XML

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Objective

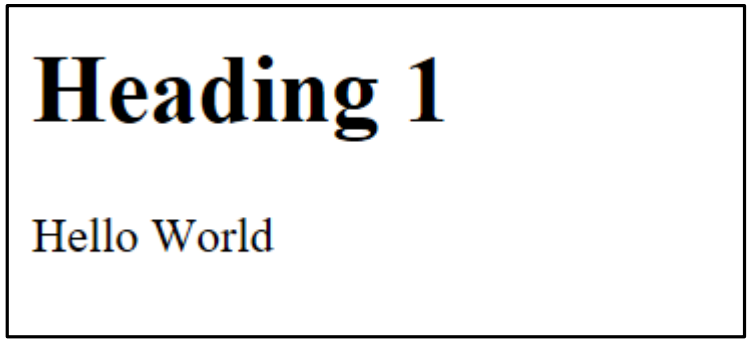
- Understand and be able to recognise XML syntax
- Understand “Well-formed” XML
- Understand and be able to explain the purpose of DTD
- Understand and be able to explain the purpose of XML schema (XSD)
- Be able to explain the difference between relational model and XML

Extensible Markup Language (XML)

- A meta-language (a language for describing other languages) that enables designers to create their own customized tags to provide functionality not available with HTML.
- Standard for data representation and exchange
- Also streaming format
- XML has a document format similar to HTML
  - Tags describe content instead of formatting

HTML

```
<html>
 <head>
  <title>My Title</title>
 </head>
 <body>
  <h1>Heading 1</h1>
  <p>Hello World</p>
 </body>
</html>
```



XML

```
<!--Bookstore with no DTD -->
<Bookstore>
  <Book ISBN="0590353403" Price="20" Edition="1st"
    <Title>Harry Potter and the Philosopher's Stone</Title>
    <Authors>
      <Author>
        <First_Name>J.k.</First_Name>
        <Last_Name>Rowling</Last_Name>
      </Author>
    </Authors>
  </Book>
 </Bookstore>
```

XML - Elements

- Elements, or tags, are most common form of markup.
- First element must be a root element, which can contain other (sub)elements.
- XML document must have one root element <Bookstore>.
  - start-tag <Bookstore>
  - end-tag </Bookstore>
- XML elements are case sensitive
- An element can be empty, in which case it can be abbreviated to <EMPTYELEMENT/>
- Elements must be properly nested.

XML - Attributes

- Attributes are name-value pairs that contain descriptive information about an element.
- Attribute is placed inside start-tag after corresponding element name with the attribute value enclosed in quotes.

```
<Book ISBN="0590353403" Price="20" Edition="1st"
```

- A given attribute may only occur once within a tag, while subelements with same tag may be repeated.

XML – Other Sections

- *XML declaration*: optional at start of XML document.

E.g., <?xml version="1.0" encoding="UTF-8" standalone="no" ?>

- *Entity references*: serve various purposes, such as shortcuts to often repeated text or to distinguish reserved characters from content.

E.g., < is the same as &lt

- *Comments*: enclosed in **<!--** and **-->** tags.

E.g., <!--this is a comment -->

- XML – Ordering
  - elements are ordered.
  - attributes are unordered.

- **C, C++ , FORTRAN, Pascal, Visual Basic, Java…**
  - are *general-purpose programming languages*
  - You can: specify calculations, actions, and decisions to be carried out in order.

- **SQL**
  - is a *special-purpose programming language*
  - You can: manage data in a relational databases.

- **XML**
  - is a ***markup*** *specification language*
  - You can: design ways of describing information (text or data), usually for storage, transmission, or processing by a program (you can use it in combination with a programming language).
  - It says nothing about what you should do with the data (although your choice of element names may hint at what they are for)

