

Codifica di Testi - XML Schema e Intro TEI a.a. 2018-2019

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Cos'è uno schema XML

Uno schema XML è un documento XML standard che descrive come deve essere realizzato un altro documento XML. Ci riferiamo a questa tecnologia con l'acronimo XSD.

A cosa serve uno Schema XML

I documenti XSD sono usati per validare documenti XML. Tuttavia un documento XSD viene realizzato tramite l'uso di un vocabolario predefinito riferibile attraverso un namespace con URI standard.

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XSD Schema

Il termine XSD o XML Schema denota un documento XML che descrive e valida la struttura e il contenuto di un altro documento XML.

XSD Schema

Dichiarazione del documento (declaration) e istanza del documento (instance).

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XSD elemento root

L'elemento radice di uno schema XSD è sempre l'elemento "`<schema>`".

Tutte le definizioni devono seguire quindi l'elemento "`<schema>`".

XSD Schema

Tutti gli elementi e gli attributi dello schema sono dichiarati all'interno del namespace

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

Tutti i documenti XSD contengono la dichiarazione a questo namespace con prefisso convenzionale **xsd** oppure **xs**.

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XSD componenti di base

I componenti di base di uno Schema XSD sono le dichiarazioni degli elementi e le dichiarazioni degli attributi.

XSD Schema

Le dichiarazioni più complesse si poggiano su queste unità: elementi e attributi.

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XSD dichiarazioni

Scrivere un pezzo di codice XSD per descrivere e validare un elemento per un documento XML è detto *element declaration*.

XSD dichiarazioni di base

XSD permette di dichiarare elementi, attributi e di specificare il numero di figli, le occorrenze, l'ordine di apparizione, e i tipi di dati del content model.

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Element Types: simple and complex

La dichiarazione di un elemento può avere un tipo semplice (*simple type*) oppure un tipo complesso (*complex type*) a seconda della sua struttura e del suo contenuto.

Simple Type e Complex Type

La dichiarazione di un elemento ha un tipo semplice se non possiede **né figli né attributi**.

La dichiarazione di un elemento ha un tipo complesso in tutti gli altri casi.

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XSD esempio

```
<xsd:schema  
  xmlns:xsd='http://www.w3.org/2001/XMLSchema''>  
  <xsd:element name='text' />  
</xsd:schema>
```

XSD esempio elemento di tipo semplice

```
<text>Il primo documento XML Validato</text>
```

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XML XSD esempio

Il documento XML istanza dello schema XSD per essere valido deve contenere un elemento radice. Validare il documento XML con il relativo XSD con XMLlint.

XMLlint

```
xmllint xmlfirst.xml --schema  
../schema/xsd/xsdfirst.xsd
```

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Element Complex Types: esempio

```
<xsd:schema
  xmlns:xsd='http://www.w3.org/2001/XMLSchema'>
  <xsd:element name='Employee'> <xsd:complexType>
    <xsd:attribute name='FirstName'/>
  </xsd:complexType> </xsd:element> </xsd:schema>
```

Element Complex Types: esempio

Il documento XML istanza dello schema:

```
<Employee FirstName="Jacob"/>
```

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Complex Types

Alla base dello standard XSD ci sono le dichiarazioni degli elementi e degli attributi, ad un livello di astrazione più alto ci sono i types e i groups.

A complex type can have attributes, child elements or both. Here is another example that shows a complex type having child elements.

Element Complex Types: Esempio Elemento con Figlio

```
<xsd:schema
  xmlns:xsd='http://www.w3.org/2001/XMLSchema'>
  <xsd:element name='text'> <xsd:complexType>
    <xsd:sequence> <xsd:element name='body'>/>
```

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Espressività dell'XSD

- Attribute Group, Element Group
- Order Indicators: all, sequence, choice
- Occurrence Indicators: minOccurs and maxOccurs
- Annotation (utili per documentare le dichiarazioni)

Espressività dell'XSD

- Data types: Built-in
- FACETS per una validazione oculata dei valori (elemento o un attributo).

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Element Declaration

An XSD element declaration represents an element in the XML instance document. An element is said to have a Simple Type if it does not have any attributes and does not have child elements.

Element Declaration: Istanza XML

```
<p>il contenuto testuale di un paragrafo</p>
```

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Global and Local element declaration

The advantage of using a global element declaration is that it can be reused (referred) at other locations from within the same schema.

When you have a global element declaration, you can refer it in multiple locations in your schema (level of reusability).

