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UNIVERSITY
OF WOLLONGONG
AUSTRALIA

CSIT884
Web Development

Lecture 07 – XSD

Lecture slides are mainly taken from UOW

Objectives

- Learn XSD language to define the structure of an XML document

XSD

- **X**ML **S**chema **D**efinition (XSD) is another way to define the legal building blocks of an XML document. It defines the document structure with a list of legal elements and attributes.
- Using a XSD, different parties can agree on a standard XML format for interchanging data.
- We can check whether an XML document conforms to a XSD or not.
- File extension is .xsd

XSD: student Example

```
<?xml version="1.0" ?>
<student xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="student.xsd">
 <firstName>John</firstName>
 <lastName>Smith</lastName>
 <email>jsmith@gmail.com</email>
 <mobile>0211223344</mobile>
</student>
```

XSD file: student.xsd

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">

 <xsd:element name="student">
  <xsd:complexType>
   <xsd:sequence>
     <xsd:element name="firstName" type="xsd:string"/>
     <xsd:element name="lastName" type="xsd:string"/>
     <xsd:element name="email" type="xsd:string"/>
     <xsd:element name="mobile" type="xsd:string"/>
   </xsd:sequence>
  </xsd:complexType>
 </xsd:element>

</xsd:schema>
```

XSD: student Example

elements and data types used in the schema come from the namespace

http://www.w3.org/2001/XMLSchema

```
<?xml version="1.0" ?>
<student xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="student.xsd">
 <firstName>John</firstName>
 <lastName>Smith</lastName>
 <email>jsmith@gmail.com</email>
 <mobile>0211223344</mobile>
</student>
```

XSD file: student.xsd

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<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">

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  <xsd:complexType>
   <xsd:sequence>
     <xsd:element name="firstName" type="xsd:string"/>
     <xsd:element name="lastName" type="xsd:string"/>
     <xsd:element name="email" type="xsd:string"/>
     <xsd:element name="mobile" type="xsd:string"/>
   </xsd:sequence>
  </xsd:complexType>
 </xsd:element>

</xsd:schema>
```

XSD: student Example

the elements and data types that come from the namespace http://www.w3.org/2001/XMLSchema should be prefixed with **xsd**

```
<?xml version="1.0" ?>
<student xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="student.xsd">
 <firstName>John</firstName>
 <lastName>Smith</lastName>
 <email>jsmith@gmail.com</email>
 <mobile>0211223344</mobile>
</student>
```

XSD file: student.xsd

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<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">

 <xsd:element name="student">
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   <xsd:sequence>
     <xsd:element name="firstName" type="xsd:string"/>
     <xsd:element name="lastName" type="xsd:string"/>
     <xsd:element name="email" type="xsd:string"/>
     <xsd:element name="mobile" type="xsd:string"/>
   </xsd:sequence>
  </xsd:complexType>
 </xsd:element>

</xsd:schema>
```

XSD: student Example

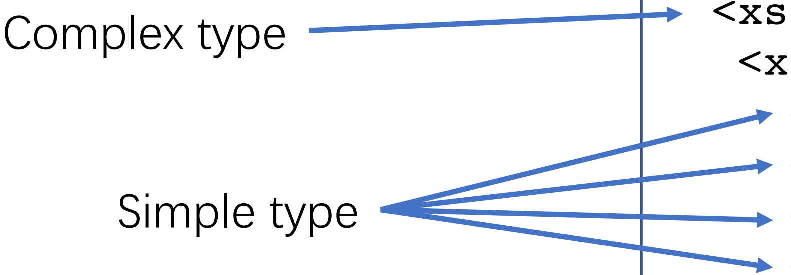
```
<?xml version="1.0" ?>
<student xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="student.xsd">
 <firstName>John</firstName>
 <lastName>Smith</lastName>
 <email>jsmith@gmail.com</email>
 <mobile>0211223344</mobile>
</student>
```

XSD file: student.xsd

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">

 <xsd:element name="student">
  <xsd:complexType>
   <xsd:sequence>
     <xsd:element name="firstName" type="xsd:string"/>
     <xsd:element name="lastName" type="xsd:string"/>
     <xsd:element name="email" type="xsd:string"/>
     <xsd:element name="mobile" type="xsd:string"/>
   </xsd:sequence>
  </xsd:complexType>
 </xsd:element>

</xsd:schema>
```



