ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ

Εισαγωγή στην Επιστήμη και Τεχνολογία των Υπηρεσιών

Ενότητα 2: Writing XML

Χρήστος Νικολάου
Τμήμα Επιστήμης Υπολογιστών

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Κοινωνικό Ταμείο
ΕΠΙΧΕΙΡΗΣΙΑΚΟ ΠΡΟΓΡΑΜΜΑ
ΕΚΠΑΙΔΕΥΣΗ ΚΑΙ ΔΙΑ ΒΙΟΥ ΜΑΘΗΣΗ
επένδυση στην κοινωνία της γνώσης
ΥΠΟΥΡΓΕΙΟ ΠΑΙΔΕΙΑΣ & ΘΡΗΣΚΕΥΜΑΤΩΝ, ΠΟΛΙΤΙΣΜΟΥ & ΑΘΛΗΤΙΣΜΟΥ
ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης
ΕΣΠΑ 2007-2013
πρόγραμμα για την ανάπτυξη
ΕΥΡΩΠΑΪΚΟ ΚΟΙΝΩΝΙΚΟ ΤΑΜΕΙΟ

Άδειες Χρήσης

Χρηματοδότηση

- Το παρόν εκπαιδευτικό υλικό έχει αναπτυχθεί στα πλαίσια του εκπαιδευτικού έργου του διδάσκοντα.
- Το έργο «**Ανοικτά Ακαδημαϊκά Μαθήματα στο Πανεπιστήμιο Κρήτης**» έχει χρηματοδοτήσει μόνο τη αναδιαμόρφωση του εκπαιδευτικού υλικού.
- Το έργο υλοποιείται στο πλαίσιο του Επιχειρησιακού Προγράμματος «Εκπαίδευση και Δια Βίου Μάθηση» και συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση (Ευρωπαϊκό Κοινωνικό Ταμείο) και από εθνικούς πόρους.

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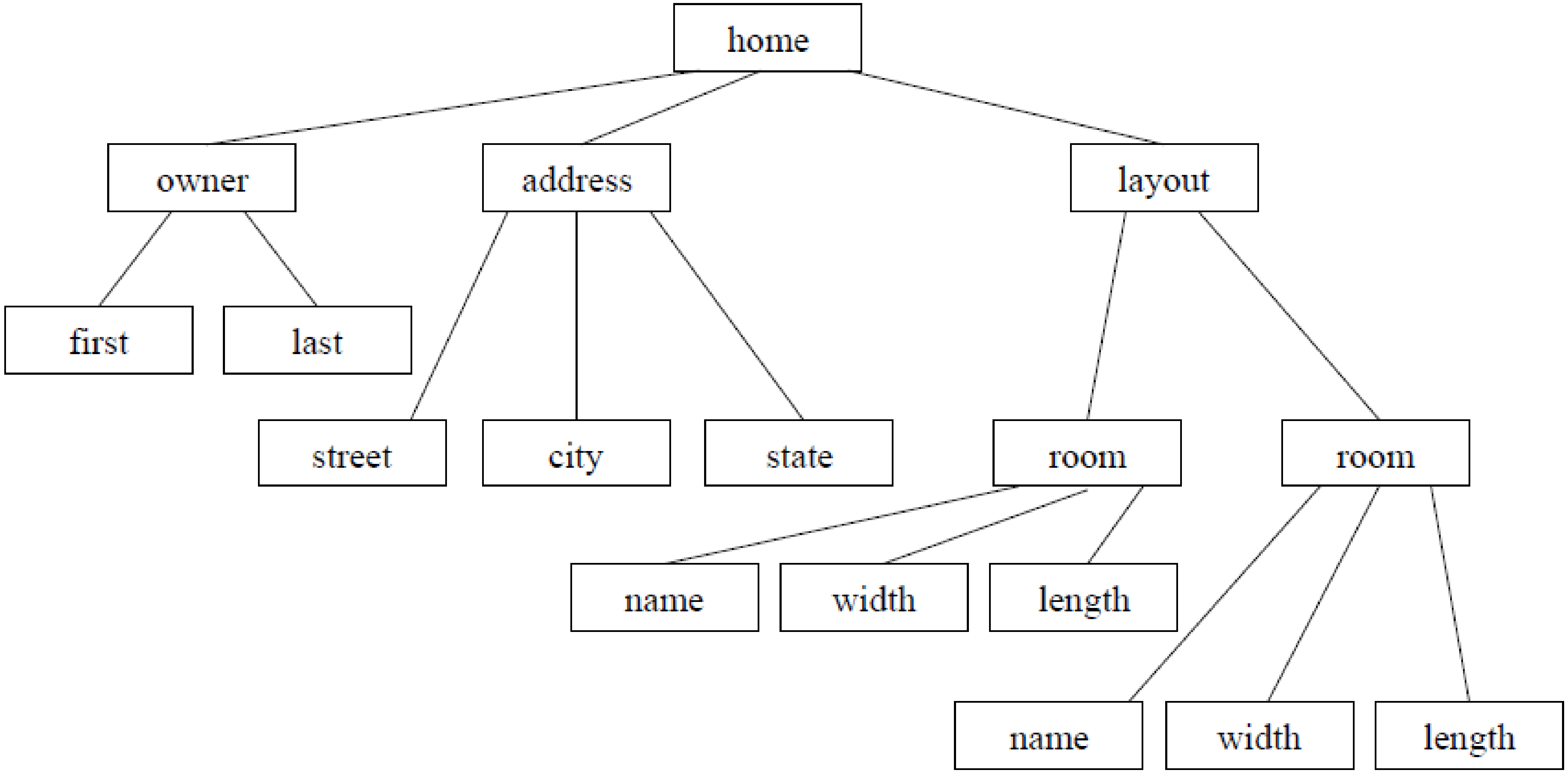
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

