XSLT

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"Learning is fun!"

Agenda

- Terminology: XSL, XSLT, XSL-FO
- Why Transformation?
- XSLT Operational Model
- Review on XPath
- XSLT Stylesheet Language (the focus of this presentation)
- XSLT vs. other Technologies

Agenda (continued)

- XSLT stylesheet language
  - template
  - value-of
  - apply-templates
  - for-each
  - if
  - when, choose, otherwise
  - sort
  - filtering

Terminology

XSL

- eXtensible Stylesheet Language
- A language for expressing stylesheets
- Made of two parts
  - XSL Transformation (XSLT)
  - XSL Formatting Objects (XSL-FO)

Transformation

- Transforming XML document into
  - Another XML document
    - XHTML
    - WML
  - HTML document
  - Text
- XSLT
  - W3C standard for XML transformation

Why Transformation?

Two Viewpoints of XML

- Presentation Oriented Publishing (POP)
  - Useful for Browsers and Editors
  - Usually used for data that will be consumed by Humans
- Message Oriented Middleware (MOM)
  - Useful for Machine-to-Machine data exchange
  - Business-to-Business communication an excellent example

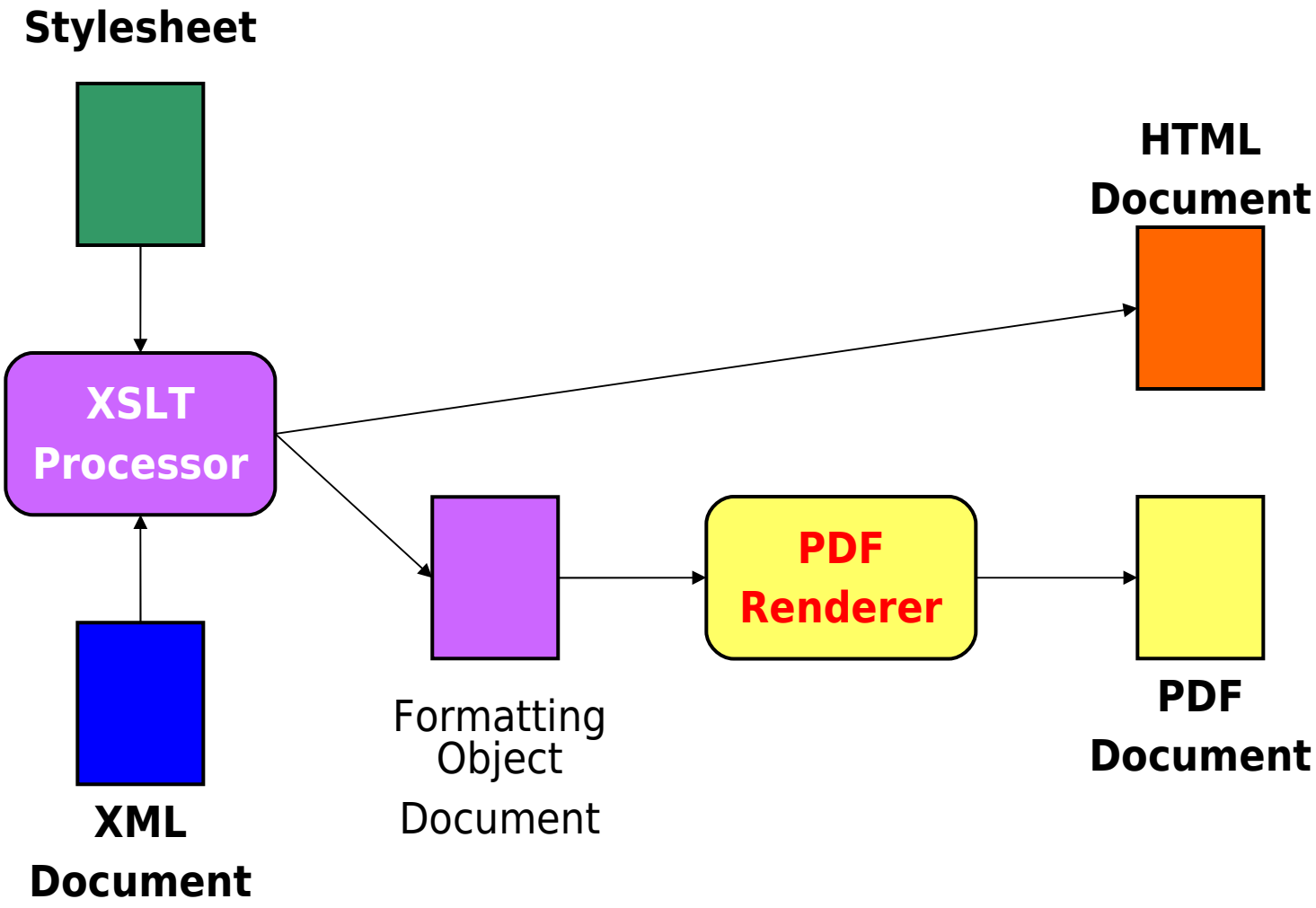
Importance of Transformation

- XSLT is useful in both POP and MOM
  - transforming data into a viewable format in a browser (POP)
  - transforming business data between content models (MOM)

