

Data-centric XML

XSLT

The Extensible Stylesheet Language

- XSL (Extensible Stylesheet Language) is divided into two parts
 - XSL-FO: Formatting Objects (out of context for data-centric XML)
 - XSLT: Transformations
- XSLT is an XML application
 - Documents are called *stylesheets*
- Specified in <http://www.w3.org/TR/xslt> (XSLT 1.0)
- XSLT 2.0: <http://www.w3.org/TR/xslt20/>
 - based on XPath 2
 - includes support for Schema types
 - not discussed here; read Annex J in spec for a list of changes

XSLT Overview

- XSLT forms a programming language
 - Stylesheet is the program, operates on input XML document
 - structured into *template rules*
 - Each template rule has a pattern and a template
 - processor compares input elements with each pattern
 - if a template rule matches, the template is written to the output tree
 - resulting output tree is serialized as XML, HTML, or plain text
- All XSLT elements are in the xsl namespace
 - <http://www.w3.org/1999/XSL/Transform>
 - Typically associated with “xsl” prefix
- Document elements are either xsl:stylesheet or xsl:transform
 - Both elements have identical meaning

Minimum Stylesheet

```
<?xml version="1.0"?>  
<xsl:stylesheet version="1.0"  
  xmlns:xsl="http://www.w3.org/1999/XSL/Transform">  
</xsl:stylesheet>
```

- Version attribute is required
- Stylesheet produces as output all text nodes, omitting all markup

Stylesheet Processors

- XSLT processors read templates and input documents, produce output documents
- Can be stand-alone, embedded in programming language, embedded into web browser, web server
- Multiple implementations
 - SAXON (Michael Kay)
 - Xalan (Apache Foundation)
 - MSXML (Microsoft)
 - xsltproc (Daniel Veillard, GNOME)
 - 4XSLT (Fourthought)
 - ...
- Web browsers honor xsl-styleSheet processing instruction in XML prolog
 - `<?xml-styleSheet type="application/xml" href="http://www.oreilly.com/styles/people.xsl"?>`

Template Rules

- `xsl:template`
- Attribute “match” is an XPath expression (the *pattern*)
 - More strictly, matches “Pattern” production
 - A node *matches* a pattern if it is member of the selected node-set, with the “current” node or one of its ancestors as the context node
- Content is the *template*
 - Could be either *literal character data*, or *literal result element*
- Literal character data is Unicode text copied to the output
`<xsl:template match=“person”>A Person</xsl:template>`
- Literal result elements are elements copied to output tree
 - Element is result element if it does not belong to the XSL namespace, and not to an extension namespace
 - Must be well-formed
`<xsl:template match=“person”><p>A Person</p></xsl:template>`

xsl:value-of

- Computes the value of a node
- Attribute “select” is an XPath expression
 - expression result is converted to its string value

```
<xsl:template match="person">  
  <p>  
    <xsl:value-of select="name"/>  
  </p>  
</xsl:template>
```

xsl:apply-templates

- By default, templates are processed top-to-bottom, starting with the root element
 - multiple matching templates are sorted by priority
 - If none matches, recursively traverses nested elements (by means of builtin template rules)
- Stylesheet can control recursive invocation using xsl:apply-templates
- select attribute defines node-set to recurse to

```
<xsl:template match="person">  
  <xsl:apply-templates select="name">  
</xsl:template>
```


Built-in template rules

```
<xsl:template match="*/">  
  <xsl:apply-templates/>  
</xsl:template>
```

```
<xsl:template match="text() | @*">  
  <xsl:value-of select="."/>  
</xsl:templates>
```

```
<xsl:template match="processing-instruction()|comment()"/>
```

Modes

- Depending on context, the same node may be output in different ways several times
 - e.g. each chapter is output once in the table of contents, and once in the body of the book
- Both `xsl:template` and `xsl:apply-templates` take a “mode” attribute
 - when operating in a mode, only templates of the current mode are considered
 - There are built-in rules for each mode:

```
<xsl:template match="*/|" mode="m">  
  <xsl:apply-templates mode="m"/>  
</xsl:template>
```

Attribute Value Templates

- Generating attribute values does not work using `xsl:value-of`
 - Cannot put XSL elements into attribute values
- Attribute values in literal elements are treated as attribute value templates
- Curly braces denote XPath expression

```
<name first="{first_name}" initial="{middle_initial}" last="{last_name}">
```

Namespaces

- Location steps always compare namespace URI and local name
- If names are in a namespace, namespace prefixes must be declared in the template