XML
Writing XML
605.44 / 635.444

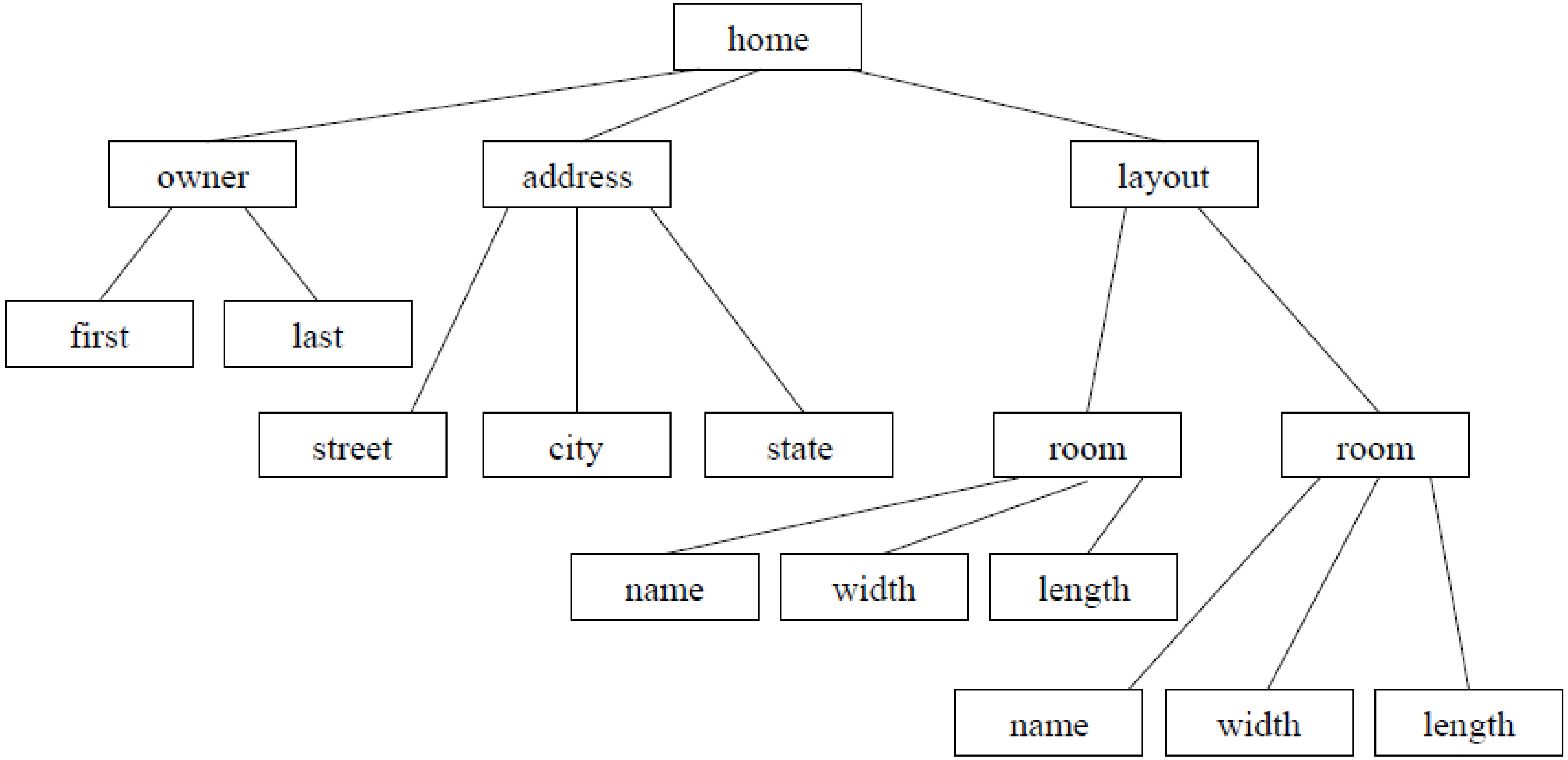
David Silberberg

Lecture 2

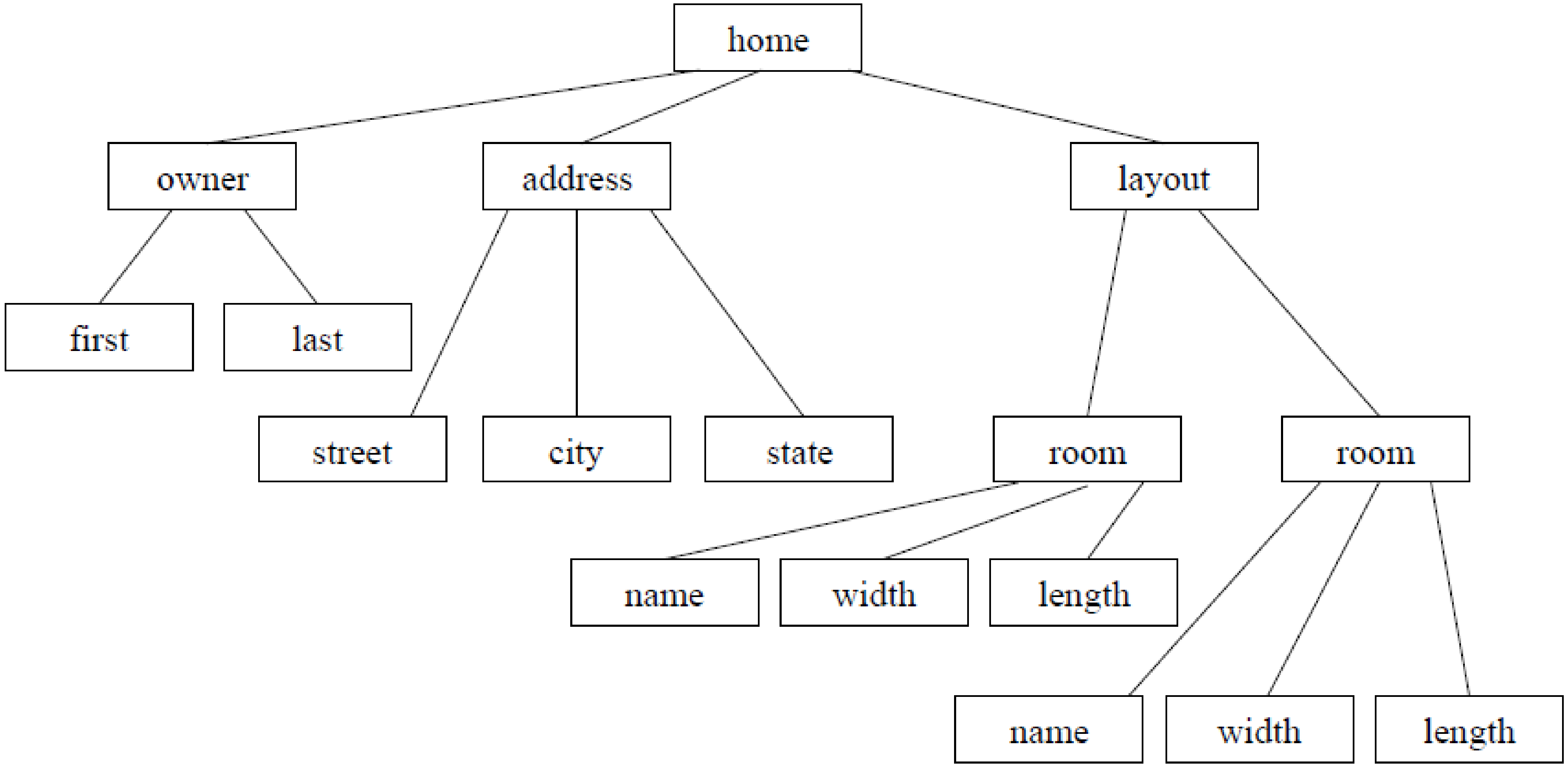
Let's Represent a House



Let’s Represent a House



Let’s Represent a House



XML Declaration (cont.)

- Encoding and Standalone attributes are optional
- First character in the file should be <
    - No breaks allowed
    - No spaces allowed
    - Some parsers are more flexible

XML Declaration - Encoding

- Definition
  - Character code is a one-to-one mapping between characters and their machine representations
  - Character encoding is the method used to represent the characters digitally
- ASCII
  - American Standard Code for Information Interchange
  - Most common English standard
  - Eight bit representations
    - "A" is 65
    - "a" is 97
  - Only represents 256 characters
  - Fine for English
  - Not fine for other character sets

Encoding (cont.)

- Unicode
  - UTF-16 (Unicode Transformation Format-16)
    - 16 bits = 2 bytes for every character
    - 2^{16} different characters can be represented
    - If you are representing ASCII text, you waste much space because every character can be represented by 1 byte
  - UTF-8
    - 8 bits = 1 byte for every character
    - Actually, the high bit encodes whether or not 7-bit ASCII is used
    - If the bit is set one way, it represents 7-bit ASCII characters in one byte
    - If the bit is set the other way, two bytes are used
    - This saves much space

Encoding (cont.)

- XML specification requires Unicode to be used internally
  - This is not usually the case for external files
  - Most are encoded with other standards
    - ISO-8859-1
    - windows-1252
    - EBCDIC
  - These are variants of ASCII, but not subsets of UTF-8 like ASCII
- The encoding attribute specified in the ?xml statement indicates the character encoding of the text to the parser
- Parser reads text and translates it to Unicode internally
- If no encoding is specified, UTF-8 or UTF-16 is assumed

Encoding (cont.)