Global element declaration: esempio

```
<xsd:schema
  xmlns:xsd='http://www.w3.org/2001/XMLSchema'>
  <xsd:element name='body'> <xsd:complexType>
    <xsd:attribute name='lang'> <xsd:attribute
      name='type'> </xsd:complexType> </xsd:element>
```


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Group declaration

Commonly used attributes and elements can be grouped together into Attribute Groups and Element Groups. You can then refer to such a group at multiple locations in your schema definition. Attribute groups and Element groups provide a certain level of reusability.

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Global element declaration: esempio

```
<xsd:group name='fileDesc'> <xsd:sequence>  
<xsd:element name='titleStmt'/> <xsd:element  
name='publicationStmt'/> <xsd:element  
name='sourceDesc'/> </xsd:sequence>
```

Global element declaration: esempio

```
<xsd:group ref='fileDesc'/>
```

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Element Declaration: Attributi

Attributi della dichiarazione di elementi: The only mandatory attribute that an element declaration should take is the “name” attribute.

Element Declaration: Attributi - Esempio

```
<xsd:element name='TEI'/>
```

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Element declaration: lista Attributi

- **name** (*g-l*) the only mandatory attribute (give meaningful names to the elements)
- **type** (*g-l*) adds data type related validations to the declaration of an element (XSD has built-in data types)
- **id** (*g-l*) uniquely identifies the given element (non ha effetti sull'istanza XML)
- **default** (*g-l*) specify the default value of an element (solo de l'elemento opzionale)
- **fixed** (*g-l*) valore di un elemento predefinito (“fixed” and “default” are mutually exclusive)

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Element declaration: lista Attributi (cont.)

- final (g) limits the declaration of substitution groups in schemas (can take values: #all, restriction and extension.)
- abstract (g) When an element is declared as abstract, it cannot be instantiated (force an element substitution)
- substitutionGroup (g) is highly extensible (could easily add new types derived) esempio SG
- minOccurs (l) control the occurrence of the elements: minimum number of times the element should appear in the XML instance (minOccurs=0 -> Optional).
- maxOccurs (l) control the occurrence of the elements: The maximum number of times the element can appear

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Element declaration: Attributi - Esempio

```
<xsd:element name='body'> <xsd:complexType>  
<xsd:sequence maxOccurs='unbounded'>  
<xsd:element ref='div' /> </xsd:sequence>  
</xsd:complexType> </xsd:element>
```

Element declaration: Attributi - Esempio

```
<xsd:element name='div' type='divType' />  
<xsd:complexType name='divType'> [...]  
</xsd:complexType>
```

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Attribute declaration:

An attribute is declared with `xsd:attribute` element. The only mandatory attribute of an attribute declaration is “name”. When an attribute is declared right under the “`xsd:schema`” element, it is called global attribute declaration. When it is declared within a Complex Type, it is called Local attribute declaration.

Attribute declaration

```
<xsd:attribute name='Name'  
type='xsd:string' />
```

Qualsiasi dichiarazione di attributo per essere effettivamente



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Attribute declaration: Attributi

- **name** (*g-l*) the name of the attribute as it should appear in the XML instance (Mandatory)
- **id** (*g-l*) used by the schema processor to uniquely identify the XSD components within a given schema
- **type** (*g-l*) associates a data type with an attribute (facilitates validation on the value). make sure that only valid values are accepted

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Attribute declaration: Attributi (cont.)

- **default** (*g-l*) The default attribute assigns a default value to an attribute declaration (solo se l'attributo non è presente)
- **fixed** (*g-l*) It prevents the attribute from taking any value other than the pre-defined one.
- **ref** (*l*) A globally declared attribute can be inserted into a complex type by using the “ref” attribute.
- **use** (*l*) specifies whether the attribute is optional or mandatory (values optional or required, prohibited).
- **form** (*l*) specifies whether the attribute needs to be qualified by a namespace prefix or not in the XML

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Attribute declaration: Esempio (global)

```
<xsd:schema
xmlns:xsd='http://www.w3.org/2001/XMLSchema''>
<xsd:attribute name='analysis' /> <!-- -->
<xsd:element name='word'> <xsd:complexType>
<xsd:attribute ref='analysis' />
</xsd:complexType> </xsd:element> </xsd:schema>
```

Global attribute declarations are useful when an attribute is declared with several validations

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Attribute declaration: Attribute Groups

Attribute Groups provide a convenient means to reuse attribute declarations in multiple complex types. Attribute Groups provide a better level of reusability by grouping one or more attribute declarations into a named group. By using an attribute group, you can avoid this repetition of code. Chain of attribute group hierarchies.

