

Data-centric XML

XML Schema (Part 1)

Schema and DTD

- Disadvantages of DTD:
 - separate, non-XML syntax
 - very limited constraints on data types (just ID, IDREF, ...)
 - no support for sets (i.e. each element type must occur precisely once)
 - all elements are global (i.e. their content model applies in the entire document)
 - no support for namespaces
- Goals of XML Schema
 - description of the structure of a document
 - description of the data of a document
 - *as a document*

References

<http://www.informatik.hu-berlin.de/~obecker/Lehre/SS2002/XML/11a-schema.xml>

- **W3 Recommendations (XML Schema 1.0)**
 - <http://www.w3.org/TR/xmlschema-0/> (Primer)
 - <http://www.w3.org/TR/xmlschema-1/> (Structures)
 - <http://www.w3.org/TR/xmlschema-2/> (Datatypes)
 - XML Schema 1.1: Candidate Recommendation
- **Other Resources**
 - <http://www.w3.org/XML/Schema>
 - <http://www.jeckle.de/xsd-de/>
 - <http://www.w3.org/2001/03/webdata/xsv>

An Example

- Example document: catalog of a bookstore

```
<buchhandlung art="belletristik">
```

```
  <buch>
```

```
    <autor>...</autor>
```

```
    <titel>...</titel>
```

```
    <verlag>...</verlag>
```

```
    <isbn>...</isbn>
```

```
    <preis>...</preis>
```

```
  </buch>
```

```
  <buch>
```

```
    ...
```

```
  </buch>
```

```
</buchhandlung>
```

An Example (2)

- Define a schema for the document
 - Starting with boilerplate

```
<xs:schema  
  xmlns:xs="http://www.w3.org/2001/XMLSchema">  
  
  ...  
</xs:schema>
```

An Example (3)

- Define the root element of the document (buchhandlung), which is of a complex type

```
<xs:schema
  xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="buchhandlung">
    <xs:complexType>
      ...
    </xs:complexType>
  </xs:element>
</xs:schema>
```

An Example (4)

- A buchhandlung contains multiple buch elements, and a art attribute

```
<xs:schema
  xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="buchhandlung">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="buch"
          maxOccurs="unbounded">
          ...
        </xs:element>
      </xs:sequence>
      <xs:attribute name="art" type="xs:string"/>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

An Example (5)

- Similarly, a buch is defined by listing its child elements

...

```
<xs:element name="buch" maxOccurs="unbounded">
```

```
  <xs:complexType>
```

```
    <xs:sequence>
```

```
      <xs:element name="autor" type="xs:string"/>
```

```
      <xs:element name="titel" type="xs:string"/>
```

```
      <xs:element name="verlag" type="xs:string"/>
```

```
      <xs:element name="isbn" type="xs:string"/>
```

```
      <xs:element name="preis" type="xs:string"/>
```

```
    </xs:sequence>
```

```
  </xs:complexType>
```

```
</xs:element>
```

...

Complete schema follows the Matryoshka design

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="buchhandlung">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="buch" maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="autor" type="xs:string"/>
              <xs:element name="titel" type="xs:string"/>
              <xs:element name="verlag" type="xs:string"/>
              <xs:element name="isbn" type="xs:string"/>
              <xs:element name="preis" type="xs:string"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
      <xs:attribute name="art" type="xs:string"/>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

Global Element Definitions

- An element defined in a schema can be used in multiple places
e.g. defined through `<xs:element name="author" type="xs:string"/>`
can be referred as `<xs:element ref="author"/>` inside e.g. `xs:sequence`
- Global element definitions produce a flat schema, like DTDs

Reusable Element Types

- Structure of a type (attributes, sequence) can be given a name, and then used to define multiple elements

```
<xs:complexType name="buchlisteTyp">
```

```
  <xs:sequence>
```

```
    <xs:element ref="buch" maxOccurs="unbounded"/>
```

```
  </xs:sequence>
```

```
  <xs:attribute ref="art"/>
```

```
</xs:complexType>
```

```
<xs:element name="buchhandlung"  
  type="buchlisteTyp"/>
```

Content Models

- Like DTDs, XML Schema allows the definition of content models
- Empty content: Complex type with no content, possibly attributes

```
<xs:element name="leer">
```

```
  <xs:complexType />
```

```
</xs:element>
```

```
<xs:element name="leerMitAtt">
```

```
  <xs:complexType>
```

```
    <xs:attribute name="att" type="xs:string"/>
```

```
  </xs:complexType>
```

```
</xs:element>
```

Simple Content with Attributes

- Example:

```
<buchtipp isbn="3-251-00452-2">Ein Buch, das in  
keinem Bücherschrank fehlen darf.</buchtipp>
```

- Starting with `xs:simpleContent`, extended with attributes

```
<xs:element name="buchtipp">
```

```
  <xs:complexType>
```

```
    <xs:simpleContent>
```

```
      <xs:extension base="xs:string">
```

```
        <xs:attribute name="isbn" type="xs:string" />
```

```
      </xs:extension>
```

```
    </xs:simpleContent>
```

```
  </xs:complexType>
```

```
</xs:element>
```

Structured Types

- Sequences (xs:sequence): List child elements in order
- Choices (xs:choice): List alternative child elements
- Sets (xs:all): List child elements that must occur, but can occur in arbitrary order
 - Must not be part of other content models
 - Must contain only elements

Cardinalities

- Attributes minOccurs= and maxOccurs= on xs:element (default is 1)
 - Only allowed for nested elements, not in global elements
 - Value “unbounded” means arbitrary repetition
- `<xs:element name="x" type="..."
minOccurs="0" maxOccurs="unbounded"/>`

Cardinalities Example

The DTD content model

`((arbeit, essen)*, (sport | spiel+)?, schlaf)+`

translates to

```
<xs:complexType>
  <xs:sequence maxOccurs="unbounded">
    <xs:sequence minOccurs="0" maxOccurs="unbounded">
      <xs:element name="arbeit" type="..." />
      <xs:element name="essen" type="..." />
    </xs:sequence>
    <xs:choice minOccurs="0">
      <xs:element name="sport" type="..." />
      <xs:element name="spiel" type="..." maxOccurs="unbounded" />
    </xs:choice>
    <xs:element name="schlaf" type="..." />
  </xs:sequence>
</xs:complexType>
```

Mixed Content

- Attribute `mixed="true"` for `xs:complexType` (`#PCDATA` | `tier` | `ort`)*

```
<xs:complexType mixed="true">  
  <xs:choice minOccurs="0" maxOccurs="unbounded">  
    <xs:element name="tier" type="..." />  
    <xs:element name="ort" type="..." />  
  </xs:choice>  
</xs:complexType>
```

- Also allowed for `xs:sequence` and `xs:all`

Attributes

- `xs:attribute`
- Always occur after child elements
- `name=` specifies attribute name
- `type=` specifies simple type
- `use="required"|"optional"`
- `default=` specifies default value
- `fixed=` specifies fixed value

XML Schema So Far

- Additions with respect to DTDs:
 - More complex cardinalities (not just +, *, ?)
 - Set content models (xs:all)
 - Mixed Content for xs:sequence, xs:all