# XML & Allied Technologies

## XML Schemas

# Quick Revision …….

- ✓ **What is the diff. between PCDATA & CDATA?**
- ✓ **What is the diff. between internal & external DTD?**
- ✓ **Define some attribute types.**
- ✓ **What are the disadvantages of DTD?**

# XML schemas

- XML schema is an XML based **alternative to DTD.**
- An XML vocabulary for **expressing your data's business rules.**
- **XML schemas are:**
    - ✓ Written in **xml**.
    - ✓ **Extensible** for future use.
    - ✓ Support **non textual data types**.
- XML document that conforms to an XML schema is said to be "***schema valid*** ".

# XML schemas

- **XML Schema is more advanced over DTDs:**
  - **Enhanced datatypes**
    - ✓ 44+ .
    - ✓ Can create your own datatypes.
  - **Object-Oriented'ish**
    - ✓Can **extend** or **restrict** a type

      (derive new type definitions on the basis of old ones)
  - Can express sets, i.e., can define the child elements to occur in **any order** .(xs:sequence, xs:all, xs:choice)

# XML Document

```
<?xml version="1.0"?>
      <note>
            <to>Tove</to>
            <from>Jani</from>
            <subject>Reminder</subject>
            <message>
            Don't forget me this weekend!
            </message>
      </note>
```

# DTD Document

```
<?xml version="1.0"?>
      <note>
            <to>Tove</to>
            <from>Jani</from>
            <subject>Reminder</subject>
```

```
<!ELEMENT note (to,from,subject,message)>
<!ELEMENT to (#PCDATA)>
<!ELEMENT from (#PCDATA)>
<!ELEMENT subject(#PCDATA)>
<!ELEMENT message (#PCDATA)>
```

# Simple Xml Schema Document

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://www.w3schools.com"
xmlns=http://www.w3schools.com
elementFormDefault="qualified">

<xs:element name="note">
   <xs:complexType>
     <xs:sequence>
       <xs:element name="to“ type="xs:string"/>
       <xs:element name="from" type="xs:string"/>
       <xs:element name=“subject" type="xs:string"/>
       <xs:element name=“message" type="xs:string"/>
     </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:schema>
```

## Simple type elements

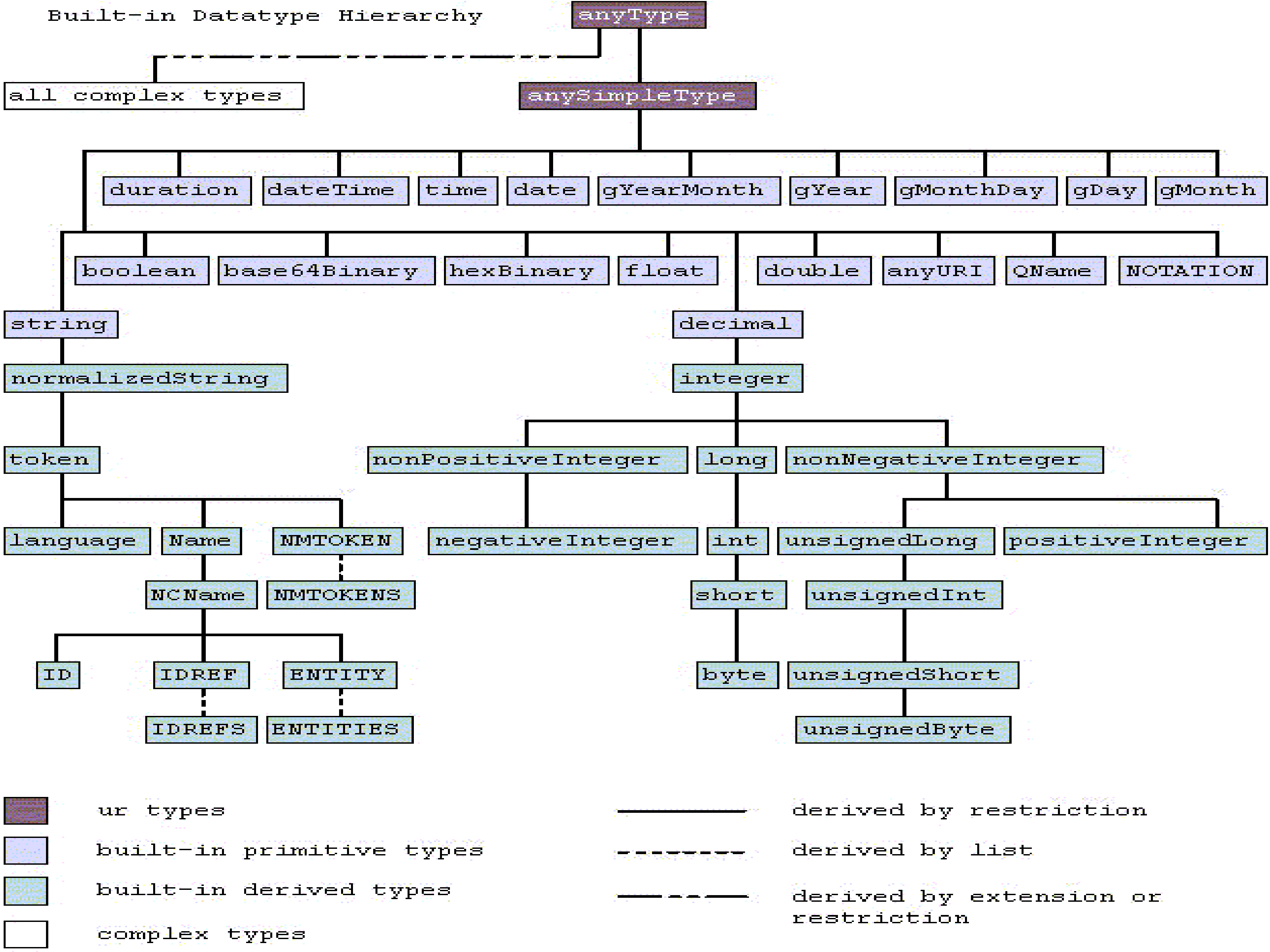
- <u>EX. :</u>