– E.g. for document

```
<people xmlns="http://www.cafeconleche.org/namespaces/people">...
```

the template should read

```
<xsl:stylesheet version="1.0" xmlns:xsl="..."
```

```
  xmlns:pe="http://www.cafeconleche.org/namespaces/people">
```

```
<xsl:template match="pe:person">
```

```
  ...
```

```
</xsl:template
```

```
</xsl:stylesheet>
```

Non-literal Elements and Attributes

- `xsl:element`
- Creating elements with computed names
- Attribute “name” is the element name (an attribute template)
- Optional attribute “namespace” gives namespace URI

```
<xsl:element name="p">Some Text</xsl:element>
```

- `xsl:attribute` can be used both inside literal elements and `xsl:element`

```
<xsl:attribute name="href">http://www.heise.de</xsl:attribute>
```

Attribute Sets

- Repeated inclusion of multiple attributes into different elements

```
<xsl:attribute-set name="head-style">  
  <xsl:attribute name="font-size">14pt</xsl:attribute>  
  <xsl:attribute name="font-weight">bold</xsl:attribute>  
</xsl:attribute-set>
```

- Usage through `xsl:use-attribute-sets` attribute on `xsl:element`, `xsl:copy`, `xsl:attribute-set`, or literal elements

```
<xsl:template match="chapter">  
  <h1 xsl:use-attribute-sets="common head-style">  
    <xsl:apply-templates/>  
  </h1>  
</xsl:template>
```

xsl:for-each

- Repeated execution of an embedded template
 - Short-hand for creation of a separate template

```
<xsl:template match="/">  
  <html>  
    <ul>  
      <xsl:foreach select="//chapter">  
        <li><xsl:value-of select="."/></li>  
      </xsl:foreach>  
    </ul>  
    <xsl:apply-templates/>  
  </html>  
</xsl:template>
```

Sorting

- `xsl:sort` is applicable to `xsl:apply-templates` and `xsl:foreach`
- “select” determines sorting key, default “.”
- “data-type” determines data type to which keys are converted
 - Default is “text”
 - Possible values are “text”, “number”, and QNames (identifying extensions)
- “order” has values “ascending”, “descending” (default ascending)
- “lang” determines language for collation (default from the environment)
- “case-order” has values “upper-first”, “lower-first”

```
<xsl:for-each select="person">  
  <xsl:sort select="@born" data-type="number"/>  
  <xsl:value-of select="last_name">  
</xsl:for-each>
```


Conditional Processing

- **xsl:if** defines conditional inclusion
 - Attribute “test” determines condition (an XPath Expr)
 - No else-part

```
<xsl:if test=“middle_initial”>  
  <xsl:value-of select=“middle_initial”/>.  
</xsl:if>
```
- **xsl:choose** offers choice among a number of alternatives
 - Multiple nodes with **xsl:when** test=“expr”
 - At most one **xsl:otherwise**

Other Nodes

- Text nodes can be created with `xsl:text`
 - Attribute `disable-output-escaping` (“yes”, “no”) can cause “<” not to be escaped
 - `xsl:text` can be used to guarantee white space in the output

- `xsl:processing-instruction` generates PIs

```
<xsl:processing-instruction  
  name="xml-stylesheet">href="book.css" type="text/css"</xsl:processing-instruction>
```

- `xsl:comment` generates comments

- `xsl:copy` copies the context node to the output

```
<xsl:template match="*|@*">      <!--identity transformation-->  
  <xsl:copy><xsl:apply-templates select="*|@*"></xsl:copy>  
</xsl:template>
```

Named Templates

- Attribute “name” gives a name to a template
 - Template names must be QNames
- `xsl:call-template name=“name”` invokes the named template
 - Template is invoked with the current context node
 - Caller can pass parameters to the template

Template Parameters

- Declared in the template with `xsl:param`
 - Referred-to in XPath expressions as a variable
 - Default value given in “select” attribute (an XPath expression)
 - Alternatively, specify default value as content
 - Parameters without a default value are empty strings by default

```
<xsl:template name="calculateArea">  
  <xsl:param name="width"/>  
  <xsl:param name="height" select="150"/>  
  <xsl:value-of select="$width * $height"/>  
</xsl:template>
```

- Parameters introduce another data type: result tree fragment
 - Parameter value can be a list of nodes, to be copied into the result
 - `xsl:copy-of select=` can be used to copy a result tree fragment into the target tree

