Computer Science E-259

XML with Java

Lecture 3: DOM Level 3

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Computer Science E-259

Last Time

- XML 1.1
- SAX 2.0.2
- JAXP 1.3 and Xerces 2.7.1
- Parsing
- My First XML Parser

Last Time

A Representative Document

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE students SYSTEM "student.dtd">

<!-- This is an XML document that describes students -->
<?studentdb displaydesc="true"?>
<students>
        <student id="0001">
                <name>Jim Bob</name>
                <status>graduate</status>
                <dorm/>
                <major>Computer Science &amp; Music</major>
                <description>
                        <![CDATA[ <h1>Jim Bob!</h1>
                        Hi my name is jim.  I look like
                        <img src="jim.jpg"> ]]>
                </description>
        </student>
        <student id="0002">
                ...
        </student>
</students>
```

Last Time

SAX 2.0.2

```
startDocument();
 endDocument();
startElement(·,·);
 endElement(·);
 characters(·);
      ...
```

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This Time

- DOM Level 3
- JAXP 1.3 and Xerces 2.7.1
- My First XML Parser

DOM Level 3

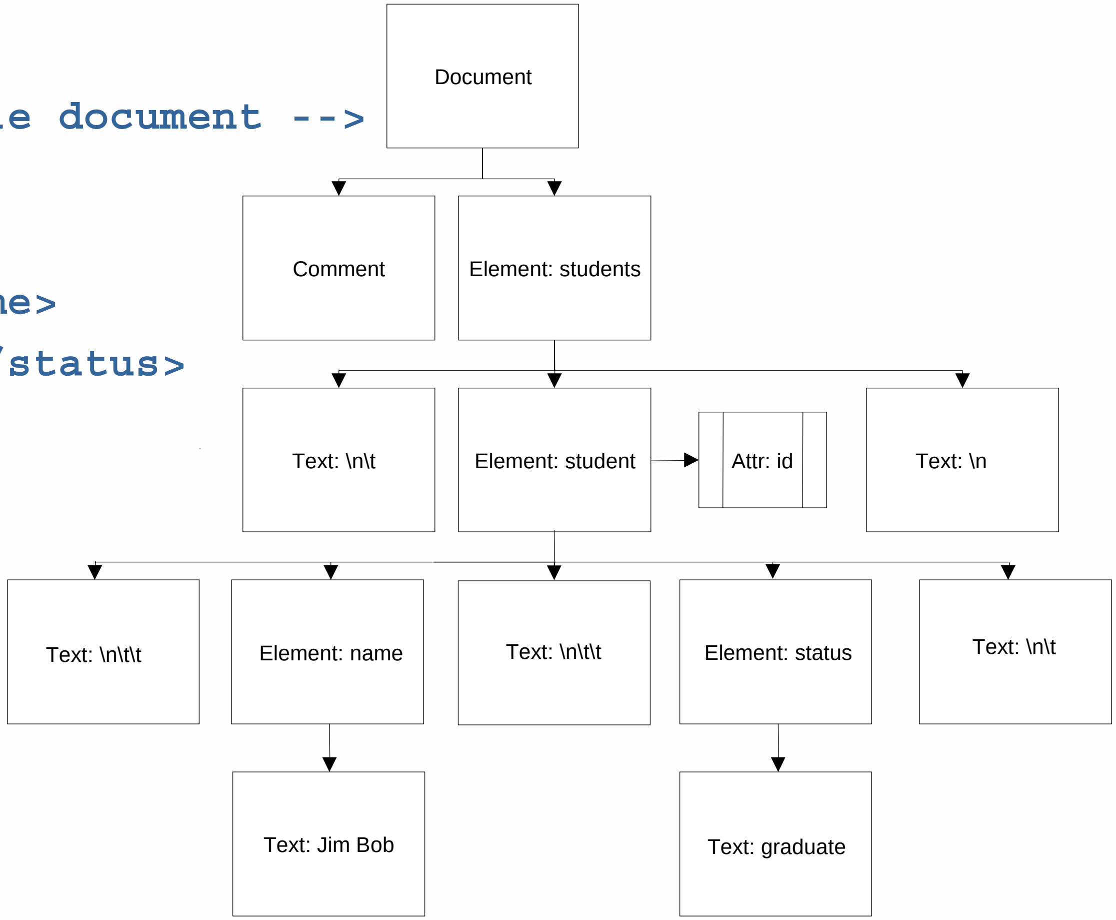
Why?

- The SAX API has a number of important advantages...
  - You can write very fast SAX parsers
    - No memory to allocate, data structures to link
    - Fire and forget
  - It is useful for large documents
    - Loading the whole document into memory is prohibitive
  - It is easy to use
- ...but it doesn't solve every problem
  - Need to have an internal data structure for some applications
  - To follow links in information (especially backwards ones)
  - To perform operations that require having multiple pieces of the document at the same time
- Enter the DOM...

DOM Level 3

By Example

