XMLTree Methods
Methods for **XMLTree**

- All the methods for **XMLTree** are *instance methods*, i.e., you call them as follows:
  
  ```
  t.methodName(arguments)
  ```

  where `t` is an initialized variable of type **XMLTree**
Methods for **XMLTree**

- All the methods for **XMLTree** are *instance methods*, i.e., you call them as follows:

  \[ \text{t.methodName}(\text{arguments}) \]

  where \( \text{t} \) is an instance of **XMLTree**

  \( \text{t} \) is called the *receiver* of the call; for all instance methods, the corresponding *distinguished formal parameter* implicitly has the name \( \text{this} \).
Implementations of XMLTree

• There are two different classes that implement the XMLTree interface contract, and you may use either one: XMLTree1 or XMLTree2

• This choice is made when you initialize a variable of type XMLTree, where you must use the name of one of these implementation classes as the name of the constructor
Implementations of XMLTree

• There are two different classes that implement the XMLTree interface contract, and you may use either one: XMLTree1 or XMLTree2

• This choice is made when you initialize a variable of type XMLTree, and you must use the name of one of these implementation classes as the name of the constructor:

The behavior of an XMLTree does not depend on which implementation you choose; this is a key benefit of design-by-contract!
Interface and Implementing Classes

XMLTree

XMLTree1 implements

XMLTree2 implements
Interface and Implementing Classes

The interface `XMLTree` has method signatures and contracts for methods.
XMLTree implements XMLTree1

The *class* XMLTree1 has method bodies; similarly XMLTree2.

XMLTree1

XMLTree2
Interface and Implementing Classes

The method bodies in XMLTree1 implement the method contracts in XMLTree2.
The method bodies in \texttt{XMLTree2} \textbf{implement} the method contracts in \texttt{XMLTree}.
Mathematical Model

• The value of an XMLTree variable is modeled as a tree of nodes whose labels are explained in the previous set of slides

• Note that this model is described informally, though it could be formalized into mathematical notation (which we will not do here)
Constructors

• There are two *constructors* for each implementation class
• The name of the constructor is the name of the implementation class
• Constructors differ only in their parameters
• For *XMLTree*, we will use only the constructor that takes one *String* parameter, either:
  – The name of an XML file on your computer
  – The URL of an XML file or an XML source on the web
Constructors

• A constructor call has the keyword `new` before the constructor name and is an expression, e.g.:
  ```java
  new XMLTree1("foo.xml")
  ```

• The value of this expression is determined by the contract for the constructor
  – In this case, the contract says the value is an `XMLTree` corresponding to the XML document named by the `String` parameter
## Example

<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>XMLTree t = new XMLTree1(&quot;foo.xml&quot;);</code></td>
<td></td>
</tr>
</tbody>
</table>
See the slides on the **XMLTree** model for a description of the tree that arises from an XML document.

```
XMLTree t = new XMLTree1("foo.xml");
```

```
t = [tree from file "foo.xml"]
```
String `label()`

- Returns the label of the root of `this`.
- Ensures:

  ```
  label = [the label of the root of `this` (not including `< >` for tags)]
  ```
## Example: Label is a Tag

<table>
<thead>
<tr>
<th><strong>Code</strong></th>
<th><strong>State</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>String $s = t.label();$</td>
<td>$t = [\text{tree for book XML example}]$</td>
</tr>
</tbody>
</table>
Example: Label is a Tag

State

$t = \text{[tree for book XML example]}$

String $s = t.label();$
Example: Label is a Tag

```
String s = t.label();
```

State

- `t = [tree for book XML example]`
- `t = [unchanged]`
- `s = "book"`
Example: Label is Not a Tag

<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>t = [tree rooted at title content in XML example]</code></td>
<td></td>
</tr>
<tr>
<td><code>String s = t.label();</code></td>
<td></td>
</tr>
</tbody>
</table>
**Java for Everyone: Late Objects**

<table>
<thead>
<tr>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t = \text{[tree rooted at title content in XML example]} )</td>
</tr>
</tbody>
</table>

String \( s = t.\text{label}(); \)
<table>
<thead>
<tr>
<th>State</th>
<th>t = [tree rooted at title content in XML example]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>String s = t.label();</td>
</tr>
<tr>
<td></td>
<td>t = [unchanged] s = &quot;Java for Everyone: Late Objects&quot;</td>
</tr>
</tbody>
</table>
isTag

boolean isTag()  

• Returns whether the label of the root of this is a tag.

