# COMP60411
# Modelling Data on the Web

## XPath, XML Schema, and XQuery

## Week 3

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# Week 1 coursework

- All graded!
  - Q1, SE1, M1
- In general,
  - Pay attention to the feedback
    - check the **rubrics**
    - Try to **regenerate**
    - Try on other people's
  - If you don't understand
    - Come talk to us!
    - We're happy to explain further
  - Remember, you'll get essays (and MCQs) on the exam
    - Practice and learn now!
    - It will help!

# SE1 General Feedback

- Check the personalised feedback given via BB
- Use a **good spell checker**, and check grammar
- No need to repeat the question or to explain terms introduced or discussed in the lecture, e.g., “conceptual model”
- Structure your essay: either
  - point out ways in which a CM can be useful, make each of these points as clear as possible, e.g., with an example; think whether this is ‘universally true’ or only in certain situations
  - explain why a designing a CM is a waste of time.
- You could have made your statement in 150 words
  - We would appreciate that
- Long conclusions are unnecessary
  - (At most, 1 sentence for summary suffices)
  - (And if you stick to 150 words, that shouldn’t be needed)

# M1 & CW1 General Feedback

- Read the specification
  - carefully
  - ask if you’re unsure
  - ask if something is unclear
  - don’t assume
- Work on basic, spec-conform solution first
  - then extend functionality

# Last Week

We have encountered many things:

**Tree data models:**

1. Data Structure formalisms: XML (including name spaces)
2. Schema Language: RelaxNG
3. Data Manipulation: DOM (and Java)

**General concepts:**

- Semi-structured data
- Self-Describing
- Trees
- Regular Expressions
- Internal & External Representation, Parsing
- Validation, valid, …
- Format

Any Questions?

# This Week

- Two new interaction mechanisms:
  - XPath
  - XQuery, extends XPath
- Your second schema language:
  - XML Schema, also known as XSD or WXS
- XSD and XQuery:
  - PSVI and typed queries
- More on Namespaces:
  - Extensibility!

# XPath

# XML documents...

There are various standards, tools, APIs, data models for XML:

- to **describe** XML documents & **validate** XML document against:
  - we have seen: RelaxNG
  - today: XML Schema
- to parse & **manipulate** XML documents programmatically:
  - we have seen & worked with: DOM (there's also SAX, etc.)
  - today, we will learn about **XPath** and **XQuery**
- transform an XML document into another XML document or into an instance of another formats, e.g., html, excel, relational tables
  - ….another form of **manipulation**

# Manipulation of XML documents

- **XPath** for navigating through and querying of XML documents

- **XQuery**
  - more expressive than XPath, uses XPath
  - for querying and data manipulation
  - Turing complete
  - designed to access large amounts of data,
    to interface with relational systems
- **XSLT**
  - similar to XQuery in that it uses XPath, ....
  - designed for "styling", together with XSL-FO or CSS

- contrast this with **DOM** and **SAX**:
  - a collection of APIs for programmatic manipulation
  - includes data model and parser
  - to build your own applications

# XPath

- designed to navigate to/select parts in a **well-formed** XML document
- no transformational capabilities (as in XQuery and XSLT)
- is a W3C standard:
  - XPath 1.0 is a 1999 W3C standard
  - **XPath 2.0** is a 2007 W3C standard **that extends/is a superset of XPath 1.0**
    - richer set of WXS types & schema sensitive queries
  - XPath 3.0 is a 2014 W3C standard
- allows to select/define *parts* of an XML document: **sequence of nodes**
- uses **path expressions**
  - to navigate in XML documents
  - to select node-lists in an XML document
  - similar to expressions in a traditional computer file system
- provides numerous built-in functions
  - e.g., for string values, numeric values, date and time comparison, node and QName manipulation, sequence manipulation, Boolean values, etc.
- Contrast with SQL!

XML Schema
later more

sequence
vs set?

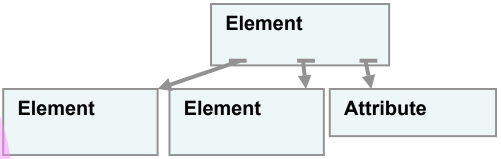
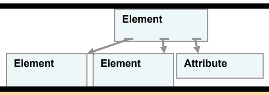
```
rm */*/*.pdf
```

# XPath: Datamodel

- remember how an XML document can be seen as a node-labelled tree
  - with element names as labels: *its DOM tree*

- XPath operates on the abstract, logical tree structure of an XML document, rather than its surface, text syntax
  - *but not on its DOM tree*!

- XPath uses **XQuery/XPath Datamodel**
  - there is a translation at http://www.w3.org/TR/xpath20/#datamodel
    - see XPath process model…
  - it is similar to the DOM tree
    - easier

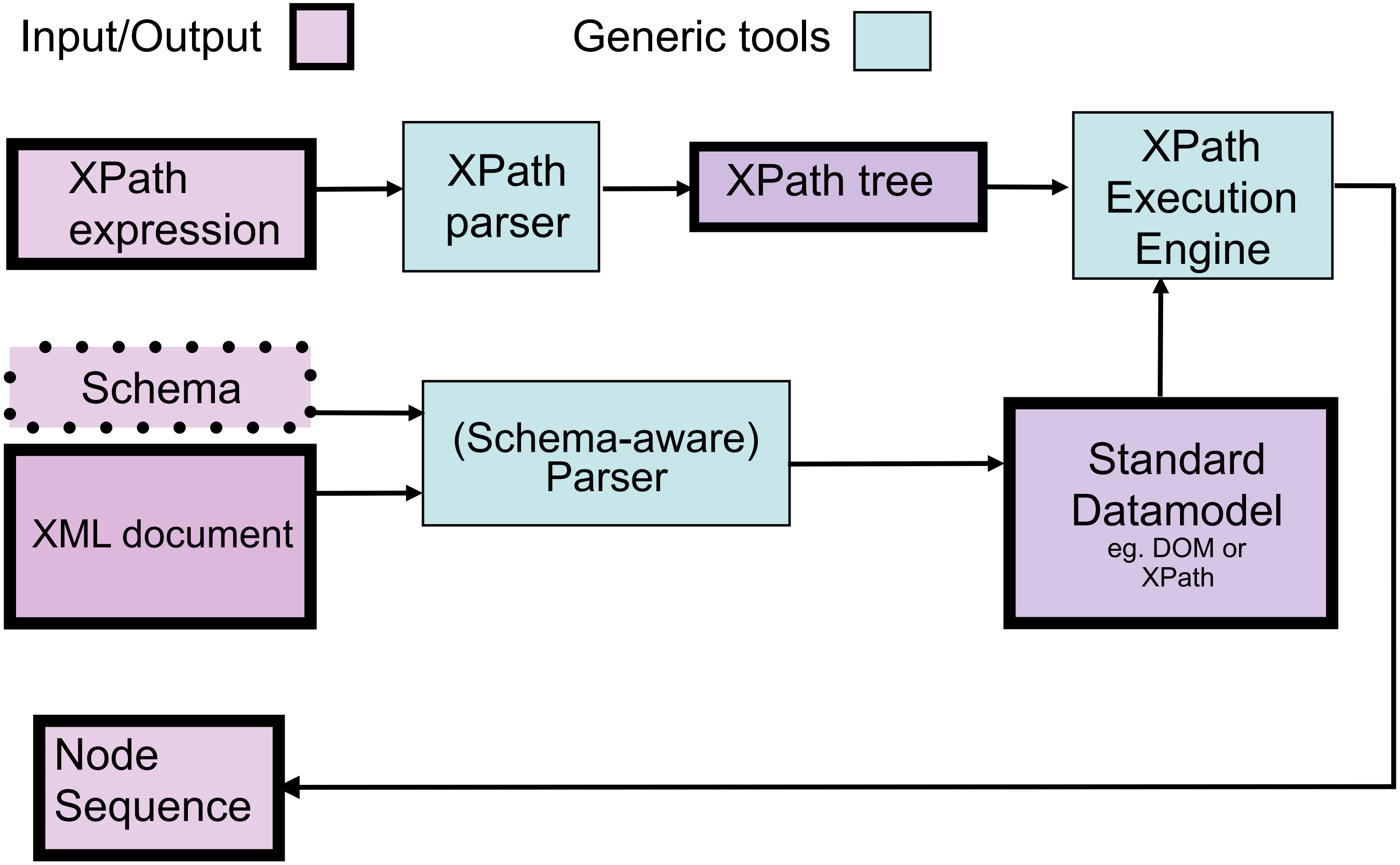
| Level | | Data unit examples | Information or Property required |
|---|---|---|---|
| cognitive | | | |
| application | | | |
| tree adorned with... | |  | |
| namespace ⋮ schema | | | nothing ⋮ a schema |
| tree | |  | well-formedness |
| token | complex | <foo:Name t=”8”>Bob | |
| | simple | <foo:Name t=”8”>Bob | |
| character | | < foo:Name t=”8”>Bob | which encoding (e.g., UTF-8) |
| bit | | 10011010 | |

choice:
DOM tree
Infoset
XPath
....

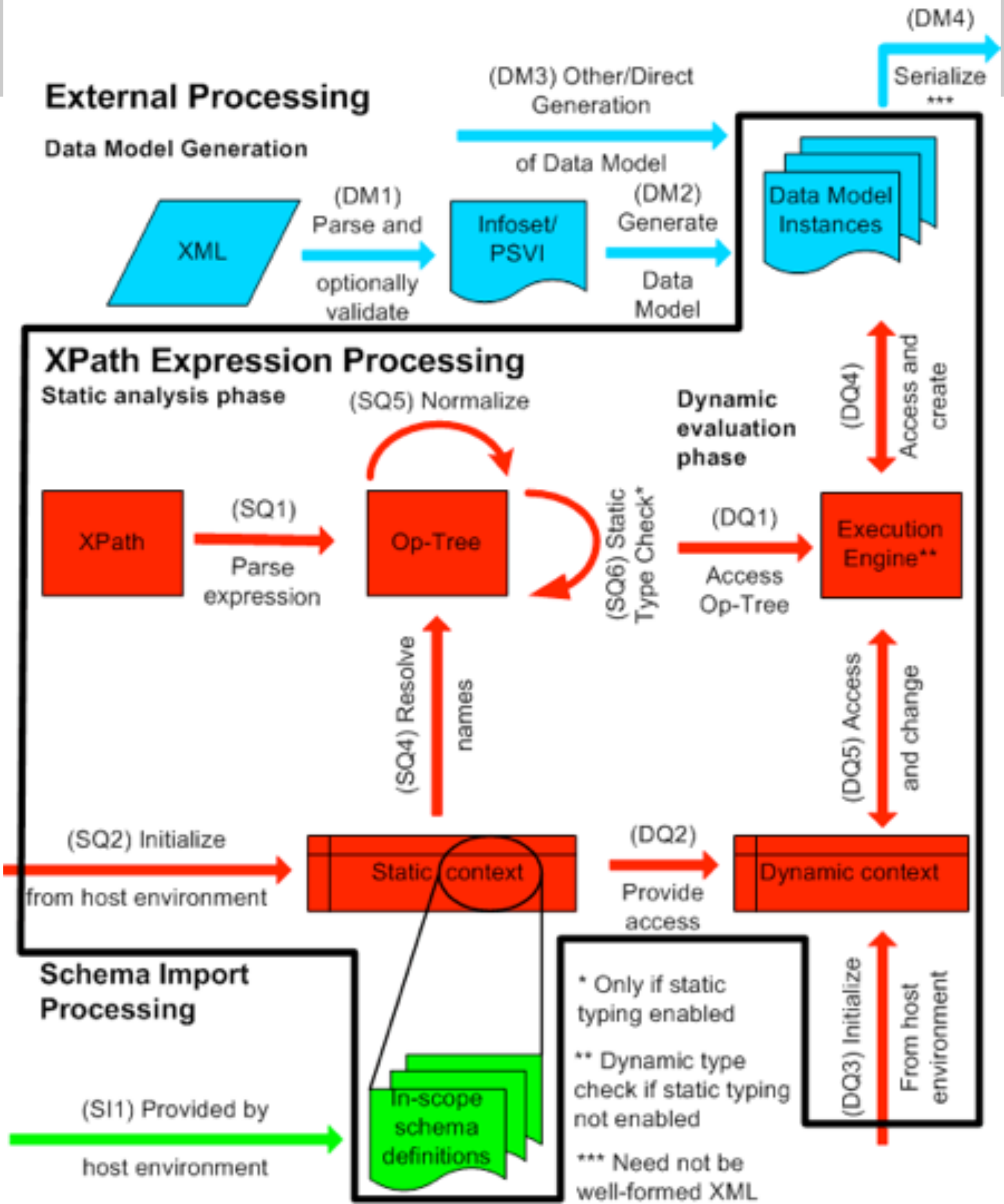
parsing

serializing

# XPath processing - a simplified view



# XPath processing - a more detailed view



External Processing

Data Model Generation

XML

(DM1) Parse and optionally validate

Infoset/ PSVI

(DM2) Generate Data Model

(DM3) Other/Direct Generation of Data Model

Data Model Instances

(DM4) Serialize ***

XPath Expression Processing

Static analysis phase

XPath

(SQ1) Parse expression

Op-Tree

(SQ5) Normalize

(SQ6) Static Type Check*

(SQ4) Resolve names

(SQ2) Initialize from host environment

Static context

Dynamic evaluation phase

(DQ1) Access Op-Tree

Execution Engine**

(DQ4) Access and create

(DQ5) Access and change

(DQ2) Provide access

Dynamic context

(DQ3) Initialize From host environment

Schema Import Processing

(SI1) Provided by host environment

In-scope schema definitions

* Only if static typing enabled

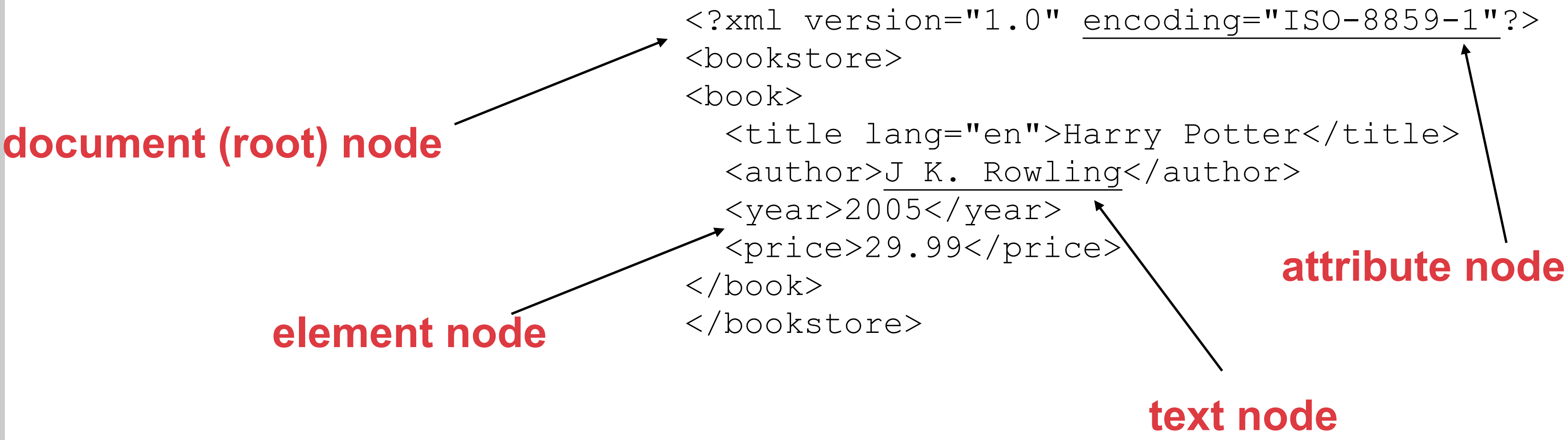
** Dynamic type check if static typing not enabled

*** Need not be well-formed XML

# XPath: Datamodel

- the XPath DM uses the following concepts
- **nodes**:
  - element
  - attribute
  - text
  - namespace
  - processing-instruction
  - comment
  - document (root)

- **atomic value**:
  - behave like nodes without children or parents
  - is an atomic value, e.g., xsd:string
- **item**: atomic values or nodes



```
<?xml version="1.0" encoding="ISO-8859-1"?>
<bookstore>
<book>
  <title lang="en">Harry Potter</title>
  <author>J K. Rowling</author>
  <year>2005</year>
  <price>29.99</price>
</book>
</bookstore>
```

**document (root) node**

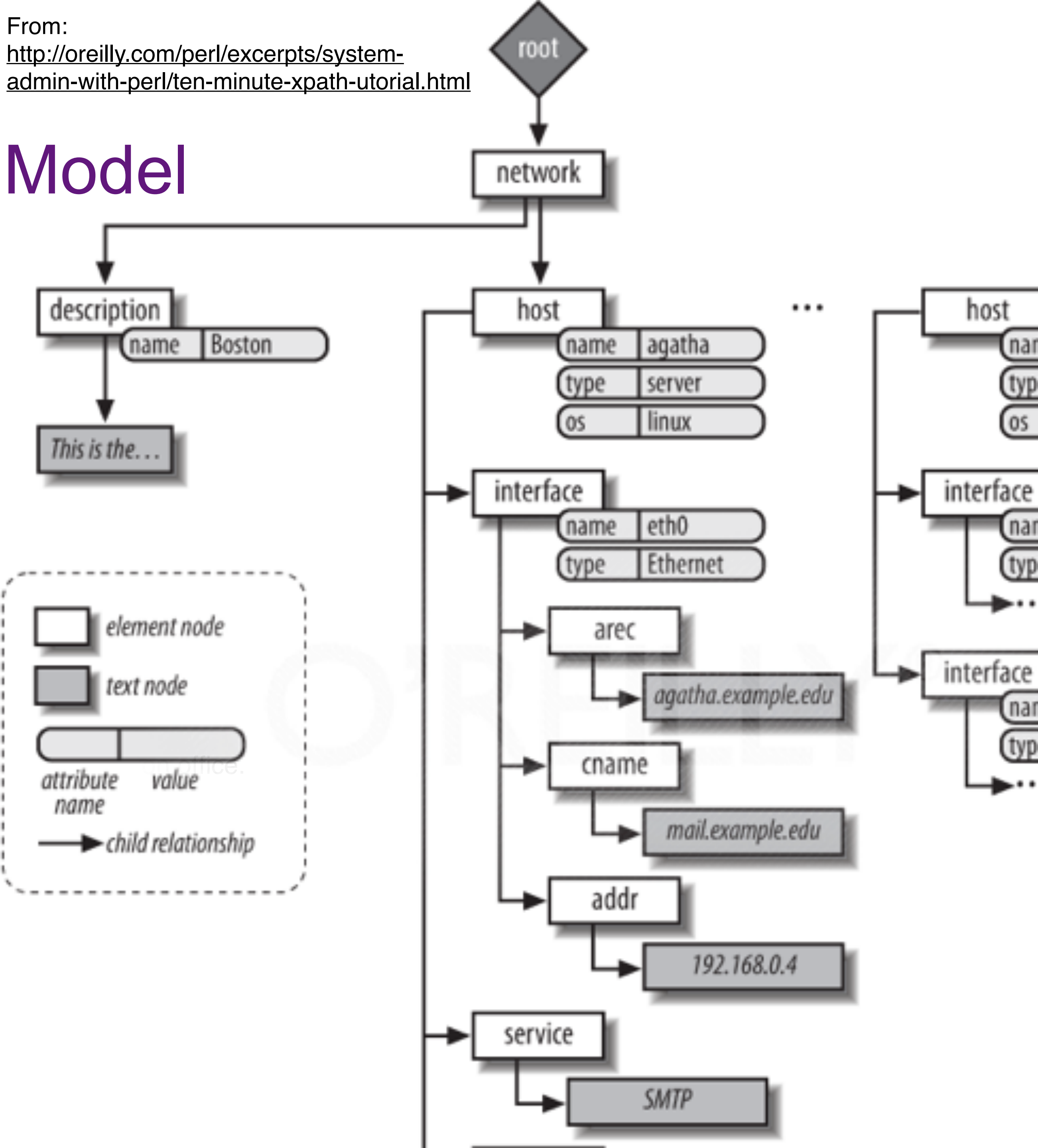
**element node**

**attribute node**

**text node**

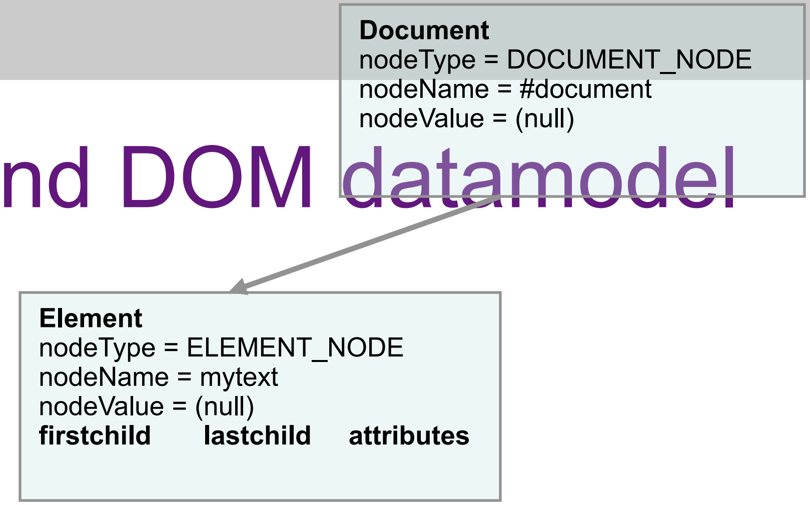
From:
http://oreilly.com/perl/excerpts/system-admin-with-perl/ten-minute-xpath-utorial.html