- An XML document may ignore the encoding if there is a protocol specific encoding
  - For example, HTTP may have a protocol specific encoding
  - HTTP takes precedence over XML
- An XML document created in Notepad on Microsoft Windows
  - Some versions save characters in windows-1252 form by default
    - You need to create the corresponding ?xml statement:
      `<?xml encoding="windows-1252"?>`
  - If the parser does not understand this encoding, then use ISO-8859-1 or ASCII instead
  - In Notepad using Windows 2000 and NT
    - Saves characters in ANSI form by default
    - You can save a file in Unicode format

Standalone

- Standalone Document Declaration (SDD)
  - Either “yes” or “no” if used
  - “yes” indicates that the XML document does not depend on other documents (stands alone)
  - “no” indicates that the XML document depends on other files
  - Not required
- XML parser is not required do anything with the *standalone* attribute
  - Provides a hint to the parser
  - If standalone is "no," it lets the parser know that it should validate the document with an external DTD file
  - Standalone is not used with external XML Schema files

Sample Headers

- <?xml version="1.0"?>
  - Standard, no frills header
  - Unicode is assumed since no encoding is specified
  - It is assumed to be standalone="yes"

- <?xml version="1.0" encoding="ASCII" standalone="no"?>
  - ASCII encoding
  - Uses an external DTD file

- <?xml version="1.0" encoding= "UTF-8" standalone="yes"?>
  - UTF-8 encoding
  - Does not use an external DTD file

Sample Headers

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  - UTF-8 encoding
  - Does not use an external DTD file

PIs Continued

- There can be many PIs in one XML file
- Convention
  - PIs that start with xml-[something] refer to XML-related technology
  - Other PIs are not XML-related technology
  - Example
    - Stylesheets are XML technology
    - <?xml-stylesheet href="House.xsl" type="text/xsl"?>
    - We will cover stylesheets later
- <?xml …?> is not really a PI
  - Cannot get the 'xml' declarations from most parsers
  - <?xml …?> can only be placed at the beginning of the document

Document Type Declarations

- Specifies a DTD for an XML document

  <!DOCTYPE home SYSTEM “C:\home.dtd”>
- Must start with <!DOCTYPE
- Must end with >
- The first parameter is the root element
  - This is the outermost tag in the content of an XML document
  - XML permits only one root in a document
  - If your XML document includes another XML document, then the other document’s root element is enclosed in your root element
  - If the root element does not match, the parser returns an error

DTDs (continuted)

- Second element
  - SYSTEM
    - Corresponding DTD is available on your system or another system
    - Need to specify the location of the DTD using a
      - Uniform Resource Locator (URL) or
      - More generally, Uniform Resource Identifier (URI)
        - » URI can be a URL or Universal Resource Name (URN)
        - » We'll cover URNs later when we speak about Namespaces
    - Examples on personal PC system
      - <!DOCTYPE home SYSTEM "C:\home.dtd">
      - <!DOCTYPE home SYSTEM "file:///DTD/home.dtd">
    - Example on other systems
      - <!DOCTYPE home SYSTEM "http://www.apl.jhu.edu/home.dtd">
      - <!DOCTYPE home SYSTEM "urn:HomeStandard:home-design">

DTDs (continuted)

- PUBLIC
  - Publicly available resources
  - Well known standards
  - Not in traditional URI format
  - Allows second URI in case the first is unavailable
  - Examples
    - <!DOCTYPE home PUBLIC
      “-//W3C//DTD XHJTML 1.0 Transitional//EN”
      “http://www.apl.jhu.edu/home.dtd”>
    - <!DOCTYPE home PUBLIC
      “HomeDesign/Home Template/”
      “http://www.apl.jhu.edu/home.dtd”>
  - May go into more detail in future lectures

Comments

- Standard comment syntax
- Starts with <!--
- Ends with -->
- Can span multiple lines
- Anything can go in between (almost anything)
- Cannot have nested comments
  - <!-- comment <!-- subcomment --> -->
- Cannot exist inside a tag
  - <home <!-- comment --> >
- Cannot contain --
  - <!-- comment -- not valid -->

The Document Root Element

- Highest level tag in document
- In well-formed documents, the document root element must be the first opening tag and the last closing tag.

```
<home>
      …
</home>
```

- Otherwise, it is just like any other tag
- There is only one document root element per document
- Allows document inclusion to work seamlessly

XML Data Elements - Names

- Can start with letters or “_” or “:”.
- After the first character, numbers, “-”, and “.” are allowed
- Names are case sensitive
  - <HOME> is different than <home>
- Names cannot:
  - start with numbers or punctuation symbols
  - contain spaces
  - (Should not) contain “:” unless you are using Namespaces
  - start with XML in upper, lower, or mixed case
- Names should be readable and reasonable
  - Not too long, too short, or too cryptic

Names (cont.)

- Names should be meaningful
- Need to have beginning and end
  - End starts with /
  - <length>14</length>
  - <width>12</width>
- If there is no text between begin and end tag
  - <painted></painted> is a bit tedious
  - <painted/> is just as good
  - <owner ssn="S-111-11-1111"/>
- Tags cannot overlap
  - <length>12<width></length>12</width>

Attributes

- What is the difference between elements and attributes?
  - ssn element

```
<owner>
        <ssn>S-111-11-1111</ssn>
</owner>
```

  - ssn attribute

```
<owner ssn="S-111-11-1111"></owner>
<owner ssn="S-111-11-1111"/>
```

- It is often a matter of preference
- There are no differences in usage or meaning. (However, IDs and IDREFs can only be defined in attributes.)