XSLT in POP

- XML document typically represents only content separated from presentation (unlike HTML)
- Transformations can be used to style (render, present) XML content into presentation
- A common styling technique presents XML in HTML format for desktop clients or WML format for mobile device client

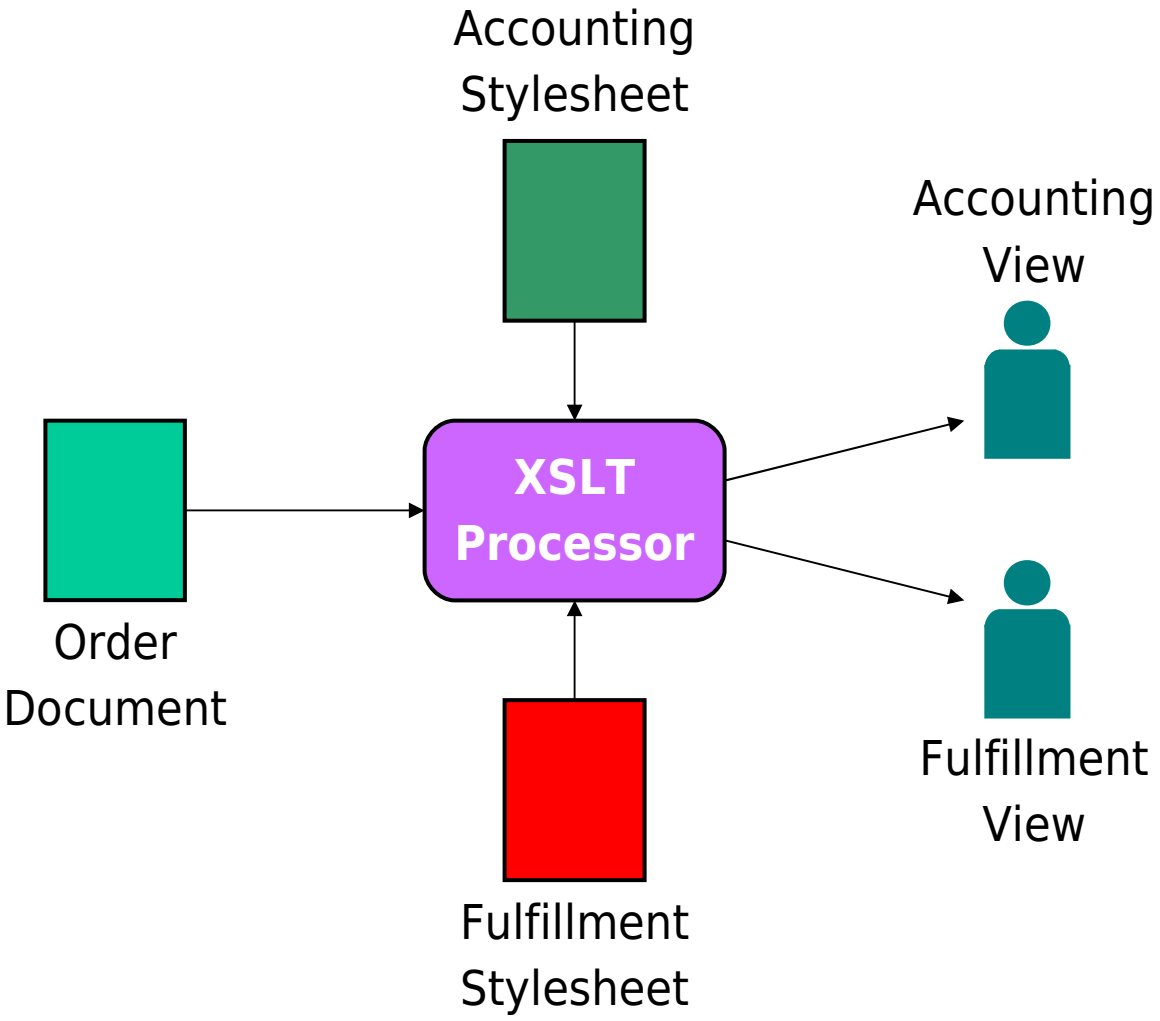
XSLT – in POP


Stylesheet
HTML
Document
XSLT
Processor
PDF
Renderer
Formatting
Object
Document
PDF
Document
XML
Document