# XPath Data Model



```
<?xml version="1.0" encoding="UTF-8"?>
<network>
   <description name="Boston">
      This is the configuration of our networ
   </description>
   <host name="agatha" type="server" os=
      <interface name="eth0" type="Etherne
         <arec>agatha.example.edu</arec>
         <cname>mail.example.edu</cname
         <addr>192.168.0.4</addr>
      </interface>
      <service>SMTP</service>
      <service>POP3</service>
      <service>IMAP4</service>
   </host>
   <host name="gil" type="server" os="linu
```

# Comparison XPath DM and DOM datamodel



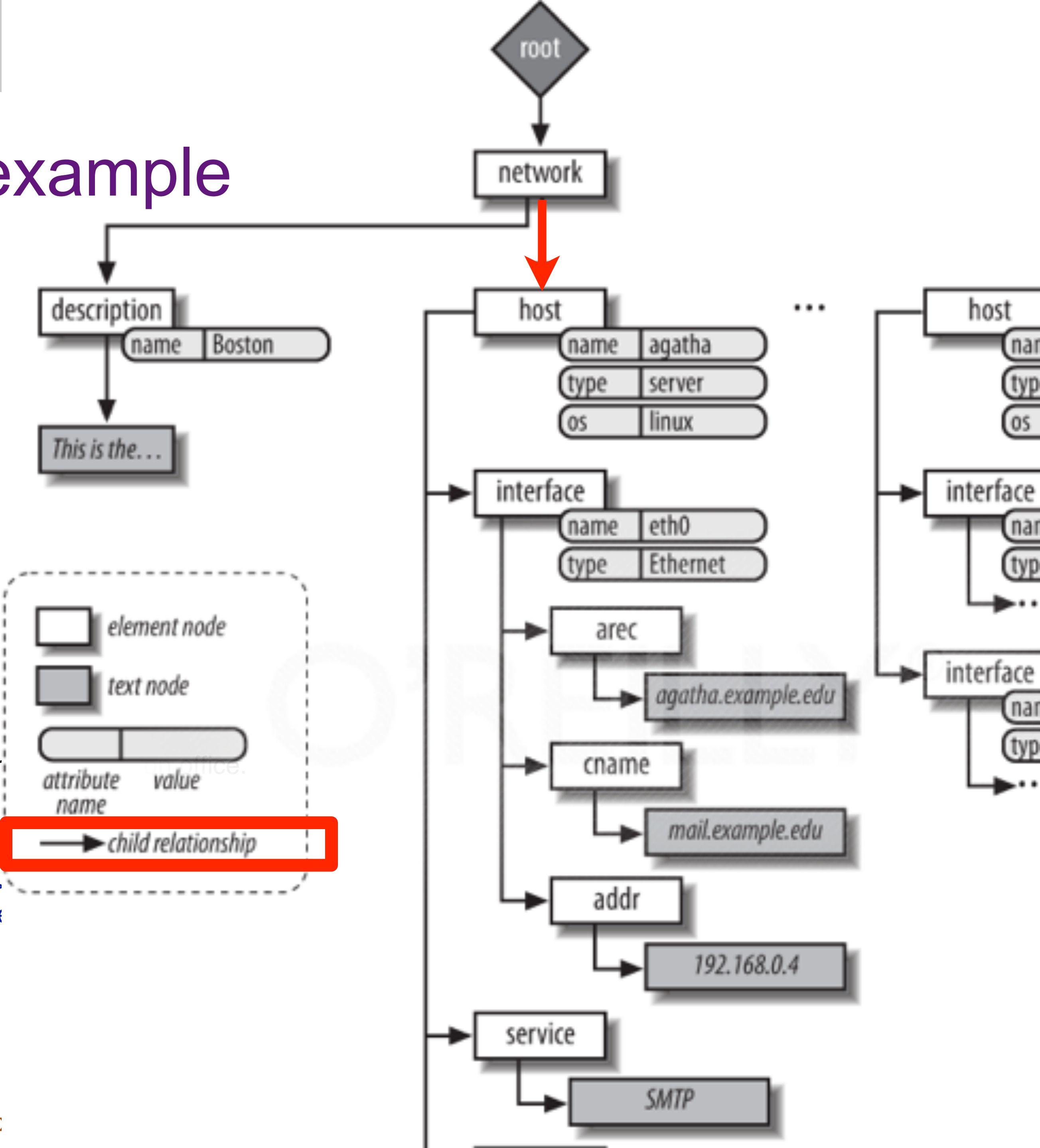
- XPath DM and DOM DM are similar, but different
  - most importantly regarding names and values of nodes but also structurally (see ★)
  - in XPath, only attributes, elements, processing instructions, and namespace nodes have names, of form (local part, namespace URI)
  - whereas DOM uses pseudo-names like #document, #comment, #text
  - In XPath, the **value** of an element or root node is the concatenation of the values of all its text node *descendants*, not null as it is in DOM:
    - e.g, XPath value of <a>A<b>B</b></a> is “AB”
  - ★ XPath does not have separate nodes for CDATA sections (they are merged with their surrounding text)
  - XPath has no representation of the DTD
    - or any schema

```
<N>here is some text and
<![CDATA[some CDATA < >]]>
</N>
```

# XPath: core terms — relation between nodes

- We know **trees** already:
  - each node has at most one **parent**
    - each node but the root node has exactly one parent
    - the root node has no parent
  - each node has zero or more **children**
  - **ancestor** is the transitive closure of parent,
    i.e., a node's parent, its parent, its parent, ...
  - **descendant** is the transitive closure of child,
    i.e., a node's children, their children, their children, ...
- when evaluating an XPath expression *p*, we assume that we know
  - which document and
  - which **context** we are evaluating *p* over
  - … we see later how they are chosen/given
- an XPath expression evaluates to a **node sequence**,
  - a **node** is a document/element/attribute node or an atomic value
  - **document order** is preserved among items

# XPath - by example

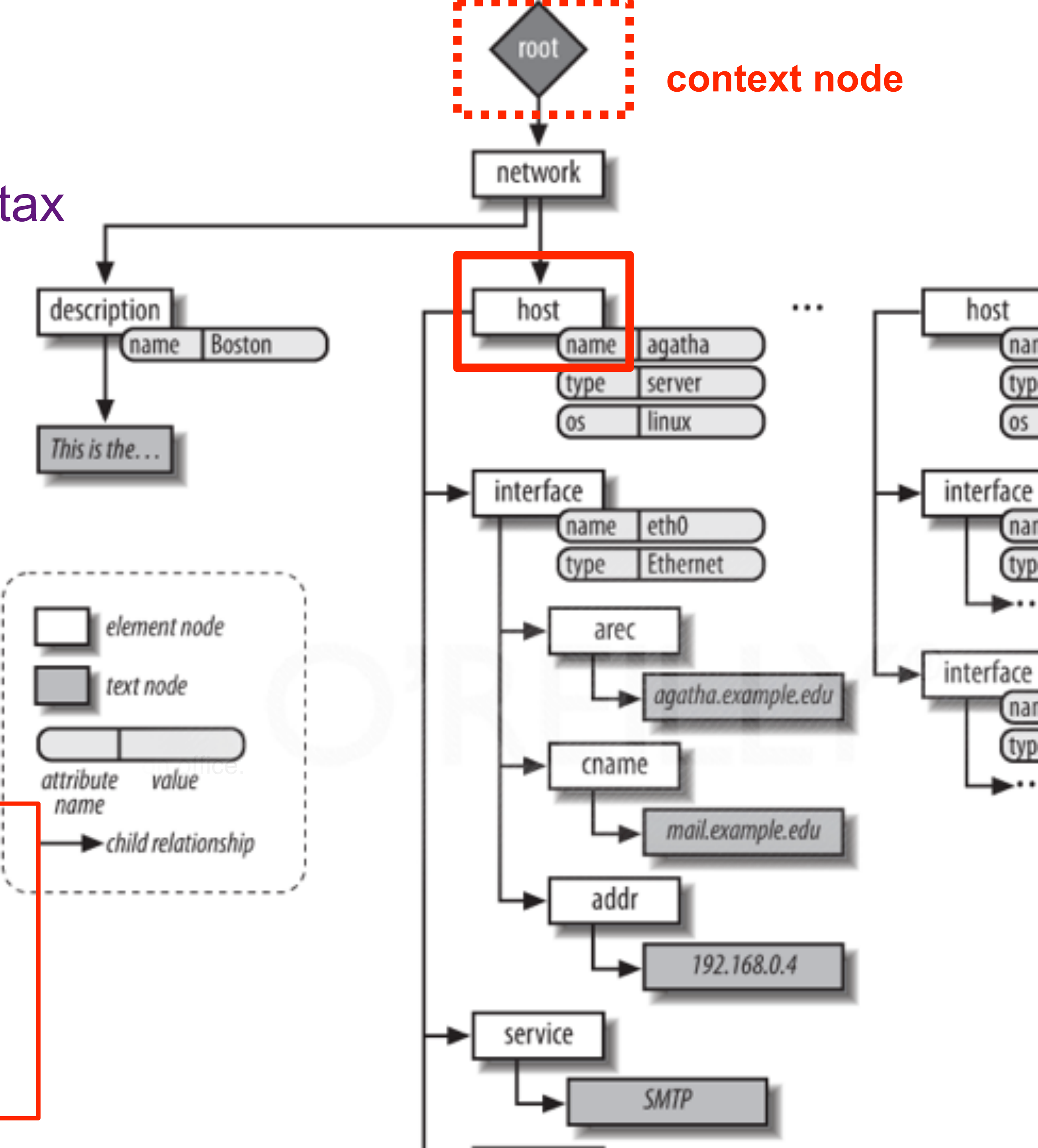


```
<?xml version="1.0" encoding="UTF-8"?>
<network>
  <description name="Boston">
    This is the configuration of our networ
  </description>
  <host name="agatha" type="server" os=
    <interface name="eth0" type="Ethern
      <arec>agatha.example.edu</arec>
      <cname>mail.example.edu</cname
      <addr>192.168.0.4</addr>
    </interface>
    <service>SMTP</service>
    <service>POP3</service>
    <service>IMAP4</service>
  </host>
  <host name="gil" type="server" os="linu
```

# XPath - abbreviated syntax by example

XPath expression:
*/*[2]

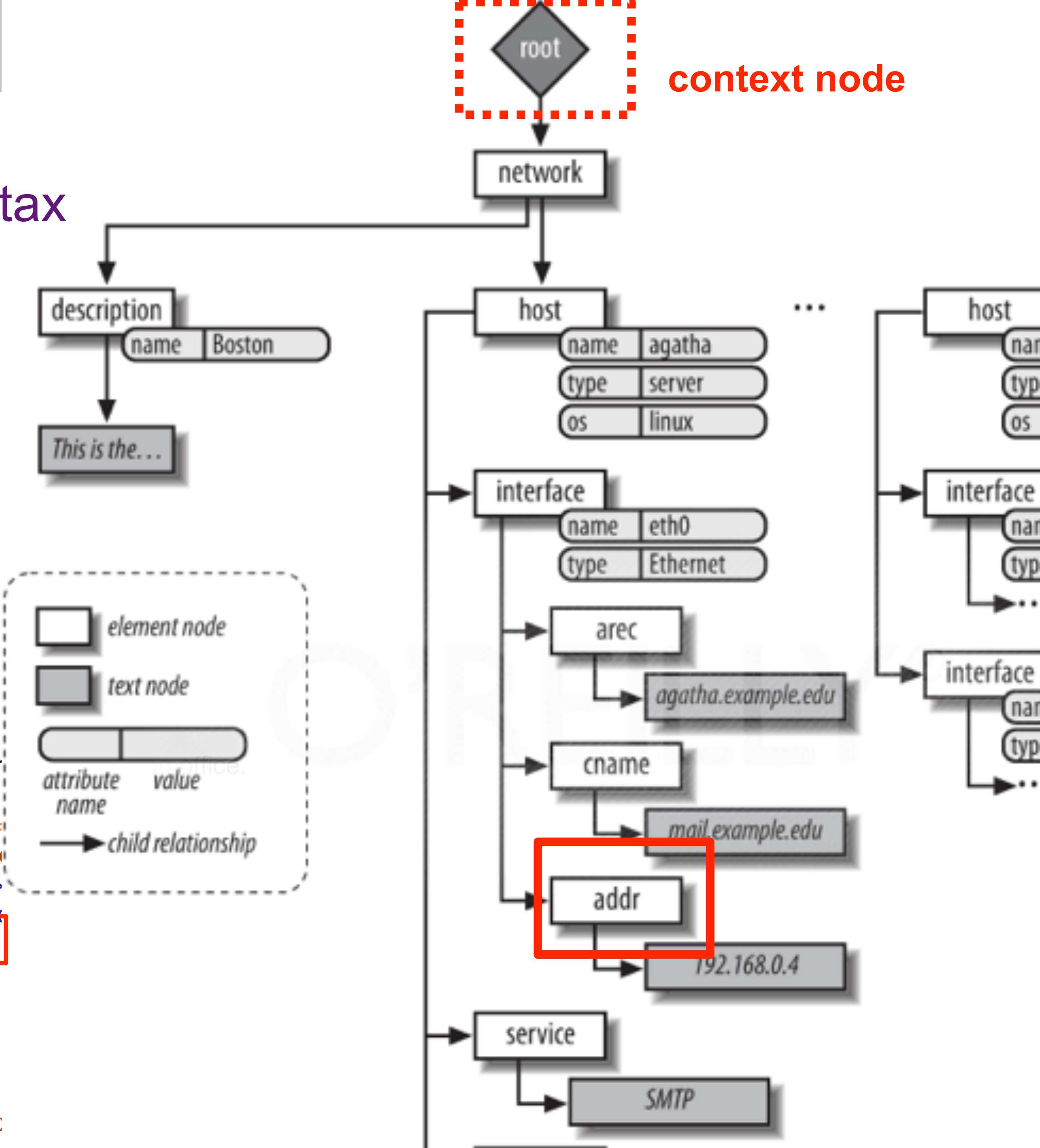
```
<?xml version="1.0" encoding="UTF-8"?>
<network>
   <description name="Boston">
      This is the configuration of our networ
   </description>
   <host name="agatha" type="server" os=
      <interface name="eth0" type="Etherne
         <arec>agatha.example.edu</arec>
         <cname>mail.example.edu</cname
         <addr>192.168.0.4</addr>
      </interface>
      <service>SMTP</service>
      <service>POP3</service>
      <service>IMAP4</service>
   </host>
   <host name="gil" type="server" os="linu
```



# XPath - abbreviated syntax by example

XPath expression:
*/*[2]/*[1]/*[3]

```
<?xml version="1.0" encoding="UTF-8"?>
<network>
   <description name="Boston">
      This is the configuration of our networ
   </description>
   <host name="agatha" type="server" os=
      <interface name="eth0" type="Etherne
         <arec>agatha.example.edu</arec>
         <cname>mail.example.edu</cname
         <addr>192.168.0.4</addr>
      </interface>
      <service>SMTP</service>
      <service>POP3</service>
      <service>IMAP4</service>
   </host>
   <host name="gil" type="server" os="linu
```

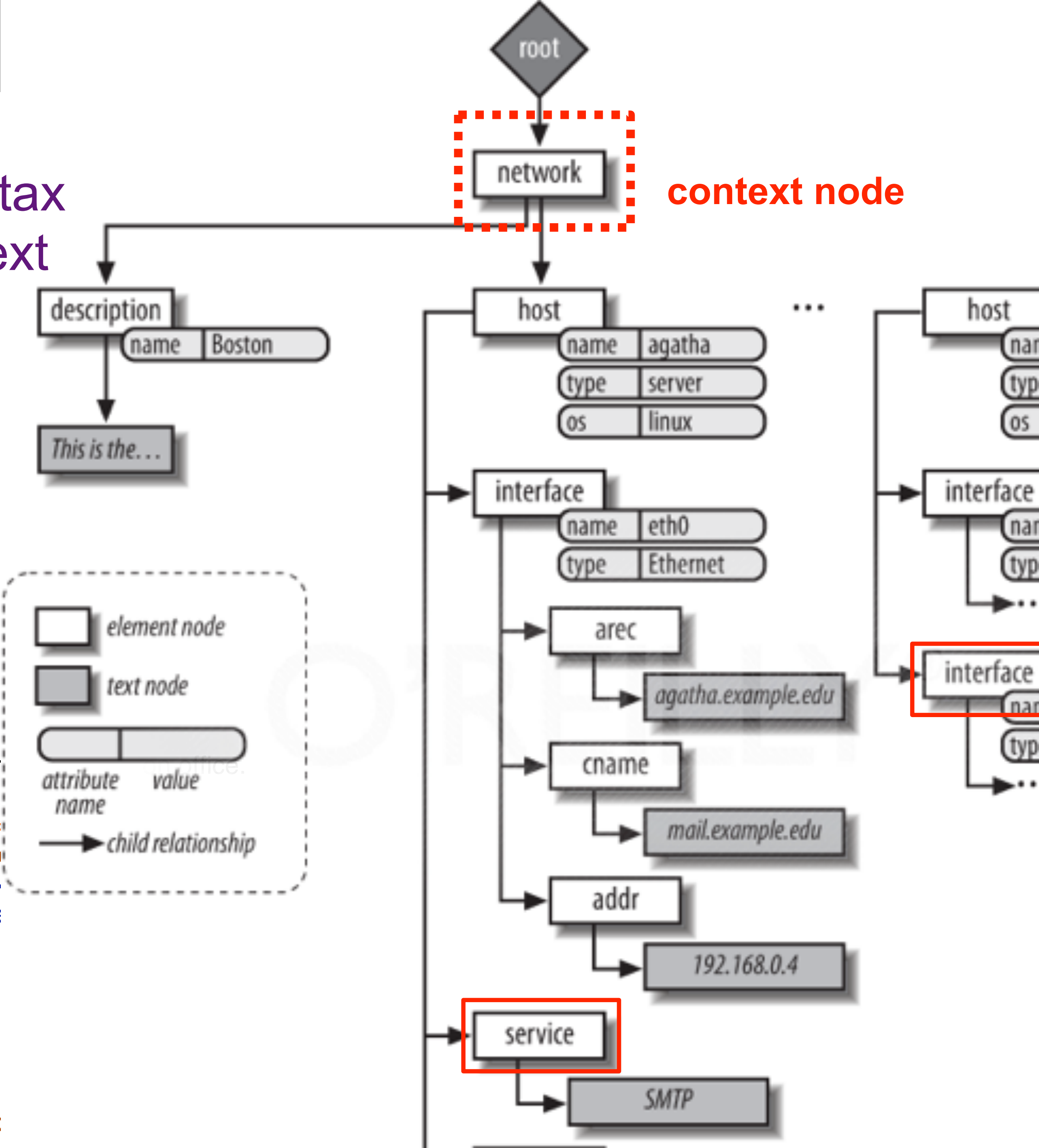


context node

# XPath - abbreviated syntax know your context node

XPath expression:
*/*[2]