XSD: element

- XML element can be defined in XSD as 2 types:
  - `simpleType`
  - `complexType`
- Element contains other elements → `complexType`
- Element contains attributes → `complexType`
- Element contains NO attributes, NO elements → `simpleType`

XSD: complex type containing elements

- Element contains other elements → `complexType`

```
<result>
 <mark>85</mark>
 <grade>A</grade>
</result>
```

```
<xsd:element name="result">
 <xsd:complexType>
  <xsd:sequence>
    <xsd:element name="mark" type="xsd:integer"/>
    <xsd:element name="grade" type="xsd:string"/>
  </xsd:sequence>
 </xsd:complexType>
</xsd:element>
```

XSD: complex type containing elements and attributes

- Element contains other elements and attributes → `complexType`

```
<scan schedule="hourly">
 <start>2018-06-20T13:00:00</start>
 <finish>2018-06-20T13:01:47</finish>
 <virusFound>true</virusFound>
</scan>
```

```
<xsd:element name="scan">
 <xsd:complexType>
   <xsd:sequence>
     <xsd:element name="start" type="xsd:dateTime" />
     <xsd:element name="finish" type="xsd:dateTime" />
     <xsd:element name="virusFound" type="xsd:boolean" />
   </xsd:sequence>
   <xsd:attribute name="schedule" type="xsd:string" />
 </xsd:complexType>
</xsd:element>
```

The attribute declarations must always come last

XSD: complex type containing attributes only

- Text-only element contains attributes (does not contain elements) → `complexType`

```
<price promotionCode="FAMILYDEAL">39.50</price>
```

```
<xsd:element name="price">
 <xsd:complexType>
   <xsd:simpleContent>
     <xsd:extension base="xsd:decimal">
       <xsd:attribute name="promotionCode" type="xsd:string" />
     </xsd:extension>
   </xsd:simpleContent>
 </xsd:complexType>
</xsd:element>
```

XSD: simple type containing no element, no attribute

- Element contains no elements, no attributes → `simpleType`

```
<website>http://www.uow.edu.au/student</website>

<lastDayToEnrol>2000-03-24</lastDayToEnrol>

<favouriteColor>blue</favouriteColor>
```

```
<xsd:element name="website" type="xsd:anyURI" />

<xsd:element name="lastDayToEnrol" type="xsd:date" />

<xsd:element name="favouriteColor" type="xsd:string" />
```

XSD: simple type with restriction

Grade can have 4 values: A, B, C, D

```
<grade>B</grade>
```

Without restriction:

```
<xsd:element name="grade" type="xsd:string" />
```

With restriction:

```
<xsd:element name="grade">
   <xsd:simpleType>
     <xsd:restriction base="xsd:string">
       <xsd:enumeration value="A"/>
       <xsd:enumeration value="B"/>
       <xsd:enumeration value="C"/>
       <xsd:enumeration value="D"/>
     </xsd:restriction>
   </xsd:simpleType>
</xsd:element>
```

XSD: simple type with restriction

Mark can have values between 0-100

```
<mark>84</mark>
```

Without restriction:

```
  <xsd:element name="mark" type="xsd:integer" />
```

With restriction:

```
<xsd:element name=”mark">
   <xsd:simpleType>
     <xsd:restriction base="xsd:integer">
       <xsd:minInclusive value="0"/>
       <xsd:maxInclusive value="100"/>
     </xsd:restriction>
   </xsd:simpleType>
</xsd:element>
```