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Attribute declaration: Esempio (global)

```
<xsd:schema
xmlns:xsd='http://www.w3.org/2001/XMLSchema'>
<xsd:attributeGroup name='EmpAttributes'> <!--
Declaration of attribute 'name' -->
<xsd:attribute name='name'> <xsd:simpleType>
<xsd:restriction base='xsd:string'>
<xsd:maxLength value='20'> </xsd:restriction>
</xsd:simpleType> </xsd:attribute> <!--
Declaration of attribute 'department' -->
<xsd:attribute name='department'>
<xsd:simpleType> <xsd:restriction
base='xsd:string'> <xsd:length value='2'>
</xsd:restriction> </xsd:simpleType>
```

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Attribute declaration: Esempio (global)

```
[...] <!-- Declaration of root element
‘‘Employees’’ --> <xsd:element name=‘‘Employees’’>
<xsd:complexType> <xsd:sequence> <!-- Declaration
of ‘‘Manager’’ element --> <xsd:element
name=‘‘Manager’’> <xsd:complexType>
<xsd:attributeGroup ref=‘‘EmpAttributes’’/>
</xsd:complexType> </xsd:element> <!-- Declaration
of ‘‘department’’ element --> <xsd:element
name=‘‘TechLead’’> <xsd:complexType>
<xsd:attributeGroup ref=‘‘EmpAttributes’’/>
</xsd:complexType> </xsd:element> </xsd:sequence>
</xsd:complexType> </xsd:element> </xsd:schema>
```

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XSD Data Type

Programming languages use data types to make sure that correct values are stored to variables and correct operations are done using those variables.

XSD Data Type

When you associate a variable to a data type you are basically restricting the values that the variable can store and restricting the permissible operations on them.

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XSD Data Type: esempio - dichiarazione

```
<xsd:schema
  xmlns:xsd='http://www.w3.org/2001/XMLSchema''>
  <xsd:element name='div'> <xsd:complexType>
    <xsd:attribute name='type' /> <xsd:attribute
      name='n' type='xsd:integer' />
  </xsd:complexType> </xsd:element> </xsd:schema>
```

XSD Data Type: esempio - istanza

```
<div type="chapter" n="1" />' (corretto)
<div type="chapter" n="uno" />' (errato)
```

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XSD Data Type

XSD supports a number of different data types to describe and validate almost all values that we might need to work with. It supports deriving new data types from the built-in data types

XSD Data Type

Data types help describe a certain piece of data more accurately and help validate them more efficiently. XSD supports almost fifty data types. They can be divided into Primitive Data Types, Derived Data Types

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Primitive Data Types

Primitive Data Types are base data types from which other data types are derived.

XSD has nineteen primitive data types

Primitive Data Types

string	boolean	decimal
float	double	duration
dateTime	time	date
gYearMonth	gYear	gMonthDay
gDay	gMonth	hexBinary
base64Binary	anyURI	QName
NOTATION		

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Primitive Data Types

Primitive Data Types are the base data types of XSD. This means that they themselves have not been derived from another type.

Derived Data Types

These are Data Types derived directly or indirectly from Primitive Data Types.

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Derived Type	Base Type
normalizedString	string
Integer	decimal

Derived Type	Base Type
Token	normalizedString
NMTOKEN	token
Name	token
Language	token
NMTOKENS	NMTOKEN
NCName	Name
ENTITY	NCName
ENTITIES	ENTITY

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Derived Type	Base Type
nonPositiveInteger	integer
nonNegativeInteger	integer
Long	integer
negativeInteger	nonPositiveInteger
int	Long
short	int
byte	short
unsignedLong	nonNegativeInteger
positiveInteger	nonNegativeInteger
unsignedInt	unsignedLong
unsignedShort	unsignedInt
unsignedByte	unsignedShort

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Data Type: Facets

Each data type has a number of properties that can be restricted to perform additional validations on the value. These properties are called **Facets** in XSD.

Data Type: Facets

So each data type has a certain number of predefined Facets. A facet controls a certain attribute or characteristic of a data type

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Data Type: Facets Esempio

```
<xsd:schema
xmlns:xsd='http://www.w3.org/2001/XMLSchema'>
<xsd:element name='name'> <xsd:complexType>
<xsd:attribute name='type'> <xsd:simpleType>
<xsd:restriction base='xsd:string'> <xsd:length
value='15'> </xsd:restriction>
</xsd:simpleType> </xsd:attribute>
</xsd:complexType> </xsd:element> </xsd:schema>
```

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Data Type: Facets Esempio

```
<xsd:schema
xmlns:xsd='http://www.w3.org/2001/XMLSchema'>
<xsd:element name='name'> <xsd:complexType>
<xsd:attribute name='type'> <xsd:simpleType>
<xsd:restriction base='xsd:string'> <xsd:patter
value='[A-Za-z]+'/> </xsd:restriction>
</xsd:simpleType> </xsd:attribute>
</xsd:complexType> </xsd:element> </xsd:schema>
```

