XML Schema

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Outline

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  - XML Schema is an XML application!
  - **Convention:** XML Schema files end with **.xsd**

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  - XML Schema is an XML application!
  - **Convention:** XML Schema files end with **.xsd**

Example. Schema declaration

```
<person
   xmlns="http://alviano.net/km"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://alviano.net/km
      person.xsd">
```

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Root element

- Elements of XML Schema are defined in the namespace `http://www.w3.org/2001/XMLSchema`
- **Convetion:** use the prefix `xs`

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    targetNamespace="URI"
    attributeFormDefault="qualified or unqualified"
    elementFormDefault="qualified or unqualified"
    version="version number">
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  - **Hint:** set the default namespace equal to `targetNamespace`

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- `targetNamespace` (optional) specifies to which namespace the elements defined by the schema belong
  - **Hint:** set the default namespace equal to `targetNamespace`
- Elements and attributes with namespace are said **qualified**
  - Qualified/unqualified names can be forced with the attributes `attributeFormDefault` and `elementFormDefault`

Element declarations

- Elements are declared by `<xs:element>`
- Elements can be global or local
  - A global declaration is a child of `<xs:schema>` (the root)
  - A local declaration is a child of some other tag

```
<xs:element name="name of the element"
   type="global type"
   ref="global element declaration"
   form="qualified or unqualified"
   minOccurs="non-negative number"
   maxOccurs="non-negative number or 'unbounded'"
   default="default value"
   fixed="fixed value">
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```

Warning!

Attributes `minOccurs` and `maxOccurs` cannot be used in global declarations

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- Types can be complex
  - Structured types
- Types can be simple
  - Specializations of other types
- There is another, special type named wildcard (or jolly)

Complex types (1)

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- Their content is a list of elements and types, to be interpreted as
  - `<xs:sequence>`: elements must appear in the given order
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Example

```
<xs:complexType name="NameOrEmail">
   <xs:choice>
      <xs:element name="email" type="xs:string"/>
      <xs:sequence>
         <xs:element name="first" type="xs:string"/>
         <xs:element name="middle" type="xs:string"/>
         <xs:element name="last" type="xs:string"/>
      </xs:sequence>
   </xs:choice>
</xs:complexType>
```

Complex types (2)

- `<xs:all>` is subject to several restrictions
  - It must be the only element in `<xs:complexType>`
  - It can contain only `<xs:element>`
  - Every `<xs:element>` can appear only once

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Example

```
<xs:element name="person-name">
   <xs:complexType>
      <xs:all>
         <xs:element name="first" type="xs:string"/>
         <xs:element name="middle" type="xs:string"
minOccurs="0"/>
         <xs:element name="last" type="xs:string"/>
      </xs:all>
   <xs:complexType>
</xs:element>
```

This is OK!

```
<person-name>
   <first>Mario</first>
   <last>Alviano</last>
</person-name>
```

This is also OK!

```
<person-name>
   <last>Alviano</last>
   <first>Mario</first>
</person-name>
```

Complex types (3)

- Complex types can have **mixed** content

Example. Mixed content

```
<xs:element name="description">
    <xs:complexType mixed="true">
        <xs:choice minOccurs="0" maxOccurs="unbounded">
            <xs:element name="em" type="xs:string" />
            <xs:element name="br" type="xs:string" />
        </xs:choice>
    </xs:complexType>
</xs:element>

<description>
    The <em>KM</em> course of the <em>Computer Science</em>
degree
</description>
```

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    </xs:complexType>
</xs:element>

<description>
    The <em>KM</em> course of the <em>Computer Science</em>
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</description>
```

- Sometimes complex types are not really complex

Example. Empty element

```
<xs:element name="br">
    <xs:complexType />
</xs:element>
```

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- Simple types, also said **derived types**, are declared by `<xs:simpleType>`
- They can be restrictions, lists or unions (of simple types)

```
<xs:simpleType name="name of the simpleType"
    final="#all or list or union or restriction">
```