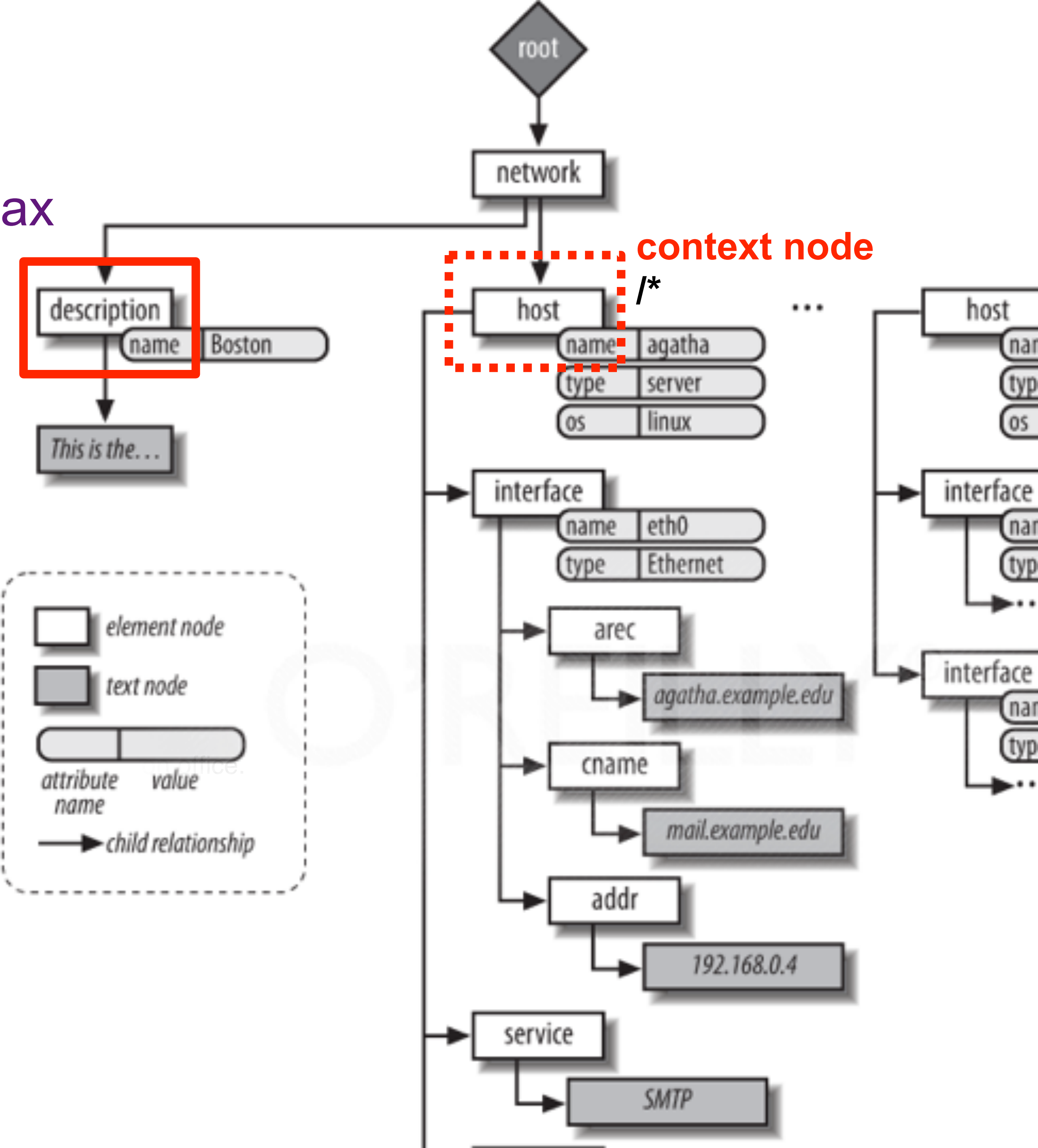
```
<?xml version="1.0" encoding="UTF-8"?>
<network>
   <description name="Boston">
      This is the configuration of our networ
   </description>
   <host name="agatha" type="server" os=
      <interface name="eth0" type="Ethern
         <arec>agatha.example.edu</arec>
         <cname>mail.example.edu</cname
         <addr>192.168.0.4</addr>
      </interface>
      <service>SMTP</service>
      <service>POP3</service>
      <service>IMAP4</service>
   </host>
   <host name="gil" type="server" os="linu
```



# XPath - abbreviated syntax absolute paths

XPath expression:
/*/*[1]

```
<?xml version="1.0" encoding="UTF-8"?>
<network>
  <description name="Boston">
    This is the configuration of our networ
  </description>
  <host name="agatha" type="server" os=
    <interface name="eth0" type="Ethern
      <arec>agatha.example.edu</arec>
      <cname>mail.example.edu</cname
      <addr>192.168.0.4</addr>
    </interface>
    <service>SMTP</service>
    <service>POP3</service>
    <service>IMAP4</service>
  </host>
  <host name="gil" type="server" os="linu
```

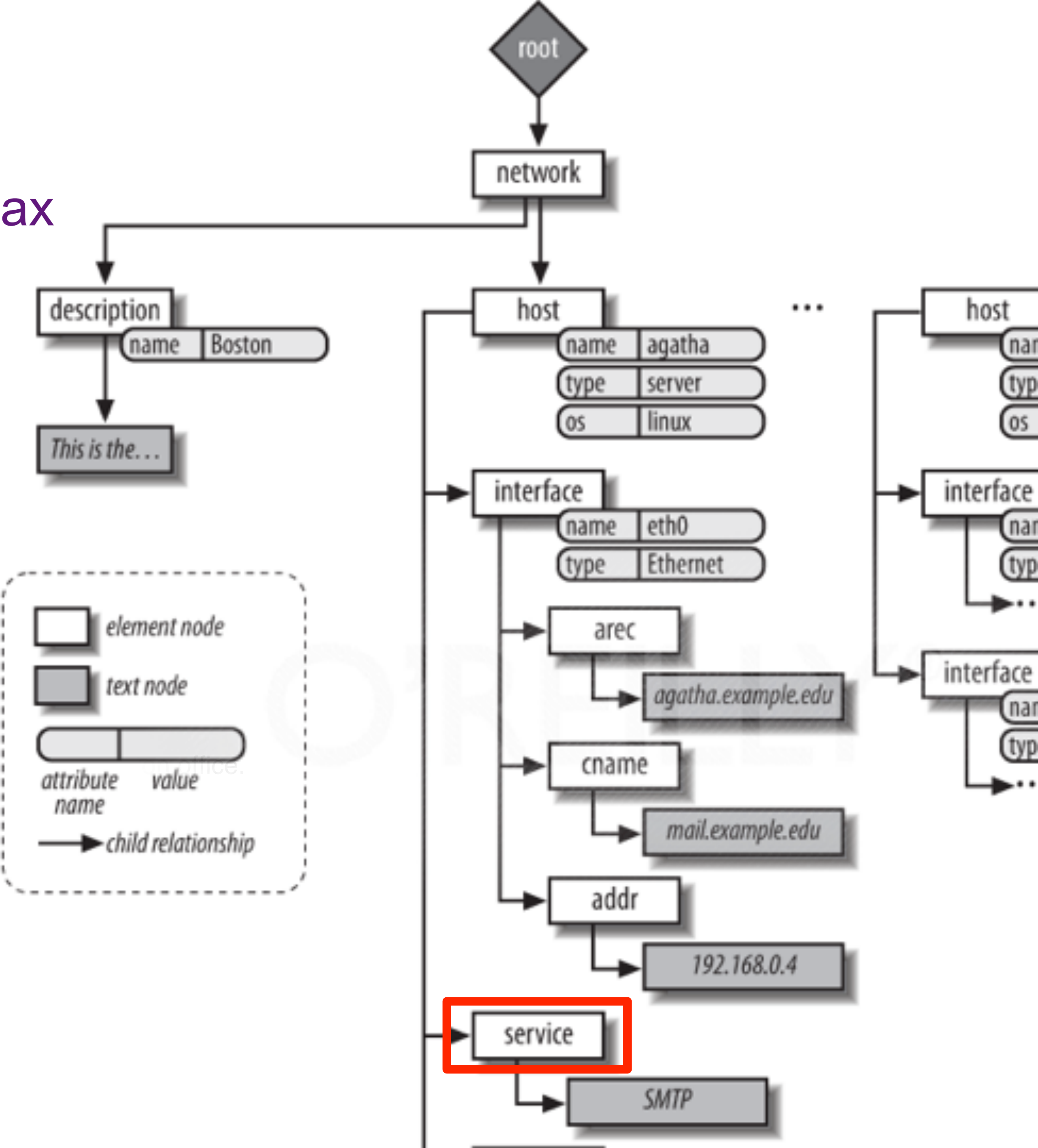


context node
/*

# XPath - abbreviated syntax local globally

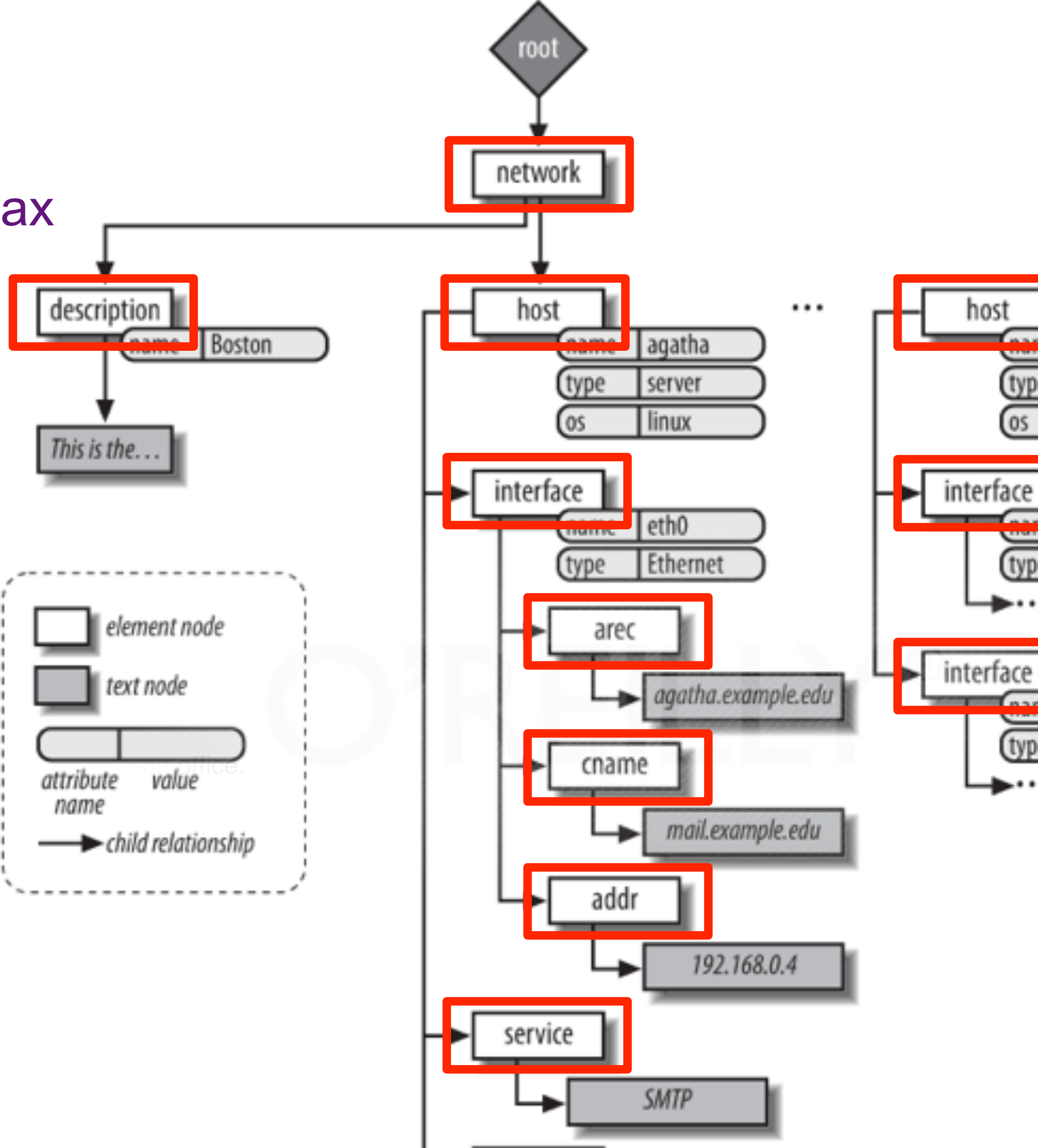
XPath expression:
//service

```
<?xml version="1.0" encoding="UTF-8"?>
<network>
   <description name="Boston">
      This is the configuration of our networ
   </description>
   <host name="agatha" type="server" os=
      <interface name="eth0" type="Etherne
         <arec>agatha.example.edu</arec>
         <cname>mail.example.edu</cname
         <addr>192.168.0.4</addr>
      </interface>
      <service>SMTP</service>
      <service>POP3</service>
      <service>IMAP4</service>
   </host>
   <host name="gil" type="server" os="linu
```



# XPath - abbreviated syntax local globally

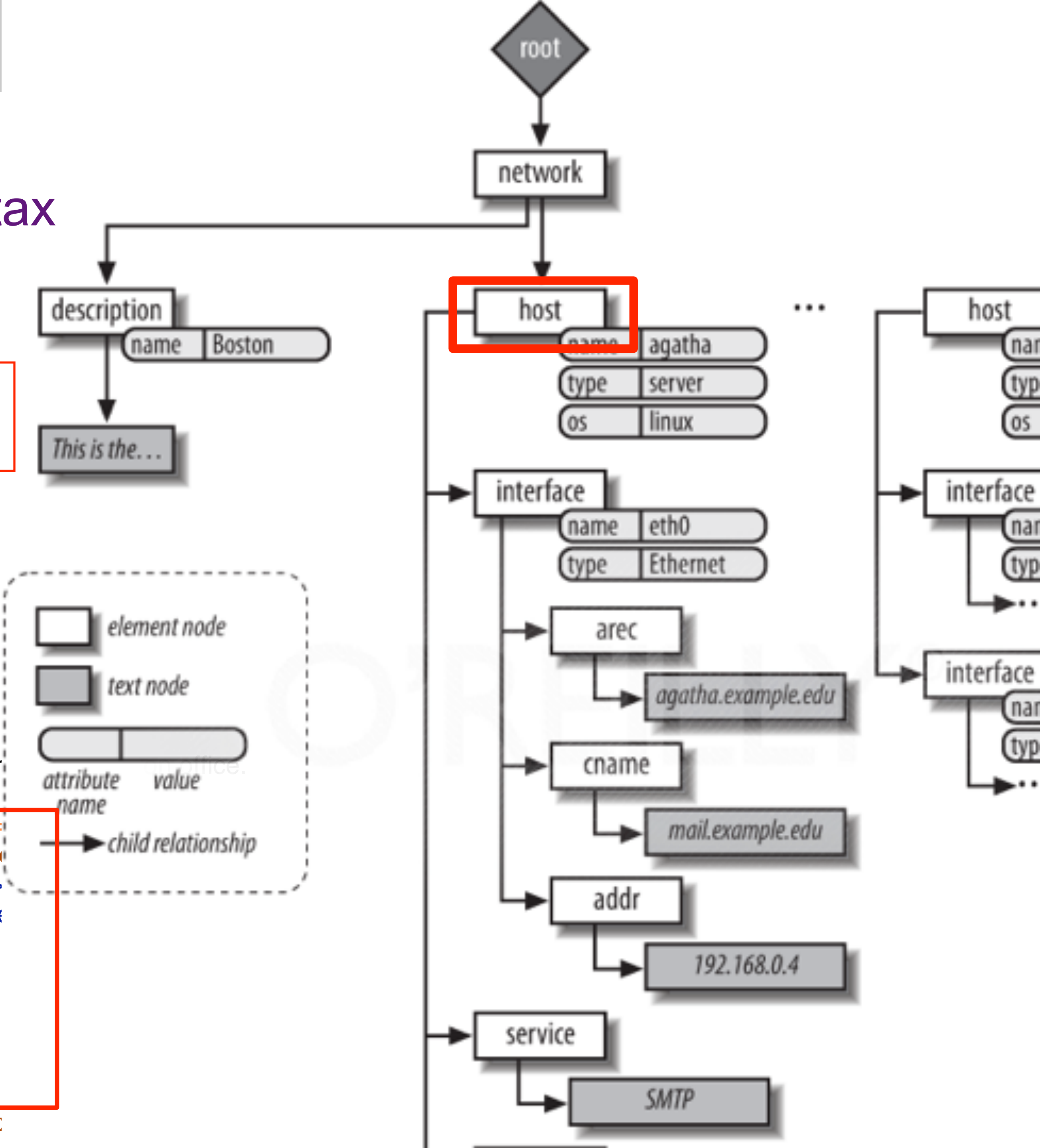
XPath expression:
//*



```
<?xml version="1.0" encoding="UTF-8"?>
<network>
   <description name="Boston">
      This is the configuration of our networ
   </description>
   <host name="agatha" type="server" os=
      <interface name="eth0" type="Ethern
         <arec>agatha.example.edu</arec>
         <cname>mail.example.edu</cname
         <addr>192.168.0.4</addr>
      </interface>
      <service>SMTP</service>
      <service>POP3</service>
      <service>IMAP4</service>
   </host>
   <host name="gil" type="server" os="linu
```

# XPath - abbreviated syntax attributes

XPath expression:
//*[@name=”agatha”]



