Chapter 2
Structured Web Documents in XML

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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"?>**

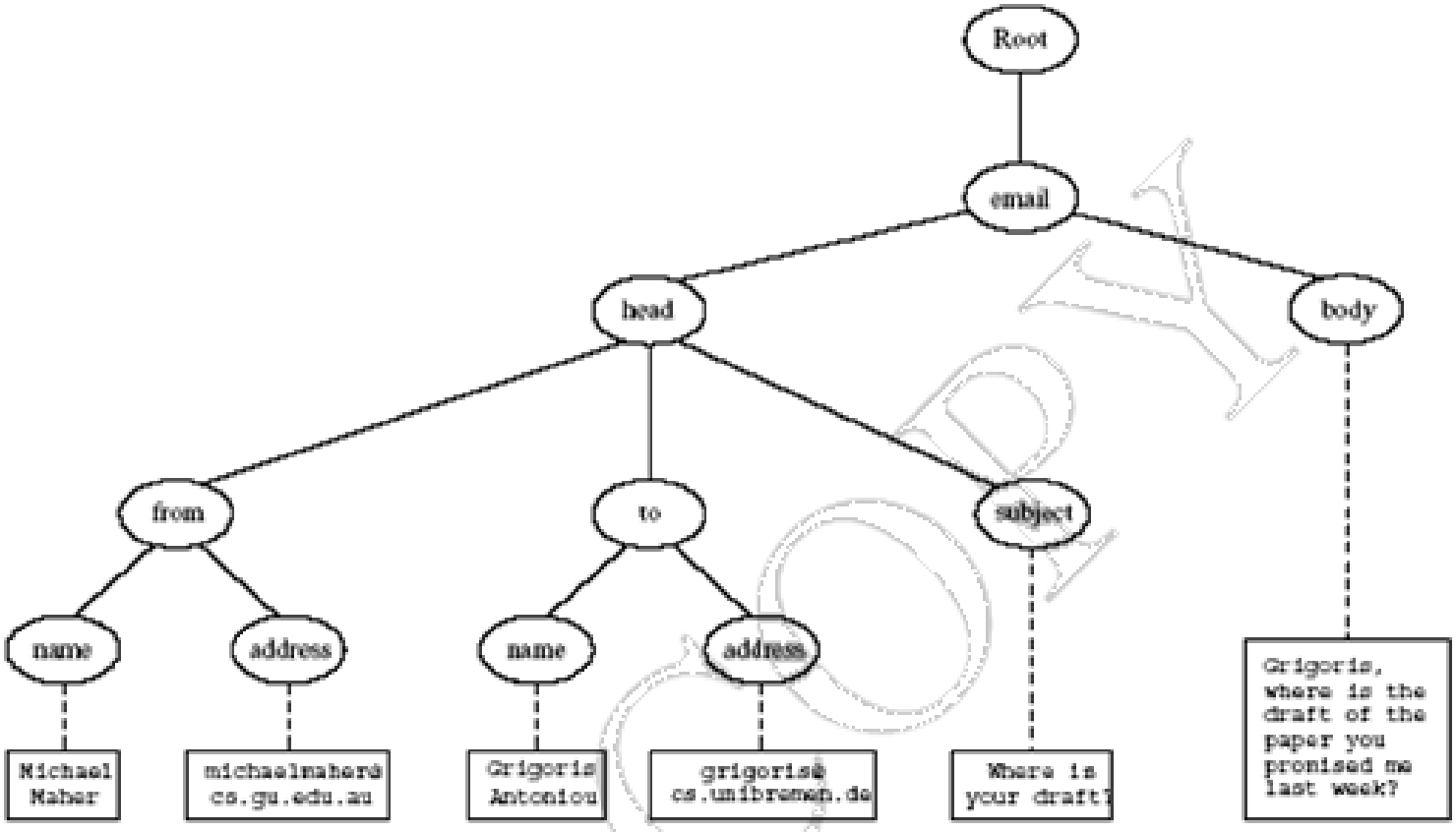
Well-Formed XML Documents

- 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

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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)>

