the document

  //author[1]/book[last()]

- Address all book element nodes without a title attribute

  //book[not @title]

General Form of Path Expressions

- A path expression consists of a series of steps, separated by slashes
- A step consists of
  - An **axis specifier**,
  - A **node test**, and
  - An optional **predicate**

General Form of Path Expressions (2)

- An **axis specifier** determines the tree relationship between the nodes to be addressed and the context node
  - E.g. parent, ancestor, child (the default), sibling, attribute node
  - // is such an axis specifier: descendant or self

General Form of Path Expressions (3)

- A **node test** specifies which nodes to address
  - The most common node tests are element names
  - E.g., ***** addresses all element nodes
  - **comment()** addresses all comment nodes

General Form of Path Expressions (4)

- **Predicates** (or *filter expressions*) are optional and are used to refine the set of addressed nodes
  - E.g., the expression **[1]** selects the first node
  - **[position()=last()]** selects the last node
  - **[position() mod 2 =0]** selects the even nodes
- XPath has a more complicated full syntax.
  - We have only presented the abbreviated syntax

Lecture Outline

1. Introduction
2. Detailed Description of XML
3. Structuring
   a) DTDs
   b) XML Schema
4. Namespaces
5. Accessing, querying XML documents: XPath
6. Transformations: XSLT

Displaying XML Documents

```
<author>
    <name>Grigoris Antoniou</name>
    <affiliation>University of Bremen</affiliation>
    <email>ga@tzi.de</email>
</author>
```

may be displayed in different ways:

Grigoris Antoniou
University of Bremen
ga@tzi.de

Grigoris Antoniou
University of Bremen
ga@tzi.de

Style Sheets

- Style sheets can be written in various languages
  - E.g. CSS2 (cascading style sheets level 2)
  - XSL (extensible stylesheet language)
- XSL includes
  - a transformation language (XSLT)
  - a formatting language
  - Both are XML applications

XSL Transformations (XSLT)

- XSLT specifies rules with which an input XML document is transformed to
  - another XML document
  - an HTML document
  - plain text
- The output document may use the same DTD or schema, or a completely different vocabulary
- XSLT can be used independently of the formatting language

XSLT (2)

- Move data and metadata from one XML representation to another
- XSLT is chosen when applications that use different DTDs or schemas need to communicate
- XSLT can be used for machine processing of content without any regard to displaying the information for people to read.
- In the following we use XSLT only to display XML documents

XSLT Transformation into HTML

```
<xsl:template match="/author">
    <html>
        <head><title>An author</title></head>
        <body bgcolor="white">
            <b><xsl:value-of select="name"/></b><br />
            <xsl:value-of select="affiliation"/><br />
            <i><xsl:value-of select="email"/></i>
        </body>
    </html>
</xsl:template>
```

Style Sheet Output

```
<html>
    <head><title>An author</title></head>
    <body bgcolor="white">
        <b>Grigoris Antoniou</b><br>
        University of Bremen<br>
        <i>ga@tzi.de</i>
    </body>
</html>
```

Observations About XSLT

- XSLT documents are XML documents
  - XSLT resides on top of XML
- The XSLT document defines a template
  - In this case an HTML document, with some placeholders for content to be inserted
- **xsl:value-of** retrieves the value of an element and copies it into the output document
  - It places some content into the template

A Template

```
<html>
    <head><title>An author</title></head>
    <body bgcolor="white">
        <b>...</b><br>
        ...<br>
        <i>...</i>
    </body>
</html>
```

Auxiliary Templates

- We have an XML document with details of several authors
- It is a waste of effort to treat each **author** element separately
- In such cases, a special template is defined for **author** elements, which is used by the main template

Example of an Auxiliary Template

```
<authors>
    <author>
        <name>Grigoris Antoniou</name>
        <affiliation>University of Bremen</affiliation>
        <email>ga@tzi.de</email>
    </author>
    <author>
        <name>David Billington</name>
        <affiliation>Griffith University</affiliation>
        <email>david@gu.edu.net</email>
    </author>
</authors>
```

Example of an Auxiliary Template (2)

```
<xsl:template match="/">
   <html>
      <head><title>Authors</title></head>
      <body bgcolor="white">
         <xsl:apply-templates select="authors"/>
         <!-- Apply templates for AUTHORS
         children -->
      </body>
   </html>
</xsl:template>
```

Example of an Auxiliary Template (3)

```
<xsl:template match="authors">
    <xsl:apply-templates select="author"/>
</xsl:template>
<xsl:template match="author">
    <h2><xsl:value-of select="name"/></h2>
    Affiliation:<xsl:value-of
        select="affiliation"/><br>
    Email: <xsl:value-of select="email"/>
    <p>
</xsl:template>
```

Multiple Authors Output

```
<html>
    <head><title>Authors</title></head>
    <body bgcolor="white">
        <h2>Grigoris Antoniou</h2>
        Affiliation: University of Bremen<br>
        Email: ga@tzi.de
        <p>
        <h2>David Billington</h2>
        Affiliation: Griffith University<br>
        Email: david@gu.edu.net
        <p>
    </body>
</html>
```

Explanation of the Example

- **xsl:apply-templates** element causes all children of the context node to be matched against the selected path expression
  - E.g., if the current template applies to ***/***, then the element **xsl:apply-templates** applies to the root element
  - I.e. the **authors** element (***/*** is located above the root element)
  - If the current context node is the **authors** element, then the element **xsl:apply-templates select="author"** causes the template for the **author** elements to be applied to all **author** children of the **authors** element

Explanation of the Example (2)