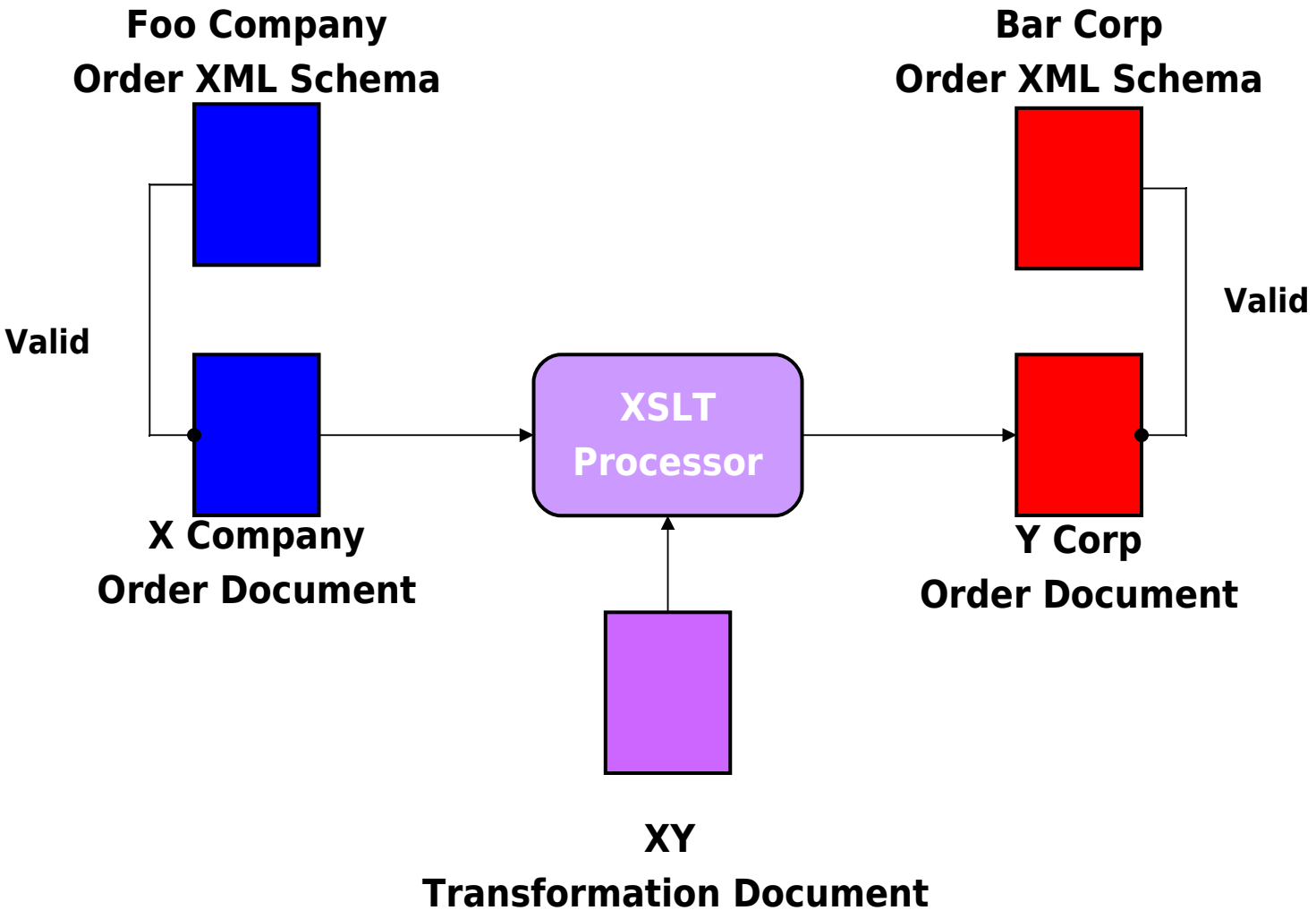
XSLT in MOM

- Important for eCommerce, B2B/EDI, and dynamic content generation
  - Different content model
  - Different structural relationship
  - Different vocabularies

