


XSLT

Introduction to Databases
CompSci 316 Fall 2016

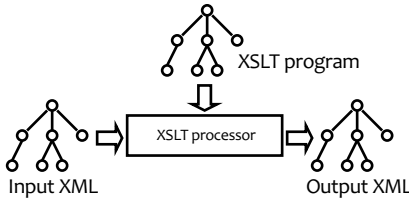


Announcements (Thu., Oct. 27)

- Homework #3 due in 1½ week
- Project milestone #2 due in 2 weeks

XSLT

- XML-to-XML rule-based transformation language
 - Used most frequently as a stylesheet language
 - An XSLT program is an XML document itself



Actually, output does not need to be in XML in general

XSLT program

- An XSLT program is an XML document containing
 - Elements in the `<xsl:>` namespace
 - Elements in user namespace
- Roughly, result of evaluating an XSLT program on an input XML document = the XSLT document where each `<xsl:>` element is replaced with the result of its evaluation
- Basic ideas
 - **Templates** specify how to transform matching input nodes
 - **Structural recursion** applies templates to input trees recursively
- Uses XPath as a sub-language

XSLT elements

- Element describing transformation rules
 - `<xsl:template>`
- Elements describing rule execution control
 - `<xsl:apply-templates>`
 - `<xsl:call-template>`
- Elements describing instructions
 - `<xsl:if>`, `<xsl:for-each>`, `<xsl:sort>`, etc.
- Elements generating output
 - `<xsl:value-of>`, `<xsl:copy-of>`, `<xsl:element>`, `<xsl:attribute>`, `<xsl:text>`, etc.

XSLT example

- Find titles of books authored by “Abiteboul”

```

{
<?xml version="1.0"?> Standard header of an XSLT document
<xsl:stylesheet
  xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
  version="2.0">
  <xsl:template match="book[author='Abiteboul']">
    <booktitle>
      <xsl:value-of select="title"/>
    </booktitle>
  </xsl:template>
</xsl:stylesheet>

```

- Not quite; we will see why later

<xsl:template>

```
<xsl:template match="book[author='Abiteboul']">
  <booktitle>
    <xsl:value-of select="title"/>
  </booktitle>
</xsl:template>
```

- `<xsl:template match="match_expr">` is the basic XSLT construct describing a transformation rule
 - `match_expr` is an XPath-like expression specifying which nodes this rule applies to
- `<xsl:value-of select="xpath_expr"/>` evaluates `xpath_expr` within the context of the node matching the template, and converts the result sequence to a string
- `<booktitle>` and `</booktitle>` simply get copied to the output for each node matched

Template in action

```
<xsl:template match="book[author='Abiteboul']">
  <booktitle>
    <xsl:value-of select="title"/>
  </booktitle>
</xsl:template>
```

• Example XML fragment

```
<book ISBN="ISBN-10" price="80.00">
  <title>Foundations of Databases</title>
  <author>Abiteboul</author>
  <author>Hull</author>
  <author>Vianu</author>
  <publisher>Addison Wesley</publisher>
  <year>1995</year>
  <section>...</section>...
</book>
<book ISBN="ISBN-20" price="40.00">
  <title>A First Course in Databases</title>
  <author>Ullman</author>
  <author>Widom</author>
  <publisher>Prentice-Hall</publisher>
  <year>2002</year>
  <section>...</section>...
</book>
```

```

} Template applies
  <booktitle>
    Foundations of Databases
  </booktitle>
} Template does not apply;
  default behavior is to process
  the node recursively and print
  all text nodes
  A First Course in Databases
  Ullman
  Widom
  Prentice-Hall
  2002
  ...

```

Removing the extra output

- Add the following template:

```
<xsl:template match="text()|@*" />
```

- This template matches all text and attributes
- XPath features
 - `text()` is a node test that matches any text node
 - `@*` matches any attribute
 - `|` means "or" in XPath
- Body of the rule is empty, so all text and attributes become empty string
 - This rule effectively filters out things not matched by the other rule

<xsl:element> and <xsl:attribute>

- Again, find titles of books authored by “Abiteboul,” but make the output look like `<BOOK title="booktitle"/>`

```

<xsl:template match="book[author='Abiteboul']">
<BOOK title="{normalize-space(title)}"/>
</xsl:template>

```

(expr) evaluates expr and replaces itself with the output string

- A more general method

```

<xsl:template match="book[author='Abiteboul']">
<xsl:attribute name="title">
<xsl:value-of select="normalize-space(title)"/>
</xsl:attribute>
<xsl:element name="attr">body</xsl:element>
</xsl:template>

```

adds an attributed named attr with value body to the parent element in the output

<xsl:element> creates an element of the given name in the output

<xsl:copy-of>

- Another slightly different example: return (entire) books authored by “Abiteboul”

```

<?xml version="1.0"?>
<xsl:stylesheet
xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
version="2.0">
<xsl:template match="text()|@*"/>
<xsl:template match="book[author='Abiteboul']">
<xsl:copy-of select="."/>
</xsl:template>
</xsl:stylesheet>

```

- `<xsl:copy-of select="xpath_expr"/>` copies the entire contents (including tag structures) of the node-set returned by `xpath_expr` to the output

Formatting XML into HTML

- Example templates to
 - Render a book title in italics in HTML
 - Render the authors as a comma-separated list

```

<xsl:template match="book/title">
<i><xsl:value-of select="normalize-space(.)"/></i>
</xsl:template>
<xsl:template match="book/author[1]">
<xsl:value-of select="normalize-space(.)"/>
</xsl:template>
<xsl:template match="book/author[position()>1]">
<xsl:text>,</xsl:text>
<xsl:value-of select="normalize-space(.)"/>
</xsl:template>