• Ensures:

  isTag = [the label of the root of this is a tag]
Example: Label is a Tag

<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>boolean b = t.isTag();</td>
<td>t = [tree for book XML example]</td>
</tr>
</tbody>
</table>
Label is a Tag

```
31 January 2021 OSU CSE

Code State

\[ \text{State} \]

\[
t = [\text{tree for book XML example}]
\]

\[
\text{boolean } b = t.isTag();
\]

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Example: Label is a Tag

```
printISBN → 978-1-118-06231-6
webISBN → 1-118063-31-7
pubDate → Dec 20 2011
```

```
t = [tree for book XML example]

boolean b = t.isTag();
```

```
t = [unchanged]
b = true
```
Example: Label is Not a Tag

<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>boolean b = t.isTag();</td>
<td>$t = [\text{tree rooted at title content in XML example}]$</td>
</tr>
</tbody>
</table>
Java for Everyone: Late Objects

State

$t = \text{[tree rooted at title content in XML example]}$

boolean $b = t.isTag()$;
Java for Everyone: Late Objects

### Example: Label is Not a Tag

<table>
<thead>
<tr>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = [\text{tree rooted at title content in XML example}]$</td>
</tr>
</tbody>
</table>

```java
boolean b = t.isTag();
```

<table>
<thead>
<tr>
<th>State</th>
</tr>
</thead>
</table>
| $t = [\text{unchanged}]$
| $b = \text{false}$ |
hasAttribute

boolean hasAttribute(String name)

• Returns whether the root tag of this has an attribute called name.

• Requires:

  [label of root of this is a tag]

• Ensures:

  hasAttribute = [label of root of this has an attribute called name]
### Example: Has One

<table>
<thead>
<tr>
<th><strong>Code</strong></th>
<th><strong>State</strong></th>
</tr>
</thead>
</table>
| \begin{Verbatim}
boolean b =
t.hasAttribute("pubDate");
\end{Verbatim} | \begin{Verbatim}
t = [tree for book XML example]
\end{Verbatim} |
### Code State

```
boolean b =
    t.hasAttribute("pubDate");
```
```java
boolean b = t.hasAttribute("pubDate");

// Output:

```

<table>
<thead>
<tr>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = \text{[tree for book XML example]}$</td>
</tr>
</tbody>
</table>

| $t = \text{[unchanged]}$ |
| $b = \text{true}$ |
Example: Has None

<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Code" /></td>
<td><img src="image" alt="State" /></td>
</tr>
<tr>
<td><code>boolean b = t.hasAttribute(&quot;fooBar&quot;);</code></td>
<td><code>t = [tree for book XML example]</code></td>
</tr>
</tbody>
</table>
Example: Has None

```java
boolean b =
t.hasAttribute("fooBar");
```

<table>
<thead>
<tr>
<th>t = [tree for book XML example]</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>State</th>
</tr>
</thead>
</table>

```xml
<book>
  printISBN → 978-1-118-06331-6
  webISBN → 1-118063-31-7
  pubDate → Dec 20 2011
</book>
```
### Has None

<table>
<thead>
<tr>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t = [\text{tree for book XML example}] )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>boolean ( b = )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t ).hasAttribute(&quot;fooBar&quot;);</td>
</tr>
</tbody>
</table>

| 
| 
| \( t = [\text{unchanged}] \) |
| \( b = \text{false} \) |
attributeValue

String attributeValue(String name)

• Returns the value associated with the attribute of the root tag of this called name.

• Requires:
   
   [label of root of this is a tag and it has an attribute called name]

• Ensures:

   attributeValue = [value associated with attribute called name of root tag of this]
# Example

<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>String v = t.attributeValue(&quot;pubDate&quot;);</code></td>
<td><code>t = [tree for book XML example]</code></td>
</tr>
</tbody>
</table>
```java
String v =
    t.getAttributeValue("pubDate");
```
Example

String v =
    t.getAttributeValue("pubDate");

State

t = [tree for
    book XML example]

v = "Dec 20 2011"
numberOfChildren

```c
int numberOfChildren()

• Returns the number of subtrees of the root of `this`.

• Requires:
  
  [label of root of `this` is a tag]

• Ensures:

  `numberOfChildren = [the number of subtrees of the root of `this`]`
Example

<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>t = [tree for book XML example]</code></td>
<td></td>
</tr>
<tr>
<td><code>int n =</code></td>
<td></td>
</tr>
<tr>
<td><code>t.numberOfChildren();</code></td>
<td></td>
</tr>
</tbody>
</table>
Example

\[ t = \text{[tree for \text{book XML example}]} \]

\[
\text{int } n = \\
t.\text{numberOfChildren}();
\]
Example

```java
int n = t.numberOfChildren();
```

<table>
<thead>
<tr>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = [\text{tree for book XML example}]$</td>
</tr>
<tr>
<td>$t = [\text{unchanged}]$</td>
</tr>
<tr>
<td>$n = 3$</td>
</tr>
</tbody>
</table>
XMLTree child(int k)

• Returns the $k$-th subtree of the root of this.