```
<price>12.3</price>
<xs:element name="price"
            type="xs:decimal"/>
```

- **Simple type :**
  - ✓ **Predefined type.**
  - ✓ **Derived from predefined type.**

- **Complex type :**

  **Have either sub-elements or "*attributes*"**


Built-in Datatype Hierarchy
anyType
all complex types
anySimpleType
duration
dateTime
time
date
gYearMonth
gYear
gMonthDay
gDay
gMonth
boolean
base64Binary
hexBinary
float
double
anyURI
QName
NOTATION
string
decimal
normalizedString
integer
token
nonPositiveInteger
long
nonNegativeInteger
language
Name
NMTOKEN
negativeInteger
int
unsignedLong
positiveInteger
NCName
NMTOKENS
short
unsignedInt
ID
IDREF
ENTITY
byte
unsignedShort
IDREFS
ENTITIES
unsignedByte
ur types
built-in primitive types
built-in derived types
complex types
derived by restriction
derived by list
derived by extension or restriction

# Built-in Simple Types

**Predefined Datatypes**

| | |
|---|---|
| ✓ String → | "Hello World" |
| ✓ boolean → | {true, false, 1, 0} |
| ✓ decimal → | 7.08 |
| ✓ float → | 12.56E3,12,12560,0,INF,-INF,NAN |
| ✓ dateTime → | <u>format:</u>*YYYY-MM-DDThh:mm:ss* |
| ✓ time → | <u>format:</u>*hh:mm:ss.sss* |
| ✓ date → | <u>format:</u>*YYYY-MM-DD* |
| ✓ gYearMonth → | <u>format:</u>*YYYY-MM* |
| ✓ gYear → | <u>format:</u>*YYYY* |
| ✓ gMonthDay → | <u>format:</u> *MM-DD* |

## Built-in Simple Types (cont.)

- Derived types :
  - ✓ negativeInteger
  - ✓ Long
  - ✓ int
  - ✓ Short
  - ✓ Byte
  - ✓ nonNegativeInteger
  - ✓ unsignedLong
  - ✓ unsignedInt
  - ✓ unsignedShort
  - ✓ unsignedByte
  - ✓ positiveInteger

## Schema Data Types

- **Creating New Data Type:**
  - Definition :
    - ✓ Create new types (both simple and complex types)
  - Declaration :
    - ✓ Enable elements and attributes with specific names and types (both simple and complex) to appear in document instances.

## 1] Create a combined Simple Type

- Schemas **provide data types** that can be combined together to produce tailored data types.

- <!-- Definition -->