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	pattern	whitespace	length	minLength	maxLength	enumeration	totalDigits	fractionDigits	minInclusive	maxInclusive	minExclusive	maxExclusive
string	✓	✓	✓	✓	✓	✓						
boolean	✓	✓										
decimal	✓	✓				✓	✓	✓	✓	✓	✓	✓
float	✓	✓				✓			✓	✓	✓	✓
double	✓	✓				✓			✓	✓	✓	✓
duration	✓	✓				✓			✓	✓	✓	✓
dateTime	✓	✓				✓			✓	✓	✓	✓
time	✓	✓				✓			✓	✓	✓	✓
date	✓	✓				✓			✓	✓	✓	✓
gYear	✓	✓				✓			✓	✓	✓	✓
gMonthDay	✓	✓				✓			✓	✓	✓	✓
gDay	✓	✓				✓			✓	✓	✓	✓
gMonth	✓	✓				✓			✓	✓	✓	✓
base64Binary	✓	✓	✓	✓	✓	✓						
base64Binary	✓	✓	✓	✓	✓	✓						
anyURI	✓	✓	✓	✓	✓	✓						
QName	✓	✓	✓	✓	✓	✓						

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Simple Type vs Complex Type

The basic distinction between simple types and complex types is that only a complex type can contain child elements and attributes.

Simple Type vs Complex Type

Simple types can only store a value. An element or attribute can have a simple type.

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```
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <xsd:element name="ZipCode" type="zipType" />
  <xsd:simpleType name="zipType">
    <xsd:restriction base="xsd:integer">
      <xsd:maxInclusive value="99999"/>
      <xsd:minInclusive value="10000"/>
    </xsd:restriction>
  </xsd:simpleType>
</xsd:schema>
```

```
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <xsd:element name="ZipCode">
    <xsd:simpleType>
      <xsd:restriction base="xsd:integer">
        <xsd:maxInclusive value="99999"/>
        <xsd:minInclusive value="10000"/>
      </xsd:restriction>
    </xsd:simpleType>
  </xsd:element>
</xsd:schema>
```

Simple Types can be declared globally or locally

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Global simple types

Global simple types help reuse the definitions as well as help organize and maintain the schema.

helpful when the same set of validations is to be performed

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simple types example

```
<xsd:simpleType name='chapterNumberType'>  
<xsd:restriction base='xsd:integer'>  
<xsd:maxInclusive value='1000'>  
<xsd:minInclusive value='1'> </xsd:restriction>  
</xsd:simpleType>
```

simple types example

```
<xsd:element name='item'> <xsd:complexType>  
<xsd:attribute name='originalChapter'  
type='chapterNumberType'> </xsd:complexType>  
</xsd:element>
```

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simple types: deriving

Un nuovo tipo può essere derivato da un tipo già dichiarato (primitivo o meno) ed ereditarne le caratteristiche.

simple types example

- Derive by restriction
- Derive by list
- Derive by Union

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simple types: deriving

This involves identifying a base type that is close to what we are looking for, and adding the additional restrictions or validation rules.

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simple types: deriving by Restriction

A restriction is defined by adding “xsd:restriction” to the Simple Type declaration. Each data type has a number of properties that restricts the set of values it can accept (facets). When you derive a new data type by restriction, you restrict one or more facets.

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simple types: deriving by Restriction

```
<xsd:simpleType name='signatureType'>  
  <xsd:restriction base='xsd:integer'>  
    <xsd:totalDigits value='5'></xsd:restriction>  
  </xsd:simpleType>
```

simple types: deriving by Restriction

```
<xsd:element name='signature'  
  type='signatureType'>  
  <signature>12345</signature> (valido)  
  <signature>123ab</signature> (non valido)
```


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simple types: deriving by List

data type can store a SPACE separated list of values accepted by the base type

simple types: deriving by List

```
<xsd:simpleType name='chapterNumberList'>
  <xsd:list itemType='xsd:integer' />
</xsd:simpleType>
  <xsd:element name='chapters'
type='chapterNumberList' />
  <chapters>1 53 60 61 205 409</chapters>
```

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simple types: deriving by Union

The derived type can store the values acceptable to any of the base types from which the new type is derived.

simple types: deriving by Union