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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**

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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

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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

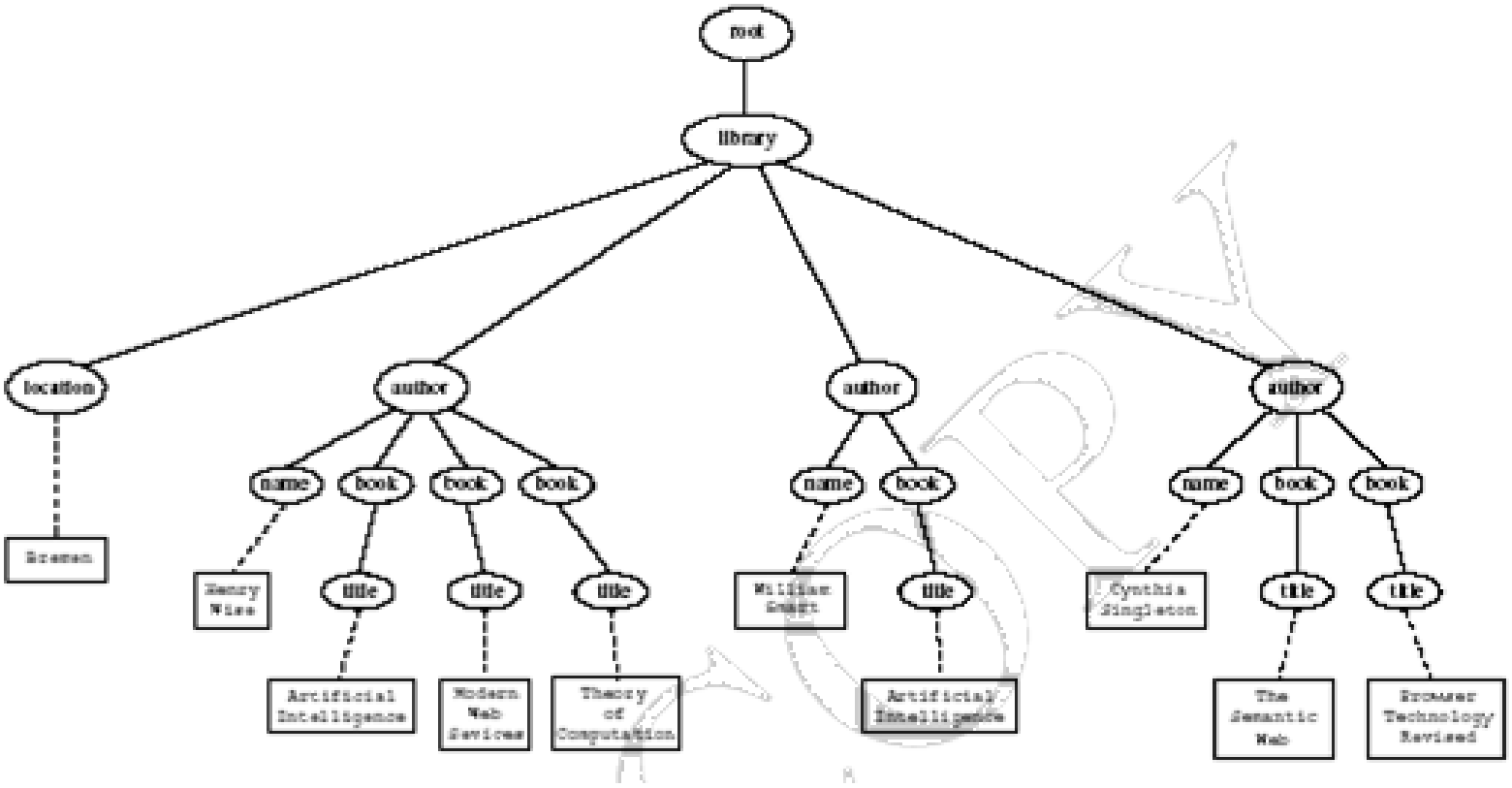
Types of Path Expressions

- **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"

