Constraining XML

lesson #lesson08

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XML Documents...

XML Documents contain a single root element, with child elements.

Each element in an XML document can have a value, attributes, and child elements.

An XML document can be validated by checking it against a constraining specification.

Agenda

1. Document Types
2. DTD Mechanics
3. XML Validation
4. Other Techniques

DOCUMENT TYPES

- A Document Type Definition (DTD) describes the intended structure and rules for an XML document.
- An XML document is "bound" to a DTD through a `<!DOCTYPE ...>` directive
- A document that claims to be of a certain type can be checked against the DTD.
- This is a *simple* way of constraining an XML document, and not the only way.

Document Type Declaration

- A DTD defines the tags allowed inside an XML document, their order and nesting, and the attributes allowed for each.
- A DTD defines a markup language!
- A DTD can be inferred from an XML document, but not the other way around!

Well-Formed vs Valid XML

- A document that follows the rules of the XML grammar is well formed.
- A document that conforms to the document type definition is valid.
- The two concepts are related but different... an XML document has to be well-formed in order to work with it, while validity improves confidence in it.
- A document can be well formed without being valid - but not the converse.
- A document with no DTD has no concept of validity.

Example: XML With Internal DTD

```
<?xml version="1.0"?>
<!DOCTYPE label[
  <!ELEMENT label (name, street, city,
    state, country, code)>
  <!ELEMENT name (#PCDATA)>
  <!ELEMENT street (#PCDATA)>
  <!ELEMENT city (#PCDATA)>
  <!ELEMENT state (#PCDATA)>
  <!ELEMENT country (#PCDATA)>
  <!ELEMENT code (#PCDATA)>
]>
```

```
<label>
  <name>Paul Allen</name>
  <street>Alaskan Way</street>
  <city>Seattle</city>
  <state>WA</state>
  <country>USA</country>
  <code>53251-0054</code>
</label>
```

Example: XML With External DTD

garage.dtd:

```
<!ELEMENT GARAGESALE (DATE, TIME, PLACE,
NOTES)>
<!ELEMENT DATE (#PCDATA)>
<!ELEMENT TIME (#PCDATA)>
<!ELEMENT PLACE (#PCDATA)>
<!ELEMENT NOTES (#PCDATA)>
```

big_weekend.xml:

```
<?xml version="1.0"?>
<!DOCTYPE GARAGESALE SYSTEM "garage.dtd">
<GARAGESALE>
  <DATE>March 6, 2002</DATE>
  <TIME>10:00 AM</TIME>
  <PLACE>GM Place</PLACE>
  <NOTES>Lots of old hockey sticks</NOTES>
</GARAGESALE>
```

DTD MECHANICS

- A DTD contains directives for elements and attribute lists.
- Collectively, these provide rules for the order, multiplicity & content of components of an XML document.

Element Declarations

- Elements are declared using an ELEMENT directive:
  `<!ELEMENT name (content)>`
- "`name`" is the tag name of an element in the XML document. It follows XML naming conventions.
- "`content`" is basicaly a list of child elements for this one.

Order Constraints

- Child elements expected in a specific order are comma-separated:
  `<!ELEMENT order (drink, food, dessert)>`
- Child elements whose order does not matter are vertical-bar-separated, using parentheses for precedence:
  `<!ELEMENT order (drink, (food | dessert))>`

Multiplicity Constraints

- Child element names without modifiers are required children:
  `<!ELEMENT fullanme (firstname, initials, surname)>`
- Child elements that are optional have a question mark modifier:
  `<!ELEMENT fullanme (firstname, initials?, surname)>`
- "Zero or more" child elements are denoted by an asterisk modifier:
  `<!ELEMENT wishlist (gift*)>`
- "One or more" child elements are denoted by a plus sign modifier:
  `<!ELEMENT thought (idea+)>`
- These can be used together:
  `<!ELEMENT thought (idea|inkling)*>`

Content Constraints

- An element without children or text value is denoted EMPTY:
  `<!ELEMENT brain EMPTY>`
- An element containg a value but no children is designated #PCDATA (for parsed character data):
  `<!ELEMENT title (#PCDATA)>`
- The "ANY" designation is for an element that can have any number and order of children, so long as their names are defined in the DTD.:
  `<!ELEMENT wishlist (ANY)>`
- An element which can contain text as well as nested child elements is called "mixed":
  `<!ELEMENT story (#PCDATA|para)*>`