```
<xsd:simpleType name='ZipCityUnion'> <xsd:union>  
<xsd:simpleType> <xsd:restriction base="ZipType"/>  
</xsd:simpleType> <xsd:simpleType>  
<xsd:restriction base="CityType"/>  
</xsd:simpleType> </xsd:union> </xsd:simpleType>
```

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simple types: deriving

The value will be accepted only if it validates successfully with one of the base types.

simple types: deriving

It is not allowed to make the value space of a derived type less restrictive than the base type.

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simple types: deriving facets

each XSD data type has a certain number of facets that control its value space.

When we derive a new Simple Type from another, the new type will inherit all the facets of the base type.

simple types: deriving facets

You can set the **fixed** attribute of the given facets to **true** to make sure that the derived types do not modify those facets.

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Simple types: controllare la derivazione

XSD provides a way to protect your Simple Type so that no other Types can inherit from it.

controllare la derivazione: l'attributo final

- restriction
- list
- union
- extension
- #all

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Simple types: controllare la derivazione - esempio

```
<xsd:schema
xmlns:xsd='http://www.w3.org/2001/XMLSchema''>
<xsd:simpleType name='zipType'
final='restriction union list extension'>
<xsd:restriction base='xsd:integer'>
<xsd:maxInclusive value='99999' fixed='true'/>
<xsd:minInclusive value='10000'/>
</xsd:restriction> </xsd:simpleType> </xsd:schema>
```

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Simple types: controllare la derivazione - esempio

Extension refers to deriving a new type from a Simple Type that results in a Complex Type

Simple types: controllare la derivazione - esempio

When the **final** attribute is set to **#all**, the Simple Type cannot be inherited at all.

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Complex Type

A complex type can have child elements and/or attributes.
Attribute declarations cannot have Complex Types.

Named Complex types

A Named Complex Type can be used within the declaration of other complex types

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Named Complex Type Esempio

```
<xsd:complexType name='addressType'> <xsd:all>  
<xsd:element name="address"/> <xsd:element  
name="street"/> <xsd:element name="settlement"/>  
<xsd:element name="country"/> </xsd:all>  
</xsd:complexType>
```

Named Complex types Esempio

```
<xsd:element name='AddressDivision'>  
<xsd:complexType> <xsd:sequence> <xsd:element  
name="addressee"/> <xsd:element name="address"  
type="addressType"/> </xsd:sequence>  
</xsd:complexType> </xsd:element>
```

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Complex Type

Named Complex Types provide a great deal of reusability. Anonymous types appears within the complex type that owns the element.

Anonymous Complex types

```
<xsd:element name='Customer'> <xsd:complexType>  
<xsd:sequence>
```

Such declarations cannot be reused

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Content Model

The structure of the child elements of a Complex Type is called its Content Model.

Content Model: Simple Content, Complex Content

- Elements having Simple Content can store a text value and can hold attributes.
- When an element has Complex Content, it can be either empty, element- only or mixed type.

Such declarations cannot be reused

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Content Model: complex content

- Empty content element may have attributes.
- An element is said to have element-only content when it has child elements – and optionally attributes, too, but doesn't hold a text value.
- When an element has mixed content model it can store child elements, attributes and text value.

Such declarations cannot be reused

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Complex type: simple content

when an element has Simple Content it can store a text value and can have attributes.

Simple Content does not allow child elements.

Complex type: simple content esempio

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

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Complex type: Empty content

Complex Types having empty content are very close to the ones having simple content

Complex type: Empty content

Empty content complex types cannot store a text value but they can have attributes

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Complex type: element-only content

These are Complex Types that hold elements and/or attributes, but no text values.

Complex type: element-only content - esempio

```
<xsd:group name='fileDesc'> <xsd:sequence>  
<xsd:element name="titleStmt"/> <xsd:element  
name="publicationStmt"/> <xsd:element  
name="sourceDesc" /> </xsd:sequence> </xsd:group>  
<xsd:element name='teiHeader'> <xsd:complexType>  
<xsd:sequence> <xsd:group ref='fileDesc' />  
</xsd:sequence> </xsd:complexType> </xsd:element>  
</xsd:schema>
```

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Complex type: mixed content

Mixed Content is a combination of Simple Content and Element-only content:

It can store child elements and attributes as well as text values.

Complex type: mixed content

Mixed content type makes text values more meaningful. The Mixed content type XML is more meaningful to an XML parser than simple text, because the information can be extracted more accurately from it.

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Complex type: mixed content - esempio

```
<xsd:element name='seg'> <xsd:complexType  
mixed='true'> <xsd:all> <xsd:element  
name="name"/> <xsd:element name="quote"/>  
</xsd:all> </xsd:complexType> </xsd:element>  
</xsd:schema>
```

Complex type: mixed content - esempio