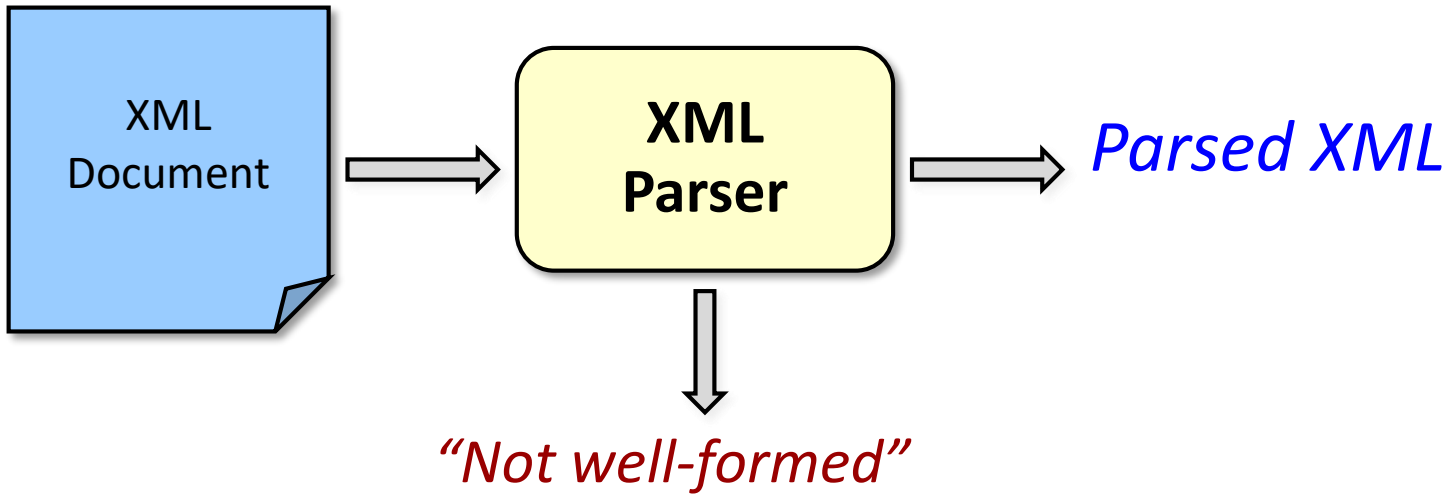
What does XML do??

- XML doesn't *do* anything!

- It's a data format which just sits there until you run a program (e.g., java, c….) which does something *with* it

“Well-Formed” XML

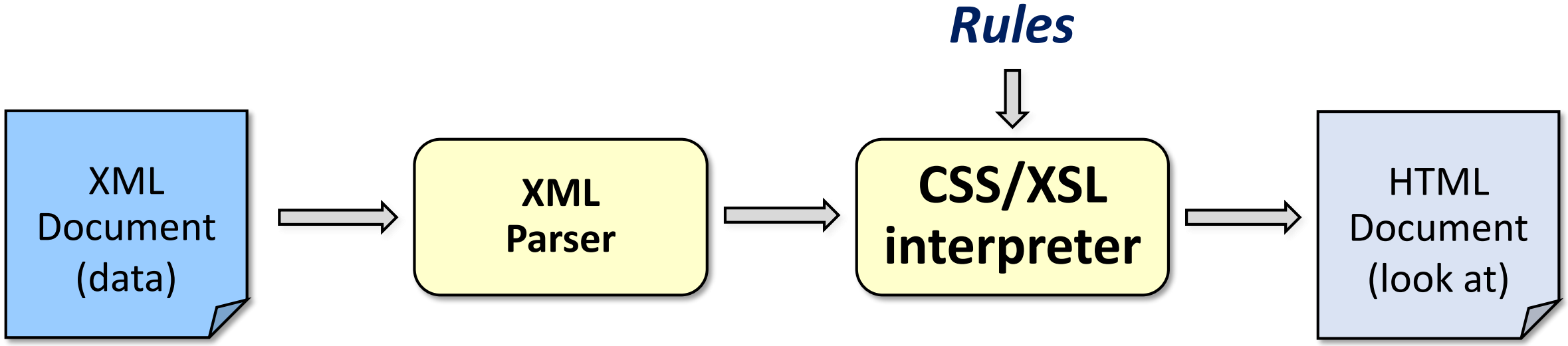
- Adheres to basic structural requirements
  - Single root element
  - Matched tags, proper nesting
  - Unique attributes within elements