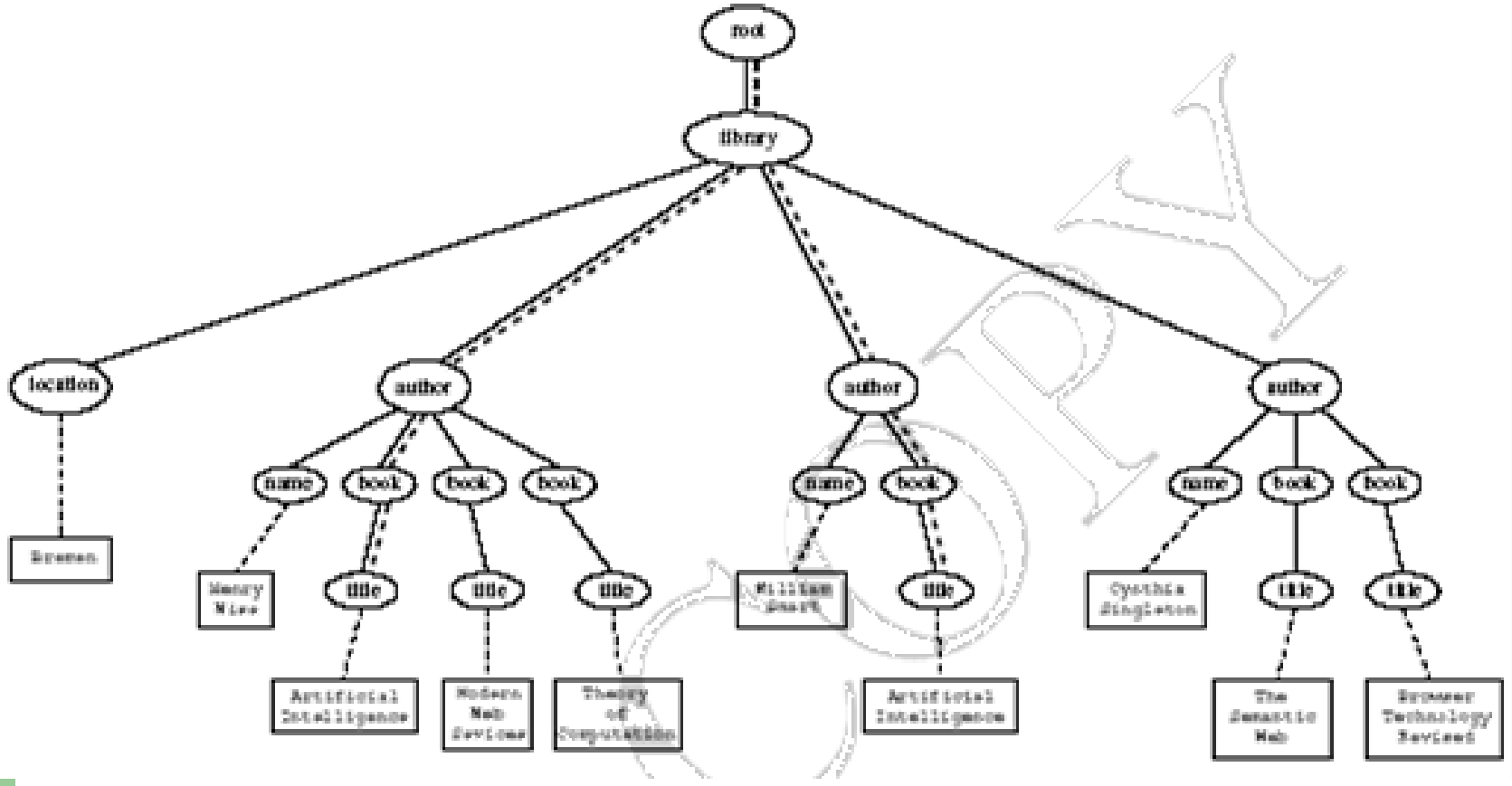
Examples of Path Expressions in XPath (5)