```
<seg><name>Petrarca</name> disse:  
<quote>Raramente la grande bellezza e la grande  
virtù dimorano assieme</quote></seg>
```

The only difference from element-only content model is the

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Complex type con attributi

When a Complex Type contains elements and attributes, the attribute declarations should appear after the element declarations.

Complex type: mixed content

```
<xsd:element name='seg'> <xsd:complexType  
  mixed='true'> <xsd:all> <xsd:element  
  name="quote"/> </xsd:all> <xsd:attribute  
  name="part"/> </xsd:complexType> </xsd:element>  
</xsd:schema>
```

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Elementi e Attributi: ordering

Attributes of an element can appear in any order. The order/position is not significant for attributes.

Elementi e Attributi: ordering

The order/position of elements is significant in XML: specify for each Complex Type whether the children should follow a specific order or not.

Elementi per la definizione degli schemi xml

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Elementi e Attributi: ordering

XSD uses order indicators to specify the order in which elements should appear inside an XML node.

Elementi e Attributi: ordering

- sequence: is used to specify that the elements should appear in exactly the same order as they are defined in the schema (`ixsd:sequence` / *i*).
- all: is used to specify that the child elements can appear in any order (`ixsd:all` / *i*).
- choice: is used when only one element from a list of child elements should appear in the XML instance (`ixsd:choice` / *i*).

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Elementi e Attributi: occurrence indicator

Attributes cannot appear more than once within the parent element.

Elementi e Attributi: ordering

We can control the occurrence of elements by using minOccurs and maxOccurs attributes of element declaration.

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minOccurs	maxOccurs	Result
1	1	The element is mandatory and should appear only once.
0	1	The element is optional. It may appear once but not more than once.
0	5	The element is optional and can appear up to 5 times.
1	5	The element is mandatory and can appear 5 times maximum.
0	unbounded	The element is optional and can appear any number of times.
1	unbounded	The element is mandatory and can appear any number of times
2	2	The element should appear exactly 2 times.

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Content Model: Deriving

New Complex Types can be derived from Complex Types having Simple Content. It is not allowed to derive Complex Content from Simple Content.

Content Model: Complex Content

Complex Content can store child elements and attributes as well as text values.

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Complex Type derivation

new types can be derived from complex types

Content Model: Complex Content

New complex types can be derived from existing complex types by restriction or by extension

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Complex Type derivation: da simple type

When you derive a complex type from a simple type, it can only have a simple content.

if the *final* attribute is set to **extension**, the simple type cannot be extended.

Complex Type derivation: da simple type - esempio

```
<xsd:complexType name='divTypeEx'>  
  <xsd:simpleContent> <xsd:extension  
base='divType'> <xsd:attribute name='type'  
use='required' /> </xsd:extension>  
</xsd:simpleContent> </xsd:complexType>
```

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Complex Type derivation: da simple type

The derivation behavior of each content model is slightly different from others.

Complex Type derivation: da simple type - esempio

- derive a new type by restriction or by extension from complex type simple content model
- derive by restriction from a complex type having simple content
- add restrictions to the content/text-value of the element
- add restrictions to the attributes

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Complex Type derivation: esempio

```
<xsd:complexType name='RestrictedPhoneType'>
  <xsd:simpleContent> <xsd:restriction
base='PhoneType'> <xsd:pattern
value="[0-9]3-[0-9]3-[0-9]4"/> <xsd:attribute
name='Type'> <xsd:simpleType> <xsd:restriction
base='xsd:string'> <xsd:enumeration
value="Home"/> <xsd:enumeration value="Work"/>
</xsd:restriction> </xsd:simpleType>
</xsd:attribute> <xsd:attribute
name="CallOnWeekend" type="xsd:boolean"
use="prohibited"/> </xsd:restriction>
</xsd:simpleContent> </xsd:complexType>
```

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Complex Type derivation: da simple type

Note the usage of *prohibited*. If you want to eliminate one or more attributes, you need to redefine them in the child type and set the *use* attribute to *prohibited*.

Complex Type derivation: da simple type - esempio

Note that when you add restrictions to the content as well as attributes, you cannot make the values less restrictive. Similarly, if an attribute is *required* in the base type, you cannot make it *optional* in the derived type.

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Complex Type derivation: da simple content

When you derive by extension from a complex type with simple content the result will always be a simple content. The only operation you can do when you extend a simple content type is to add new attributes.

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Complex Type derivation

A complex type with element-only content can be extended or restricted to create new types.

Complex Type derivation

The most common usage of deriving by restriction from an element-only content type is to remove one or more elements or attributes. Elements from the base type are not passed down to the derived type by default.

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All mandatory elements in the base type must exist in the derived type as well

Complex Type derivation

- If the elements in the base type are declared within a sequence group, the derived type cannot change it to all or choice groups.
- If the base type has all, the derived type can change it to sequence.
- If the base type has choice, the derived type must also have choice.

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All mandatory elements in the base type must exist in the derived type as well

Complex Type derivation

- if you want to remove an attribute you need to re-declare it in the derived type as *prohibited*.
- A derived type cannot eliminate an attribute declared as mandatory in the base type.
- You need to redefine an attribute in the derived type only if you want to restrict the value space of the attribute.

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Complex Type derivation: esempio