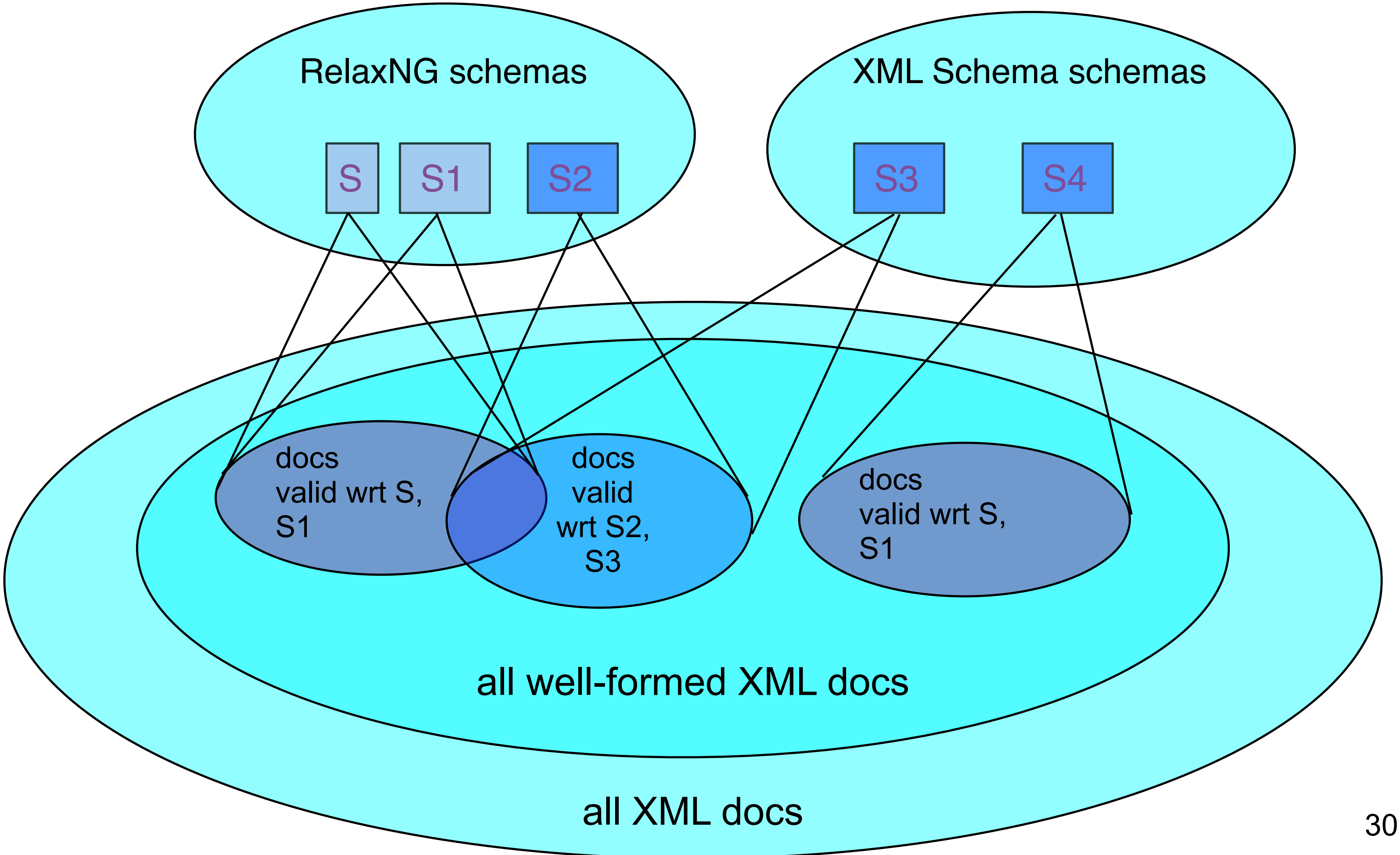
```
<?xml version="1.0" encoding="UTF-8"?>
<network>
   <description name="Boston">
      This is the configuration of our networ
   </description>
   <host name="agatha" type="server" os=
      <interface name="eth0" type="Ethern
         <arec>agatha.example.edu</arec>
         <cname>mail.example.edu</cname
         <addr>192.168.0.4</addr>
      </interface>
      <service>SMTP</service>
      <service>POP3</service>
      <service>IMAP4</service>
   </host>
   <host name="gil" type="server" os="linu
```

Find more about XPath:
read up and
play with examples,
e.g., in <oXygen/>®

# Contrast with SQL
# (Just with what you’ve seen!)

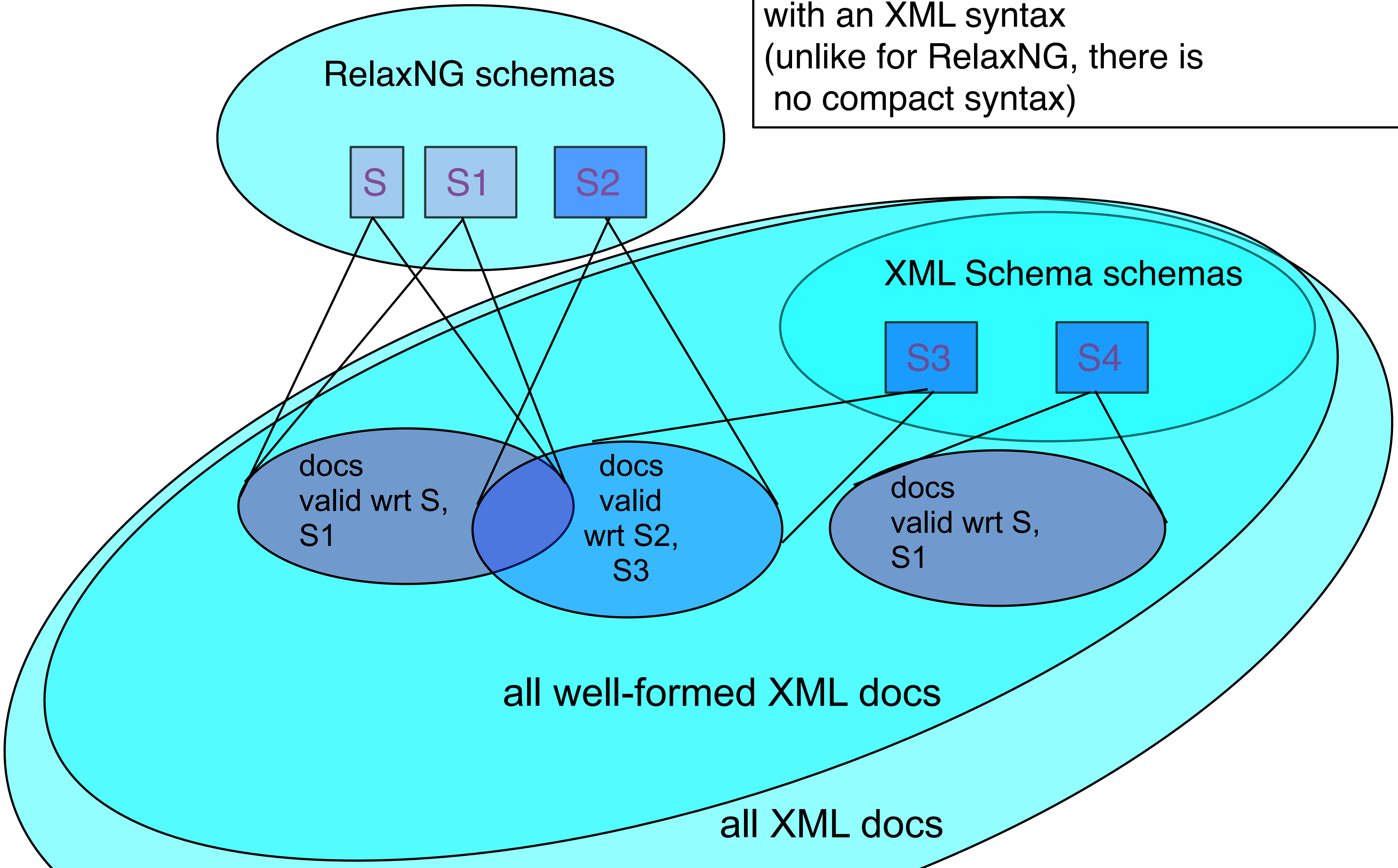
# XML Schema
# another schema language for XML

# There is more than 1 schema language



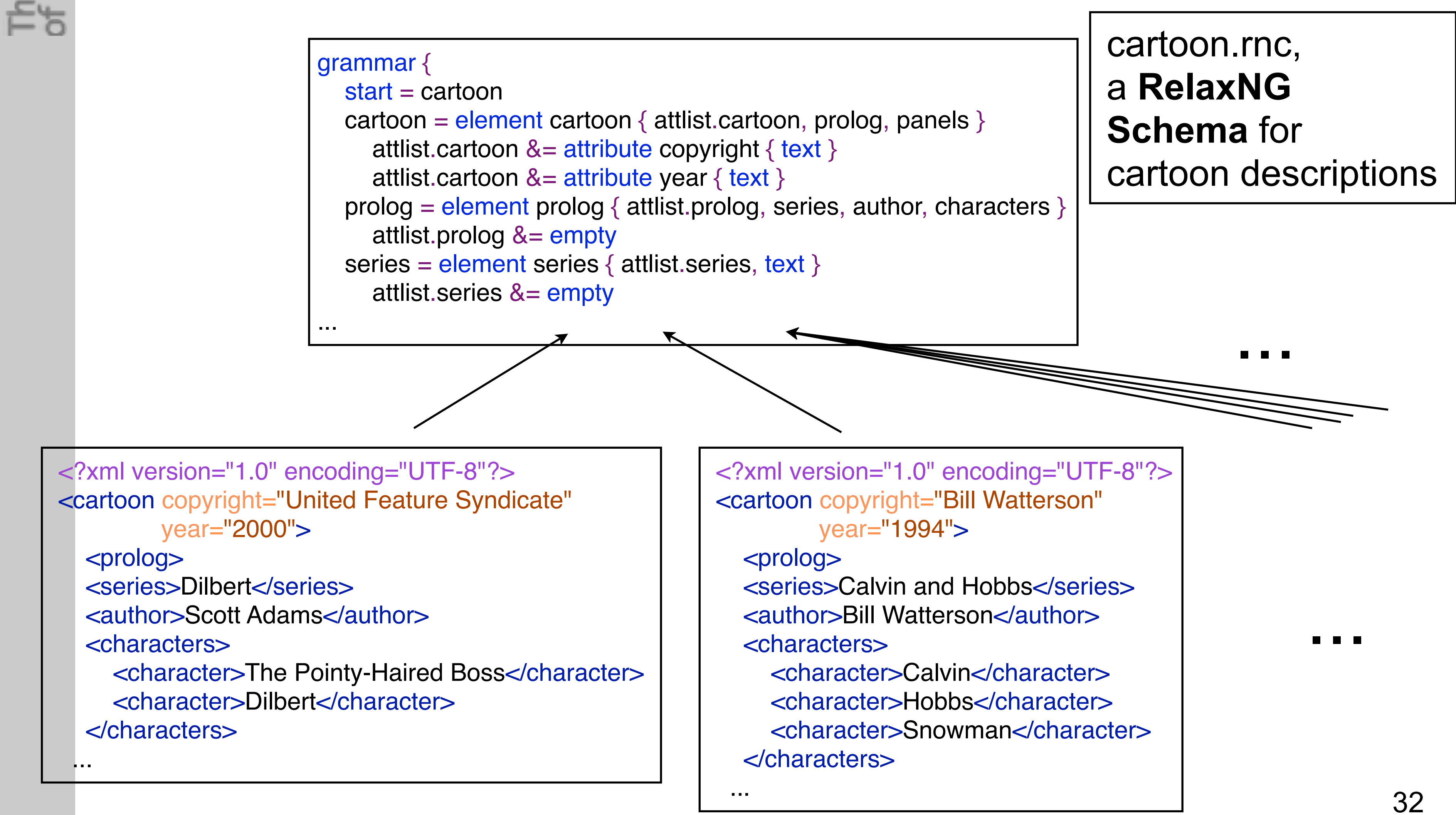
# A more correct picture:

**XML Schema** is an XML schema language with an XML syntax
(unlike for RelaxNG, there is
no compact syntax)



# Schema languages for XML

provide means to define the legal structure of an XML document



```
grammar {
   start = cartoon
   cartoon = element cartoon { attlist.cartoon, prolog, panels }
      attlist.cartoon &= attribute copyright { text }
      attlist.cartoon &= attribute year { text }
   prolog = element prolog { attlist.prolog, series, author, characters }
      attlist.prolog &= empty
   series = element series { attlist.series, text }
      attlist.series &= empty
...
```

cartoon.rnc,
a **RelaxNG Schema** for
cartoon descriptions

```
<?xml version="1.0" encoding="UTF-8"?>
<cartoon copyright="United Feature Syndicate"
         year="2000">
   <prolog>
   <series>Dilbert</series>
   <author>Scott Adams</author>
   <characters>
      <character>The Pointy-Haired Boss</character>
      <character>Dilbert</character>
   </characters>
 ...
```

```
<?xml version="1.0" encoding="UTF-8"?>
<cartoon copyright="Bill Watterson"
         year="1994">
   <prolog>
   <series>Calvin and Hobbs</series>
   <author>Bill Watterson</author>
   <characters>
      <character>Calvin</character>
      <character>Hobbs</character>
      <character>Snowman</character>
   </characters>
 ...
```

# Schema languages for XML

A variety of schema languages have been developed for XML; they vary w.r.t.

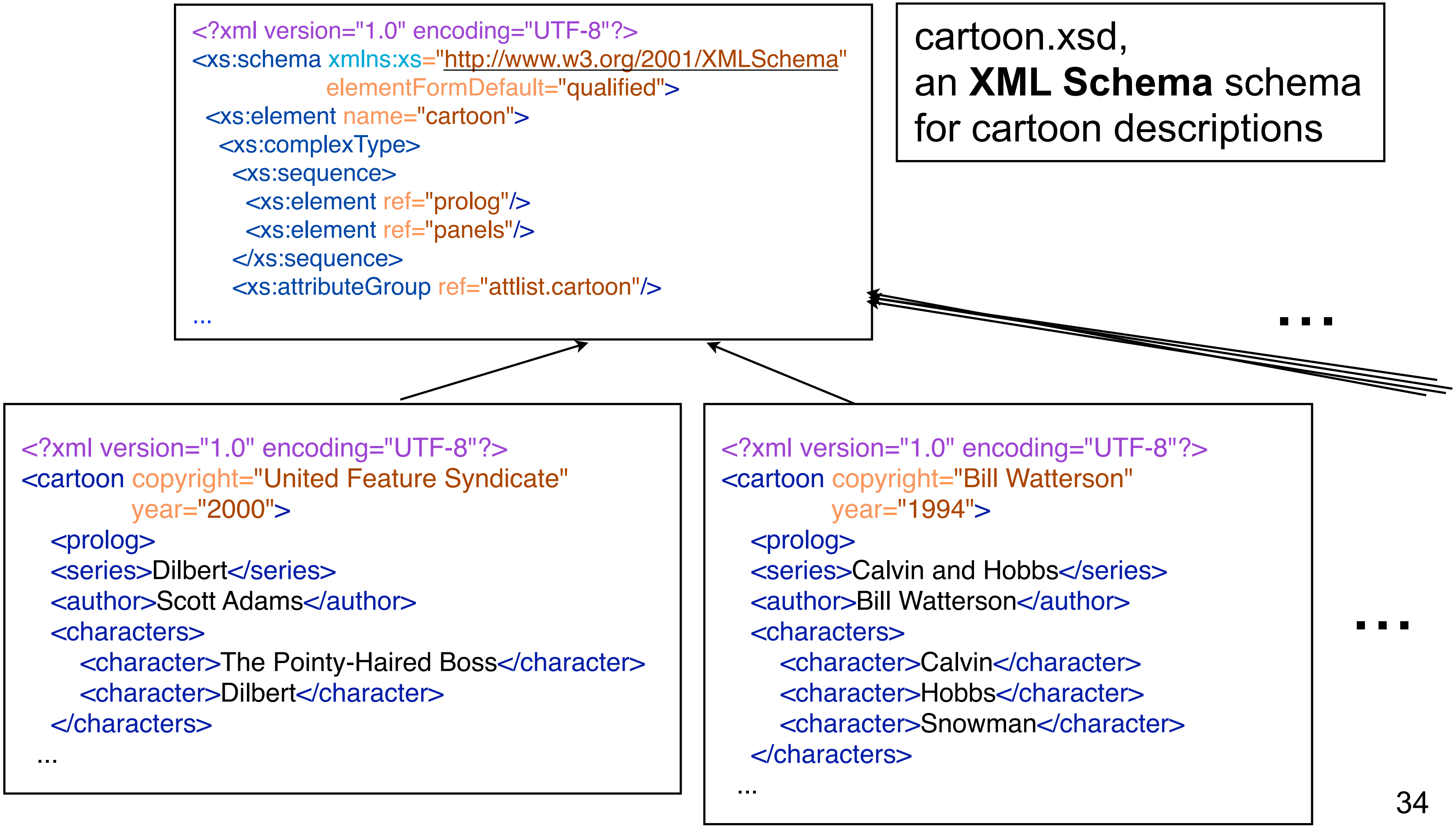
- their **expressive power**:
  - “do I have a means to express *foo*?”
  - “how hard is it to describe *foo?”*

- **ease of use/understanding**:
  - “how easy it is to *write* a schema?”
  - “how easy is it to *understand* a schema written by somebody else?”

- **the complexity of validating** a document w.r.t. a schema:
  - “how much space/time does it take to verify whether a document is valid w.r.t. a schema (in the size of document and schema)?”
  - (Mostly for implementors!)

# Schema languages for XML

provide means to define the legal structure of an XML document



```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
                elementFormDefault="qualified">
 <xs:element name="cartoon">
   <xs:complexType>
     <xs:sequence>
       <xs:element ref="prolog"/>
       <xs:element ref="panels"/>
     </xs:sequence>
     <xs:attributeGroup ref="attlist.cartoon"/>
...
```

cartoon.xsd,
an **XML Schema** schema
for cartoon descriptions

...

```
<?xml version="1.0" encoding="UTF-8"?>
<cartoon copyright="United Feature Syndicate"
             year="2000">
   <prolog>
   <series>Dilbert</series>
   <author>Scott Adams</author>
   <characters>
      <character>The Pointy-Haired Boss</character>
      <character>Dilbert</character>
   </characters>
 ...
```

```
<?xml version="1.0" encoding="UTF-8"?>
<cartoon copyright="Bill Watterson"
             year="1994">
   <prolog>
   <series>Calvin and Hobbs</series>
   <author>Bill Watterson</author>
   <characters>
      <character>Calvin</character>
      <character>Hobbs</character>
      <character>Snowman</character>
   </characters>
 ...
```

...