XSLT – in MOM

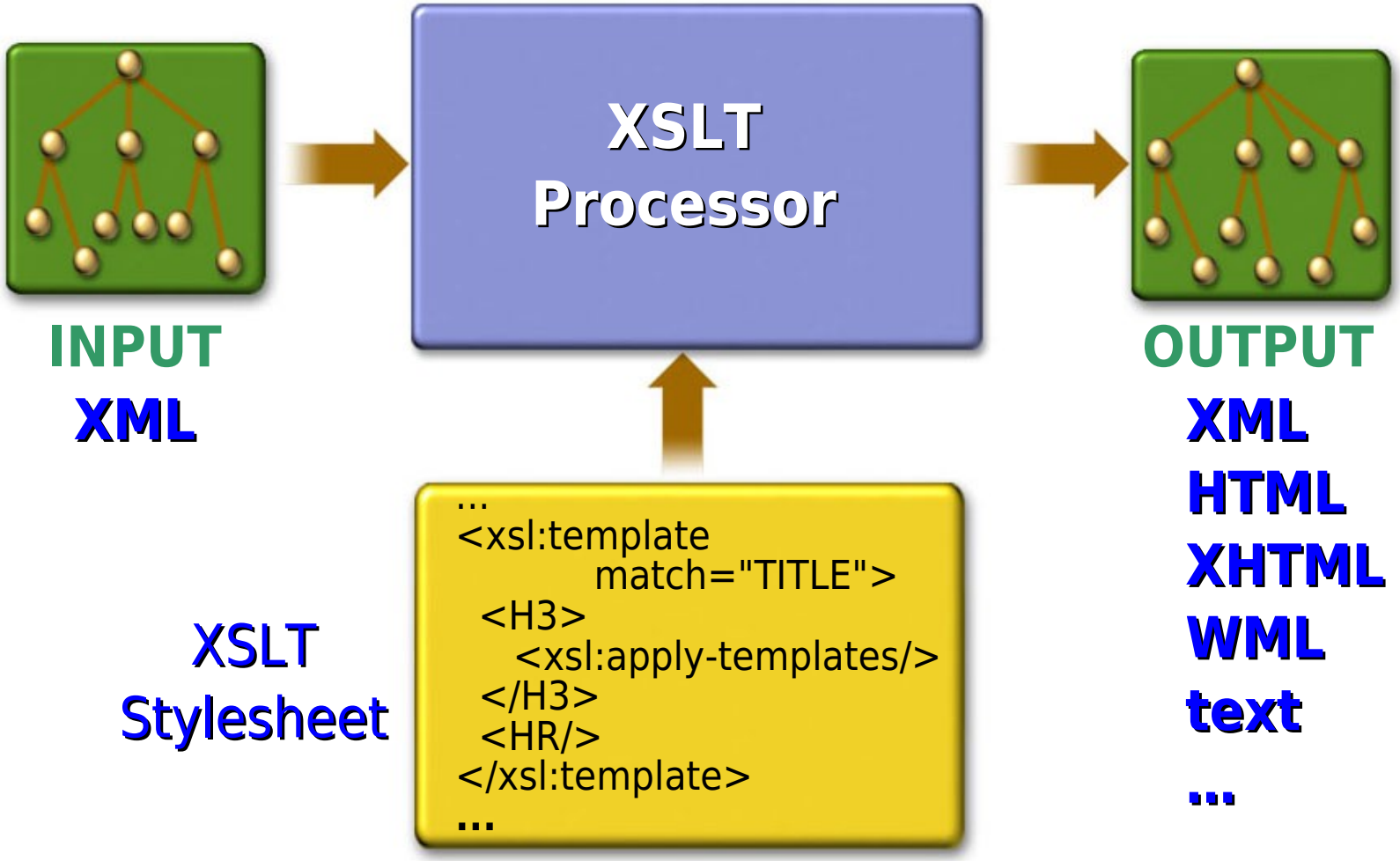

Accounting
Stylesheet
Accounting
View
XSLT
Processor
Order
Document
Fulfillment
View
Fulfillment
Stylesheet

XSLT – Data Transformation



XSLT
Operational Model

XSLT Operational Model



What is XSLT Processor?

- Piece of software
  - Reads an XSLT stylesheet and input XML document
  - Converts the input document into an output document
  - According to the instruction given in the XSLT stylesheet
- Called “stylesheet processor” sometimes

Examples of XSLT Processor

- Built-in within a browser
  - Most browsers performs the XSLT transformation out of the box
- Built-in within web or application server
  - Apache Cocoon
- Java packages
  - JAXP
  - Apache.org's Xalan

What is XSLT Stylesheet?

- Contains instruction of transformation
- Genuine XML document
- Root element typically is
  - stylesheet or transform
  - Both are defined in standard XSLT namespace
    - http://www.w3.org/XSL/Transform
    - xsl as customary prefix
  - XSLT processor should understand both

Review on XPath

What is XPath?