- It is good practice to define a template for each element type in the document
  - Even if no specific processing is applied to certain elements, the **xsl:apply-templates** element should be used
  - E.g. **authors**
- In this way, we work from the root to the leaves of the tree, and **all** templates are applied

Processing XML Attributes

- Suppose we wish to transform to itself the element:

<person firstname="John" lastname="Woo"/>

- Wrong solution:

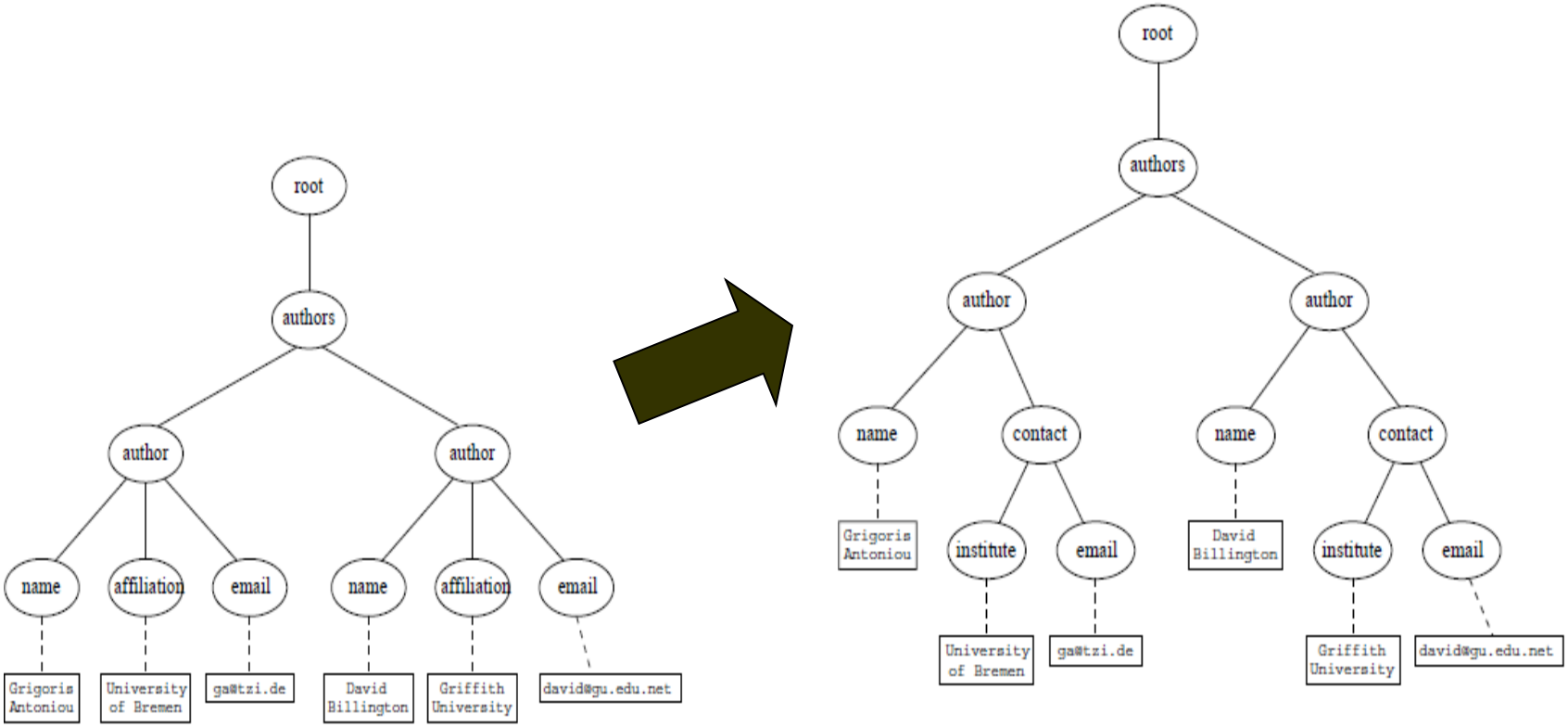
```
<xsl:template match="person">
   <person firstname="<xsl:value-of
   select="@firstname">"
   lastname="<xsl:value-of select="@lastname">"/>
</xsl:template>
```

Processing XML Attributes (2)

- Not well-formed because tags are not allowed within the values of attributes
- We wish to add attribute values into template

```
<xsl:template match="person">
        <person
        firstname="{@firstname}"
        lastname="{@lastname}"/>
</xsl:template>
```

Transforming an XML Document to Another



Transforming an XML Document to Another (2)

```
<xsl:template match="/">
    <?xml version="1.0" encoding="UTF-16"?>
    <authors>
            <xsl:apply-templates select="authors"/>
    </authors>
</xsl:template>

<xsl:template match="authors">
    <author>
            <xsl:apply-templates select="author"/>
    </author>
</xsl:template>
```

Transforming an XML Document to Another (3)

```
<xsl:template match="author">
    <name><xsl:value-of select="name"/></name>
    <contact>
        <institution>
            <xsl:value-of select="affiliation"/>
        </institution>
        <email><xsl:value-of select="email"/></email>
    </contact>
</xsl:template>
```

Summary

- XML is a metalanguage that allows users to define markup
- XML separates content and structure from formatting
- XML is the de facto standard for the representation and exchange of structured information on the Web
- XML is supported by query languages

Points for Discussion in Subsequent Chapters

- The nesting of tags does not have standard meaning
- The semantics of XML documents is not accessible to machines, only to people
- Collaboration and exchange are supported if there is underlying shared understanding of the vocabulary
- XML is well-suited for close collaboration, where domain- or community-based vocabularies are used
  - It is not so well-suited for global communication.