```
<xs:simpleType name=“mytype">
  <xs:union memberTypes=“xs:integer xs:string"/>
</xs:simpleType>
```

- <!-- Declaration -->

```
<xs:element name=“age” type=“mytype”/>
```

## 2] Derived from existing simple type

- Derived from existing simple types (predefined or derived).
- Typically restricting existing simple type.
- The legal range of values for a new type is subset of the ones of existing type.
- Existing type is called *base* type.
- Use *restriction* element along with facets to restrict the range of values.

# Example

```
<xs:simpleType name= "name">
 <xs:restriction base= "xs:source">
    <xs:facet value= "value"/>
    <xs:facet value= "value"/>
             …
   </xs:restriction>
</xs:simpleType>
```

**Facets:**
**length, maxlength, minlength minInclusive, maxInclusive minExclusive,maxExclusive, Pattern, enumeration ….**

**Sources:**
**String, boolean, number,float,double ,duration, dateTime,time …**

# Derived simple type (cont.)

- **Ex.:**

**The string primitive datatype optional facets:**

- ✓ **Length.**
- ✓ **minLength.**
- ✓ **maxLength.**
- ✓ **Pattern.**
- ✓ **Enumeration.**

# Derived simple type (cont.)

```
<xs:simpleType name="TelephoneNumber">          ①
 <xs:restriction base="xs:string">              ②
    <xs:length value="8"/>                      ③
    <xs:pattern value="\d{3}-\d{4}"/>           ④
 </xs:restriction>
</xs:simpleType>
```

1. This creates a new datatype called 'TelephoneNumber'.
2. Elements of this type can hold string values.
3. But the string length must be exactly 8 characters long.
4. The string must follow the pattern: ddd-dddd, where 'd' represents a 'digit'.

# Example (enumeration)

```
<xs:simpleType name="shape">
 <xs:restriction base="xs:string">
   <xs:enumeration value="circle"/>
   <xs:enumeration value="triangle"/>
   <xs:enumeration value="square"/>
 </xs:restriction>
</xs:simpleType>
```

- **Patterns, enumerations** => "or" them together.
- **All other facets** => "and" them together.

# Facets of the integer Datatype

- The integer data type optional facets:
  - ✓ totalDigits.
  - ✓ Pattern.
  - ✓ Enumeration.
  - ✓ minInclusive.
  - ✓ maxInclusive.
  - ✓ minExclusive.
  - ✓ maxExclusive.

# Example (numeric range)

```
<xs:simpleType name="myInteger">
  <xs:restriction base="xs:integer">
     <xs:minInclusive value="10000"/>
     <xs:maxInclusive value="99999"/>
  </xs:restriction>
</xs:simpleType>
```

- minInclusive & maxInclusive are ***facets*** to ***integer*** type

# Example (numeric range)

```
<simpleType name=“lessthanonehundred-and-one”>
  <restriction base='integer'>
     <maxExclusive value='101'/>
  </restriction>
</simpleType>
```

- Limits values to integers less than or equal to 100.

# Example(numeric range)

```
<simpleType name='more-than-ninety-nine'>
  <restriction base='integer'>
      <minExclusive value='99'/>
    </restriction>
</simpleType>
```

- Limits values to integers greater than or equal to 100.

## 3] Creating simpleType from created simpleType

- We have created a simpleType using one of the built-in data types (by restricting our base type).

- However, we can create a simpleType that **restricts another simpleType** as the base.

# Example

```
<xs:simpleType name= "EarthSurfaceElevation">
    <xs:restriction base="xs:integer">
        <xs:minInclusive value="-1290"/>
        <xs:maxInclusive value="29035"/>
    </xs:restriction>
</xs:simpleType>
```

```
<xs:simpleType name="BostonAreaSurfaceElevation">
   <xs:restriction base="EarthSurfaceElevation">
          <xs:minInclusive value="0"/>
          <xs:maxInclusive value="120"/>
   </xs:restriction>
</xs:simpleType>
```

# Fixing a Facet Value

- Sometimes when we define a simpleType we want to require that one (or more) facet have an unchanging value. That is, we want to make the facet a constant.