Passing Parameters

- Element `xsl:with-param` in `xsl:call-template` and `xsl:apply-template`
- Attributes `name` and `select`

```
<xsl:call-template name="calculateArea">  
  <xsl:with-param name="width" select="100"/>  
</xsl:call-template>
```

Global Parameters

- `xsl:param` elements inside `xsl:stylesheet`
- Parameter passing implementation-defined
 - Xalan: `-param name value`
 - `xsltproc`: `--param`, `--stringparam`
 - XT, `msxsl`, Saxon: `name=value`
 - Java TrAX API: `Transformer.setParameter`

Variables

- `xsl:variable name="variablename" select="expression"`
 - Alternatively, specify value using `xsl:variable` content

```
<xsl:variable name="y">  
  <xsl:choose>  
    <xsl:when test="$x > 7">  
      <xsl:text>13</xsl:text>  
    </xsl:when>  
    <xsl:otherwise>15</xsl:otherwise>  
  </xsl:choose>  
</xsl:variable>
```

- Variables are bound at the point of definition, cannot be changed afterwards
 - Use recursion to rebind a variable in a nested invocation
- Variable scope is the element in which it is contained

Processor Parametrization

- Configuration by attributes of and elements inside `xsl:stylesheet`
 - Attribute “extension-element-prefixes” gives a list of namespace prefixes for extension elements
 - Attribute “exclude-result-prefixes” lists namespaces which should not occur in the output

xsl:output

- xsl:output specifies how to generate a byte stream
 - method="xml" | "html" | "text" | qname
 - version = <version of the output method>
 - XML: default is 1.0, HTML: default is 4.0
 - encoding=<name of output encoding>
 - omit-xml-declaration="yes"|"no"
 - standalone="yes"|"no"
 - doctype-public=<public id>
 - doctype-system=<system id>
 - cdata-section-elements=<list of elements whose text content should use CDATA sections>
 - indent="yes"|"no"
 - media-type=<MIME type> (text output: default is text/plain)
- multiple xsl:output declarations are merged
 - default values for unspecified flags are set after merging, depending on output method

Default Output Method

- Default method is html if
 - root node has an element child,
 - localname of first such element is “html” (any case); namespace is null
 - text nodes preceding that element contain only white-space
- Otherwise, default method is xml
- Default method should be used if there is no xsl:output, or none of the xsl:output elements contain method=

Whitespace Stripping

- Sometimes, text nodes consisting only of white-space are stripped
- White-space is preserved if:
 - the parent element is listed as preserving
 - the text node contains non-whitespace characters
 - an ancestor has `xml:space="preserve"`, and no closer ancestor has `xml:space="default"`
- In the input document, elements are listed as preserving in the `xsl:strip-space/xsl:preserve-space` element
 - Initial default is to preserve white space

```
<xsl:strip-space elements="tr td th tbody"/>
```
- In the template, only `xsl:text` is listed as preserving

Combining Stylesheets

- `xsl:include` incorporates a stylesheet on the XML tree level
`<xsl:include href="toot-o-matic-variables.xsl"/>`
- `xsl:import` incorporates stylesheets “logically”
 - imported stylesheets have lower precedence
 - templates, strip-space, etc. can be overridden in the importing style sheet
 - `xsl:apply-imports` works like `xsl:apply-templates`, but only considers imported templates

Priority

- Each template has a priority
- Templates without explicit priority have builtin priority
 - -0.5 for general node tests (node(), text(), *, ...) without predicate and other location steps
 - -0.25 for tests of the form prefix:* or @prefix:*
 - 0 for tests consisting just of a name (elem, @attr)
 - 0.5 for all other patterns
- Attribute priority= on a template specifies explicit priority

Following Links

- Core functions from XPath are available
 - id() function looks useful, but requires the DTD to be available
- XSLT supports arbitrary additional keys into the document
 - Declared through xsl:key

```
<xsl:key name="person-by-year" match="person" use="@born"/>
```

 - name= specifies the parameter to the key() function
 - match= specifies the candidate nodes that this key indexes
 - use= specifies the key value
 - key() function takes key name and key value, returns selected nodes

```
key('person-by-year', '1912')
```

Numbering

- `xsl:number` element generates numbers, following various schemes
- `value=` specifies the value to print
`<xsl:number value="position()" format="1." />`
- Otherwise, `count=` specifies the things to be counted
 - optionally, `from=` specifies where to start counting
- `level=` specifies nesting of numbers
 - ‘single’ produces a single level of numbers (1., 2., 3., ...), counting siblings
 - ‘multiple’ numbers different levels (1.1., 1.2., 1.3., 2.1., ...), according to nesting
 - ‘any’ numbers a single level, counting all preceding elements in the document