Attribute Declarations

- Attributes are declared using an ATTLIST directive:
  `<!ATTLIST element-name [name, type, modifier]+>`
- Sample attribute declarations:

```
<!ATTLIST category code CDATA #REQUIRED>
<!ATTLIST quarter number (1|2|3|4) #REQUIRED year CDATA #REQUIRED >
<!ATTLIST quarter
  number (1|2|3|4) #REQUIRED
  year CDATA #REQUIRED
>
```

- Attributes can be defined & specified in XML document in any order.
- First use in XML sticks, others ignored

Attribute Types

- An attribute whose value is a text string is denoted as CDATA:
  `<!ATTLIST name title CDATA #REQUIRED>`
- An attribute can have an enumeration of allowed values:
  `<!ATTLIST name title (mr|mrs|dr) #REQUIRED>`
  These are separated by vertical bars, and cannot contain spaces.

Attribute Modifiers

- An attribute which is required for an element in the XML document has a modifier of "#REQUIRED":
  `<!ATTLIST name title CDATA #REQUIRED>`
- An attribute which is optional has a modifier of "#IMPLIED":
  `<!ATTLIST name title CDATA #IMPLIED>`
- An attribute with a default value has that default value inside quotes:
  `<!ATTLIST name title CDATA "Mr">`

Attribute ID Notes

There are some additional attribute types, though seldom used because there are other, better techniques to address their intended purpose.

- A `NMTOKEN` attribute has a value which contains only letters, digits, hyphen, point, underscore, and colon; the value has to start with a letter
- An `ID` attribute is one which is a `NMTOKEN` and whose value has to be unique amongst all `ID` attributes in the document
- An `IDREF` attribute is one whose value is meant to reference an `ID` somewhere in the document

XML VALIDATION

- A DTD can be validated inside NetBeans, by right-clicking inside its editor panel and choosing "Check DTD".
- An XML document with a document type can be validated inside NetBeans, by right-clicking inside its editor panel and choosing "Validate XML".
- An XML document without a document type cannot be validated, but its well-formedness can be checked inside NetBeans, by right-clicking inside its editor panel and choosing "Check XML".

Server-Side Validation (Short Story)

An XML document can also be validated server-side, programmatically. The folllowing shows the general idea.

```
$doc = new DOMDocument();
$doc->validateOnParse = true;
$doc->load('abc.xml');
```

Returns TRUE if valid, FALSE otherwise

Server-Side Validation (Long Story)

More proper server-side validation, with error-checking:

```
libxml_use_internal_errors(true);
if ($doc->validate())
  return 'DTD validated ok';
else {
  $result = "<b>Oh nooooo...</b><br/>";
  foreach (libxml_get_errors() as $error) {
    $result .= $error->message . '<br/>';
  }
  libxml_clear_errors(); // clear the error message buffer
  return $result;
}
```

OTHER TECHNIQUES

- DTDs are simple, widespread, and limited.
- They are generally considered obsolete, being replaced by schemas.
- But they are so simple, while schemas have a much steeper learning curve.

Sample Schema Exceprt

Here is one part of a schema, only defining a country data type, which could be an element or an alttribute.

```
<!-- There are three countries in our data set.
It makes sense to restrict a country type to one
of that list. We can add to the list later if North America grows.
Note that we will have to capitalize these later for reporting. -->
<xs:simpleType name="Tcountry">
  <xs:restriction base="xs:string">
    <xs:enumeration value="canada"/>
    <xs:enumeration value="mexico"/>
    <xs:enumeration value="usa"/>
  </xs:restriction>
</xs:simpleType>
```

Sample Relax NG Exceprt

Here is one part of a Relax NG schema....

```
<element name="addressBook" xmlns="http://relaxng.org/ns/structure/1.0">
  <oneOrMore>
    <element name="card">
      <element name="name">
        <text/>
      </element>
      <element name="email">
        <text/>
      </element>
    </element>
  </oneOrMore>
</element>
```

Congratulations!

You have completed lesson #lesson08: Constraining XML

If you would take a minute to provide some feedback, we would appreciate it!

The next activity in sequence is: tutorial06 Working With XML and DTDs

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