Attributes (continued)

- Usually, element data is information that is of interest to a user or someone looking at the document
- Usually, attribute data is information that is of interest to a program for some reason
  - Can be identification number that is not of concern to average user
  - Can be information used for indexing or searching
- Must have values
  - Invalid: <name paid>…</name>
  - Valid: <name paid="true">…</name>
- Values must be surrounded by "" or ''
  - Single quotes can be contained in double quotes or visa versa

White Space

- HTML
  - Strips white space that is considered insignificant

    ```
    <P>You can write a paragraph.      This one has two
    sentences.</P>
    ```

  - HTML prints it as follows

    ```
    You can write a paragraph. This one has two sentences.
    ```

  - To preserve the space in HTML, special “non-breaking spaces” (&nbsp;) are used

    ```
    <P>You can write a paragraph.&nbsp;&nbsp;&nbsp;&nbsp;
    &nbsp;&nbsp;This one has two sentences.</P>
    ```

  - HTML prints it as follows

    ```
    You can write a paragraph.      This one has two sentences.
    ```

White Space (cont.)

- XML
  - Does not strip white space

    ```
    <P>You can write a paragraph.      This one has two
      sentences.</P>
    ```
  - Data is as follows

    ```
    You can write a paragraph.      This one has two
      sentences.
    ```
  - Carriage returns, line feeds, and new lines
    - All different on different operating systems
    - XML strips them out and replaces with a single line feed character
    - Data exchange is simplified

White Space (cont.)

- XML
  - White space between tags

```
<owner ssn="S-111-11-1111">
      <first>David</first>
</owner>
```

  - Should there be a line feed after <owner> and before <first>?
  - If so, this is *extraneous white space*
  - Cannot tell from this document alone
  - DTD or Schema files answer this question

Illegal Characters

- Cannot use “<“ and “&” characters
- Example:
  - <fact>8 < 80 & 80 > 8</fact>
  - Parser expects no space after <
  - Parser expects no space after &
  - Need escaping characters

Escaping Characters

- Escaping characters

&amp;	- the &amp; character
&lt;	- the &lt; character
&gt;	- the &gt; character
&apos;	- the ‘ character
&quot;	- the “ character
&amp;nnn;	- the Unicode character
&amp;#xnnn;	- the hexadecimal number (&amp;169; or &#xA9; is ©)

- Example
  - &lt;fact&gt;8 &lt; 80 &amp; 80 &gt; 8&lt;/fact&gt;

Constants

- Can represent constant values with escaping characters
- Anything after an & and before ; is considered an *entity reference*
- XML handles the escaped characters on the previous page in a special way
- In general, the parser will use DTD and Schema files or other means to deal with constants
- Examples
  - <room>&MyFavoriteRoom;</room>
  - Parser or program will deal with it

Unparsed Data (CDATA)

- CDATA stands for Character Data
- Useful for passing large chunks of literal text without the parser touching it
- Example:

```
<![CDATA[
    <Room 1>Dining Room
    <Room 2>Living Room
]]>
```

Parsers

- Apache Xerces: http://xerces.apache.org/
- DataChannel XJ Parser: http://xdev.datachannel.com/directory/xml_parser.html
- IBM XML4J: http://alphaworks.ibm.com/tech/xml4j
- James Clark's XP:
  - http://www.jclark.com/xml/xp
  - http://www.jclark.com/xml/expat.html
- OpenXML: http://www.openxml.org
- Oracle XML Parser: http://technet.oracle.com/tech/xml
- Sun Microsystems Project X: http://java.sun.com/products/xml
- Tim Bray's Lark and Larval: http://www.textuality.com/Lark
- Vivid Creations ActiveDOM: http://www.vivid-creations.com

XML Parser Errors

- Two types of errors in XML
- Errors
  - Violation of the rules in the specification where results are undefined
  - Parser is allowed to recover from the error and continue
- Fatal Errors
  - XML document is not well formed
  - Parser may only continue to identify more errors
  - Parser will not try to recover

Design Considerations

- Should one model a given data item as a **<u>subelement</u>** or as an **<u>attribute</u>** of an existing element?
- Example, you could model the title of a slide either as:

```
<slide>
  <title>This is the title</title>
</slide>
```

- or as:

```
<slide title="This is the title">
...
</slide>
```

Forced Choices

- Sometimes, the choice between an attribute and an element is forced on you by the nature of attributes and elements
- The data contains substructures
  - Must be modeled as an *element*
  - Attributes take only simple strings.
  - So if the title can contain emphasized text like this:

    `The <em>Best</em> Choice, then the title must be an element.`
- The data contains multiple lines
  - Here, it also makes sense to use an element
  - Attributes need to be simple, short strings or else they become unreadable, if not unusable.