```
<!-- This is an example document -->
<students>
  <student id="0001">
    <name>Jim Bob</name>
    <status>graduate</status>
  </student>
</students>
```



DOM Level 3

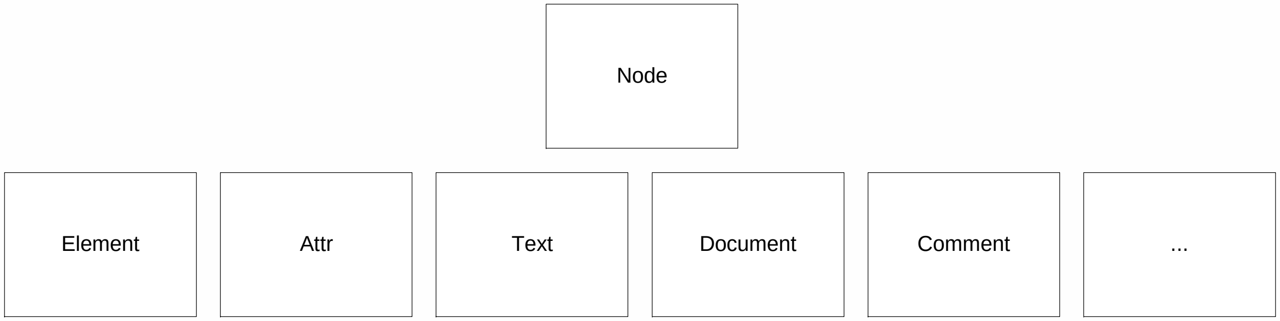
By Definition

- The result of parsing a document with a DOM parser is a DOM tree that matches the structure of that document
- After parsing is complete, the tree data can be used by application
- A DOM tree may be different than trees you have seen in the past
    - There are different types of nodes in the tree
    - Only some nodes can have children
    - For nodes that are allowed children, there is no limit on the number of child nodes
    - Attributes can grow the tree "horizontally" as well as vertically
    - Can think of a DOM tree as a hybrid of list and tree concepts

DOM Level 3

By Definition

- Presents a language-neutral interface for manipulating hierarchical documents
  - Used for both (X)HTML and XML
- Object hierarchy: every object type represents a component of the XML information model



DOM Level 3

Relationship with SAX

- Although the result of using a DOM parser and a SAX parser may seem very different…
- …both DOM and SAX are methods for encoding the structure and content of an XML document
  - SAX does this by the type and order of events that are invoked
  - DOM does this by using objects in a tree data-structure
- In fact, it is possible to create a DOM tree from a series of SAX events
  - One of the things you have to do in Project 1!

DOM Level 3

A Sample Document

```
<students>
     <student id="0001"/>
</students>
```

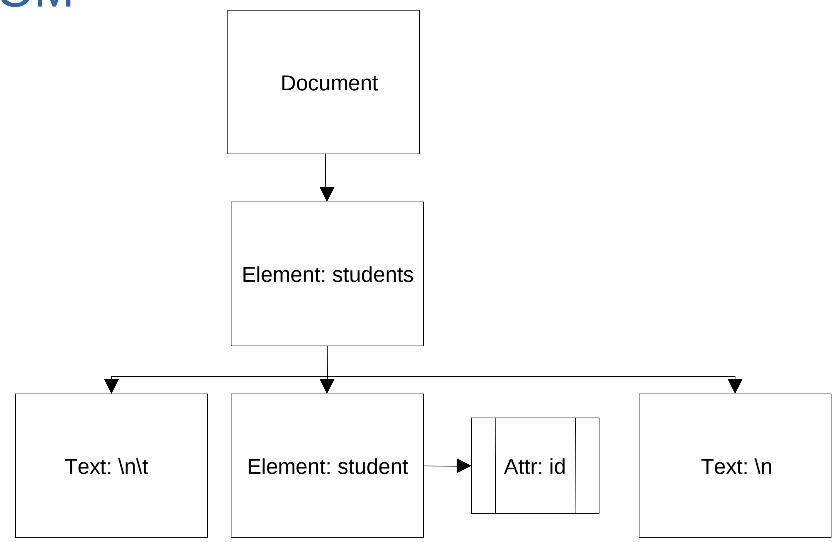
DOM Level 3

Relationship with SAX

Document