• Requires:

  [label of root of this is a tag and 0 <= $k$ < number of subtrees of the root of this]

• Ensures:

  \text{child} = [the \text{$k$-th subtree of the root of this}]
<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>t = [tree for book XML example]</code></td>
<td></td>
</tr>
<tr>
<td><code>XMLTree st =</code></td>
<td></td>
</tr>
<tr>
<td><code>t.child(1);</code></td>
<td></td>
</tr>
</tbody>
</table>
XMLTree st = t.child(1);
Example

```
XMLTree st = t.child(1);
```

State

t = [tree for book XML example]

```
XMLTree st = [tree rooted at title tag]
```
Example

```
XMLTree st = t.child(1);
```

```
t  [unchanged]
st = [tree rooted at title tag]
```
Complex Expressions

• Continuing code from the previous example, this expression has the same type and value as \texttt{st.child(0)}:
  \texttt{t.child(1).child(0)}

• And this expression has what type and what value?
  \texttt{t.child(1).child(0).label()}
Complex Expressions

• Continuing from the previous example, this expression has the same type and value as `st.child(0)`: `t.child(1).child(0)`

• And this expression has what type and what value?
  `t.child(1).child(0).label()`
  
  The type is **String**, the return type of the **label** method; the value is **"Java for Everyone: Late Objects"**.
An Aside: Iterators and Iterables

• An *iterator* lets you easily “visit” all members of a “collection” of things (without changing them while visiting them)

• A “collection” of things you can iterate on is called *iterable*

• The *collection classes* of the Java library and the OSU CSE components library have methods to give you an iterator for the corresponding collection and thus are iterable
An Aside: Iterators and Iterables

• An *iterator* lets you easily “visit” all members of a “collection” of things (without changing them while visiting them)

• A “collection” of things you can iterate on is called *iterable*

• The *collection classes* of the Java library and the OSU CSE components library have methods to give you an iterator for the corresponding collection and thus are iterable

For now, we’ll not further elaborate what is meant by a “collection”; it’s what you probably think it is.
Example Code With Iterable

• Suppose `dictionary` is some iterable collection of, say, `Strings`

• This code “does something” with each `String` in the collection
  
  ```java
  for (String word : dictionary) {
    // do something with word
  }
  ```
Example Code With Iterable

• Suppose `dictionary` is some iterable collection of, say, `Strings`

• This code “does something” with each `String` in the collection

```java
for (String word : dictionary) {
    // do something with word
}
```

This is called a **for-each loop**
attributeNames

Iterable<String> attributeNames()

• Returns an Iterable<String> of the attribute names of the root of this.

• Requires:

  [label of root of this is a tag]

• Ensures:

  attributeNames = [an Iterable<String> of the attribute names of the root of this]
## Example

<table>
<thead>
<tr>
<th>Code</th>
<th>State</th>
</tr>
</thead>
</table>
| \begin{verbatim}  
    Iterable<String> it = t.attributeNames();
\end{verbatim} | \begin{verbatim}  
    t = [tree for book XML example]
\end{verbatim} |
Example

```
<book>
  printISBN → 978-1-118-06331-6
  webISBN → 1-118063-31-7
  pubDate → Dec 20 2011
</book>
```

```
t = [tree for book XML example]
```

```
Iterable<String> it =
t.attributeNames();
```
Example

State

\[ t = \text{[tree for book XML example]} \]

\[
\text{Iterable<String> } it = t.\text{attributeNames}();
\]

\[
t = \text{[unchanged]}
it = \text{[iterable for 3 Strings]}
\]
Iterating Over Attribute Names

• To iterate over the attributes of the root of an `XMLTree` there is no need to declare an `Iterable`

• This code “does something” with each attribute name (String) of the root of `XMLTree` `t`:

```java
for (String name : t.attributeNames()) {
    // do something with attribute name
}
```
display

```c
void display()

• Displays `this` in a new window.
• Ensures:

  `[this is displayed in a new window]`
```
**toString**

String `toString()`

- Returns an XML string representation of `this`.
- Ensures:

  ```
  toString = [an XML string representation of `this`]
  ```
toString

String toString()

• Returns an XML string representation of this.
• Ensures:

```
toString = [an XML representation of this]
```

Equivalent to the content of an XML file that, if identified in the constructor for XMLTree, would result in the XMLTree this.
An Immutable Type

• Observation: no method changes the value of an XMLTree variable!
  – Once an XMLTree variable is initialized by assigning it a value (e.g., the result of a constructor call), its value cannot be changed except by assigning something else to it

• This kind of type is called immutable
  – More details later…
Resources

• OSU CSE Components API: XMLTree
  – http://web.cse.ohio-state.edu/software/common/doc/