Forced Choices (2)

- The data changes frequently
  - When the data will be frequently modified, especially by the end user, then it makes sense to model it as an element
  - XML-aware editors tend to make it easy to find and modify element data
  - Attributes can be somewhat harder to get to, and therefore somewhat more difficult to modify.
- The data is a small, simple string that rarely if ever changes
  - This is data that can be modeled as an attribute
  - However, just because you can does not mean that you should

Forced Choices (3)

- The data is confined to a small number of fixed choices
  - Here is one time when it makes sense to use an attribute
  - Using DTD or Schema specifications, attributes can be prevented from taking on values that are not in the pre-approved lists
  - An XML-aware editor can even provide those choices in a drop-down list
  - Note: the gain in validity restriction comes at a cost in extensibility
    - Author of the XML document cannot use any value that is not part of the DTD
    - If another value becomes useful in the future, the DTD or Schema will have to be modified before the document author can make use of it

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Stylistic Choices (2)

- Visibility
  - If data is intended to be shown to end users, then it is reasonable to model them as elements
  - If the data guides XML processing but are never displayed, then it may be better to model them as attributes
  - Example
    - *manufacturer name* can be modeled as an element
    - *manufacturer's code number* can be modeled as an attribute

Stylistic Choices (3)

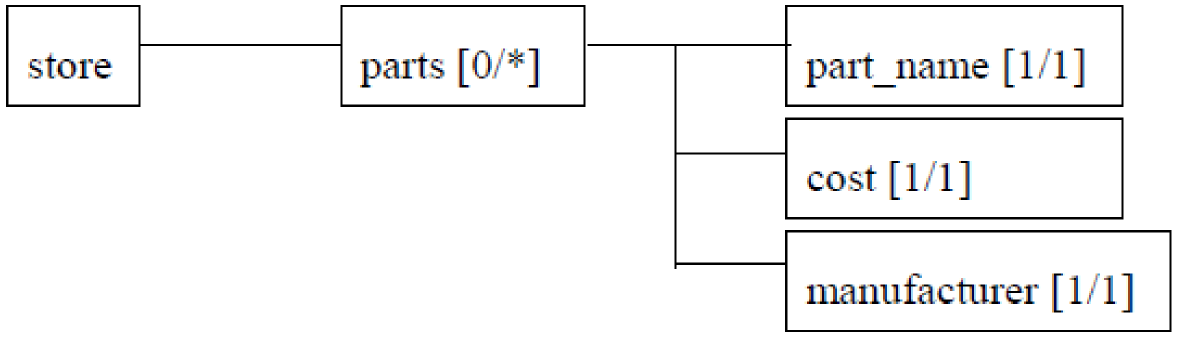
- Consumer / Provider
  - Determine who is the consumer and/or provider of the information
  - Human enters *manufacturer name* so it is modeled as an element
  - Software supplies *manufacturer's code number* so it is modeled as an attribute
- Container vs. Contents
  - Another way of thinking about elements and attributes is to think of an element as a container
  - The contents of the container (water or milk) correspond to XML data modeled as elements
  - On the other hand, the characteristics of the container (blue or white, pitcher or can) correspond to XML data modeled as attributes

Modeling XML

- Pictures are always useful when conveying a design of a data model
- I will present just one of many possible XML data structure models
- This will be modified slightly later in the semester when representing DOM structure
- The main point is to model the hierarchy correctly

Modeling a Simple XML Structure

- Represent each element/attribute using a rectangle
  - Do not be concerned about whether you will ultimately represent data as an element or an attribute
  - The hierarchy is the most important aspect right now
  - Lines between elements/attributes represent direct hierarchical structure
- Example hierarchy:

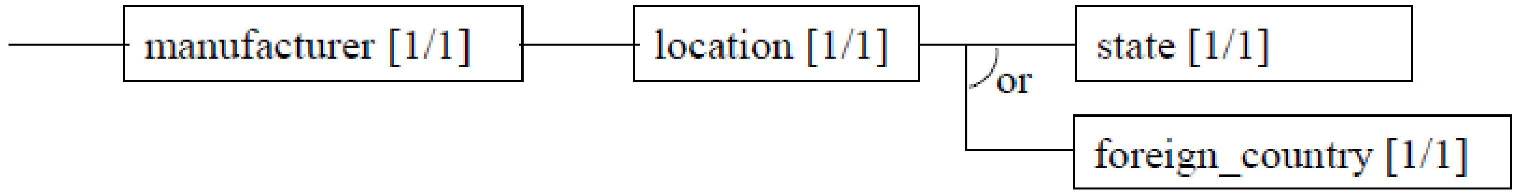


Hierarchy Explanation

- Document root element is *store*
  - Does not need a cardinality
  - There can only be one of these in an XML document
- *store* has one type of child which is *parts*
  - At a minimum, there can be no *parts*
  - At a maximum, there can be an infinite number of *parts*
- *parts* must have 3 children – *part_name, cost, manufacturer*
  - At a minimum, there can be one of each of these children per each *parts*
  - At a maximum, there can be one of each of these children per each *parts*

Modeling Choice

- Suppose the location of a *manufacturer* is either represented as a U.S. state or a foreign country, but not both.
  - An **or** is used to represent this choice
  - The **or** is placed in the hierarchy as:



Modeling Known Values

- In general, the range of data values of elements and attributes are many
  - It does not make sense to list all values
- In some cases, the range of data values are few
  - It is useful to list all the values
  - This is how it can be represented in the model:

```
state [1/1] – range: AK, AL, …
```

```
title [1/1] – range: Mr., Ms., Mrs., Miss, Dr.
```