- **Note:** attribute `final` forbid further derivations
- Restrictions apply one or more **facets**
  - `minExclusive`, `maxExclusive`, `minInclusive`, `maxInclusive`, `totalDigits`, `length`, `minLength`, `maxLength`, `enumeration`, `whiteSpace`, `pattern`

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Example

```
<xs:simpleType>
    <xs:restriction base="xs:string">
        <xs:enumeration value="Home" />
        <xs:enumeration value="Work" />
    </xs:restriction>
</xs:simpleType>
```

Simple types (2)

- Lists are space-separated, hence the simpleType used for validating items in the list must not allow spaces

```
<xs:list itemType="name of simpleType used for
validating items in the list" />
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Example

```
<xs:simpleType name="ContactType">
   <xs:restriction base="xs:string">
      <xs:enumeration value="Home" />
      <xs:enumeration value="Work" />
   </xs:restriction>

</xs:simpleType>
<xs:simpleType name="ContactTypeList">
   <list itemType="ContactType" />
</xs:simpleType>
```

I tipi semplici (3)

- Unions are declared by `<xs:union>`

```
<xs:union memberTypes="whitespace separated list
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Example

```
<xs:simpleType name="UnknownString">
   <xs:restriction base="xs:string">
      <xs:enumeration value="Unknown" />
   </xs:restriction>
</xs:simpleType>

<xs:simpleType name="UnknownOrFloatType">
   <xs:union memberTypes="xs:float UnknownString" />
</xs:simpleType>
```

The wildcard (or jolly)

- Sometimes you just need any content

```
<xs:any minOccurs="non-negative number"
    maxOccurs="non-negative number or ubounded"
    namespace="allowable namespaces"
    processContents="lax or skip or strict" />
```

- As `namespace` one can use
  - `##any`, i.e., anything
  - `##other`, i.e., different from `targetNamespace`
  - `##targetNamespace`
  - `##local`, i.e., unqualified names
  - a space-separated list of namespaces
- As `processContent`
  - `skip` if the content must not be validated
  - `lax` to validate reporting warnings
  - `strict` to validate reporting errors

Outline

Attributes

- Attributes of a complexType are declared by `<xs:attribute>` (the syntax is similar to `<xs:element>`; the type must be simple)

```
<xs:attribute name="name of the element"
   type="global type"
   ref="global element declaration"
   form="qualified or unqualified"
   default="default value"
   fixed="fixed value"
   use="optional or prohibited or required">
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Example 1

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<xs:attribute name="title">
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Example 1

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<xs:attribute name="title">
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        <!- - type information - ->
    </xs:simpleType>
</xs:attribute>
```

Example 2

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

Text only elements with attributes

- Text only elements are usually simpleTypes (eg. xs:string)
- Elements with attributes have complexTypes

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- How to add attributes to text only elements?
- Use `<xs:simpleContent>` and `<xs:extension>`

Example

```
<xs:complexType>
   <xs:simpleContent>
      <xs:extension base="xs:integer">
         <xs:attribute name="currency" type="xs:string" />
      </xs:extension>
   </xs:simpleContent>
</xs:complexType>
```

Outline

Groups of elements

- XML Schema allows to define groups by `<xs:group>`
- Groups can be referred more times

Example

```
<xs:group name="NameGroup">
   <xs:sequence>
      <xs:element name="first" type="xs:string">
      <xs:element name="middle" type="xs:string" minOccurs="0"
/>
      <xs:element name="last" type="xs:string">
   </xs:sequence>
</xs:group>

<xs:complexType name="NameType">
   <xs:group ref="NameGroup" />
</xs:complexType>
```

Groups of attributes and built-in types

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  - The tag `<xs:attributeGroup>` is used
- There are several built-in types, i.e., types defined in the language
  - `xs:string, xs:normalizedString, xs:byte, xs:unsignedByte, xs:hexBinary, xs:positiveInteger, xs:negativeInteger, xs:int, xs:short, ...`