```

- `<xsl:text>` allows more precise control of white space in output

<xsl:apply-templates>

- Example: generate a table of contents
 - Display books in an HTML unordered list
 - For each book, first display its title, and then display its sections in an HTML ordered list
 - For each section, first display its title, and then display its subsections in an HTML ordered list

```

<xsl:template match="title">
  <xsl:value-of select="normalize-space(.)" />
</xsl:template>
<xsl:template match="section">
  <li>
    <xsl:apply-templates select="title" />
    <ol><xsl:apply-templates select="section" /></ol>
  </li>
</xsl:template>
  <xsl:apply-templates
    select="xpath_expr" />
  applies templates recursively to
  the node-set returned by xpath_expr

```

(Continue on next slide)

Example continued

```

<xsl:template match="book">
  <li>
    <xsl:apply-templates select="title" />
    <ol><xsl:apply-templates select="section" /></ol>
  </li>
</xsl:template>
<xsl:template match="bibliography">
  <html>
    <head><title>Bibliography</title></head>
    <body>
      <ul><xsl:apply-templates select="book" /></ul>
    </body>
  </html>
</xsl:template>

```

- One problem remains
 - Even if a book or a section has no sections, we will still generate an empty element

<xsl:if>

- A fix using <xsl:if>: replace


```

<ol><xsl:apply-templates select="section" /></ol>

```

 with


```

<xsl:if test="section">
  <ol><xsl:apply-templates select="section" /></ol>
</xsl:if>

```
- The body of <xsl:if test="xpath_cond"> is processed only if xpath_cond evaluates to true

Output control

```
<xsl:output method="html" indent="yes"/>
```

- Specifies that output
 - Will be HTML
 - Will be indented to make reading easier
- Other possible method values include "text", "xml"
 - For XML output, if you want to suppress “<?xml ...?>” at the beginning of the output, set attribute `omit-xml-declaration="yes"`

White space control

- White space is everywhere in XML


```
...
<book ISBN="ISBN-10" price="80.00">
  <title>
    Foundations of Databases
  </title>
  ...
```

 - “`Foundations of Databases`” goes into a text node (assuming no DTD)
 - “`Foundations of Databases`” goes in another text node
- Specify `<xsl:strip-space elements="*" />` to remove text nodes (under any element) containing only white space
- To strip leading and trailing white space and replace any sequence of white space characters by a single one, specify


```
<xsl:template match="text()">
  <xsl:value-of select="normalize-space()" />
</xsl:template>
```

<xsl:for-each>

- `<xsl:for-each select="xpath_expr">`
`body`
`</xsl:for-each>`
 - Process `body` for each node in the node-set returned by `xpath_expr`
 - Processing context changes to the node being processed
- Another way to render authors as a comma-separated list


```
<xsl:template match="book">
  ...
  <xsl:for-each select="author">
    <xsl:if test="position()>1">, </xsl:if>
    <xsl:value-of select="normalize-space(.)" />
  </xsl:for-each>
  ...
</xsl:template>
```

Named templates with parameters

- Define a generic template for rendering a list of things as a comma-separated list
 - Cannot use `match` because we do not know in advance the things to render

```
<xsl:template name="comma-separated-list">
  <xsl:param name="things-to-be-formatted"/>
  <xsl:for-each select="$things-to-be-formatted">
    <xsl:if test="position()>1">, </xsl:if>
    <xsl:value-of select="normalize-space(.)"/>
  </xsl:for-each>
</xsl:template>
```

Calling templates with parameters

- Use the named template

```
<xsl:template match="book">
  <xsl:value-of select="normalize-space(title)"/>
  <xsl:text>: </xsl:text>
  <xsl:call-template name="comma-separated-list">
    <xsl:with-param name="things-to-be-formatted"
      select="author"/>
  </xsl:call-template>
  <br/>
</xsl:template>
```

- `<xsl:with-param name="para_name" select="xpath_expr">` evaluates `xpath_expr` and passes its result as the value of the parameter `para_name`
- `<xsl:call-template>` invokes the named template without changing the context

Other useful features

- `<xsl:text>
</xsl:text>` inserts a newline in the output
- `<xsl:message>` for debugging
 - `<xsl:message terminate="yes">` exits the program
- `<xsl:variable>` defines a (constant) variable
- `<xsl:function>` defines a function
- `<xsl:key>` defines a key that can be used for lookups

XSLT summary

- Used often as a stylesheet language, but can be considered a query language too
 - Grouping in XSLT 2.0 (<xsl:for-each-group>)
 - Very expressive, with full recursion
 - Cannot be replaced by XQuery?
 - Well, XQuery supports user-defined functions, which can be recursive
 - Easily non-terminating, difficult to optimize
 - Cannot replace XQuery
- So many features, so little time!

Review

- XML: tree (or graph)-structured data
- DTD: simple schema for XML
 - Well-formed XML: syntactically correct
 - Valid XML: well-formed and conforms to a DTD
- XML Schema: a more sophisticated schema for XML
- XPath: path expression language for XML
 - An XPath expression selects a list of nodes in an XML document
 - Used in other languages
- XQuery: SQL-like query language for XML
 - FLWOR expression, quantified expression, aggregation, etc.
- XSLT: stylesheet language for XML, in XML
 - Transforms input XML by applying template rules recursively on the structure of input XML