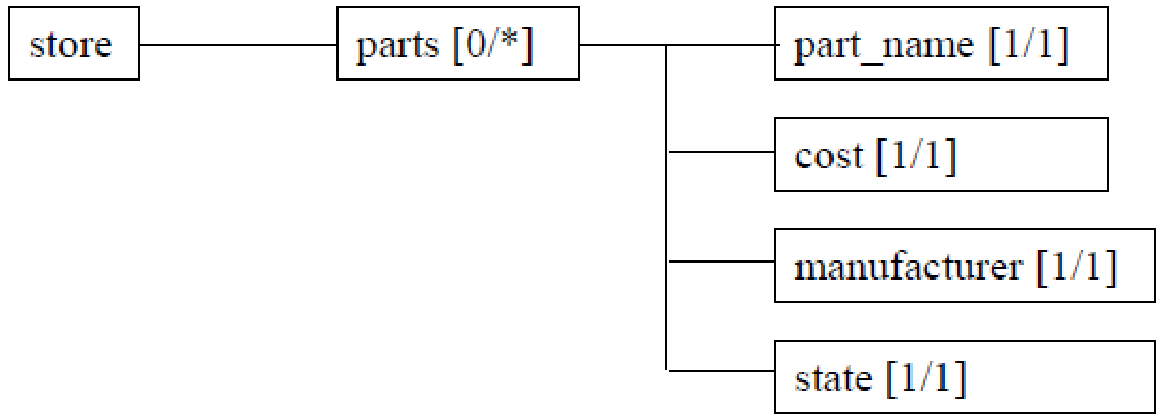
Normalization

- The process of eliminating redundancies is known as normalization
- Defining DTD entities or Schema types is one good mechanism to help guide data normalization
- The considerations for defining an entity reference are similar to those you would apply to modularize database tables or program code

Normalization (2)

- Whenever you find yourself writing the same thing more than once, create one element substructure
  - Use IDREFs to reference the element substructure
  - IDs and IDREFs can only be defined in attributes
  - Lets you write it one place and reference it multiple places.
- If the information is likely to change and is used in more than one place, define it in one place
- Normalization produces modular XML that is smaller as well as easier to update and maintain
- The normalization process can make the resulting document somewhat more difficult to visualize
- However, once you understand it, it makes sense

Problems of Un-normalized Data



part_name	cost	manufacturer	state
widgit	$3	Acme Inc.	MD
thing-a-ma-bob	$5	Acme Inc.	MD
doodad	$4	XYZ Ent.	NJ

Un-normalized XML

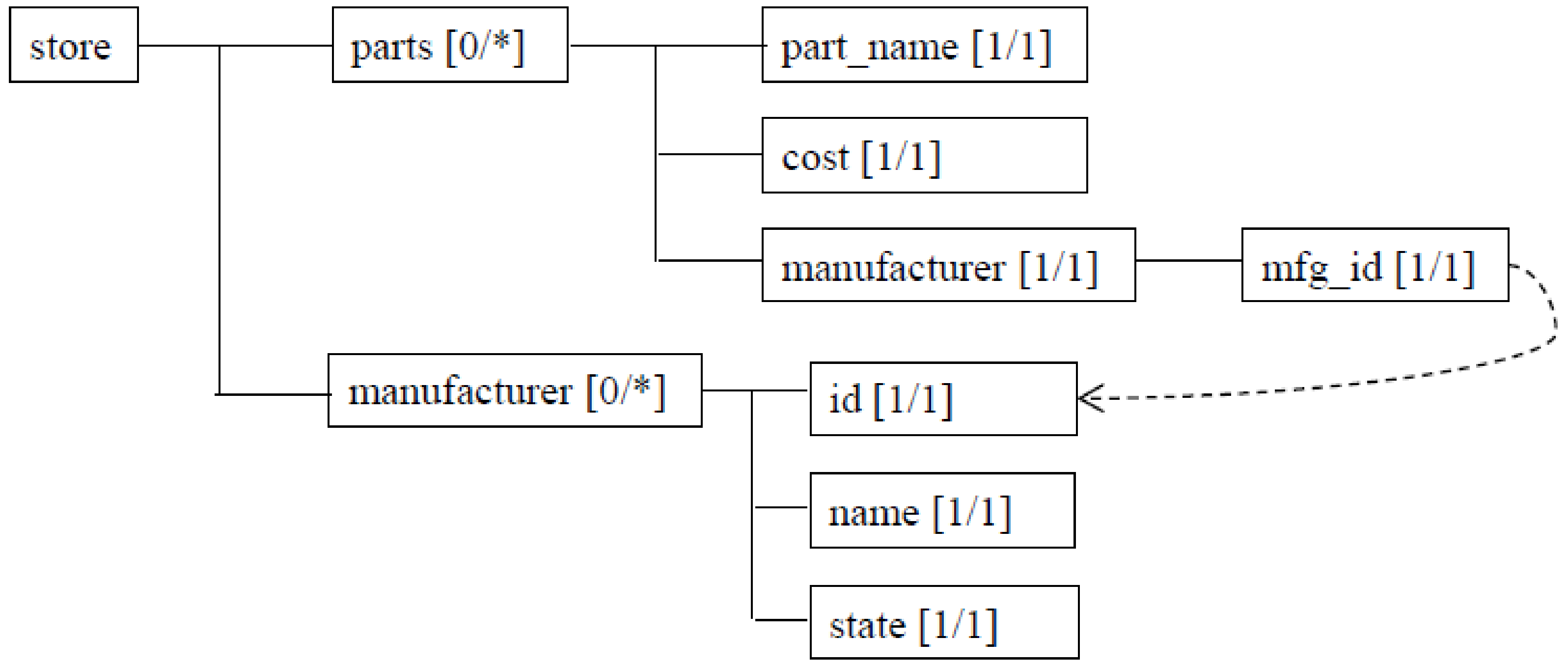
```
<store>
        <parts>
             <part_name> widget </part_name>
             <cost> 3 </cost>
             <manufacturer> Acme Inc. </manufacturer>
             <state> MD </state>
        </parts>
        <parts>
             <part_name> thing-a-ma-bob </part_name>
             <cost> 5 </cost>
             <manufacturer> Acme Inc. </manufacturer>
             <state> MD </state>
        </parts>
        <parts>
             <part_name> doodad </part_name>
             <cost> 4 </cost>
             <manufacturer> XYZ Ent. </manufacturer>
             <state> NJ </state>
        </parts>
</store>
```