Numbering (2)

- lang= specifies the language for numbering
- format= specifies the format of numbers
 - format string is split into alphanumeric parts
 - each part formats a level in numbering
 - decimal numbers can specify minimum width (e.g. 01 specifies 01, 02, 03, ..., 99, 100, ...)
 - ‘A’ generates ‘A’, ‘B’, ‘C’, ‘D’, ‘E’, ..., ‘AA’,...
 - ‘a’ likewise
 - ‘i’ and ‘I’ generate Roman numerals
- letter-value= can be ‘alphabetic’ or ‘traditional’
- grouping-separator (’,’) and grouping-size (‘3’) specify numeric grouping

Numbering (3)

- Examples:

```
<xsl:number level="multiple" count="chapter|sect1|sect2" format="1.1.1." />
```

counts chapters, then sect1 within a chapter, sect2 within sect1

```
<xsl:template match="note">
```

```
  <fo:block>
```

```
    <xsl:number level="any" from="chapter" format="(1) " />
```

```
    <xsl:apply-templates/>
```

```
  </fo:block>
```

```
</xsl:template>
```

numbers all notes subsequently within a chapter

Multiple Input Documents

- `document('url')` gives a root node of an external document
- Can be combined with location steps

```
<xsl:for-each select="/report/po">
```

```
  <xsl:apply-templates select="document(@filename)/purchase-order"/>
```

```
</xsl:for-each>
```

XSLT Extensions

- **Extension elements:**
 - Declared through extension-element-prefix
 - Implemented in the XSLT processor
 - Presence can be detected through element-available-function
 - element-available('redirect:write')
 - Multiple vendors can be supported by checking system-property ('xsl:vendor')
 - element-available not implemented in XT
- **Extension functions**
 - Likewise declared through extension-element-prefix
 - Can be typically implemented by providing additional source code to the processor

Multiple Output Documents

- Xalan: Namespace `redirect="org.apache.xalan.xslt.extensions.Redirect"`
 - Elements `redirect:open`, `redirect:close`, `redirect:write`
 - Attribute `select=` specifies file name
 - Content of `xsl:write` is written to the output file
- SAXON: Namespace `saxon="http://icl.com/saxon"`
 - Element `saxon:output`
 - Attribute `href=` specifies output file, attribute value templates allowed
 - Content of `saxon:output` is written to a file
- XT: Namespace `xt="http://www.jclark.com/xt"`
 - Element `xt:document`
 - Attribute `method=` specifies output method
 - Attribute `href=` specifies output file

Pattern Syntax

- [1] Pattern ::= LocationPathPattern
| Pattern '|' LocationPathPattern
- [2] LocationPathPattern ::= '/' RelativePathPattern?
| IdKeyPattern (('/' | '//') RelativePathPattern)?
| '//'? RelativePathPattern
- [3] IdKeyPattern ::= 'id' '(' Literal ')'
| 'key' '(' Literal ',' Literal ')'
- [4] RelativePathPattern ::= StepPattern
| RelativePathPattern '/' StepPattern
| RelativePathPattern '/' StepPattern
- [5] StepPattern ::= ChildOrAttributeAxisSpecifier NodeTest Predicate*
- [6] ChildOrAttributeAxisSpecifier ::= AbbreviatedAxisSpecifier
| ('child' | 'attribute') '::'

Additional Functions

- **string format-number(number, string, string?)**
 - format the number according to the JDK 1.1 DecimalFormat string
 - third argument specifies meaning of format characters
 - defaults from xsl:decimal-format element
 - e.g. `format-number(528.3, '#.##;-#.##')` → 528.3
- **node-set current()** gives the 'current' node
 - in a Filter expressions, this might be different from the context node
- **string unparsed-entity-uri(string)**
- **string generate-id(node-set?)**
- **object system-property(string)**
 - supported are `xsl:version`, `xsl:vendor`, `xsl:vendor-url`

Additional Functions (2)

- `boolean element-available(string)`
- `boolean function-available(string)`

Additional Elements

- `xsl:message terminate="yes"|"no"` displays debug information
- `xsl:fallback` is executed if its parent element is an extension element that cannot be found

Literal Result as a Stylesheet

- Simplified form of a style-sheet
- Top-Level node can be literal element
 - style-sheet does not contain any templates, just a literal result
- Can use `xsl:for-each`, `xsl:value-of` inside elements