# XML Schema

- XML Schema is also referred to as XML Schema Definition, abbr. **XSD**
- is a W3C standard, see http://www.w3.org/XML/Schema

- a RNG in compact syntax (or DTD) is **not** a well-formed XML document
  - though you can use the RelaxNG XML format
- an XML Schema **is** a well-formed XML document
  - no human oriented syntax
- XML Schema
  - is *mostly* more expressive than DTDs
  - but *overlaps* with RelaxNG: each has non-shared features
- in contrast to DTDs, XML Schema supports
  - **namespaces**, so we can combine several documents: for schema validation, universal names are used (rather than qualified names)
  - **datatypes**, including simple datatypes for parsed character data and for attribute values, e.g., for *date* (when was 11/10/2006?)
- XML provides more support for describing the (element and mixed) content of elements

# XML Schema: a first example

Example with RNG:

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

<note>
   <to>Tove</to>
   <from>Jani</from>
   <sentOn>2007-01-29</sentOn>
   <body>
      Have a nice weekend!
   </body>
</note>
```

**note.rnc:**

```
default namespace = "http://www.w3schools.com"
element note {
    element to { text },
    element from {  text },
    element sentOn { text },
    element body {  text }
    }
```

# XML Schema: a first example

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

<note xmlns=
      "http://www.w3schools.com"
   xmlns:xs=
      "http://www.w3.org/2001/XMLSchema"
   xmlns:xsi=
      "http://www.w3.org/2001/XMLSchema-instance">

   <to>Tove</to>
   <from>Jani</from>
   <sentOn>2007-01-29</sentOn>
   <body>
      Have a nice weekend!
    </body>
</note>
```

**note.xsd:**

```
<?xml version="1.0"?>
<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="sentOn" type="xs:date"/>
         <xs:element
               name="body" type="xs:string"/>
       </xs:sequence>
     </xs:complexType></xs:element></xs:schema>
```

**Datatypes**!

# XML Schema: some remarks

- to validate an XML document against an XML schema,
  - we use a **validating XML parser** that supports **XML Schema**
  - e.g., DOM level 2, SAX2
- in XML Schema,
  - each element and type can only be declared once
  - almost all elements can contain an element <xs:annotation>...</xs:annotation> as their first child: useful, e.g., for

```
<xs:simpleType name="northwestStates">
    <xs:annotation>
        <xs:documentation>States in the Pacific Northwest of US
                          </xs:documentation>
    </xs:annotation>
   <xs:restriction base="xs:string"></xs:restriction>
 </xs:simpleType>
```

- XML Schema provides support for modularity & re-use through
  - xs:import
  - xs:include
  - xs:redefine

# XML Schema & Namespaces

- most XML Schema schemas start like this, in note.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
        targetNamespace="http://www.w3schools.com"
        xmlns="http://www.w3schools.com"
        elementFormDefault="qualified" >
…..
</xs:schema>
```

**XML Schema** namespace e.g. for datatypes like xs:integer

Target namespace of elements defined in this schema, e.g. for sentOn

- and a document using such a schema looks like this:

```
<?xml version="1.0"?>
<note xmlns="http://www.w3schools.com"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
```

Local (default) namespace

“This document uses a schema”

# XML Schema & Namespaces

- XML Schema supports (and uses) **namespaces**
- an XML Schema typically has 2 namespaces:
  - targetNamespace for those **elements defined in schema** and
    - which also might need a separate declaration
  - XMLSchema namespace http://www.w3.org/2001/XMLSchema
  - (and may involve many more!)

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

<p:note
   xmlns:p="http://www.w3schools.com"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
   <p:to>Paul</p:to>
```

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

<note
   xmlns="http://www.w3schools.com"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
   <to>Paul</to>
```

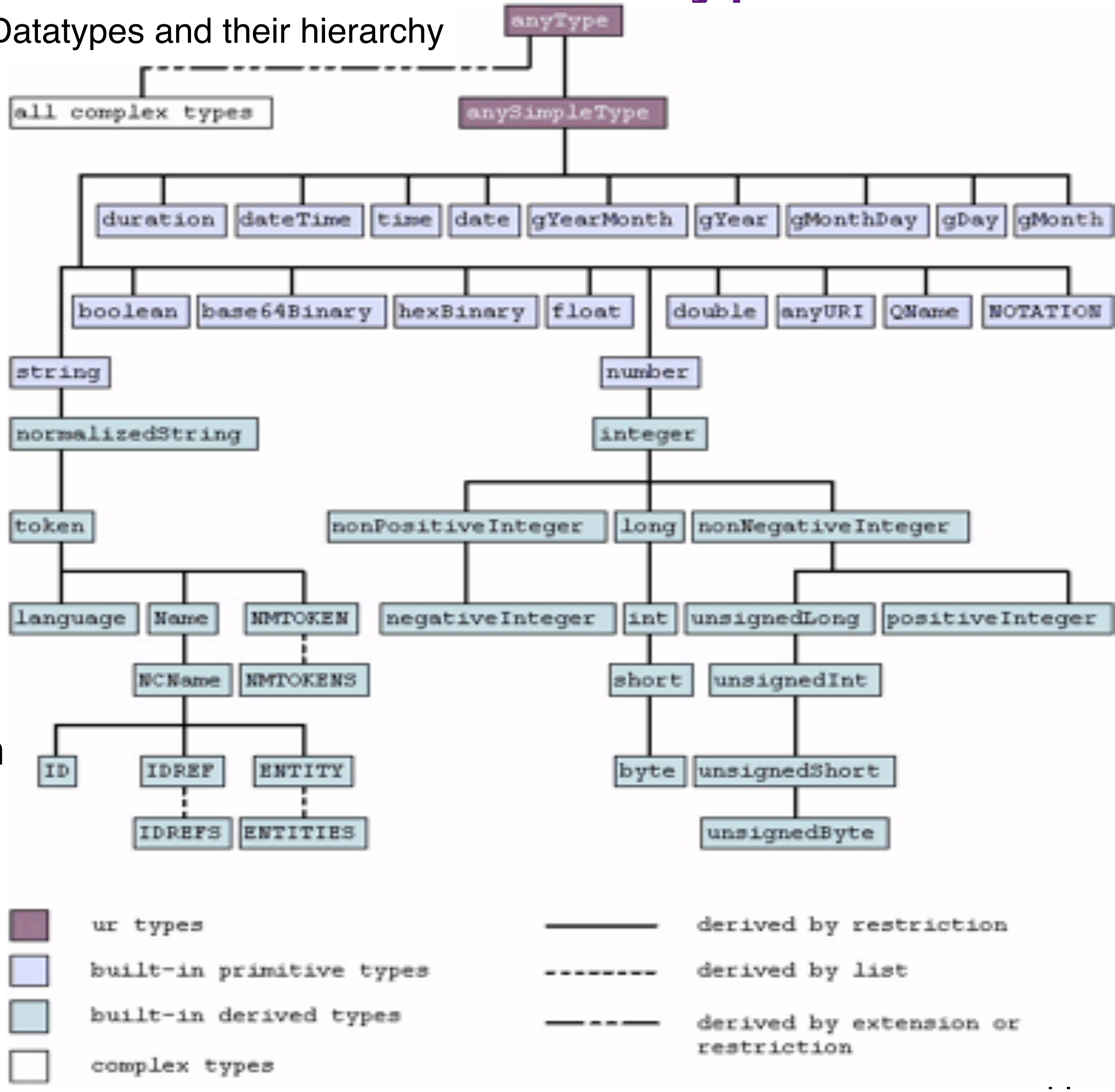
**note.xsd:**

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

# XML Schema core concepts: datatypes

- in the previous examples, we used 2 Built-in datatypes:
  - xs:string
  - xs:date
- many more:
  - built-in/atomic/ primitive e.g., xs:dateTime
  - composite/ user-defined e.g., xs:lists, xs:union
  - through restrictions/ user-defined e.g., ints < 10

Built-In Datatypes and their hierarchy



# XML Schema core concepts: datatypes

each XSD datatype comes with a

- **value space**, e.g., for xs:boolean, this is {true, false}.
- **lexical space**, e.g., for xs:boolean, this is {true, false, 1, 0}, and
- **lexical-to-value** mapping that has to be neither injective nor surjective
    - for xs:boolean, it’s surjective, but not injective
- **constraining facets** that can be used in restrictions of that datatype
    - e.g., maxInclusive, maxExclusive, minInclusive, …for xs:integer
    - e.g., for defining “SmallInteger” or “ShortString”

# XML Schema: types

We can define **types** in XSD, in two ways:

- **xs:simpleType** for simple types, to be used for
  - **attribute values** and
  - **elements** without element child nodes and without attributes
- **xs:complexType** for complex types, to be used for
  - **elements** with
    - element content or
    - mixed element content or
    - text content and attributes

# XML Schema: type declarations

- can be **anonymous**, e.g., in the definition of age or person below:

```
<xs:element name="age">
   <xs:simpleType>
      <xs:restriction base="xs:integer">
         <xs:minInclusive value="3"/>
         <xs:maxInclusive value="7"/>
      </xs:restriction>
   </xs:simpleType>
</xs:element>
```

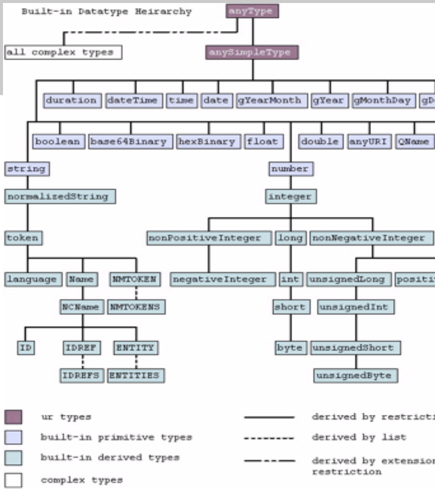
```
<xs:element name="person">
   <xs:complexType>
      <xs:sequence>
         <xs:element name="Name" type="Nametype"/>
         <xs:element name="DoB" type="xs:date"/>
      </xs:sequence>
      <xs:attribute name="friend" type="xs:boolean"/>
   </xs:complexType>
</xs:element>
```

- can be **named**, e.g., Agetype or Persontype

```
<xs:element name="age" type="AgeType"/>

   <xs:simpleType name="AgeType">
      <xs:restriction base="xs:integer">
         <xs:minInclusive value="3"/>
         <xs:maxInclusive value="7"/>
      </xs:restriction>
   </xs:simpleType>
```

```
<xs:element name="person" type="PersonType"/>

   <xs:complexType name ="PersonType">
      <xs:sequence>
         <xs:element name="Name" type="Nametype"/>
         <xs:element name="DoB" type="xs:date"/>
      </xs:sequence>
      <xs:attribute name="friend" type="xs:boolean"/>
   </xs:complexType>
```

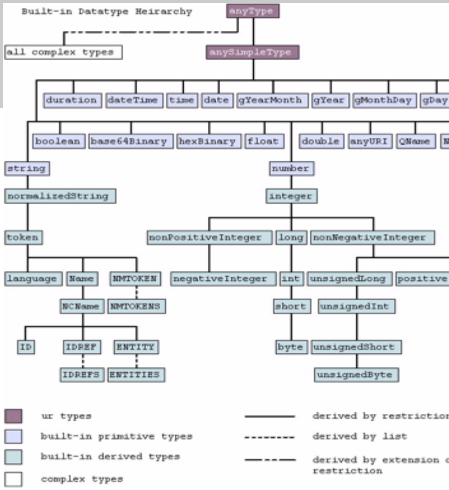
# XML Schema: atomic simple types



- are based on the numerous built-in datatypes
- that can be restricted using **xs:restriction** facets, e.g.,

| | |
|---|---|
| enumeration | <xs:simpleType name="bikeType"><br>    <xs:restriction base="xs:string"><br>        <xs:enumeration value="MTB"/><br>        <xs:enumeration value="road"/><br>    </xs:restriction><br></xs:simpleType> |
| length | <xs:simpleType name="eightChar"><br>    <xs:restriction base="xs:string"><br>    <xs:length value="8"/><br>    </xs:restriction><br></xs:simpleType> |

# XML Schema: atomic simple types



- are based on the numerous built-in datatypes
- that can be restricted using **xs:restriction** facets, e.g.,

| | |
|---|---|
| maxLength<br>minLength | <xs:simpleType name="medStr"><br><xs:restriction base="xs:string"><br><xs:minLength value="5"/><br><xs:maxLength value="8"/><br></xs:restriction><br></xs:simpleType> |
| maxExclusive/maxInclusive<br>minExclusive/minInclusive | <xs:simpleType name="age"><br><xs:restriction base="xs:integer"><br><xs:minInclusive value="0"/><br><xs:maxInclusive value="120"/><br></xs:restriction><br></xs:simpleType> |
| patterns (using regular expressions close to Perl’s) | <xs:simpleType name="simpleStr"><br><xs:restriction base="xs:string"><br><xs:pattern value="([a-z][A-Z])+"/><br></xs:restriction><br></xs:simpleType> |

# XML Schema: composite simple types

- we can use built-in datatypes not only in **restrictions**,
- but also in **compositions** to :
  - xs:list
  - xs:union

```
<xs:simpleType name='myList'>
    <xs:list itemType='xs:integer'/>
</xs:simpleType>

<xs:simpleType name='ShortList'>
    <xs:restriction base='myList'>
        <xs:maxLength value='8'/>
 </xs:restriction>
</xs:simpleType>
```

```
<xs:simpleType name="colourListOrDate">
    <xs:union memberTypes="colourList xs:date"/>
</xs:simpleType>

<xs:simpleType name="colourList">
    <xs:list>
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:enumeration value="red"/>
                <xs:enumeration value="green"/>
                <xs:enumeration value="blue"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:list>
</xs:simpleType>
```

# XML Schema: simple types

```
<xs:complexType name="PersonType">
      <xs:sequence>
         <xs:element name="Name" type="xs:string"/>
         <xs:element name="DoB" type="xs:date"/>
      </xs:sequence>
      <xs:attribute name="friend" type="xs:boolean" default="true"/>
      <xs:attribute name="phone" type="xs:string"/>
   </xs:complexType>
```

- can be used in
  - element declarations, for elements without element child nodes
  - attribute declarations
- we can specify fixed or default values

# XML Schema: simple content

- xs:simpleType for
  - **attribute values** and
  - **elements** without element child nodes and without attributes

- for elements
  - where we cannot use xs:simpleType because of attribute declarations
  - but that have simple (e.g., text) content only,
  - ➥ we can use xs:simpleContent, e.g.

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

- xs:complexType for
  - **elements** with
    - element content or
    - mixed element content or
    - text content and attributes

# XML Schema: complex types

```
<xs:complexType name="nametype">
        <xs:sequence>
            <xs:element name="fname" type=“xs:string"/>
            <xs:element name="fname" type="xs:string"/>
            <xs:element name="lname" type="xs:string"/>
        </xs:sequence>
</xs:complexType>
```

- **element order enforcement constructs:**
  - **sequence**: order preserving
  - **all**: like sequence, but not order preserving
  - **choice**: choose exactly one
- these constructs can be combined with minOccurs and maxOccurs,
  - by default, both are set to 1,
  - but they can be set to any non-negative integer or “unbounded”, e.g.

```
<xs:complexType name="nametype">
        <xs:sequence>
            <xs:element name="fname" type="xs:string"/>
            <xs:element name="mname" type="xs:string"
                minOccurs="0"
                maxOccurs="7"/>
            <xs:element name="lname" type="xs:string"/>
        </xs:sequence>
</xs:complexType>
```

# XML Schema: mixed content

- to allow for mixed content, set attribute mixed=“true”, e.g.,

```
<xs:complexType name="PersonType" mixed="true">
    <xs:sequence>
        <xs:element name="Name" type="xs:string"/>
        <xs:element name="DoB" type="xs:date"/>
    </xs:sequence>
    <xs:attribute name="friend" type="xs:boolean" default="true"/>
    <xs:attribute name="phone" type="xs:string"/>
</xs:complexType>
```

  – but we
    - cannot constrain **where** the text occurs between elements,
    - can only say that content *can be* mixed

# XML Schema: restriction and extension

- we have already used xs:extension and xs:restriction both for
  - simple types and
  - complex types
- they are XML Schema’s mechanisms for ***inheritance***
- **extension**: specifying a new type X by extending Y
  - this “appends” X’s definition to Y’s, e.g.,

```
<xs:simpleType name="AgeType">
   <xs:restriction base="xs:integer">
      <xs:minInclusive value="3"/>
      <xs:maxInclusive value="7"/>
   </xs:restriction>
</xs:simpleType>

<xs:complexType name="NewAgeType">
   <xs:simpleContent>
   <xs:extension base="AgeType">
      <xs:attribute name="range" type="xs:string"/>
   </xs:extension>
   </xs:simpleContent>
</xs:complexType>
```

```
<xs:complexType name="PersonType">
   <xs:sequence>
      <xs:element name="Name" type="xs:string"/>
      <xs:element name="DoB" type="xs:date"/>
   </xs:sequence>
   <xs:attribute name="friend" type="xs:boolean"
                 default="true"/>
   <xs:attribute name="phone" type="xs:string"/>
</xs:complexType>

<xs:complexType name="LongPersonType">
   <xs:complexContent>
      <xs:extension base="PersonType">
         <xs:sequence>
            <xs:element name="address" type="xs:string"/>
         </xs:sequence>
      </xs:extension>
   </xs:complexContent></xs:complexType>
```

# XML Schema: restriction and extension

- **restriction**: easy for simple types
  we have seen it several times

```
<xs:simpleType name="AgeType">
   <xs:restriction base="xs:integer">
      <xs:minInclusive value="3"/>
      <xs:maxInclusive value="7"/>
   </xs:restriction>
</xs:simpleType>
```

- **restriction:** “cumbersome” for complex types:
  specifying a new type X by restricting a complex type Y requires the **reproduction** of Y’s definition, e.g.,

```
<xs:complexType name="PersonType">
   <xs:sequence>
      <xs:element name="Name" type="xs:string"/>
      <xs:element name="DoB" type="xs:date"/>
   </xs:sequence>
   <xs:attribute name="friend" type="xs:boolean"/>
   <xs:attribute name="phone" type="xs:string"/>
 </xs:complexType>

 <xs:complexType name="StrictPersonType">
   <xs:complexContent>
      <xs:restriction base="PersonType">
         <xs:sequence>
            <xs:element name="Name">
               <xs:simpleType>
                  <xs:restriction base="xs:string">
                     <xs:pattern value="[A-Z]([a-z]+)””/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
            <xs:element name="DoB" type="xs:date"/>
         </xs:sequence>
         <xs:attribute name="friend" type="xs:boolean"/>
         <xs:attribute name="phone" type="xs:string"/>
      </xs:restriction>
   </xs:complexContent></xs:complexType>
```

# XML Schema: restriction and extension

- **usage**: in a document, an element of a type derived by restriction or extension from Y can be used in place of an element of type Y…
  - provided you say so explicitly, e.g., in

```
<person phone="2">
   <Name>Peter</Name>
   <DoB>1966-05-04</DoB>
</person>
<person xsi:type="LongPersonType" phone="5432" friend="0">
   <Name>Paul</Name>
   <DoB>1967-05-04</DoB>
   <address>Manchester</address>
</person>
```

- this means that a validating XML parser has to manage a schema’s **type hierarchy**
  - to ensure that LongPersonType was really derived by restriction or extension from the type expected for person
  - but it doesn’t have to “guess” an element’s type from its properties
- In SE3: compare they “pain & gain” of using types to “pain & gain” of using other features like substitution groups!

# XML Schema: restriction and extension

- to prevent a type from being instantiated directly, use e.g.,

  ```
  <xs:complexType name="StrictPersonType" abstract="true">
  ```

- to prevent a type from being further extended and/or restricted use e.g.,

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

- closely related to the mechanism of restriction/extension are **substitution groups**, i.e., a mechanism to allow to replace one element with a group of others

# XML Schema: summary of complex types

- we have simple and complex **types**:
  - simple types for attribute values and text in elements
  - complex types for elements with child elements or attributes
- we have simple and complex **content** of elements:
  - simple content:
    - elements with only text between tags and possibly attributes
  - complex content
    - element content (elements only)
    - mixed content (elements and text)
    - empty content (at most attributes)
- a complex content type can be specified in 3 ways: using
  - element order enforcement constructs (all, sequence, choice)
  - a single child of simpleContent:
    derive a complex type from a simple or complex type with simple content
  - a single child of complexContent:
    derive a complex type from another complex type
    using restriction or extension

# Comparing XML Schema & RelaxNG

- You know one better than the other…one is simpler than the other…
- in RNG, no mechanism for manipulating datatypes, lists, unions,…
  - but you can borrow this from XSD!
- in RNG, no restrictions & extension, no (non-atomic) **types**
  - in a document, an element of a type derived by restriction from Y can be used in place of an element of type Y
  - this can make writing complex schemas easier!
  - but this means that a validating XML parser has to manage a schema's **type hierarchy**
- XML Schema has restrictions on expressing constraints on **content models**
  - so that matching a node's childnode sequence against the corresponding content model is "easier"
  - e.g., *XML Element Declarations Consistent* constraint
- is there a **set of XML documents** (e.g., your cartoon descriptions)
  - for which we can formulate a RNG
  - but not an XML schema?
  - or the other way round?

# Extensibility

is a
systemic measure of the ability
to extend a system/XML format/XML schema
and
the level of effort required
to implement the extension.

from http://en.wikipedia.org/wiki/Extensibility

# RNGs and extensibility

RelaNG schemas

- **Multiple** RNGs
- Given a **single** RNG, we can easily
  - **loosen** features
    - Choice
    - Repetition (regular expressions!)
    - ANY - for elements of any kind!
    - #IMPLIED and #DEFAULT
  - **tighten** features
    - naturally: every name must have a declaration!
    - No namespace sensitivity

# Example