```
<xsd:complexType name='RestrictedPhoneType'>
  <xsd:simpleContent> <xsd:restriction
    base='PhoneType'> <xsd:pattern
      value="[0-9]3-[0-9]3-[0-9]4"/> <xsd:attribute
        name='Type'> <xsd:simpleType> <xsd:restriction
          base='xsd:string'> <xsd:enumeration
            value="Home"/> <xsd:enumeration value="Work"/>
        </xsd:restriction> </xsd:simpleType>
      </xsd:attribute> <xsd:attribute
        name="CallOnWeekend" type="xsd:boolean"
        use="prohibited"/> </xsd:restriction>
    </xsd:simpleContent> </xsd:complexType>
```

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Complex Type derivation: esempio

```
<xsd:element name="Contact"  
type="RestrictedContactType"/> <xsd:complexType  
name="ContactType"> <xsd:sequence> <xsd:element  
name="Phone" minOccurs="0"/> <xsd:element  
name="Email" minOccurs="0"/> </xsd:sequence>  
<xsd:attribute name="Name" /> <xsd:attribute  
name="Title"/> </xsd:complexType>
```

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Complex Type derivation: esempio

```
<xsd:complexType name='RestrictedContactType'>
  <xsd:complexContent>
    <xsd:restriction
      base='ContactType'>
      <xsd:sequence>
        <xsd:element
          name='Phone'>
          <xsd:simpleType>
            <xsd:restriction
              base='xsd:string'>
              <xsd:pattern
                value="[0-9]3-[0-9]3-[0-9]4"/>
            </xsd:restriction>
          </xsd:simpleType>
        </xsd:element>
      </xsd:sequence>
      <xsd:attribute name="Title" use="prohibited"/>
      <xsd:attribute name='Name'>
        <xsd:simpleType>
          <xsd:restriction base='xsd:string'>
            <xsd:maxLength value="20"/>
          </xsd:restriction>
        </xsd:simpleType>
      </xsd:attribute>
    </xsd:restriction>
  </xsd:complexContent>
</xsd:complexType>
```

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Complex Type derivation

It is also possible to derive an empty content complex type from an element-only content type. By keeping the restriction element empty, we can derive an empty content type. This does not affect the attributes.

Complex Type derivation

Gli elementi del tipo dell'elemento base devono essere opzionali

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Complex Type extension

complex types are extended to add new elements and attributes

Complex Type extension

When deriving by extension, all elements and attributes in the base type will be passed down to the derived type by default.

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Complex Type derivation: esempio

```
<xsd:element name="Contact"  
type="ExtendedContactType"/> <xsd:complexType  
name="ContactType"> <xsd:sequence> <xsd:element  
name="Phone"/> <xsd:element name="Email"  
minOccurs="0"/> </xsd:sequence> <xsd:attribute  
name="Name" use="required"/> <xsd:attribute  
name="Title"/> </xsd:complexType> </xsd:schema>
```

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Complex Type derivation: esempio

```
<xsd:complexType name='ExtendedContactType'>  
  <xsd:complexContent>  
    <xsd:extension  
      base='ContactType'>  
      <xsd:sequence>  
        <xsd:element  
          name='Fax' />  
      </xsd:sequence>  
      <xsd:attribute  
        name='Department' />  
      </xsd:extension>  
    </xsd:complexContent>  
  </xsd:complexType>
```

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Complex Type: deriving

You can derive new complex types from a mixed content complex type by restriction or by extension. Derivation of complex types with mixed content is very similar to the derivation of element-only types.

Complex Type: deriving

when deriving by restriction from a mixed type, you can derive a mixed type, element-only type or empty content type. The rules of derivation are similar to the rules of element-only content model: Elements declared in the parent type do not pass down to the derived type.

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Complex Type derivation: esempio