```
<xs:simpleType name= "ClassSize">
   <xs:restriction base="xs:nonNegativeInteger">
      <xs:minInclusive value="10” fixed="true"/>
      <xs:maxInclusive value="60"/>
   </xs:restriction>
</xs:simpleType>
```

## 1] Complex types

- Defined using "*complexType*" element typically contain :
  - ✓ Element declarations .
  - ✓ *Attribute* declarations .
  - ✓ *Element* references .

## a. Complex Types contain( text + attributes ) only

```
<name age=“24">ahmed</name>

<xs:element name=“name“ >
  <xs:complexType>
    <xs:simpleContent>
        <xs:extension base="xs:string">
            <xs:attribute name=“age“
                     type="xs:integer”/>
        </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:element >
```

## b. Complex Types contain Nested Elements only

```
<person>
    <frstname>Mohamed</frstname>
    <lstname>Ahmed</lstname>
</person>

<xs:element name="person">
  <xs:complexType>
     <xs:sequence>(xs:all)(xs:choice)
          <xs:element name="frstname“
                      type="xs:string"/>
          <xs:element name="lstname“
                      type="xs:string"/>
     </xs:sequence>
  </xs:complexType>
</xs:element>
```

## c. Complex Types contain Nested + attributes only

```
<father job="Engineer”>
   <mother>hoda</mother>
    <daughter>Kareema</daughter>
</father>
```

```
<xs:element name="father">
 <xs:complexType  mixed=“false">
     <xs:sequence>
  <xs:element name="mother“ type=“xs:string”/>
  <xs:element name="daughter“ type=“xs:string”/>
     </xs:sequence>
     <xs:attribute name="job" type="xs:string“

     default="Engineer"/>
 </xs:complexType>
</xs:element>
```

## d. Complex Types mixed content(Nested + Text)

```
<salutation>DearMr
       <name>RobertSmith</name>
</salutation>

<xs:element name="salutation“>
 <xs:complexType mixed="true">
   <xs:sequence>(xs:all)
      <xs:element name="name“ type="xs:string"/>
   </xs:sequence>
 </xs:complexType>
</xs:element>
```

## e. Empty Content (selfclosed)

```
<internationalPrice currency="EUR"/>

<xs:element name="internationalPrice">
   <xs:complexType>
      <xs:complexContent>
         <xs:restriction base="xs:anyType">
         <xs:attribute name=“currency”
              type="xs:string"/>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
</xs:element>
```

# Occurrences of elements

```
<xs:sequence>
    <xs:element name=“person” minOccurs=“1”>
</xs:sequence>
```

- **minOccurs**
- **maxOccurs**
- **fixed = “Hi”**: If the element appears, the value **must** be “Hi”, otherwise the value is set to “Hi” by the parser.
- **default = “Hi”**: If the element appears, the value is set to what is specified, otherwise value is set to “Hi” by the parser

# Occurrences of attributes

- Attributes can occur once or not at all
  - ✓**use** attribute (required / optional).
  - ✓**default** attribute.
  - ✓**fixed**  attribute .

```
<xs:attribute name="age" type="xs:integer"
        use="required" fixed="22"/>
<xs:attribute name="age" type="xs:integer"
        use="required" />
<xs:attribute name="age" type="xs:integer"
        use="optional" fixed="22"/>
<xs:attribute name="age" type="xs:integer"
        use="optional" default="22"/>
```

# Elements Occurrences Examples

```
<xs:element name=“test” type=“xs:string”
 minOccurs=“1” maxOccurs=“1”
 minOccurs=“2” maxOccurs=“unbounded”
 minOccurs=“1” maxOccurs=“1”   fixed=“Hi”
 minOccurs=“0” maxOccurs=“1”   default=“Hi”
>