Displaying XML

Use rule-based language to translate to HTML

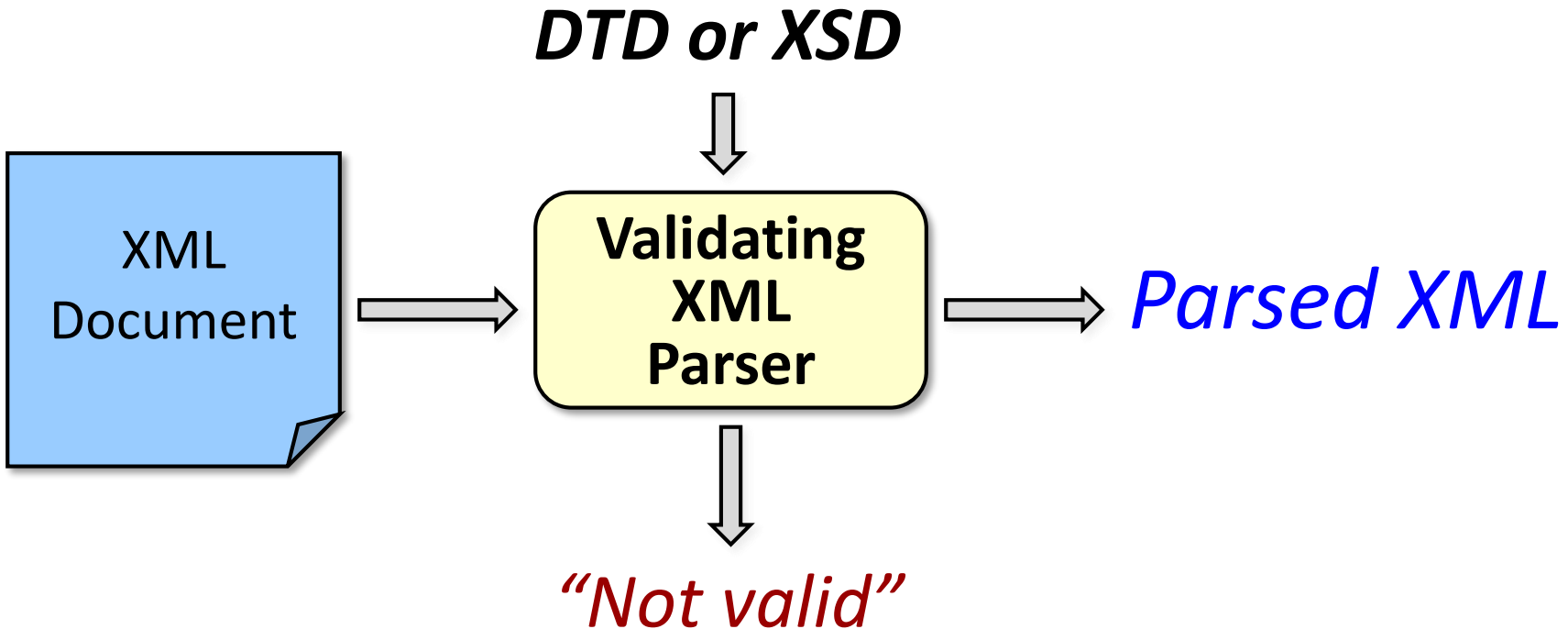
- *Cascading StyleSheets* (CSS): alternative rendering to the tags
- *eXtensible Stylesheet Language* (XSL): defines how data is rendered



Document Type Definitions (DTDs)

- **Defines the valid syntax of an XML document.**
- specifying elements, attributes, nesting, ordering, #occurrences, also special attribute types ID and IDREF(S)
- Term *vocabulary* sometimes used to refer to the elements used in a particular application.
- Grammar specified using EBNF, not XML.
- Although optional, DTD is recommended for document conformity.