```
start = element problem  {(declaration,declaration)+}>
```

```
start = element problem  {declaration,declaration+}>
```

- Two RNGs
  - One describing a **superset** of the other
  - Safe for generation
    - Not as safe for consumption
    - But perhaps safe in the right way?
- Multiple RNGs vs. Well-formedness
  - Finding a fit
  - Finding a “best” fit
    - Too tight a fit is pointless
    - Too loose can be pointless too!

# WXS and Extensibility

XML Schema
schemas

- Multiple WXS
  - As with RNGs
  - WXS can relate
    - I.e., A WXS can **extend** or **refine** another WXS
    - ...see **include** and **import**
    - Just as a **type** can **extend** another
      - Inter-schema refinement can do **more**
  - with namespace support!
- In a single WXS
  - Choice and repetition
  - Wildcards!
    - Strictly more expressive
    - Namespace aware

```
<xs:any namespace="##other" processContents="lax"/>
<xs:any namespace="http://www.w3.org/1999/XSL/"/>
<xs:any namespace="##targetNamespace"/>
<xs:anyAttribute namespace="http://www.w3.org/XML/"/>
```

- (RelaxNG also has modularity and extension features)

# Namespaces

- Their fundamental goal:
  - to manage names...
  - provide “Decentralised extensibility”
    - What does this mean?
- Their fundamental limitation:
  - Name extensibility only!
  - Clash prevention only!
    - At least at the technical level...
- Schemas need to be namespace sensitive
  - And to enable more elaborate behavior

# XML Schema: Namespaces

- targetNamespace
  - Every WXS has a **targetNamespace**
    - At least implicitly
    - for those elements **defined** in schema
    - It also has a lot of symbol spaces
  - But any <ws:schema> has only **one** targetNamespace!
    - We need to relate documents (i.e., DOMs!)
    - a ws:schema **component** can have more namespaces!

# Some Namespace Patterns

For example

- Contained NS Pattern
- Global Attributes NS Pattern
  - Attributes are weird
- General Extension NS Pattern
- Version
- Abuse

Be sure you understand the difference between
- namespace *declarations*
- namespaces,
- expanded names,
- namespace scope, etc.

# Remember Namespaces?!

- **Namespace declarations**, e.g., xmlns:calc="http://bjp.org/calc/"
  - looks like/can be treated as a **normal** attributes (CW2)
- **Qualified names** ("QNames"), e.g., calc:plus
  - Prefix, e.g., calc
  - Local name, e.g., plus
- **Expanded name,** e.g., {http://bjp.org/calc/}plus
- **Namespace name**, e.g., http://bjp.org/calc/
- The **scope** of a declaration is:
  - The element where the declaration **appears** together with
  - **the descendants** of that element...
    - ...**except** those descendants which have a **conflicting declaration**
      - (and their descendants, etc.)
    - I.e., a declaration with the same prefix
- Scopes nest and shadow
  - Deeper nested declarations redefine/overwrite outer declarations

# The Contained Namespace Patterns

on pattern

position where a “context” is shared by subtrees

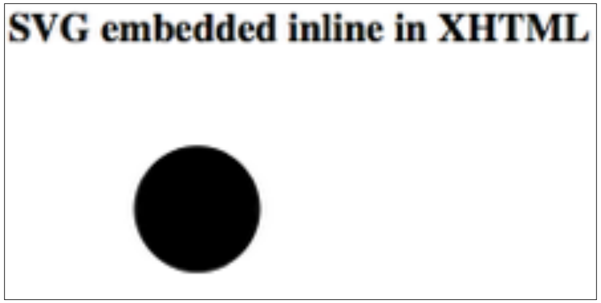
  – Think SVG in HTML

- where an element with all its attributes and “relevant” descendants share the same namespace and processing
  – a descendant may be the root of a new “context” subtree
  – but then is in a new namespace with its own processing instruction
  – which will also apply to all its descendants, apart from ...

```
<html xmlns="http://www.w3.org/1999/xhtml">
   <head><title>SVG embedded inline in XHTML</title></head>
   <body>
      <h1>SVG embedded inline in XHTML</h1>
      <svg xmlns="http://www.w3.org/2000/svg"
         width="300" height="200">
         <circle cx="150" cy="100" r="50" />
      </svg>
   </body>
</html>
```

HTML namespace

SVG namespace



# The **Contained** Namespace Patterns

another example:

```
<xsl:stylesheet xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
   xmlns:xs="http://www.w3.org/2001/XMLSchema" exclude-result-prefixes="xs" version="2.0">
   <xsl:import-schema schema-location="http://ex.org/minischema.xsd"/>
   <xsl:template match="/*">
      ...
   </xsl:template>
</xsl:stylesheet>
```

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
         <xs:element name="a" type="Union"/>
         <xs:simpleType name="Union">
            <xs:union memberTypes="xs:integer xs:boolean"/>
         </xs:simpleType>
</xs:schema>
```

```
<xsl:stylesheet xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
   xmlns:xs="http://www.w3.org/2001/XMLSchema" exclude-result-prefixes="xs" version="2.0">
   <xsl:import-schema>
      <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
         <xs:element name="a" type="Union"/>
         <xs:simpleType name="Union">
            <xs:union memberTypes="xs:integer xs:boolean"/>
         </xs:simpleType>
      </xs:schema>
   </xsl:import-schema>
   <xsl:template match="/*">
      ...
   </xsl:template>
</xsl:stylesheet>
```

# How to Capture in XML Schema?

- xs:import
  - Declares a foreign namespace
    - and associated schema (but no prefix for it: the schema does this!)

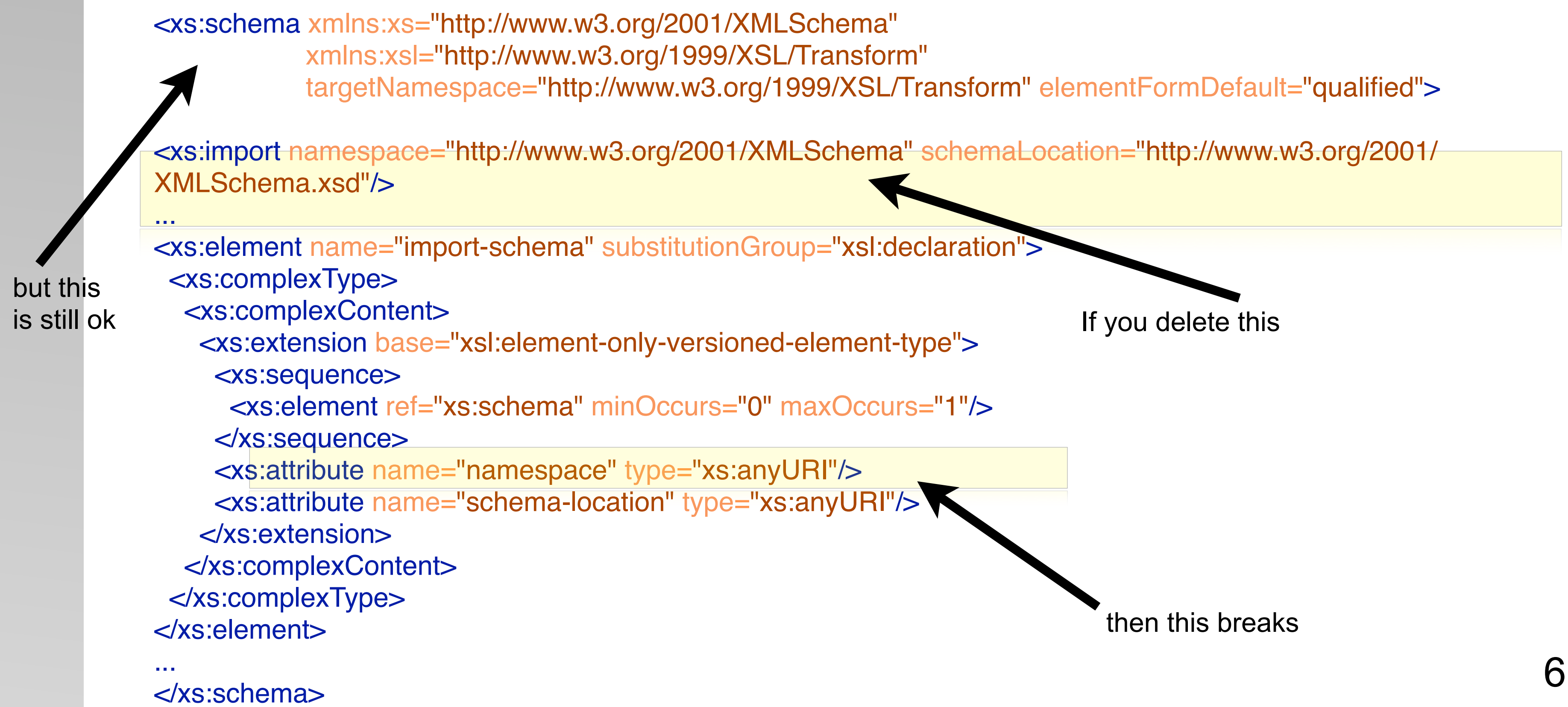
```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
           xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
           targetNamespace="http://www.w3.org/1999/XSL/Transform" elementFormDefault="qualified">

<xs:import namespace="http://www.w3.org/2001/XMLSchema" schemaLocation="http://www.w3.org/2001/
XMLSchema.xsd"/>
...
<xs:element name="import-schema" substitutionGroup="xsl:declaration">
  <xs:complexType>
    <xs:complexContent>
      <xs:extension base="xsl:element-only-versioned-element-type">
        <xs:sequence>
          <xs:element ref="xs:schema" minOccurs="0" maxOccurs="1"/>
        </xs:sequence>
        <xs:attribute name="namespace" type="xs:anyURI"/>
        <xs:attribute name="schema-location" type="xs:anyURI"/>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
</xs:element>
...
</xs:schema>
```

Brings in the foreign namespace
and its declarations

And we can now use elements declared

# How to Capture in XML Schema?

- xs:import
  - Declares a foreign namespace
    - and associated schema



```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
           xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
           targetNamespace="http://www.w3.org/1999/XSL/Transform" elementFormDefault="qualified">

<xs:import namespace="http://www.w3.org/2001/XMLSchema" schemaLocation="http://www.w3.org/2001/
XMLSchema.xsd"/>
...
<xs:element name="import-schema" substitutionGroup="xsl:declaration">
  <xs:complexType>
    <xs:complexContent>
      <xs:extension base="xsl:element-only-versioned-element-type">
        <xs:sequence>
          <xs:element ref="xs:schema" minOccurs="0" maxOccurs="1"/>
        </xs:sequence>
        <xs:attribute name="namespace" type="xs:anyURI"/>
        <xs:attribute name="schema-location" type="xs:anyURI"/>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
</xs:element>
...
</xs:schema>
```

but this
is still ok

If you delete this

then this breaks

# How to Capture in XML Schema?

- Strange:
  - xmlns declares the namespace binding
  - xs:import makes that namespace “schema active”

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
           xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
           targetNamespace="http://www.w3.org/1999/XSL/Transform" elementFormDefault="qualified">

<xs:import namespace="http://www.w3.org/2001/XMLSchema" schemaLocation="http://www.w3.org/2001/
XMLSchema.xsd"/>
...
<xs:element name="import-schema" substitutionGroup="xsl:declaration">
  <xs:complexType>
    <xs:complexContent>
      <xs:extension base="xsl:element-only-versioned-element-type">
        <xs:sequence>
          <xs:element ref="xs:schema" minOccurs="0" maxOccurs="1"/>
        </xs:sequence>
        <xs:attribute name="namespace" type="xs:anyURI"/>
        <xs:attribute name="schema-location" type="xs:anyURI"/>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
</xs:element>
...
</xs:schema>
```

but this
is still ok

If you delete this

then this breaks

# Attributes & Namespaces

- **Why** do we have attributes?
  - Attributes aren’t **ordered**
  - Attributes don’t **repeat**
  - Attributes don’t **contain markup**
    - They can’t contain **structured data**
  - Require a **special** node type, axes, syntax, etc.
  - **Prefixless** attribute name weirdness:

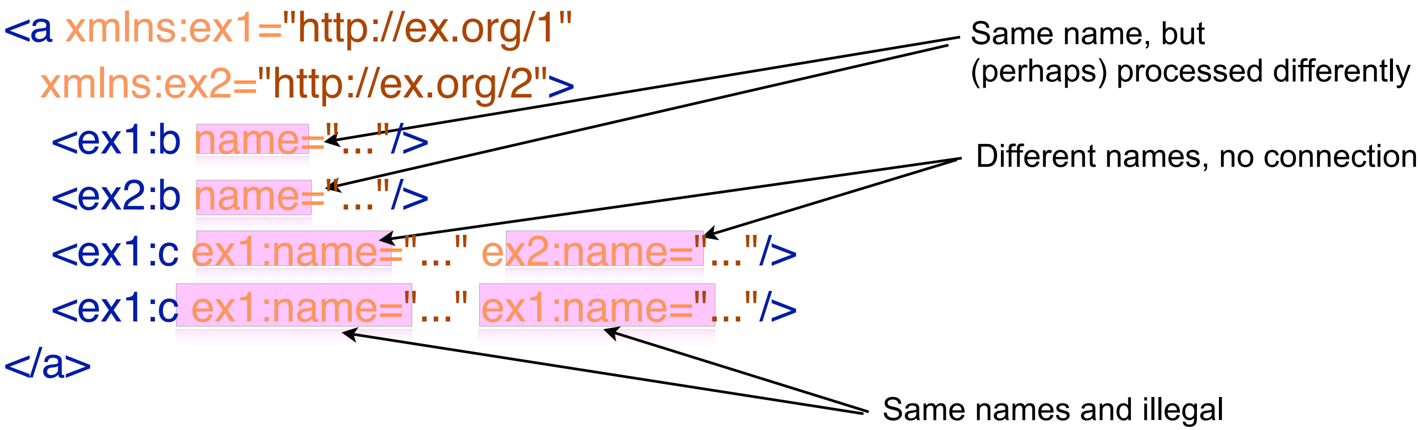
A default namespace declaration applies to all **unprefixed *element*** names within its scope.
Default namespace declarations do ***not*** apply directly to ***attribute*** names; the interpretation of unprefixed attributes is determined by the **element** on which they appear.

# “Local” vs. “Global” Attributes

Another namespace pattern

- Attributes in the null namespace
  - Null namespace attributes are contextually processed
    - Thus “local”

A default namespace declaration applies to all **unprefixed *element*** names within its scope. Default namespace declarations do ***not*** apply directly to ***attribute*** names; the interpretation of unprefixed attributes is determined by the **element** on which they appear.



```
<a xmlns:ex1="http://ex.org/1"
   xmlns:ex2="http://ex.org/2">
    <ex1:b name="..."/>
    <ex2:b name="..."/>
    <ex1:c ex1:name="..." ex2:name="..."/>
    <ex1:c ex1:name="..." ex1:name="..."/>
</a>
```

Same name, but (perhaps) processed differently

Different names, no connection

Same names and illegal

# Global Attributes Example

- Language extensions
  - xml:lang
  - xml:base
  - xml:space
  - xml:id

```
<xs:attributeGroup name="specialAttrs">
 <xs:attribute ref="xml:base"/>
 <xs:attribute ref="xml:lang"/>
 <xs:attribute ref="xml:space"/>
 <xs:attribute ref="xml:id"/>
</xs:attributeGroup>
```

# Consider queries

```
<a type="a" xmlns:ex1="bla" xmlns:ex2="bla2" xmlns="bla3">
    <ex1:b name="1"/>
    <ex2:b name="2"/>
    <ex1:c ex1:name="3" ex2:name="4"/>
    <ex1:c ex1:name="5"/>
    <b name="6"/>
</a>
```

- `//@*` (all 6 attribute nodes)
- `//@name` (only 3 unprefixed attribute nodes)
- `//@ex1:name` (3,5)
- `//@*[namespace-uri()="bla2"]` (4)
- `//@*[namespace-uri()=""]` (1,2,6)

# What to do with new version of format?

- Make it live in **new namespace**!
  - For what sorts of change?
    - Any change?
    - Extensions?
    - Revisions?
    - Just the “meaning”?
    - “Sufficient” change?
- Changing the namespace breaks stuff
  - So, perhaps do this when a change should break things?
  - http://www.w3.org/2001/tag/doc/namespaceState.html
  - http://www.w3.org/TR/xmlschema-guide2versioning/

# Extension *within* a Namespace?

- Alternative Schema!
  - Just make a separate, unrelated document
- Use xs:include
  - Like xs:import but for “same namespace”
  - Use xs:redefine to redefine **components**
    - But not elements!
      - (Anonymous/unnamed types bite you)
    - Can only refine not completely redefine

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    targetNamespace="http://MyComppositeSchema">
    <xs:include schemaLocation="http://www.cs.man.ac.uk/~sattler/myFirstSchema.xsd"/>
    <xs:include schemaLocation="http://www.cs.man.ac.uk/~sattler/myOtherSchema.xsd"/>

  …..
</xs:schema>
```

# Wildcards

- xs:any
  - Allows any element (etc) from any namespace!
  - With or without a definition
    - That is, can allow for any well formed XML
    - Sometimes known as an **open content model**
- Consider comment
  - What if we want structured comments?
    - With any XML whatsoever!

```
<xs:element name="comment">
    <xs:complexType mixed="true">
      <xs:sequence>
        <xs:any minOccurs="0" maxOccurs="unbounded" processContents="skip"/>
      </xs:sequence>
    </xs:complexType>
</xs:element>
```

```
<el:comment
  xmlns:el="http://owl.cs.manchester.ac.uk/2010/comp/ssd-60372/day2/el">
  <h>What's this element?</h> Oo, mixed content! <a xmlns="http://ex.org" b="?"/>
  <el:foo>Junk!</el:foo>
</el:comment>
```

# Tighter Wildcards

- We can control
  - **Which** namespaces
    - Name any specific number of namespaces
    - Explicitly forbid a namespace (e.g., not http://ex.org/)
    - Allow all, only non-targetNS, the targetNS, etc.
  - Degree of validation
    - strict: must be valid against a declaration
    - skip: anything well-formed!
    - lax: validate what you can figure out to validate, ignore the rest

```
<xs:any namespace="http://MyTrusted" minOccurs="0"
      maxOccurs="unbounded" processContents="lax" />
```

# Rules of Thumb:

- For **multiple** WXS documents over **one** NS
  - Use xs:include
  - Can mix content models on existing elements!
  - Modularize development
    - With a bit of version hacking
- For making **one** schema over **multiple** NSs
  - Use xs:import
  - “Required” for multi-NS formats
    - since there is only 1 targetNameSpace per WXS
    - encourages NS centered development modularization
- For dealing with NSs not in your control
  - Use wildcards
- For relaxing parts of a document toward well-formed
  - Use wildcards

# Empirical Interlude

# Schemas?

- In SQL, schema before all
  - CREATE TABLE or nothing happens
  - Can’t INSERT INTO
  - Can’t SELECT FROM
  - So every SQL database has a schema
    - And the data conform
- XML, never *need* a schema
  - Except the minimal schema of well-formed-ness
    - Which is more mere minimal syntax
  - So why?
    - To *communicate*
    - To *error check*
    - To *guide tools*
- Given these advantages
  - How often used?