XSD: `studentList` example

```xml
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
          <firstName>John</firstName>
          <lastName>Smith</lastName>
          <email>jsmith@gmail.com</email>
     </student>
     <student>
          <firstName>Mary</firstName>
          <lastName>Jane</lastName>
          <email>mjane@gmail.com</email>
      </student>
</studentList>
```

```xml
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
          <xsd:sequence>
            <xsd:element name="student" minOccurs="0"
 maxOccurs="unbounded">
              <xsd:complexType>
                 <xsd:sequence>
               <xsd:element name="firstName"
              type="xsd:string"/>
               <xsd:element name="lastName" type="xsd:string"/>
               <xsd:element name="email" type="xsd:string"/>
                 </xsd:sequence>
               </xsd:complexType>
             </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
    </xsd:element>
</xsd:schema>
```

XSD: studentList example

```
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
          <firstName>John</firstName>
          <lastName>Smith</lastName>
          <email>jsmith@gmail.com</email>
     </student>
     <student>
          <firstName>Mary</firstName>
          <lastName>Jane</lastName>
          <email>mjane@gmail.com</email>
      </student>
</studentList>
```

Let’s start with the root element studentList

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
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            <xsd:element name="student" minOccurs="0"
    maxOccurs="unbounded">
               <xsd:complexType>
                  <xsd:sequence>
                <xsd:element name="firstName"
               type="xsd:string"/>
                <xsd:element name="lastName" type="xsd:string"/>
                <xsd:element name="email" type="xsd:string"/>
                   </xsd:sequence>
                 </xsd:complexType>
               </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
    </xsd:element>
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```

XSD: studentList example

```
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
          <firstName>John</firstName>
          <lastName>Smith</lastName>
          <email>jsmith@gmail.com</email>
     </student>
     <student>
          <firstName>Mary</firstName>
          <lastName>Jane</lastName>
          <email>mjane@gmail.com</email>
      </student>
</studentList>
```

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
           <xsd:sequence>
            <xsd:element name="student" minOccurs="0"
    maxOccurs="unbounded">
              <xsd:complexType>
                 <xsd:sequence>
             <xsd:element name="firstName"
            type="xsd:string"/>
             <xsd:element name="lastName" type="xsd:string"/>
             <xsd:element name="email" type="xsd:string"/>
                 </xsd:sequence>
               </xsd:complexType>
             </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
    </xsd:element>
</xsd:schema>
```

Let's start with the root element `studentList`

- It is a complex type

XSD: studentList example

```
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
          <firstName>John</firstName>
          <lastName>Smith</lastName>
          <email>jsmith@gmail.com</email>
     </student>
     <student>
          <firstName>Mary</firstName>
          <lastName>Jane</lastName>
          <email>mjane@gmail.com</email>
      </student>
</studentList>
```

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
           <xsd:sequence>
            <xsd:element name="student" minOccurs="0"
    maxOccurs="unbounded">
                 <xsd:complexType>
                    <xsd:sequence>
                <xsd:element name="firstName"
               type="xsd:string"/>
                <xsd:element name="lastName" type="xsd:string"/>
                <xsd:element name="email" type="xsd:string"/>
                    </xsd:sequence>
                  </xsd:complexType>
             </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
    </xsd:element>
</xsd:schema>
```

Let’s start with the root element `studentList`

- It is a complex type
- which contains a sequence of `student` elements

XSD: studentList example

```
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
          <firstName>John</firstName>
          <lastName>Smith</lastName>
          <email>jsmith@gmail.com</email>
     </student>
     <student>
          <firstName>Mary</firstName>
          <lastName>Jane</lastName>
          <email>mjane@gmail.com</email>
      </student>
</studentList>
```

Let’s start with the root element `studentList`

- It is a complex type
- which contains a sequence of `student` elements
- `studentList` contains zero or unlimited number of `student` elements

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
           <xsd:sequence>
            <xsd:element name="student" minOccurs="0"
    maxOccurs="unbounded">
                  <xsd:complexType>
                     <xsd:sequence>
                  <xsd:element name="firstName"
                 type="xsd:string"/>
                  <xsd:element name="lastName" type="xsd:string"/>
                  <xsd:element name="email" type="xsd:string"/>
                     </xsd:sequence>
                   </xsd:complexType>
             </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
    </xsd:element>
</xsd:schema>
```

XSD: `studentList` example