“Valid” XML


DTD or XSD
XML Document
Validating XML Parser
Parsed XML
“Not valid”

Document Type Definitions (DTDs)

```
<!DOCTYPE Bookstore [
   <!ELEMENT Bookstore (Book*, Author*)>
   <!ELEMENT Book (Title, Remark?)>
   <!ATTLIST Book ISBN ID #REQUIRED
                  Price CDATA #REQUIRED
                  Authors IDREFS #REQUIRED>
   <!ELEMENT Title (#PCDATA)>
   <!ELEMENT Remark (#PCDATA | BookRef)*>
   <!ELEMENT BookRef EMPTY>
   <!ATTLIST BookRef book IDREF #REQUIRED>
   <!ELEMENT Author (First_Name, Last_Name)>
   <!ATTLIST Author Ident ID #REQUIRED>
   <!ELEMENT First_Name (#PCDATA)>
   <!ELEMENT Last_Name (#PCDATA)>
]>
```

```
<Bookstore>
  <Book ISBN="0590353403" Price="20" Edition="1st" Authors="JR">
    <Title>Harry Potter and the Philosopher's Stone</Title>
    <Authors>
      <Author>
        <First_Name>J.k.</First_Name>
        <Last_Name>Rowling</Last_Name>
      </Author>
    </Authors>
  </Book>
  <Book ISBN="9781292061184" Price="35" Edition="6th" Authors="TC CB">
    <Title>Database Systems</Title>
    <Remark>Buy this book with
      <BookRef book="0590353403"/>
      - A great deal!
    </Remark>
    <Authors>
      <Author ID="TC">
        <First_Name>Thomas</First_Name>
        <Last_Name>Connolly</Last_Name>
      </Author>
      <Author ID="CB">
        <First_Name>Carolyn</First_Name>
        <Last_Name>Begg</Last_Name>
      </Author>
    </Authors>
  </Book>
</Bookstore>
```

DTDs – **Element** Type Declarations

- Identify the rules for elements that can occur in the XML document. Options for repetition are:
  - ***** zero or more occurrences for an element;
  - **+** one or more occurrences for an element;
  - **?** zero occurrences or (exactly) one occurrence for an element.

- Name with no qualifying punctuation must occur exactly once.
- Commas between element names indicate they must occur in succession; if commas omitted, elements can occur in any order.
- #PCDATA: *parsable character data*, declares the base elements

DTDs – **Attribute** List Declarations

- Identify which elements may have attributes, what attributes they may have, what values attributes may hold, plus optional defaults.
- Some types:
  - CDATA: character data, containing any text.
  - whether an attribute must occur (#REQUIRED) or not (#IMPLIED),
  - ID: used to identify individual elements in document (ID is an element name).
  - IDREF/IDREFS: must correspond to value of ID attribute(s) for some element in document.
  - List of names: values that attribute can hold

DTDs – Element Identity, IDs, IDREFs

- ID allows unique key to be associated with an element.
- IDREF allows an element to refer to another element with the designated key.
- Attribute type IDREFS allows an element to refer to multiple elements.
- To loosely model relationship *Branch Has Staff*:
  - <!ATTLIST STAFF staffNo ID #REQUIRED>
  - <!ATTLIST BRANCH staff IDREFS #IMPLIED>

XML Schema (XSD)

- DTDs have number of limitations:
  - it is written in a different (non-XML) syntax;
  - it has no support for namespaces;
  - it only offers extremely limited data typing.
  - **OLD!**
- XML Schema is more comprehensive method of defining content model of an XML document.
- Tries to overcome XML deficiencies.
- Additional expressiveness will allow Web applications to exchange XML data more robustly without relying on ad hoc validation tools.

XML Schema (XSD)

- XML schema is the definition (both in terms of its organization and its data types) of a specific XML structure.
- Like DTDs, can specify elements, attributes, nesting, ordering, occurrences
- Also data types, keys, (typed) pointers, and more

- Schema is an **XML** document, and so can be edited and processed by same tools that read the XML it describes.

XSD

- Type
- Key declaration
- References
- Occurrence constraints

Type

Example of type definition:

XSD:

```
<xsd:attribute name="Price" type="xsd:integer" use="required"/>
```

XML:

```
<Book ISBN="0590353403" Price="100">
```

If Price=“100” is changed to Price=“foo”, it would not validate

<xsd:key>

- Specifies that an attribute/element value (or set of values) must be a key within the containing element in an instance document

- A key means that data should be unique within a specified scope, non-nillable, and always present.