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  - The tag `<xs:attributeGroup>` is used
- There are several built-in types, i.e., types defined in the language
  - `xs:string, xs:normalizedString, xs:byte, xs:unsignedByte, xs:hexBinary, xs:positiveInteger, xs:negativeInteger, xs:int, xs:short, ...`
- In addition to the types defined by XML Schema, one can use types in the XML Recommendation
  - `ID, IDREF, IDREFS, ENTITY, ENTITIES, NOTATION, NMTOKEN, NMTOKENS`

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Combine more schemes

- A schema can be imported by `<xs:import>`
- `<xs:import>` must be a child of `<xs:schema>`

```
<xs:import namespace="..." schemaLocation="..." />
```

- The namespace specifies which elements to import
- Usually, imported elements are defined in namespaces different from `targetNamespace`

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<xs:import namespace="..." schemaLocation="..." />
```

- The namespace specifies which elements to import
- Usually, imported elements are defined in namespaces different from `targetNamespace`
- To import elements in `targetNamespace` use `<xs:include>`

```
<xs:include schemaLocation="..." />
```

New feature of XML Schema 1.1

- XML Schema 1.1 allows to declare assertions

```
<xs:assert test="XPath expression" />
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- We will see XPath in the next lecture

Example

```
<xs:element name="sizeRange">
   <xs:complexType>
      <xs:sequence>
         <xs:element name="minSize" type="xs:decimal" />
         <xs:element name="maxSize" type="xs:decimal" />
      </xs:sequence>
      <xs:assert test="minSize le maxSize" />
   </xs:complexType>
</xs:element>
```

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Exercises

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  - `xmllint -schema XMLSchemaFile XMLfile -noout`

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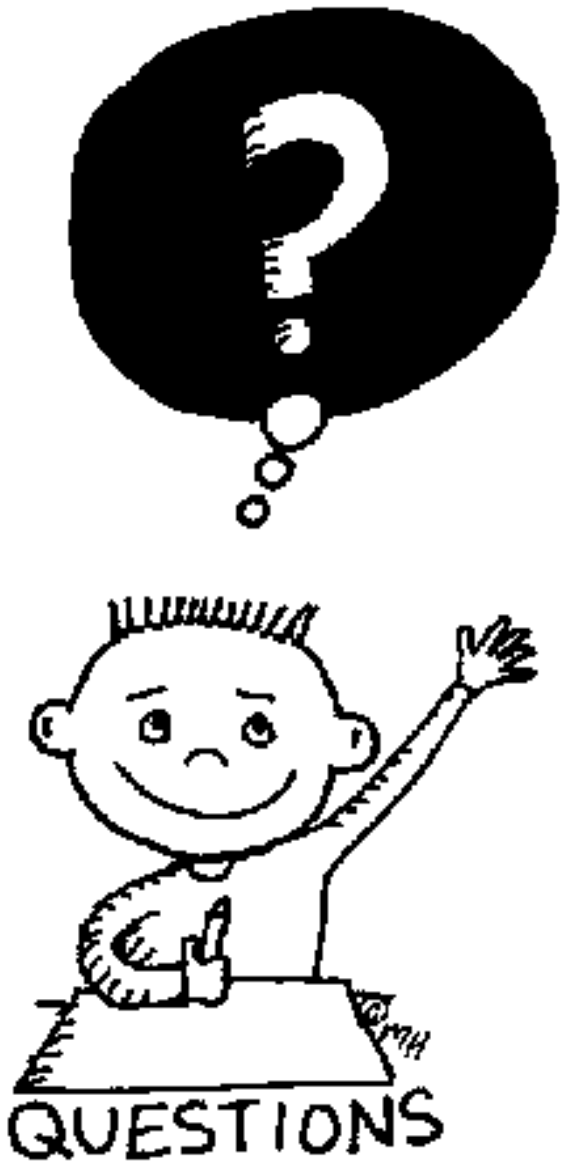
1. Given the specification in **personName.txt**, write an XML Schema and an XML document
2. Given the specification in **catalog.txt** and the documents **catalog1.xml** and **catalog2.xml**, write an XML Schema
3. Given the specification in **bank-accounts.txt** and the document **bank-accounts.xml**, write an XML Schema



END OF THE LECTURE