```
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
        <firstName>John</firstName>
        <lastName>Smith</lastName>
        <email>jsmith@gmail.com</email>
     </student>
     <student>
        <firstName>Mary</firstName>
        <lastName>Jane</lastName>
        <email>mjane@gmail.com</email>
      </student>
</studentList>
```

The element **`student`** is also a complex type

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
           <xsd:sequence>
             <xsd:element name="student" minOccurs="0"
    maxOccurs="unbounded">
               <xsd:complexType>
                  <xsd:sequence>
               <xsd:element name="firstName"
              type="xsd:string"/>
               <xsd:element name="lastName" type="xsd:string"/>
               <xsd:element name="email" type="xsd:string"/>
                  </xsd:sequence>
                </xsd:complexType>
              </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
     </xsd:element>
</xsd:schema>
```

XSD: `studentList` example

```
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
         <firstName>John</firstName>
         <lastName>Smith</lastName>
         <email>jsmith@gmail.com</email>
     </student>
     <student>
         <firstName>Mary</firstName>
         <lastName>Jane</lastName>
         <email>mjane@gmail.com</email>
      </student>
</studentList>
```

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
           <xsd:sequence>
             <xsd:element name="student" minOccurs="0"
    maxOccurs="unbounded">
               <xsd:complexType>
                  <xsd:sequence>
                <xsd:element name="firstName"
               type="xsd:string"/>
                <xsd:element name="lastName" type="xsd:string"/>
                <xsd:element name="email" type="xsd:string"/>
                  </xsd:sequence>
                </xsd:complexType>
             </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
     </xsd:element>
</xsd:schema>
```

The element **`student`** is also a complex type

- which contains a sequence of elements

XSD: studentList example

```
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
          <firstName>John</firstName>
          <lastName>Smith</lastName>
          <email>jsmith@gmail.com</email>
     </student>
     <student>
          <firstName>Mary</firstName>
          <lastName>Jane</lastName>
          <email>mjane@gmail.com</email>
      </student>
</studentList>
```

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
           <xsd:sequence>
             <xsd:element name="student" minOccurs="0"
    maxOccurs="unbounded">
               <xsd:complexType>
                  <xsd:sequence>
               <xsd:element name="firstName"
              type="xsd:string"/>
               <xsd:element name="lastName" type="xsd:string"/>
               <xsd:element name="email" type="xsd:string"/>
                  </xsd:sequence>
                </xsd:complexType>
             </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
   </xsd:element>
</xsd:schema>
```

The element **student** is also a complex type

- which contains a sequence of elements:
  `firstName, lastName, email`

XSD: `studentList` example

```
<?xml version="1.0" ?>
<studentList xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="studentList.xsd">
    <student>
          <firstName>John</firstName>
          <lastName>Smith</lastName>
          <email>jsmith@gmail.com</email>
     </student>
     <student>
          <firstName>Mary</firstName>
          <lastName>Jane</lastName>
          <email>mjane@gmail.com</email>
      </student>
</studentList>
```

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <xsd:element name="studentList">
         <xsd:complexType>
           <xsd:sequence>
              <xsd:element name="student" minOccurs="0"
    maxOccurs="unbounded">
                <xsd:complexType>
                   <xsd:sequence>
                <xsd:element name="firstName"
               type="xsd:string"/>
                <xsd:element name="lastName" type="xsd:string"/>
                <xsd:element name="email" type="xsd:string"/>
                   </xsd:sequence>
                 </xsd:complexType>
              </xsd:element>
           </xsd:sequence>
         </xsd:complexType>
   </xsd:element>
</xsd:schema>
```

The `firstName`, `lastName`, `email` elements are all simple type

XSD: `dailyTransaction` example