Problems of Un-normalized Data (2)

- Repetition anomaly - state repeated
- Update anomaly - state updated twice
- Insertion anomaly
  - Cannot add new manufacturer until we have part
  - Visa versa
- Deletion anomaly - deleting 'doodad' deletes XYZ from DB

Modeling References

- To normalize
  - The data must be aggregated into logical groups
  - The groups must reference through identifier references

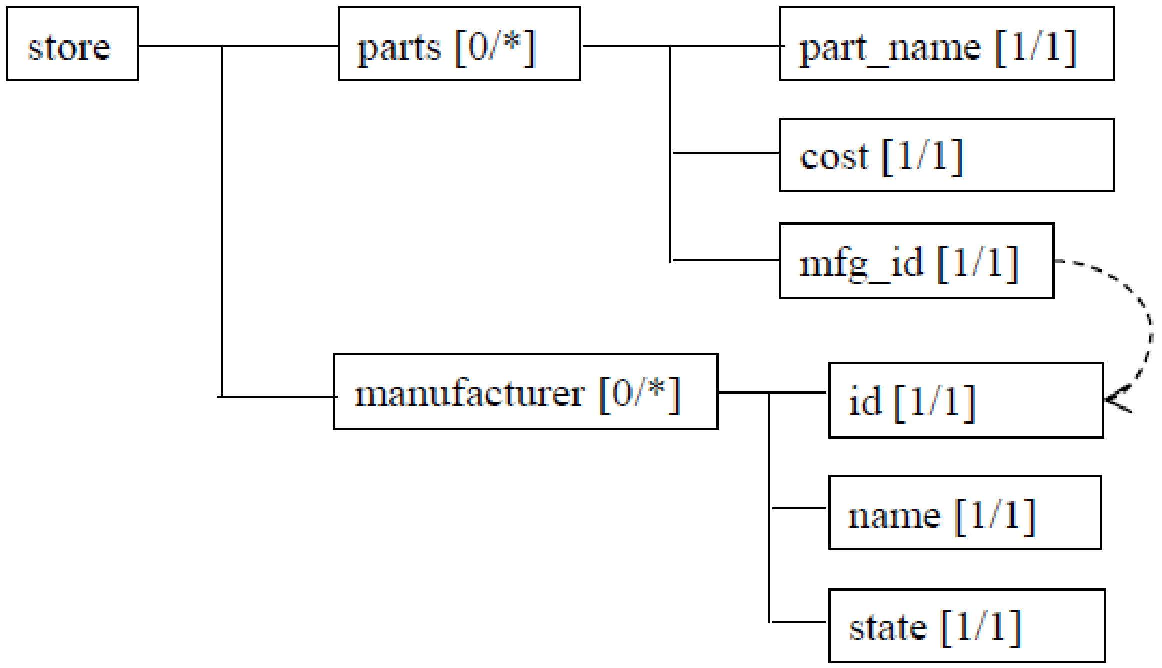


Normalized XML

```
<store>
    <parts>
        <part_name> widget </part_name>
        <cost> 3 </cost>
        <manufacturer mfg_id="m1"/>
    </parts>
    <parts>
        <part_name> thing-a-ma-bob
        </part_name>
        <cost> 5 </cost>
        <manufacturer mfg_id="m1"/>
    </parts>
    <parts>
        <part_name> doodad </part_name>
        <cost> 4 </cost>
        <manufacturer mfg_id="m2"/>
    </parts>
```

```
    <manufacturer id="m1">
        <name>Acme Inc. </name>
        <state> MD </state>
    </manufacturer>
    <manufacturer id="m2">
        <name>XYZ Ent. </name>
        <state> NJ </state>
    </manufacturer>
</store>
```

Another Possible Model



Normalized Version of Other Model

```
<store>
        <parts mfg_id="m1">
             <part_name> widget </part_name>
             <cost> 3 </cost>
        </parts>
        <parts mfg_id="m1">
             <part_name> thing-a-ma-bob
             </part_name>
             <cost> 5 </cost>
        </parts>
        <parts mfg_id="m2">
             <part_name> doodad </part_name>
             <cost> 4 </cost>
        </parts>
        <manufacturer id="m1">
             <name>Acme Inc. </name>
             <state> MD </state>
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             <state> NJ </state>
        </manufacturer>
</store>
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Τέλος Ενότητας