<xs:element name="grandmother“ type="xs:string"
            minOccurs=“0"
            maxOccurs="unbounded"/>
```

## 2] Create Complex Type from <u>another created</u> comlpex type

- We can do a form of subclassing complexType definitions.
- We call this "derived types“:

  ✓ Derive by **extension**:

    - extend the parent complexType with more element.

  ✓ Derive by **restriction**:

    - create a type which is a subset of the base type.  There are two ways to subset the elements

## Derived by extension

```
<xs:complexType name="Publication">
     <xs:sequence>
         <xs:element name="Title" type="xs:string"
                    maxOccurs="unbounded"/>
         <xs:element name="Author" type="xs:string"
                     maxOccurs="unbounded"/>
</xs:sequence>
</xs:complexType>
<xs:complexType name="BookPublication">
   <xs:complexContent>
      <xs:extension base="Publication" >
        <xs:sequence>
        <xs:element name="ISBN" type="xs:string"/>
       </xs:sequence>
    </xs:extension>
   </xs:complexContent>
</xs:complexType>
```

# Derived by Restriction

```
<xs:complexType name="Publication">
 <xs:sequence>
   <xs:element name="Title" type="xs:string"
               maxOccurs="unbounded"/>
   <xs:element name="Author" type="xs:string“
               maxOccurs="unbounded"/>
</xs:sequence></xs:complexType>
<xs:complexType name= "SingleAuthorPublication">
 <xs:complexContent>
   <xs:restriction base="Publication">
     <xs:sequence>
    <xs:element name="Title“  type="xs:string“
                maxOccurs="unbounded"/>
    <xs:element name="Author" type="xs:string"/>
   </xs:sequence>
  </xs:restriction>
 </xs:complexContent>
</xs:complexType>
```

## Prohibiting Derivations

- Publication cannot be extended nor restricted:

```
<xs:complexType name="Publication” final="#all" >
```

- Publication cannot be restricted:

```
<xs:complexType name="Publication“  final="restriction" >
```

- Publication cannot be extended:

```
<xs:complexType name="Publication“  final="extension" >
```

## Elements Refrences

- Used for code organization.
- Must define the element we reference to.

```
<xs:element name="family">
   <xs:complexType>
       <xs:sequence>
            <xs:element ref="son" minOccurs="2"/>
       <xs:sequence>
   </xs:complexType>
</xs:element>
<xs:element name="son" type="xs:string"/>
```

# Group Element

- The group element enables you to **group** together **element declarations**.

**Note:**

The group element is just for grouping together element declarations, **no attribute declarations allowed**!

# Group Element

```
<xs:element name="Book" >
     <xs:complexType>
            <xs:sequence>
                    <xs:group ref="PublicationElements"/>
            </xs:sequence>
     </xs:complexType>
</xs:element>

<xs:group name="PublicationElements">
   <xs:sequence>
      <xs:element name="Title" type="xs:string"/>
      <xs:element name="Author" type="xs:string“
                        maxOccurs="unbounded"/>
      <xs:element name="Date" type="xs:string"/>
    </xs:sequence>
</xs:group>
```

## General examples

**Example 1:**

Consider the case where we need to Convert the following ***BookStore.dtd*** file to the XML Schema syntax:

```
<!ELEMENT BookStore (Book)+>
<!ELEMENT Book (Title, Author, Date, ISBN, Publisher)>
<!ELEMENT Title (#PCDATA)>
<!ELEMENT Author (#PCDATA)>
<!ELEMENT ISBN (#PCDATA)>
```

```
<?xml version="1.0"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
                  targetNamespace="http://www.books.org”  elementFormDefault="qualified">
   <xs:element name="BookStore">
      <xs:complexType>                                      <!ELEMENT BookStore (Book)+>
         <xs:sequence>
            <xs:element ref="Book" minOccurs="1" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="Book">
      <xs:complexType>                          <!ELEMENT Book (Title, Author, ISBN)>
         <xs:sequence>
            <xs:element ref="Title" minOccurs="1" maxOccurs="1"/>
            <xs:element ref="Author" minOccurs="1" maxOccurs="1"/>
            <xs:element ref="ISBN" minOccurs="1" maxOccurs="1"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="Title" type="xs:string"/> <!ELEMENT Title (#PCDATA)>
   <xs:element name="Author" type="xs:string"/><!ELEMENT Author (#PCDATA)>
   <xs:element name=“ISBN" type="xs:string"/><!ELEMENT ISBN(#PCDATA)>
</xs:schema>
```

## General examples

**Example 2:**