```
<students>
    <student id="0001"/>
</students>
```

DOM



Handler

```
startDocument();
startElement("students", {});
characters("\n\t");
startElement("student", {("id", "0001")});
endElement("student");
characters("\n");
endElement("students");
endDocument();
```

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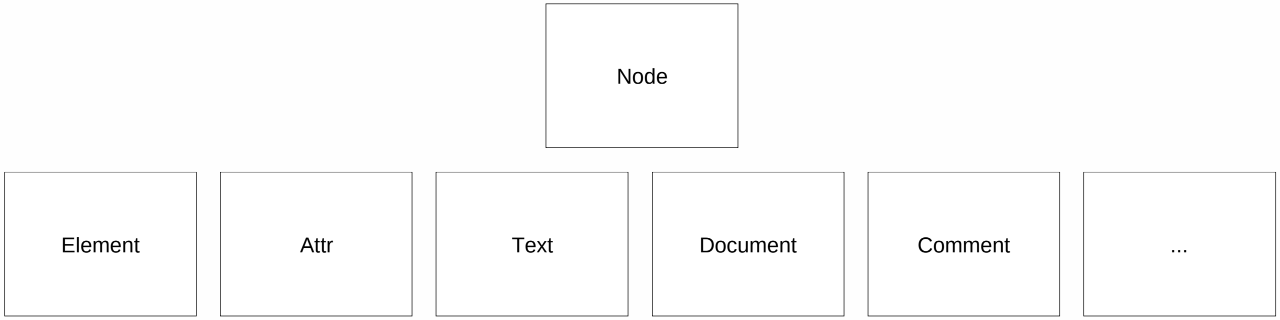
Nodes



Node

Element

Attr

Text

Document

Comment

...

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Nodes

- All objects in the DOM tree implement a **`Node`** interface
- The **`Node`** interface contains methods to get
  - a name (used to store the name of the node)
  - a value (used to store the value of the node, if any)
  - a child list (a list of nodes that are children of the current node)
  - a list of attributes
  - the parent of the node
- Not every node subtype has meaningful data to return from these methods (*e.g.*, only **`Element`** has attributes)
- Provides most of the functionality you ever want on a node
  - Get the children of an element
  - Get the value of a text node
  - Modify the DOM tree by adding or removing elements
  - ...

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Interfaces

- The W3C defined the DOM interfaces for a language-neutral data structure
  - In Java, these interfaces are in the **`org.w3c.dom`** package
- In any one language, applications can use the interfaces without ever "seeing" the actual implementation
  - In Java, you program against **`org.w3c.dom.Node`** and not, *e.g.*, **`org.apache.xerces.dom.NodeImpl`**
- In My First XML Parser, we
  - don't use the **`org.w3c.dom`** interfaces
  - simplify by using a **`Node`** base class and subclasses instead of separating an interface from an implementation

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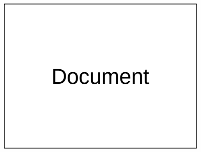
Document



- At the root of the XML DOM is a `Document` object
  - This is not the same as the root element!
- Can have content that is valid at the top level of an XML document
  - Processing instructions, comments
- Also contains the (one and only one) document element
- Contains functions for creating other types of DOM Nodes
  - Remember, the DOM specifies an interface, not an implementation!
  - This design pattern is known as a *factory*

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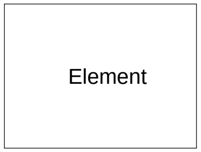
Element



Element

- The most "interesting" object in the DOM tree, as it makes up most of the structure
- Adds a few additional utility functions on top of the Node interface for manipulating attributes

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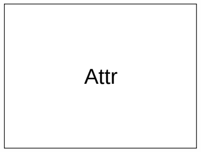
Attr


Attr

- Somewhat special in the DOM hierarchy in that it is not part of the DOM tree proper
- Elements have a list of attributes attached

DOM Level 3

...

...

- Most of the other DOM types are relatively simple, and use the name and value fields defined by the base Node interface
- **`CDATASection`**, **`Comment`**, **`ProcessingInstruction`**, and **`Text`**, for instance, all fall into this category

JAXP 1.3 and Xerces 2.7.1

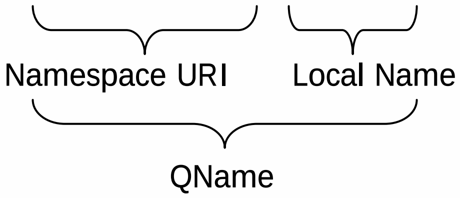
DocumentBuilderDemo

```
javax.xml.parsers.DocumentBuilderFactory
javax.xml.parsers.DocumentBuilder
org.w3c.dom.*
...
```

JAXP 1.3 and Xerces 2.7.1

Namespaces

- Many of JAXP’s APIs mention XML namespaces
- Namespaces are a way to specify groupings of tag and attribute names so that two names with different meanings don't “collide”
  - For example, the element “name” may refer to a person in a student markup language, but may refer to a book in a library markup language
- Allow you to specify a namespace, local name, and fully qualified name
  - `studentml:name`



- More to come…

My First XML Parser

`DOMBuilderDemo`

```
cscie259.project1.mf.*
```

Next Time

- CSS Level 2
- XPath 1.0
- XSLT 1.0
- TrAX
- Project 2

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