```
<xsd:complexType name="RestrictedNoteType"
mixed='true'> <xsd:complexContent>
<xsd:restriction base='NoteType'> <xsd:sequence>
<xsd:element name="name"/> </xsd:sequence>
</xsd:restriction> </xsd:complexContent>
</xsd:complexType>
```

by simply removing the "mixed" attribute from the complex type declaration you derive an element-only complex type from mixed content.

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Complex Type: deriving - Mixed Content

When deriving from a mixed type by restriction, we could create an empty content type if all the elements in the base type are optional. By keeping the restriction element empty we could eliminate all the elements declared in the base type (if those elements are declared optional in the base type). To eliminate attributes, you need to declare them in the derived type with prohibited attribute.

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Complex Type derivation: esempio

```
<xsd:complexType name='SimpleNoteType'>  
  <xsd:simpleContent> <xsd:restriction  
base='NoteType'> <xsd:simpleType>  
  <xsd:restriction base="xsd:string"/>  
  </xsd:simpleType> </xsd:restriction>  
  </xsd:simpleContent> </xsd:complexType>
```

the XSD specification allows deriving a simple content from a mixed-content type

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Complex Type derivation: esempio

```
<xsd:complexType name='NoteType'  
mixed='true'> <xsd:sequence> <xsd:element  
name="name"/> <xsd:element name="mobile"/>  
</xsd:sequence> </xsd:complexType>
```

when deriving by extension, we could create only a mixed content complex type

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Complex Type derivation: esempio

```
<xsd:element name="InvoiceNote"  
type="ExtendedNoteType"/>
```

```
<xsd:complexType name='ExtendedNoteType'  
mixed='true'> <xsd:complexContent>  
<xsd:extension base='NoteType'> <xsd:sequence>  
<xsd:element name='email' /> </xsd:sequence>  
</xsd:extension> </xsd:complexContent>  
</xsd:complexType>
```

when deriving by extension, we could create only a mixed content complex type

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Complex Type derivation: esempio

```
<InvoiceNote> Call <name>Steve</name> on  
<mobile>999 999 9999</mobile> or  
<email>steve@somedomain.com</email> before  
shipping the order. </InvoiceNote>
```

when deriving by extension, we could create only a mixed content complex type

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Complex Type extension

Derive a new type from an empty content element by restriction or by extension

Complex Type extension

Since an empty content complex type can have only attributes, the only purpose of deriving from an empty content type by restriction is to eliminate attributes or add additional validations to the attributes.

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Complex Type extension

when you derive by extension you can create an empty type, mixed type or element only content type.

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Complex Type derivation: esempio

```
<xsd:complexType name='EmptyPhoneType'>  
<xsd:complexContent> <xsd:extension  
base='PhoneType'> <xsd:sequence> <xsd:element  
name='Mobile' /> </xsd:sequence> </xsd:extension>  
</xsd:complexContent> </xsd:complexType>
```

we can derive an element only content type from an empty content type by extension

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Complex Type derivation: esempio

```
<xsd:complexType name='EmptyPhoneType'  
mixed='true'> <xsd:complexContent>  
<xsd:extension base='PhoneType'> <xsd:sequence>  
<xsd:element name="Mobile"/> </xsd:sequence>  
</xsd:extension> </xsd:complexContent>  
</xsd:complexType>
```

It is also possible to derive a mixed content type from an empty content type.

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Complex Type derivation: esempio

```
<Phone Home='888-888-8888'  
Work='777-777-7777'> If not available at home or  
work, call me on my <Mobile>666-666-6666</Mobile>.  
</Phone>
```

It is also possible to derive a mixed content type from an empty content type.

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Derivazione: riepilogando

Base Content Type	Derived Content Type							
	Simple		Element Only		Mixed		Empty	
	Rest	Ext	Rest	Ext	Rest	Ext	Rest	Ext
Simple	Yes	Yes						
Element Only			Yes	Yes			Yes	
Mixed			Yes		Yes	Yes	Yes	
Empty				Yes		Yes	Yes	Yes

New complex types can be created from complex types by extension and restriction.

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Complex Type derivation: final attribute

The derivation of a complex type can be controlled by using the final attribute of Complex Type Declaration.

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Complex Type derivation: final attribute

taking one of the following three values:

- restriction: prevent derivation by restriction
- extension: derivation by extension
- #all: prevent type derivation by restriction or by extension

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Complex Type derivation: esempio

```
<xsd:complexType name='ContactType'  
  final='extension restriction'> <xsd:sequence>  
  <xsd:element name="Phone" minOccurs="0"/>  
  </xsd:sequence> <xsd:attribute name="Name" />  
</xsd:complexType>
```

how to control the derivation of a given complex type:

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Complex Type derivation: esempio

```
<xsd:complexType name='ExtendedContactType'>  
<xsd:complexContent> <xsd:extension  
base="ContactType"/> </xsd:complexContent>  
</xsd:complexType>
```

how to control the derivation of a given complex type:

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