- Address all books with title “Artificial Intelligence”

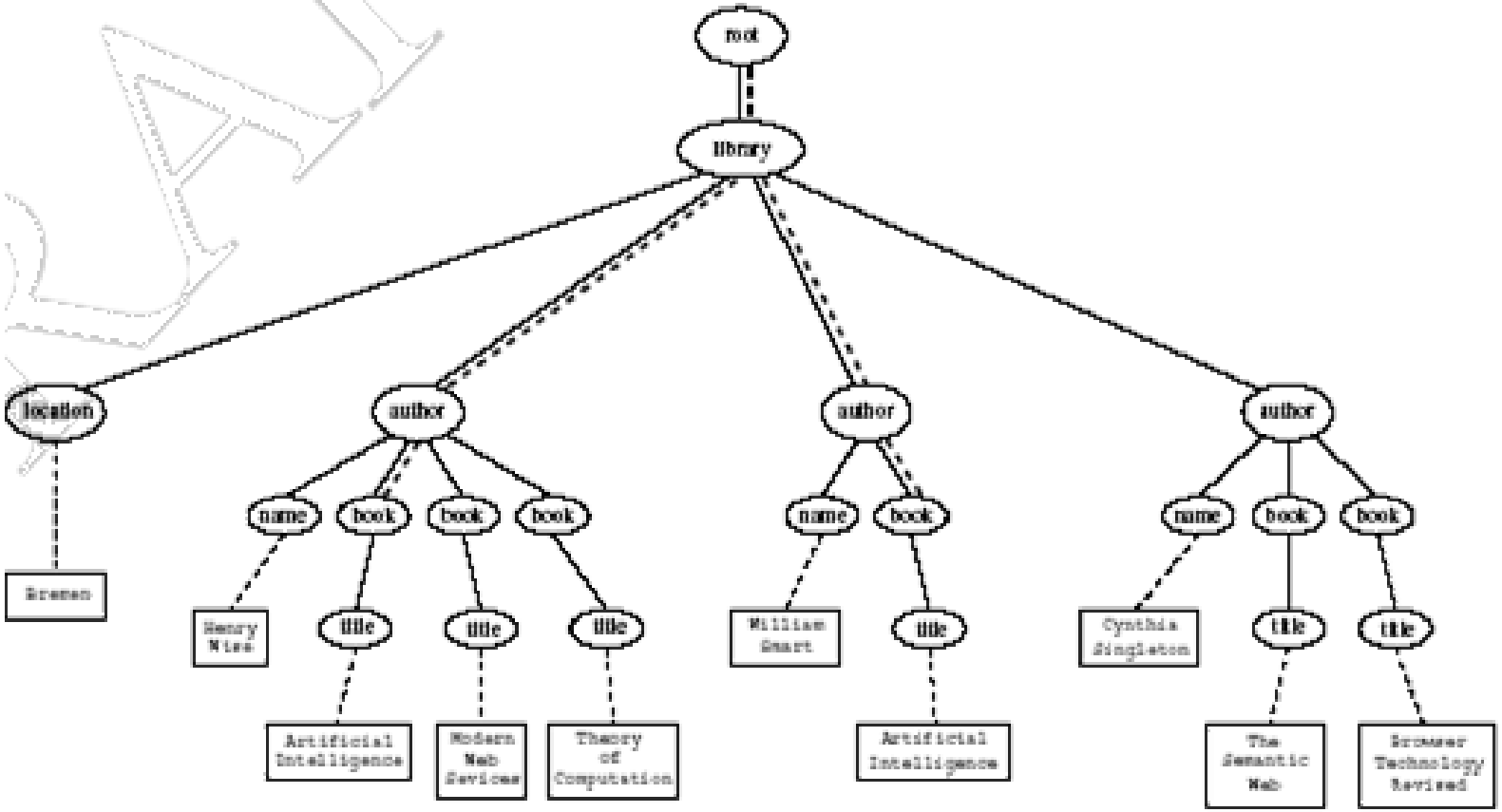
  /book[@title="Artificial Intelligence"]