# Consider....

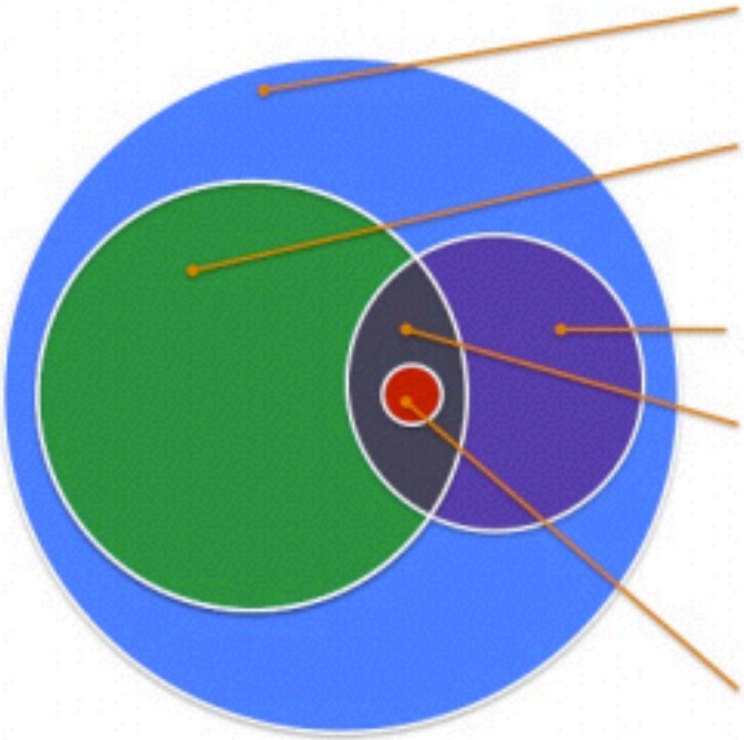
XSD = WXS

> It was a bit disappointing to notice that a relatively large fraction of the XSDs we retrieved did not pass a conformance test by SQC. As mentioned in Section 2, only 30 out of a total of 93 XSDs were found to be adhering to the current specifications of the W3C [17].

> Often, lack of conformance can be attributed to growing pains of an emerging technology: the SQC validates according to the 2001 specification and 19 out of the 93 XSDs have been designed according to a previous specification. Some simple types have been omitted or added from one version from one version of the specs to another causing the SQC to report errors.

*DTDs versus XML Schema: A Practical Study* [2004]

# Today’s XML



Documents in collection
180,640 (100.0%)

Well-formed documents
154,263 (85.4%)

Documents that reference a downloadable DTD or XSD
44,758 (24.8%)

Well-formed documents that reference a downloadable DTD or XSD
30,495 (16.9%)

Documents that validate with their schema
15,996 (8.9%)

**Figure 1: Summary of the Quality of the XML Web.**

The Quality of the XML Web [2011]

# Today’s XML

- Weird facts:
  - 18% are not well formed
    - 66.4% of non-well formed documents have a DOCTYPE!
      - WHY!?
- “Validity is rare on the web. Just over 10% of the well-formed documents are also valid.”
  - Is there a difference between DTDs and WXS?

The Quality of the XML Web [2011]

# Invalid with DOCTYPE

docs that claim to be valid against X (X is ok) but aren’t

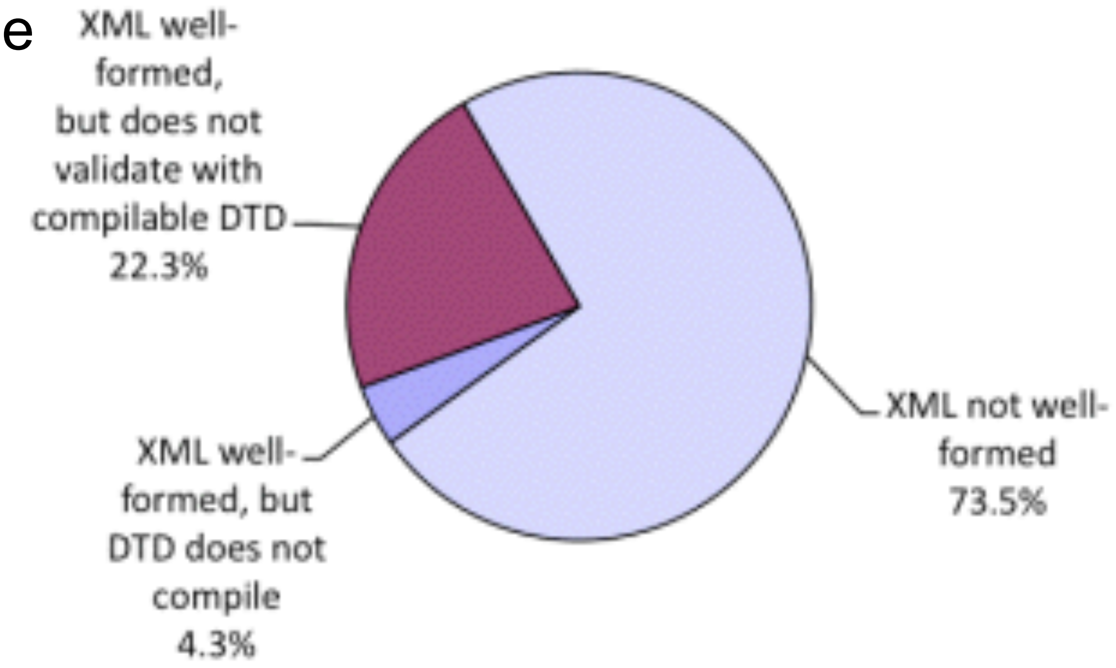


**Figure 2: Distribution of causes for non-validation: DTD.**

The Quality of the XML Web [2011]

# Invalid with “schemaLocation”

docs that claim to be valid against X (X is ok) but aren’t

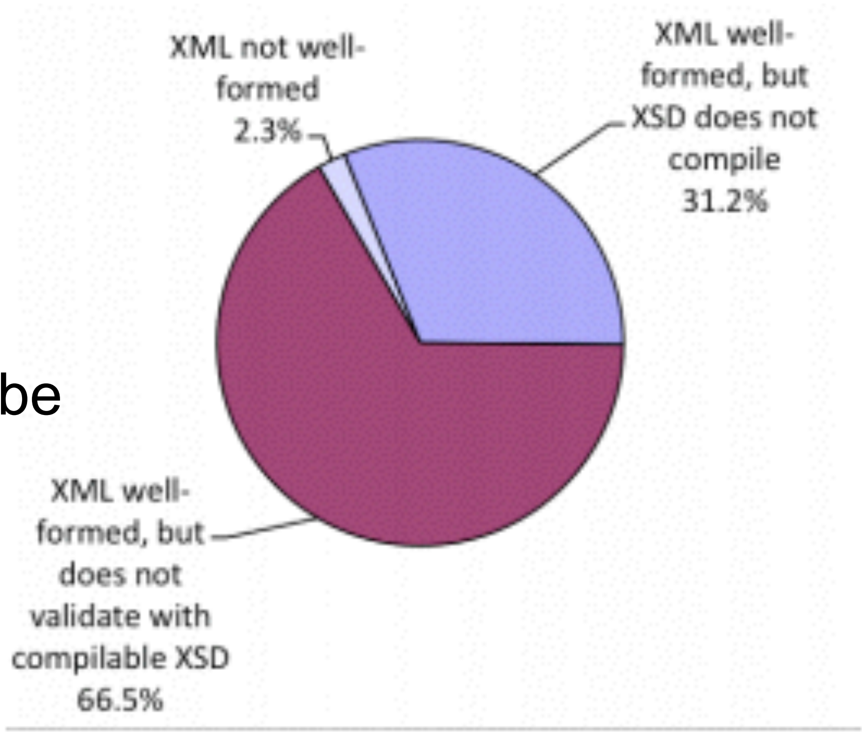


**Figure 3: Distribution of causes for non-validation: XSD.**

The Quality of the XML Web [2011]

# XQuery

# XQuery

- is a language for querying XML **data**
- it is built on/heavily uses/extends XPath expressions
  - smooth syntactic extensions: every XPath is an XQuery
- a W3C standard since 2007, see http://www.w3.org/TR/xquery/
- is supported by major database engines (IBM, Oracle, Microsoft, etc.)
- it can be used to
  - extract information to use in a Web Service
  - generate summary reports
  - transform XML data to HTML
  - search Web documents for relevant information
  - ...and to answer queries

# XQuery: some basics

W3C speak

- XQuery provides support for datatypes, i.e., we
  - have variables and can
  - declare their type, yet the **query processor** *may* be **strict**: no attempt at a conversion to the correct type *needs* to be made!
  - e.g., if I try to add an integer with a decimal or write an integer into a decimal variable, the query processor *may* stop with an error
- like XPath, XQuery is based on **node sequences**
  - a sequence is a (poss. empty) list of **nodes**
  - as usual, nodes are of one of 7 kinds: element, attribute, text, namespace, processing-instruction, comment, or document (root)
  - if *$mySeq* is a sequence, *$mySeq*[3] is its third item
- all variable names start with “$” as in *$mySeq*
- comments are between “(:” and “:)” as in “(: this is a comment:)”
- a central, SQL-like part are **FLOWR expressions**

# FLWOR expressions

**people.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<contactlist>
   <person categ="friend" age="25">
      <name>
    <lastname>Doe</lastname>
    <firstname>John</firstname>
      </name>
      <phone>0044 161 1234 5667</phone>
      <address> 123 Main Street</address>
 <city>Manchester</city>
   </person>
...
```

- “FLWOR” is pronounced “flower”
- a FLWOR expression has 5 possibly overlapping parts:
  - For e.g., for *$x* in doc(”people.xml")/contactList/person
  - Let e.g., let *$i := 3* let *$n* := *$x*/name/firstname
  - Where e.g., where *$x*/@categ = “friend”
  - Order by e.g., order by *$x*/name/lastname ascending
  - Return e.g., return concat(*$x*/name/lastname, “, “*$x*/name/firstname)

**F** and **L** can appear any (!) number of times in any order.
**W** and **O** are optional, but must appear in the order given.
**R** has always to be there...depending on who you ask...

# FLWOR expressions

**people.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<contactlist>
    <person categ="friend" age="25">
        <name>
      <lastname>Doe</lastname>
      <firstname>John</firstname>
        </name>
        <phone>0044 161 1234 5667</phone>
        <address> 123 Main Street</address>
  <city>Manchester</city>
    </person>
...
```

- a **for expression** determines what to iterate through
- is basically of the form

> for *variable* (as *datatype*)? (at *position*)*?* in *expression*

- where *expression* is
  - any XPath location path or
  - a FLWOR expression (nesting!) or
  - a logic expression (if-then-else, etc.), later more
- e.g., for *$b* in doc(”people.xml")/contactList/person[@categ = “friend”]
  - query processor goes through the sequence of all (element) nodes selected by the XPath location path
- e.g.,

```
for $b at $p in doc("contactlist.xml")/contactList/person
    where $p = 3
    return $b
```

  - query processor goes through (the singleton sequence containing) the third element node of the node set selected by the XPath location

# FLWOR expressions

**people.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<contactlist>
    <person categ="friend" age="25">
        <name>
      <lastname>Doe</lastname>
      <firstname>John</firstname>
        </name>
        <phone>0044 161 1234 5667</phone>
        <address> 123 Main Street</address>
  <city>Manchester</city>
    </person>
...
```

- a **let expression** binds a variable to a value
- is basically of the form

```
let variable (as datatype)?  := expression
```

- where *expression* is
  - any XPath location path or
  - a FLOWR expression or
  - a logic expression (if-then-else, etc.), later more
- e.g.,

```
for $b in
  doc("people.xml")/contactlist/person
let $name as element() := $b/name/firstname
return $name
```

```
for $b in
     doc("people.xml")/contactlist/person
let $name as text() :=
  if (xs:integer($b/@age) < xs:integer(16))
     then ($b/name/firstname/text())
     else ($b/name/lastname/text())
return $name
```

# FLWOR expressions

**people.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<contactlist>
   <person categ="friend" age="25">
      <name>
     <lastname>Doe</lastname>
     <firstname>John</firstname>
      </name>
      <phone>0044 161 1234 5667</phone>
      <address> 123 Main Street</address>
 <city>Manchester</city>
   </person>
...
```

- we can repeat and mix for and let expressions
- a FLOWR expression
  - has at least one **for** or one **let** expression,
  - but can have any number of them in any order
- careful: the order plays a crucial role for their meaning
- make sure to bind variables to the right values before using them in **for** expression:

```
let $doc := doc("people.xml")
for $p in $doc/contactlist/person
let $n := $p/name/lastname/text()
let $a := $p/@age
for $double in $doc/contactlist/person[@age = $a][name/lastname/text() = $n]
….
```

# FLWOR expressions

- **return expression** determines output
- is basically of the form

```
return expression
```

**people.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<contactlist>
   <person categ="friend" age="25">
      <name>
    <lastname>Doe</lastname>
    <firstname>John</firstname>
      </name>
      <phone>0044 161 1234 5667</phone>
      <address> 123 Main Street</address>
 <city>Manchester</city>
   </person>
...
```

- where *expression* is one of the logical expressions to be defined later
- it returns elements *as they are,* i.e., with attributes and descendants
- e.g.,

```
<MyFriendList>
for $b in doc("people.xml")/contactlist/person[@categ="friend"]
return $b/name/firstname/text()
</MyFriendList>
```

returns <MyFriendList>John Millie...</MyFriendList>

- careful: we needed “{“, “}” to distinguish between text and instructions

```
for $b in /contactlist/person
let $name as element() := $b/name/firstname
return  <short> { $name/text() }</short>
```

```
people.xml
<?xml version="1.0" encoding="UTF-8"?>
<contactlist>
   <person categ="friend" age="25">
      <name>
     <lastname>Doe</lastname>
     <firstname>John</firstname>
      </name>
      <phone>0044 161 1234 5667</phone>
      <address> 123 Main Street</address>
  <city>Manchester</city>
   </person>
...
```

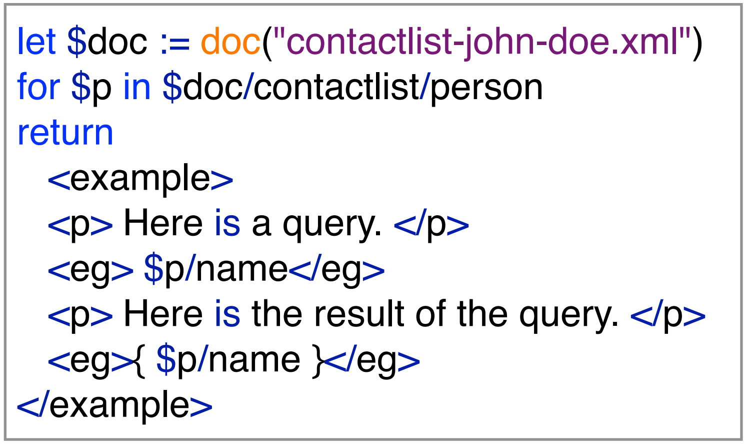
# FLWOR expressions

- as mentioned before, we can make use of logical expressions including
  - if-then-else
  - some/every
  - Boolean expressions
- e.g.,

```
let $doc := doc("people.xml")
return
<MyFriendList>
 {
 for $b in $doc/contactlist/person[@categ="friend"]
  return
  <friend>
  { (if (xs:integer($b/@age) < xs:integer(16))
     then  $b/name/firstname/text()
     else  $b/name/lastname/text()) }
  </friend>
 }
</MyFriendList>
```

# XQuery: constructors

- as we have seen, we can use text in the return part
- to return a more complex XML document, we can make use of **constructors**
  - e.g., direct element constructors as in the previous example
  - or direct element constructors with attributes
- we use “{“ and “}” to delimit expressions that are *evaluated*, e.g.,



```
let $doc := doc("contactlist-john-doe.xml")
for $p in $doc/contactlist/person
return
   <example>
   <p> Here is a query. </p>
   <eg> $p/name</eg>
   <p> Here is the result of the query. </p>
   <eg>{ $p/name }</eg>
</example>
```

- if we want to construct
  elements with attributes, we can do this easily: e.g.,
  return <friend phone =“{ xs:string($p/phone) }”>{ (if (...

# FLOWR expressions

- **where** is used to filter the node sets selected through let and for
- like in SQL, we can use **where** for **joins** of several trees or documents
- e.g.,

```
for $p in
     doc("contactlist-john-doe.xml")/contactlist/person
for $c in doc("cities.xml")/citylist/city
where $p/city/text() = $c/name/text()
return concat("Dear ", $p/name/firstname,
                                    ", do you like ", $c/club ,"? " )
```

**people.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<contactlist>
   <person categ="friend" age="25">
      <name>
    <lastname>Doe</lastname>
    <firstname>John</firstname>
      </name>
      <phone>0044 161 1234 5667</phone>
      <address> 123 Main Street</address>
  <city>Manchester</city>
   </person>
...
```

**cities.xml**

```
<?xml version="1.0" encoding=”UTF-8"?>
<citylist>
  <city>
       <name>Manchester</name>
       <club>Manchester United</club>
  </city>
  <city>
        <name>Munich</name>
        <club>Die Loewen</club>
  </city>
...
```

# FLOWR expressions

- a more realistic, SQL-like example
  (from <oXygen/>):

**product.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<products>
    <product>
        <productId>1</productId>
        <productName>Wave Runner</productName>
        <productSpec>120 HP blaa</productSpec>
    </product>
...
```

```
<sales>
   {
       for $product in doc("products.xml")/products/product,
             $sale in doc("sales.xml")/sales/sale
       where $product/productId = $sale/@productId
       return <product id="{$product/productId}">
             { $product/productName, $product/productSpec,
                $sale/mrq, $sale/ytd, $sale/margin }
                  </product>
   }
</sales>
```

**sale.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<sales>
    <sale productId="1">
        <mrq>180$</mrq>
        <ytd>18.87% up</ytd>
        <margin>5%</margin>
    </sale
...
```

# FLOWR expressions

- like in SQL, we can nest expressions
- e.g., the previous example does not work in case a city has several clubs:

```
~~for $p in~~
~~     doc("contactlist-john-doe.xml")/contactlist/person~~
~~for $c in doc("cities.xml")/citylist/city~~
~~where $p/city/text() = $c/name/text()~~
~~return concat("Dear ", $p/name/firstname,~~
```

```
<sales>
 {for $p in doc("contactlist-john-doe.xml")/contactlist/person
  for $c in doc("cities.xml")/citylist/city
  where $p/city = $c/name
  return
    (for $i in 1 to fn:count($c/club)
     return concat("Dear ", $p/name/firstname,
       ", do you like ", $c/club[$i], " ?"))}
 </sales>
```

**people.xml**

```
<?xml version="1.0" encoding="UTF-8"?>
<contactlist>
    <person categ="friend" age="25">
        <name>
      <lastname>Doe</lastname>
      <firstname>John</firstname>
        </name>
        <phone>0044 161 1234 5667</phone>
        <address> 123 Main Street</address>
  <city>Manchester</city>
    </person>
...
```

**cities.xml**

```
<?xml version="1.0" encoding=”UTF-8"?>
<citylist>
  <city>
       <name>Manchester</name>
       <club>Manchester United</club>
       <club>Manchester City</club>
  </city>
  <city>
        <name>Munich</name>
        <club>Die Loewen</club>
       <club>Bayern-Muenchen</club>
  </city>
...
```

# XQuery FLOWR expressions

- **order by** allows us to order sequences before we return them
- we can combine several orderings into new ones *lexicographically*
- e.g.,

  ```
  for $nr in 1 to 5
      for $letter in ("a", "b", "c")
      order by $nr descending, $letter descending
      return concat($nr, $letter)
  ```

  yields 5c 5b 5a 4c 4b ....
- e.g.,

  ```
  for $nr in 1 to 5
      for $letter in ("a", "b", "c")
      order by $letter descending, $nr descending
      return concat($nr, $letter)
  ```

  yields 5c 4c 3c 2c 1c 5b...