```
<!ELEMENT BookStore (Book+)>
<!ELEMENT Book (Title, Author)>
<!ATTLIST Book
Category (autobiography | fiction) #REQUIRED
 InStock (true | false) "false“    >
<!ELEMENT Title (#PCDATA)>
<!ELEMENT Author (#PCDATA)>
```

**Note**: - I can use **attribute reference .**

- I can use **attribute group .**
- I can specify a user defined simple **type within the attribute** if it wont be reused.

# Attribute using ref

```
<xs:element name="Book"  maxOccurs="unbounded">
 <xs:complexType>
  <xs:sequence>
    <xs:element name="Title" type="xs:string"/>
    <xs:element name="Author" type="xs:string"/>
  </xs:sequence>
  <xs:attribute ref="Category" use="required"/>
  <xs:attribute name="InStock" type="xs:boolean"
              default="false"/>
 </xs:complexType>
</xs:element>
<xs:attribute name="Category">
    <xs:simpleType>
       <xs:restriction base="xs:string">
       <xs:enumeration value="autobiography"/>
       <xs:enumeration value="fiction"/>
       </xs:restriction>
     </xs:simpleType>
</xs:attribute>
```

# Attribute group ref.

```
<xs:element name="BookStore">
 <xs:complexType>
   <xs:sequence>
     <xs:element name="Book"  maxOccurs="unbounded">
       <xs:complexType>
        <xs:sequence>
         <xs:element name="Title" type="xs:string"/>
         <xs:element name="Author" type="xs:string"/>
        </xs:sequence>
        <xs:attributeGroup ref="BookAttributes"/>
       </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:attributeGroup name="BookAttributes">
<xs:attribute name="Category" use="required">
   <xs:simpleType>
     <xs:restriction base="xs:string">
     <xs:enumeration value="autobiography"/>
     <xs:enumeration value="fiction"/>
    </xs:restriction>
   </xs:simpleType>
</xs:attribute>
<xs:attribute name="InStock" type="xs:boolean" default="false"/>
</xs:attributeGroup>
```

Category (autobiography | fiction) #REQUIRED

InStock (true | false) "false"

## Schema file

```
<?xml version="1.0"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"---------------(1)
              targetNamespace=http://www.books.org- -  - - - - - - - - - - - - - (2)
              elementFormDefault="qualified">-------------------------------(3)
……..
</xs:schema>
```

1) The elements and datatypes that are used to construct schemas: ***schema***, ***Element***, ***complexType***, ***Sequence*** and ***string*** come from the http://…/XMLSchema namespace.

2) Says that the elements defined by this schema BookStore: ***Book***,***Title***, ***Author***, ***Date*** , ***ISBN*** and ***Publisher*** are to go in this namespace.

3) This is to imply to any instance document which conforms to this schema: Any elements used by the instance document which were declared in this schema must be namespace qualified by the namespace specified by target Namespace.

**Note: The "target Namespace" (2) attribute is removed when elements aren't to go to any namespace.**

## Referencing a schema in an XML instance document

```
<?xml version="1.0"?>
<BookStore xmlns ="http://www.books.org"                    ①
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"            ③
xsi:schemaLocation="http://www.books.org/BookStore.xsd">
   OR                                                          ②
xsi:noNamespaceSchemaLocation="fname.xsd">
...
</BookStore>
```

1.First, using a default namespace declaration, tell the schema-validator that all of the elements used in this instance document come from the Book namespace.

2. Second, with schemaLocation tell the schema-validator that the *http://www.books.org* namespace is defined by BookStore.xsd
In case Of no namespace associated,use
”xsi:nonamespaceSchemaLocation”

3. Third, tell the schema-validator that the schemaLocation attribute we are using is the one in the XMLSchema-instance namespace.