- Used by XSLT (and by other XML technologies such as XPointer) for referencing elements and attributes of an XML document
- The “referencing” is done through expression language (pattern)
- Supports a tree structure expression
  - Example: 7th child element of the third *person* element

XPath

- XPath expression results in a node set
  - A node set of "*person*" elements under "*people*" element
- Various functions can be used on node sets, including:
  - `not()` – eliminate a specific node
  - `position()` – return the position within a node set
  - `count()` – returns the number of nodes in a node set

XSLT Example 0

XML Example Document

```
<?xml version="1.0"?>
<people>

  <person born="1912" died="1954">
    <name>
      <first_name>Alan</first_name>
      <last_name>Turing</last_name>
    </name>
    <profession>computer scientist</profession>
    <profession>mathematician</profession>
    <profession>cryptographer</profession>
  </person>

  <person born="1918" died="1988">
    <name>
      <first_name>Richard</first_name>
      <middle_initial>M</middle_initial>
      <last_name>Feynman</last_name>
    </name>
    <profession>physicist</profession>
    <hobby>Playing the bongoes</hobby>
  </person>

</people>
```

Minimal (Empty) but Complete XSLT Stylesheet: example0.xsl

```
<?xml version="1.0"?>


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

</xsl:stylesheet>
```

Result of XSLT Processing

```
<?xml version="1.0" encoding="utf-8"?>


      Alan
      Turing

    computer scientist
    mathematician
    cryptographer


      Richard
      M
      Feynman

    physicist
    Playing the bongoes
```

Explanation of the Result

- Applying empty stylesheet to any XML document
  - Elements in the XML document are traversed sequentially
  - Content of each element is put in output
    - Attributes are NOT traversed
  - Default behavior of “getting content of an element” is outputting the “text” of the traversed sub-elements
- Without any specific templates to apply to an element
  - XSLT processor falls back to default behavior

xml-stylesheet Instruction

<?xml-stylesheet ..> Processing Instruction

- Can be included as part of XML document
- Tells XML-aware browser where to find associated stylesheet

```
<?xml version="1.0"?>
<?xml-stylesheet
        type="text/xml"
        href="http://www.oreilly.com/styles/people.xsl"?>
<people>
....
```

Template

What does a Template do?

- Controls which output is created from which input
- *<xsl:template ..>*
- *match=”..”* attribute contains an XPath expression
  - XPath expression identifies input node set it matches
- For each node in the node set, the template contents (things between *<xsl:template ..>* and *</xsl:template>* tags) are instantiated and inserted into the output

XSLT Example 1

Very Simple XSLT Stylesheet 1: example1.xsl

```
<?xml version="1.0"?>

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


        <xsl:template match=”people">

        </xsl:template>


</xsl:stylesheet>
```

XML Example Document: people.xml (Source document)

```
<?xml version="1.0"?>
<people>

  <person born="1912" died="1954">
    <name>
      <first_name>Alan</first_name>
      <last_name>Turing</last_name>
    </name>
    <profession>computer scientist</profession>
    <profession>mathematician</profession>
    <profession>cryptographer</profession>
  </person>

  <person born="1918" died="1988">
    <name>
      <first_name>Richard</first_name>
      <middle_initial>M</middle_initial>
      <last_name>Feynman</last_name>
    </name>
    <profession>physicist</profession>
    <hobby>Playing the bongoes</hobby>
  </person>

</people>
```

Result of XSLT Transformation

```
<?xml version="1.0" encoding="UTF-8"?>
```

Explanation of the Result

- <xsl:template..> in the XSLT stylesheet generates a result node set
  - There is one <*people*> node in the result node set
- Each element in the input document is processed in sequence according to the stylesheet
  - There is a template for <people> element, so template is applied (instead of default behavior) - it will be replaced by the template content, which is "null" (there is nothing between <*xsl:template*> .. and </*xsl:template*>

XSLT Example 2

Very Simple XSLT Stylesheet 2: example2.xsl

```
<?xml version="1.0"?>

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


        <xsl:template match=”people">
        Folks in Brandeis XML class
        </xsl:template>


</xsl:stylesheet>
```

Result

<?xml version="1.0" encoding="UTF-8"?>

Folks in Brandeis XML class

XSLT Example 3

Very Simple XSLT Stylesheet 3: example3.xsl

```
<?xml version="1.0"?>

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


    <xsl:template match="person">

    A Person

    </xsl:template>


</xsl:stylesheet>
```

XML Example Document

```
<?xml version="1.0"?>
<people>

  <person born="1912" died="1954">
    <name>
      <first_name>Alan</first_name>
      <last_name>Turing</last_name>
    </name>
    <profession>computer scientist</profession>
    <profession>mathematician</profession>
    <profession>cryptographer</profession>
  </person>

  <person born="1918" died="1988">
    <name>
      <first_name>Richard</first_name>
      <middle_initial>M</middle_initial>
      <last_name>Feynman</last_name>
    </name>
    <profession>physicist</profession>
    <hobby>Playing the bongoes</hobby>
  </person>

</people>
```

Result

```
<?xml version="1.0" encoding="utf-8"?>


A Person


A Person
```

- Whitespace outside of <*person*> element preserved
- <*person*> element is replaced by contents of template, "*A Person*"