- 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

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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:

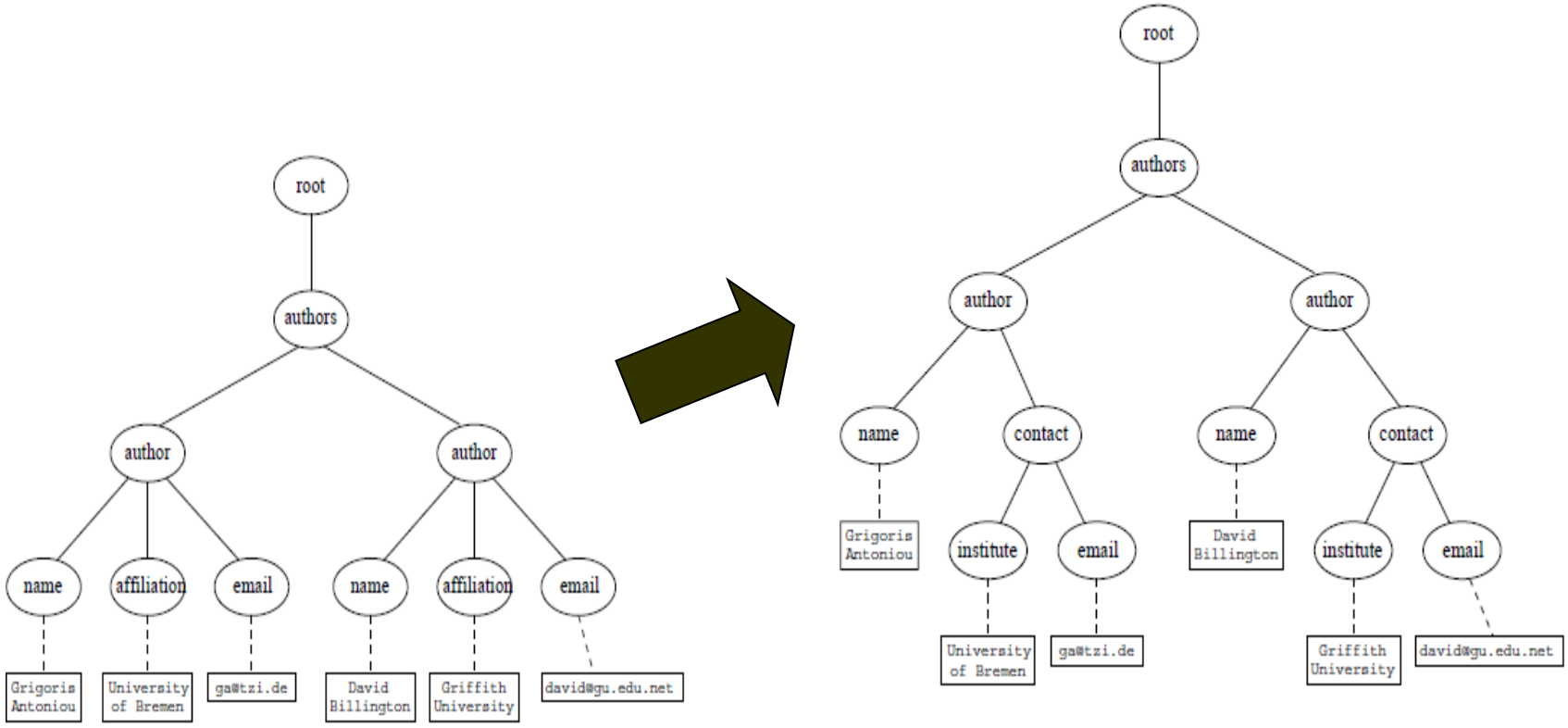
```
<xsl:template match="person">
   <person firstname="<xsl:value-of
   select="@firstname">"
   lastname="<xsl:value-of select="@lastname">"/>
</xsl:template>
```

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.