```
<?xml version="1.0" ?>
<dailyTransaction date="24/02/2015">
   <person staffDbId="103" operation="update">
     <firstName>John</firstName>
     <lastName>Smith</lastName>
     <mobile>0211223344</mobile>
   </person>
   <person staffDbId="-1" operation="add">
     <firstName>Mary</firstName>
     <lastName>Jane</lastName>
     <mobile>0244556677</mobile>
   </person>
</dailyTransaction>
```

`complexType:` `dailyTransaction, person`

`simpleType:` `firstName, lastName, mobile`

XSD: dailyTransaction example

```
<?xml version="1.0" ?>
<dailyTransaction date="24/02/2015">
   <person staffDbId="103" operation="update">
     ...
   </person>
   <person staffDbId="-1" operation="add">
     ...
   </person>
</dailyTransaction>
```

Start with the root element dailyTransaction:

```
<?xml version="1.0" ?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
 <xsd:element name="dailyTransaction">
  <xsd:complexType>
   ...
  </xsd:complexType>
 </xsd:element>
</xsd:schema>
```

XSD: dailyTransaction example

```
<?xml version="1.0" ?>

<dailyTransaction date="24/02/2015">

   <person staffDbId="103" operation="update">

     ...

   </person>

   <person staffDbId="-1" operation="add">

     ...

   </person>

</dailyTransaction>
```

The root element `dailyTransaction` contains a sequence of `person` elements and has attribute `date`

```
<?xml version="1.0" ?>

<xsd:element name="dailyTransaction">

 <xsd:complexType>

  <xsd:sequence>

  ...

  </xsd:sequence>

  <xsd:attribute name="date" type="xsd:string" />

 </xsd:complexType>

</xsd:element>
```

XSD: dailyTransaction example

```
<?xml version="1.0" ?>
<dailyTransaction date="24/02/2015">
   <person staffDbId="103" operation="update">
     ...
   </person>
   <person staffDbId="-1" operation="add">
     ...
   </person>
</dailyTransaction>
```

The root element dailyTransaction contains a sequence of person elements and has attribute date

```
<?xml version="1.0" ?>
<xsd:element name="dailyTransaction">
 <xsd:complexType>
  <xsd:sequence>
   <xsd:element name="person" minOccurs="0"
maxOccurs="unbounded">
    ...
   </xsd:element>
  </xsd:sequence>
  <xsd:attribute name="date" type="xsd:string" />
 </xsd:complexType>
</xsd:element>
```

XSD: dailyTransaction example

```
<person staffDbId="103" operation="update">
   <firstName>John</firstName>
   <lastName>Smith</lastName>
   <mobile>0211223344</mobile>
 </person>
```

```
<xsd:element name="person" minOccurs="0”
maxOccurs="unbounded">
 <xsd:complexType>
  <xsd:sequence>
  ...
  </xsd:sequence>
  <xsd:attribute name="staffDbId" type="xsd:integer" />
  <xsd:attribute name="operation" type="xsd:string" />
 </xsd:complexType>
</xsd:element>
```

The element `person` contains:

- elements: `firstName, lastName, mobile`
- attributes: `staffDbId, operation`

XSD: dailyTransaction example

```
<person staffDbId="103" operation="update">
   <firstName>John</firstName>
   <lastName>Smith</lastName>
   <mobile>0211223344</mobile>
 </person>
```

The element person contains:

- elements: firstName, lastName, mobile
- attributes: staffDbId, operation

```
<xsd:element name="person" minOccurs="0”
maxOccurs="unbounded">
 <xsd:complexType>
  <xsd:sequence>
   <xsd:element name="firstName" type="xsd:string"/>
   <xsd:element name="lastName" type="xsd:string"/>
   <xsd:element name="mobile" type="xsd:string"/>
  </xsd:sequence>
  <xsd:attribute name="staffDbId" type="xsd:integer" />
  <xsd:attribute name="operation" type="xsd:string" />
 </xsd:complexType>
</xsd:element>
```

References

- https://www.w3schools.com/xml/schema_intro.asp
- https://msdn.microsoft.com/en-us/library/ms256235(v=vs.110).aspx