Explanation of the Result

- <xsl:template..> in the XSLT stylesheet generates a result node set
  - There are two <person> nodes in the result node set
- Each element in the input document is processed in sequence
  - There is no template for <people> element, so default behavior is used
  - There is a template for <person> element, so template is applied (instead of default behavior) - it will be replaced by the template content, which is “A Person”

XSLT Example 4

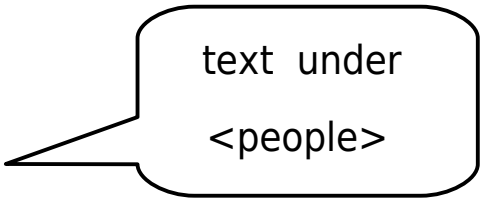
Very Simple XSLT Stylesheet 4: example4.xsl

```
<?xml version="1.0"?>

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


    <xsl:template match="person">

    A Person

    </xsl:template>


</xsl:stylesheet>
```

- Same stylesheet with example 3 but with different input XML document (*people1.xml*, which is shown in the next slide)

New XML Example Document: people1.xml

```
<?xml version="1.0"?>
<people>

  <person born="1912" died="1954">
    <name>
      <first_name>Alan</first_name>
      <last_name>Turing</last_name>
    </name>
    <profession>computer scientist</profession>
    <profession>mathematician</profession>
    <profession>cryptographer</profession>
  </person>

  <person born="1918" died="1988">
    ...
  </person>

  Some text here under people element!

  <clinton>
  Monica is under Clinton element!
  </clinton>

</people>
```



Result

```
<?xml version="1.0" encoding="UTF-8"?>
```

A Person ← Template content

A Person ← Template content

Some text here under people elememt! ← Default behaviour of <people> element

Monica is under Clinton element! ← Default behaviour of <clinton> element

Explanation

- Each element in the input document is processed in sequence
  - There is no template for <people> element, so it is processed in default mode
  - There is a template for <person>, so template is applied
  - There is no template for <clinton> element, so it is processed in default mode

XSLT Example 5

A Simple XSLT Stylesheet: example5.xsl

```
<?xml version="1.0"?>

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


  <xsl:template match="person">
    <p>A Person</p>
  </xsl:template>


</xsl:stylesheet>
```

Result

```
<?xml version="1.0" encoding="utf-8"?>


  <p>A Person</p>

  <p>A Person</p>
```

- Template content contains tags (<*p*> in this example) and character data (*A Person* in this example)

xsl-valueof

What does xsl:value-of element do?

- Controls what gets generated as output (instead of generating literal values as output as we've seen in the previous examples)
  - Example: For each person element, display his/her first name in upper case

xsl:value-of element

- Extracts the string value of an element or an attribute and writes it to output
  - string value - text content of the element after all the tags have been removed and entity references are resolved
- *select* attribute containing XPath expression identifies an element or an attribute
  - It could be a node set, in which case, the string value of first node is taken

XSLT Example 6

example6.xsl

- For all <person> elements (node set), display string value of the <name> elements (node set)

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

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

</xsl:stylesheet>
```

XML Example Document

```
<?xml version="1.0"?>
<people>

  <person born="1912" died="1954">
    <name>
      <first_name>Alan</first_name>
      <last_name>Turing</last_name>
    </name>
    <profession>computer scientist</profession>
    <profession>mathematician</profession>
    <profession>cryptographer</profession>
  </person>

  <person born="1918" died="1988">
    <name>
      <first_name>Richard</first_name>
      <middle_initial>M</middle_initial>
      <last_name>Feynman</last_name>
    </name>
    <profession>physicist</profession>
    <hobby>Playing the bongoes</hobby>
  </person>

</people>
```

Result

```
<?xml version="1.0" encoding="UTF-8"?>

    <p>
        Alan
        Turing
    </p>

    <p>
        Richard
        M
        Feynman
    </p>
```

Explanation

- Create a node set A via *match="person"*
  - Two <*person*> elements in the node set A
- For each <person> element in the node set A, create a node set B via *select="name"*
  - One <name> element in each node set B
- Display string value of each node set B

```
<name>
   <first_name>Alan</first_name>
   <last_name>Turing</last_name>
</name>
```

```
Alan
Turing
```

XSLT Example 6a (Use the same example6.xml stylesheet with a new XML document)

example6.xsl

- For every <person> element (in a node set returned from match=”person”, display string value of the <name> element of the node set returned from select=”name”)

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

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

New XML Example Document: people2.xml

```
<?xml version="1.0"?>
<people>

  <person born="1912" died="1954">
    <name>
      <first_name>Alan</first_name>
      <last_name>Turing</last_name>
    </name>
     <name>
      <given_name>Alan2</first_name>
      <surname>Turing2</last_name>
     </name>
    <profession>computer scientist</profession>
    <profession>mathematician</profession>
    <profession>cryptographer</profession>
  </person>