Key declaration

XSD:

```
<xsd:key name="BookKey">
        <xsd:selector xpath="Book"/>
        <xsd:field xpath="@ISBN"/>
</xsd:key>
<xsd:key name="AuthorKey">
        <xsd:selector xpath="Author"/>
        <xsd:field xpath="@Ident"/>
</xsd:key>
```

XML:

```
<Author Ident="HG">
        <First_Name>Hector</First_Name>
        <Last_Name>Garcia-Molina</Last_Name>
</Author>
<Author Ident="TC">
        <First_Name>Thomas</First_Name>
        <Last_Name>Connolly</Last_Name>
</Author>
<Author Ident="CB">
        <First_Name>Carolyn</First_Name>
        <Last_Name>Begg</Last_Name>
</Author>
```

```
<Book ISBN="9781292061184" Price="35">
        <Title>Database Systems </Title>
        <Authors>
                <Auth authIdent="TC"/>
                <Auth authIdent="CB"/>
        </Authors>
</Book>
```

<xsd:keyref>

- Specifies that an attribute or element value (or set of values) correspond to those of the specified **key** or **unique** element

References

XSD:

```
<xsd:keyref name="AuthorKeyRef" refer="AuthorKey">
        <xsd:selector xpath="Book/Authors/Auth"/>
        <xsd:field xpath="@authIdent"/>
</xsd:keyref>
<xsd:keyref name="BookKeyRef" refer="BookKey">
        <xsd:selector xpath="Book/Remark/BookRef"/>
        <xsd:field xpath="@book"/>
</xsd:keyref>
```

XML:

```
<Book ISBN="9781292061184" Price="35">
        <Title>Database Systems</Title>
        <Authors>
                <Auth authIdent="TC"/>
                <Auth authIdent="CB"/>
        </Authors>
        <Remark>
                Buy this book with
                <BookRef book="0590353403"/>
         - a great deal!
         </Remark>
</Book>
```

Occurrences

- Specifies the min/max number of occurrences

```
<xsd:element name="Book" type="BookType" minOccurs="0" maxOccurs="unbounded"/>
<xsd:element name="Author" type="AuthorType" minOccurs="0" maxOccurs="unbounded"/>

<xsd:element name="Auth" maxOccurs="unbounded">

<xsd:element name="Remark" minOccurs="0">
```

XML Schema – Simple Types

- Elements that do not contain other elements or attributes are of type simpleType.

```
<xsd:element name="STAFFNO" type = "xsd:string"/>
<xsd:element name="DOB" type = "xsd:date"/>
<xsd:element name="SALARY" type = "xsd:decimal"/>
```

- Attributes must be defined last:

```
<xsd:attribute name="branchNo" type = "xsd:string"/>
```

XML Schema – Complex Types

- Elements that contain other elements are of type complexType.
- List of children of complex type are described by sequence element.

```
<xsd:element name = “STAFFLIST”>
      <xsd:complexType>
            <xsd:sequence>
                  <!-- children defined here -->
            </xsd:sequence>
      </xsd:complexType>
</xsd:element>
```

Cardinality

- Cardinality of an element can be represented using attributes minOccurs and maxOccurs.
- To represent an optional element, set minOccurs to 0; to indicate there is no maximum number of occurrences, set maxOccurs to “unbounded”.

```
<xsd:element name=“DOB” type=“xsd:date” minOccurs = “0”/>
<xsd:element name=“NOK” type=“xsd:string” minOccurs = “0” maxOccurs = “3”/>
```

Key Constraints

- Define keys as in relational model. Also allows the key to be referenced.

```
<xsd:key name = “STAFFNOISKEY”>
      <xsd:selector xpath = “STAFF”/>
      <xsd:field xpath = “STAFFNO”/>
</xsd:key>
```

Querying XML

- Not nearly as mature as Querying Relational
  - Newer
  - No underlying algebra
- Sequence of development
  1. XPath (Path expressions + conditions)
  2. XSLT (XPath + transformations, output formatting)
  3. Xquery (Xpath + full-featured QL)

Relational Model versus XML

	Relational	**XML (Semi-Structured data)**
Structure	Tables, columns, rows	Hierarchical, tree
Schema	Fixed in advance	Self-describing, flexible
Queries	SQL, simple language, standard	Not so simple
Ordering	None	Ordered
Implementation	Mature, native	Add-on