  <person born="1918" died="1988">
    <name>
      <first_name>Richard</first_name>
      <middle_initial>M</middle_initial>
      <last_name>Feynman</last_name>
    </name>
    <profession>physicist</profession>
    <hobby>Playing the bongoes</hobby>
  </person>

</people>
```

The 2nd <name> element is added for the 1st <person> element

Result (Same as Example 6)

```
<?xml version="1.0" encoding="UTF-8"?>

    <p>
        Alan
        Turing
    </p>

    <p>
        Richard
        M
        Feynman
    </p>
```

Explanation

- The first <*person*> element has two <name> elements in the node set
- Displaying string value of a node set takes the first node in the set and display text value of it

```
<name>
   <first_name>Alan</first_name>
   <last_name>Turing</last_name>
</name>
<name>
   <given_name>Alan2</given_name>
   <surname>Turing2</surname>
</name>
```

```
Alan
Turing
```

Review of what we learned so far

- <xsl:template match=”element-name">
  - Create a node set using match=”element-name"
  - For each node in the node set, replace it with what is specified within the <xsl:template ..> and </xsl:template>
- <xsl:value-of select="element-name"/>
  - Create a node set using select="element-name"
  - Display the string value of the node set

xsl:apply-templates

What does xsl:apply-templates do?

- Controls which child nodes of a context node a template is applied to

XSLT Example 7

xsl:apply-templates Example

- I would like the output to look like as following
  - Last name then first name
  - Only name not profession nor hobby

```
<?xml version="1.0" encoding="utf-8"?>

    Turing
        Alan

    Feyman
        Richard
```

Let's say we use example7.xsl

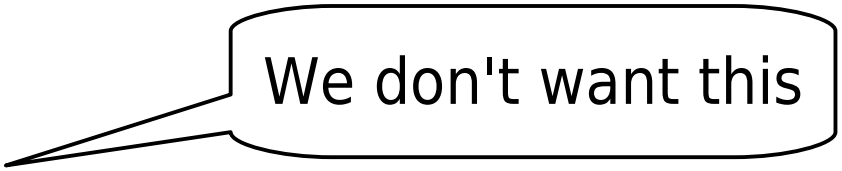
```
<?xml version="1.0"?>

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


  <xsl:template match="name">
    <xsl:value-of select="last_name"/>,
    <xsl:value-of select="first_name"/>
  </xsl:template>

  <!-- Something is missing here -->
```

XML Example Document

```
<?xml version="1.0"?>
<people>

  <person born="1912" died="1954">
    <name>
      <first_name>Alan</first_name>
      <last_name>Turing</last_name>
    </name>
    <profession>computer scientist</profession>
    <profession>mathematician</profession>
    <profession>cryptographer</profession>
  </person>

  <person born="1918" died="1988">
    <name>
      <first_name>Richard</first_name>
      <middle_initial>M</middle_initial>
      <last_name>Feynman</last_name>
    </name>
    <profession>physicist</profession>
    <hobby>Playing the bongoes</hobby>
  </person>

</people>
```

Result (Different from what we want)

```
<?xml version="1.0" encoding="utf-8"?>

    Turing
        Alan

    computer scientist
    mathematician
    cryptographer

    Feyman
        Richard

    physicist
    Playing the bongoes
```



Explanation of result

- Each element in the input document is processed in sequence – any template applicable to each element is then applied
  - There is no template for <people> and <person> elements - processed in default mode
  - There is a template for <name> element – so template is applied
  - There is no template for other elements (<profession>, <hobby>) so they are processed in default mode
- We do not want other elements (<profession>, <hobby>) to be processed
  - This is where <xsl:apply-templates> can be useful

XSLT Example 8

xsl:apply-templates example8.xsl

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

  <xsl:template match="name">
    <xsl:value-of select="last_name"/>,
    <xsl:value-of select="first_name"/>
  </xsl:template>

  <!-- Apply templates only to name children of person -->
  <xsl:template match="person">
    <xsl:apply-templates select="name"/>
  </xsl:template>

</xsl:stylesheet>
```

Result

```
<?xml version="1.0" encoding="utf-8"?>

    Turing
        Alan

    Feyman
        Richard
```

Explanation of result

- Each element in the input document is processed in sequence – any template applicable to each element is then applied
  - There is a template for <person> element
  - The template of <person> element says “Search for a template for <name> element and apply it!”

XSLT Example 8a

xsl:apply-templates: example8a.xsl

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

  <!-- Apply templates only to name children -->
  <xsl:template match="person">
    <xsl:apply-templates select="name"/>
  </xsl:template>

  <xsl:template match="name">
    <xsl:value-of select="last_name"/>,
    <xsl:value-of select="first_name"/>
  </xsl:template>

</xsl:stylesheet>
```

Result (Same result as with example8.xsl)

```
<?xml version="1.0" encoding="UTF-8"?>

    Turing,
    Alan

    Feynman,
    Richard
```

Explanation of result

- Ordering of <xsl:template> within a stylesheet does not matter

XSLT Example 8b

xsl:apply-templates: example8b.xsl

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

  <xsl:template match="name">
    <xsl:value-of select="last_name"/>,
    <xsl:value-of select="first_name"/>
  </xsl:template>

  <xsl:template match="profession">
     My profession!
  </xsl:template>

  <!-- Apply templates only to name children -->
  <xsl:template match="person">
    <xsl:apply-templates select="name"/>
  </xsl:template>

</xsl:stylesheet>
```

Result

```
<?xml version="1.0" encoding="UTF-8"?>

    Turing,
    Alan

    Feynman,
    Richard
```

Explanation of result

- The template of <profession> does not get applied because template of <person> says only the template of <name> should be applied

XSLT Example 8c

xsl:apply-templates: example8c.xsl

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

  <xsl:template match="name">
    <xsl:value-of select="last_name"/>,
    <xsl:value-of select="first_name"/>
  </xsl:template>

  <xsl:template match="profession">
     My profession!
  </xsl:template>

  <!-- Apply templates only to name children -->
  <xsl:template match="person">
    <xsl:apply-templates/>
  </xsl:template>

</xsl:stylesheet>
```

Result

```
<?xml version="1.0" encoding="UTF-8"?>


    Turing,
Alan

 My profession!


 My profession!


 My profession!



    Feynman,
Richard

 My profession!

    Playing the bongoes
```

Explanation of result

- The templates of both <name> and <profession> get applied
- Since there is no template for <hobby>, default behavior is taken

XSLT Example 9

example9.xsl

```
<?xml version="1.0"?>
<xsl:stylesheet version="1.0"
        xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:template match="people">
    <html>
      <head><title>Famous Scientists</title></head>
      <body>  <xsl:apply-templates/>   </body>
    </html>
  </xsl:template>
  <xsl:template match="person">
    <xsl:apply-templates select="name"/>
  </xsl:template>
  <xsl:template match="name">
    <p><xsl:value-of select="last_name"/>,
    <xsl:value-of select="first_name"/></p>
  </xsl:template>
</xsl:stylesheet>
```

Result

```
<html>
<head><title>Famous Scientists</title></head>
<body>

  <p>Turing,
   Alan</p>

  <p>Feynman,
   Richard</p>

</body>
</html>
```

Explanation of result

- Replace every *people* element with *html* element
- The template of <person> says to apply the template of <name> for all person nodes
- The template of <name> says to display last name and first name

Attributes

Attributes: example10.xsl

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

  <xsl:template match="people">
    <html>
      <head><title>Famous Scientists</title></head>
      <body>
        <dl>
          <xsl:apply-templates/>
        </dl>
      </body>
    </html>
  </xsl:template>

  <xsl:template match="person">
    <dt><xsl:apply-templates select="name"/></dt>
    <dd><ul>
      <li>Born: <xsl:apply-templates select="@born"/></li>
      <li>Died: <xsl:apply-templates select="@died"/></li>
    </ul></dd>
  </xsl:template>

</xsl:stylesheet>
```

Attributes

- Default rule does not apply
  - *apply-templates* has to be present in order to output values of attributes

Result

```
<html>
   <head>
      <title>Famous Scientists</title>
   </head>
   <body>
      <dl>


         <dt>
            Alan
            Turing

         </dt>
         <dd>
            <ul>
               <li>Born: 1912</li>
               <li>Died: 1954</li>
            </ul>
         </dd>
```

XSLT vs. other Technologies

XSLT and DOM

- Most XSLT engine uses DOM internally
  - Reason for slow performance and high memory requirement
- DOM could be used for transformation as well
  - DOM does NOT provide any ready-to-use XPath functionality however
  - XSLT is completely declarative
  - XSLT is more portable than DOM

XSLT vs. Programming

- Programming is useful when you do more than transformation
- Examples
  - Interpreting certain elements as database queries
  - Inserting the query results into output document
  - Asking users questions in the middle of transformation

Summary

Summary

- XSLT is useful to both POP and MOM
- XSLT Stylesheet Language
  - <xsl:template match=”XPath">
  - <xsl:value-of select="XPath"/>
  - <xsl:apply-templates select="XPath"/>

References

- “XML in a Nutshell” written by Elliotte Rusty Harold & W. Scott Means, O’Reilly, Jan. 2001(1st Edition), Chapter 8 “XSL Transformation”
- Apache.Org, Xalan
- JAXP 1.1

Thank you!

Sang Shin
Michèle Garoche
http://www.javapassion.com
“Learning is fun!”