# XQuery: grouping

- like SQL, XQuery provides **aggregation functions**
  - max and min
  - average
  - count, etc
- like in SQL, when we want to use them, we need to *group:*
- but this comes natural, e.g.,

```
for $an in fn:distinct-values(doc("orders.xml")/orderlist/order/artNr)
let $arts := doc("orders.xml")/orderlist/order[artNr = $an]
where fn:count($arts) >= 3
return
  <high-demand-item>
    <articleNr> { $an } </articleNr>
    <maxPrice> { fn:max($arts/price) } </maxPrice>
    <avgPrice>  { fn:avg($arts/price) } </avgPrice>
  </high-demand-item>
```

# Examples

contactlist.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<contactList>
  <person categ="friend" age="25">
    <name>
      <lastname>Doe</lastname>
      <firstname>John</firstname>
    </name>
    <phone>0044 161 1234 5661</phone>
    <address> 123 Main Street</address>
    <city>Manchester</city>
  </person>
  <person categ="friend" age="14">
    <name>
      <lastname>Doen</lastname>
      <firstname>Jane</firstname>
    </name>
    <phone>0049 89 1234 5662</phone>
    <address> 25 King Street</address>
    <city>Munich</city>
  </person>
  <person categ="foe" age="45">
    <name>
      <lastname>Do</lastname>
      <firstname>Jonathan</firstname>
    </name>
    <phone>0044 161 1234 5663</phone>
    <address> 12 Queen Street</address>
    <city>Manchester</city>
  </person>
  <person categ="foe" age="13">
    <name>
      <lastname>Dove</lastname>
      <firstname>Jamie</firstname>
    </name>
    <phone>0049 89 1234 5664</phone>
    <address> 23 Main Street</address>
    <city>Munich</city>
  </person>
</contactList>
```

# Example queries

- Q1:
  ```
  for $b in doc("contactlist.xml")/contactList/
            person[@categ = "friend"][position() = 1]
  return $b
  ```

- Q2:
  ```
  for $b at $p in doc("contactlist.xml")/
            contactList/person[@categ = "foe"]
  where $p = 2
  return $b
  ```

- Q3:
  ```
  for $b at $p in doc("contactlist.xml")/
            contactList/person[@categ = "foe"]
  where $p = 3
  return $b
  ```

- Q4:
  ```
  for $p in doc("contactlist.xml")/contactList/person[@age > 16]
  return $p/name
  ```

# Example queries (cont.)

- Q5:

```
for $p in doc("contactlist.xml")/contactList/person
return $p/phone
```

- Q6:

```
let $doc := doc("contactlist.xml")
for $p in $doc/contactList/person
let $a := xs:integer($p/@age)
let $c := xs:string($p/@categ)
where $a < xs:integer(16)
and $c = "foe"
return $p
```

- Q7:

```
for $c in fn:distinct-values(doc("contactlist.xml")/contactList/person/city)
let $p := doc("contactlist.xml")/contactList/person[city = $c]
order by fn:avg($p/@age)
return
<city name = "{$c}">
   <avg_age>{fn:avg($p/@age)}</avg_age>
</city>
```

# XQuery: functions

- XQuery is more than FLWOR expression
- it provides more than 100 built-in functions, we have already seen some, plus
  - e.g., <name>{uppercase($p/lastname)}</name>
  - e.g., let $nickname := (substring($p/firstname,1,4))
- it allows the user to define functions

```
declare function prefix:function_name(($parameter as datatype)*)
 as returnDatatype
{
(: ...your function code here... :)
};
```

- e.g.,

```
declare function local:minPrice(
  $price as xs:decimal,
  $discount as xs:decimal )
as xs:decimal {
   let $disc := ($price * $discount) div 100
   return ($price - $disc) }
```

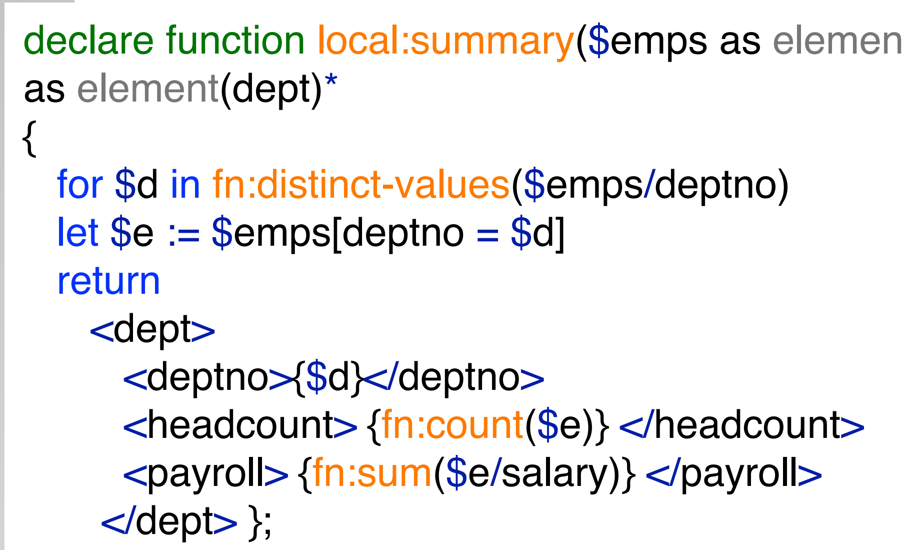
to be used e.g., in

```
<minPrice>
   { local:minPrice($book/price,
                    $book/discount)}
</minPrice>
```

# XQuery: functions

- XQuery is more than FLWOR expression
- it provides more than 100 built-in functions, we have already seen some, plus
  - e.g., <name>{uppercase($p/lastname)}</name>
  - e.g., let $nickname := (substring($p/firstname,1,4))
- it allows the user to define functions

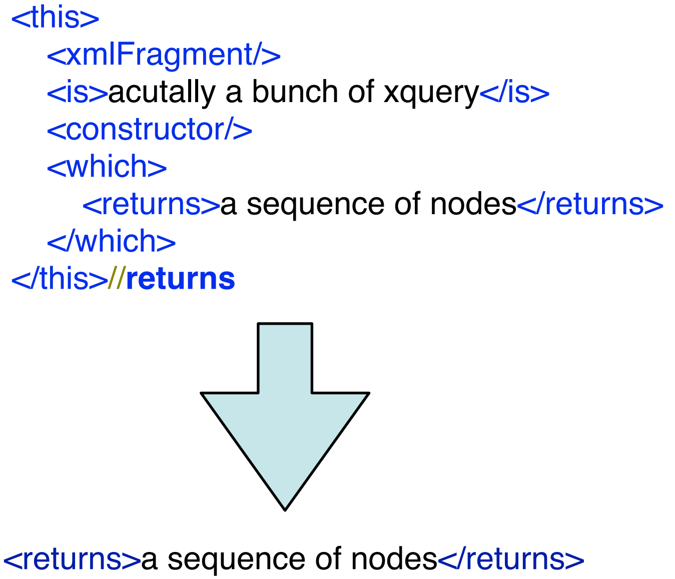
To summarize the departments from Manchester, use:
local:summary(doc("acme_corp.xml")//employee[location = “Manchester"])



```
declare function local:summary($emps as element(employee)*)
as element(dept)*
{
   for $d in fn:distinct-values($emps/deptno)
   let $e := $emps[deptno = $d]
   return
      <dept>
         <deptno>{$d}</deptno>
         <headcount> {fn:count($e)} </headcount>
         <payroll> {fn:sum($e/salary)} </payroll>
       </dept> };
```

# XQuery Functions: Closure

- XQuery is compositional
  - a query returns a **node sequence**
  - a functions return **node sequence**
    - A single node is a singleton node sequence and vice versa
  - So we can write queries with functions at key steps
    - Not just in predicate tests!



```
<this>
   <xmlFragment/>
   <is>acutally a bunch of xquery</is>
   <constructor/>
   <which>
      <returns>a sequence of nodes</returns>
   </which>
</this>//returns
```

```
<returns>a sequence of nodes</returns>
```

# XQuery Functions: Closure

- XQuery is compositional
  - – a query returns a **node sequence**
  - – a functions return **node sequence**
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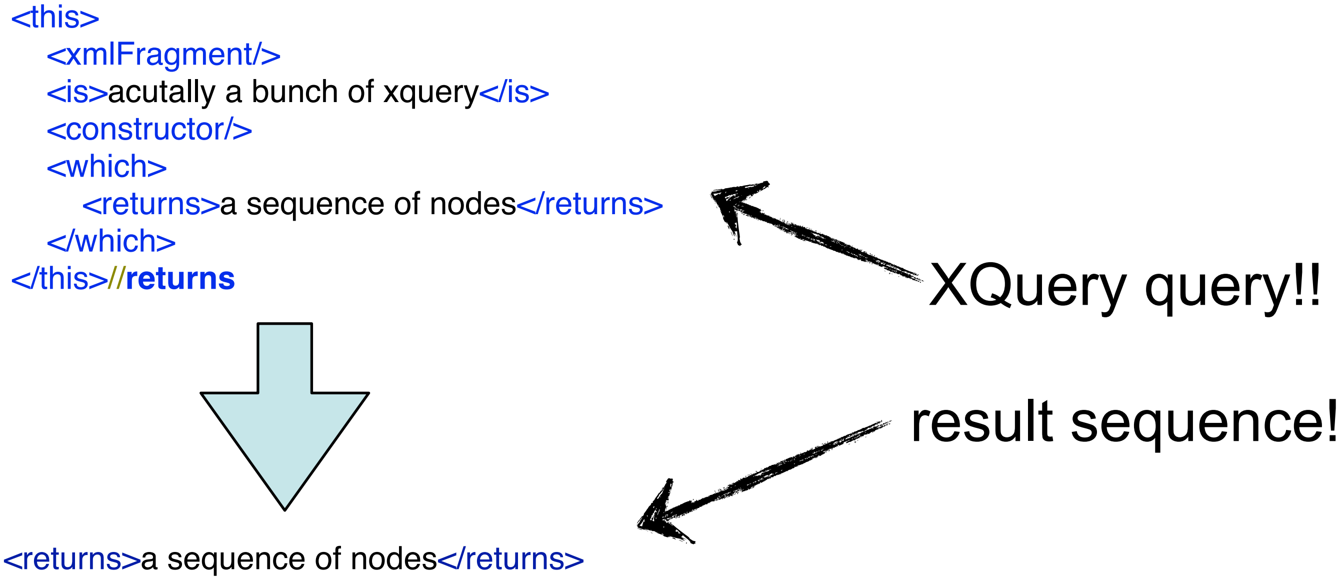


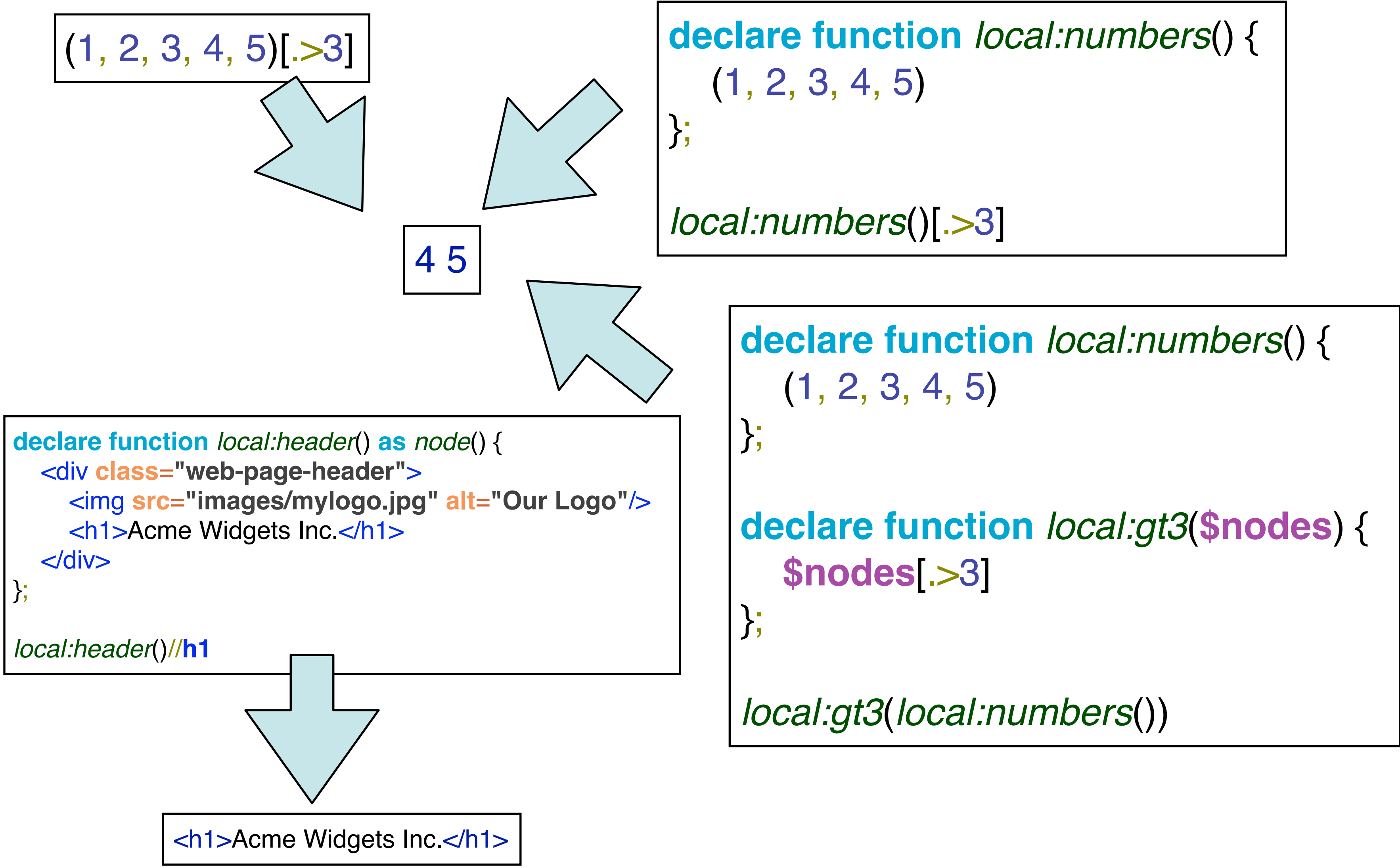
```
<this>
   <xmlFragment/>
   <is>acutally a bunch of xquery</is>
   <constructor/>
   <which>
      <returns>a sequence of nodes</returns>
   </which>
</this>//returns
```

XQuery query!!

result sequence!

```
<returns>a sequence of nodes</returns>
```

# XQuery Functions: Closure



```
(1, 2, 3, 4, 5)[.>3]
```

```
declare function local:numbers() {
    (1, 2, 3, 4, 5)
};

local:numbers()[.>3]
```

```
declare function local:numbers() {
    (1, 2, 3, 4, 5)
};

declare function local:gt3($nodes) {
    $nodes[.>3]
};

local:gt3(local:numbers())
```

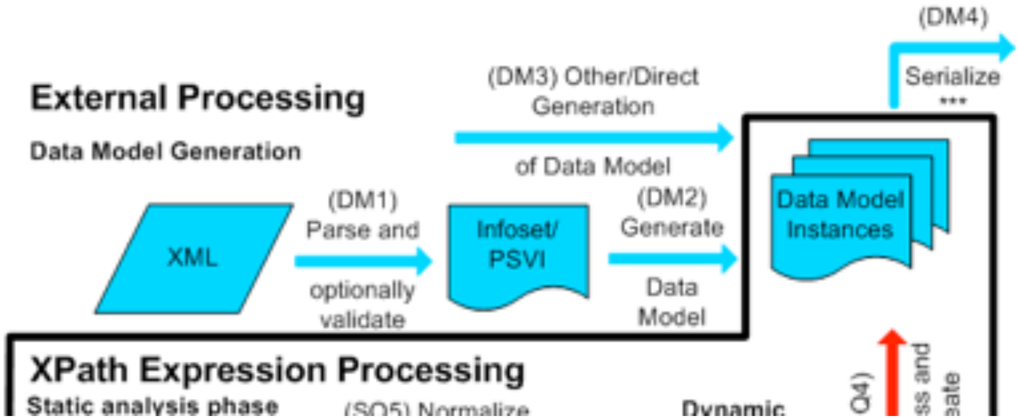
```
4 5
```

```
declare function local:header() as node() {
   <div class="web-page-header">
      <img src="images/mylogo.jpg" alt="Our Logo"/>
      <h1>Acme Widgets Inc.</h1>
   </div>
};

local:header()//h1
```

```
<h1>Acme Widgets Inc.</h1>
```

# XQuery, schemas, and types



- if you query documents that are associated with a **schema**, you can exploit **schema-aware query answering**:
  - WXS has **default values**, e.g., answer to this query may vary depending on your schema!

```
for $m in
doc('personal.xml')//*[@isFriend = 'true']
return $m/name/family/text()
```

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified">
  <xs:element name="person"/>
  <xs:attributeGroup name="attlist.person">
    <xs:attribute name="id" use="required" type="xs:ID"/>
    <xs:attribute name="isFriend" default="true">
      <xs:simpleType>
        <xs:restriction base="xs:token">
          <xs:enumeration value="true"/>
          <xs:enumeration value="false"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:attribute>
  </xs:attributeGroup>
</xs:schema>
```

# XQuery, schemas, and types

- if you query documents that are associated with a **schema**, you can exploit **schema-aware query answering**, eg XML Schema aware like SAXON-EE:
  - careful if you use <oXygen>: it sometimes confuses SAXON-HE/SAXON-**EE**
  - WXS has **default values**, e.g., answer to this query may vary depending on your schema

```
import schema namespace uli="www.uli.org" at "test4.xsd";
for $m in doc('Untitled7.xml')//uli:nEl
return  data($m/@attr)
```

```
<?xml version="1.0" encoding="UTF-8"?>
<uli:nlist xmlns:uli="www.uli.org"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="www.uli.org file:test4.xsd">
   <uli:nEl>3</uli:nEl>
   <uli:nEl attr="4">4</uli:nEl>
   <uli:nEl>5</uli:nEl>
</uli:nlist>
```

```
…
<xs:element name="nlist">
      <xs:complexType>
         <xs:sequence>
            <xs:element name="nEl"
               type="uli:number"
               maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>

   <xs:complexType name="number">
       <xs:simpleContent>
       <xs:extension base="xs:integer">
       <xs:attribute name="attr"
          default="15"/>
       </xs:extension>
       </xs:simpleContent>
   </xs:complexType>
```

# XQuery, schemas, and types

- if you query documents that are associated with a **schema**, you can exploit **schema-aware query answering**, eg XML Schema aware like SAXON-SA:
  - WXS has **types**, e.g., answer to this query may vary depending on your schema

```
module namespace;
import schema namespace uli="www.uli.org" at "test4.xsd";
for $m in doc(‘Untitled5.xml')//element(*, uli:A)
return $m/uli:friend/text()
```

```
<?xml version="1.0" encoding="UTF-8"?>
<uli:list xmlns:xsi=
        "http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="www.uli.org test4.xsd"
    xmlns:uli="www.uli.org">
  <uli:friend>Paul</uli:friend>
  <uli:friend>Peter</uli:friend>
  <uli:friend>Mary</uli:friend>
  <uli:friend>Joanne</uli:friend>
  <uli:friend>Lucy</uli:friend>
</uli:list>
```

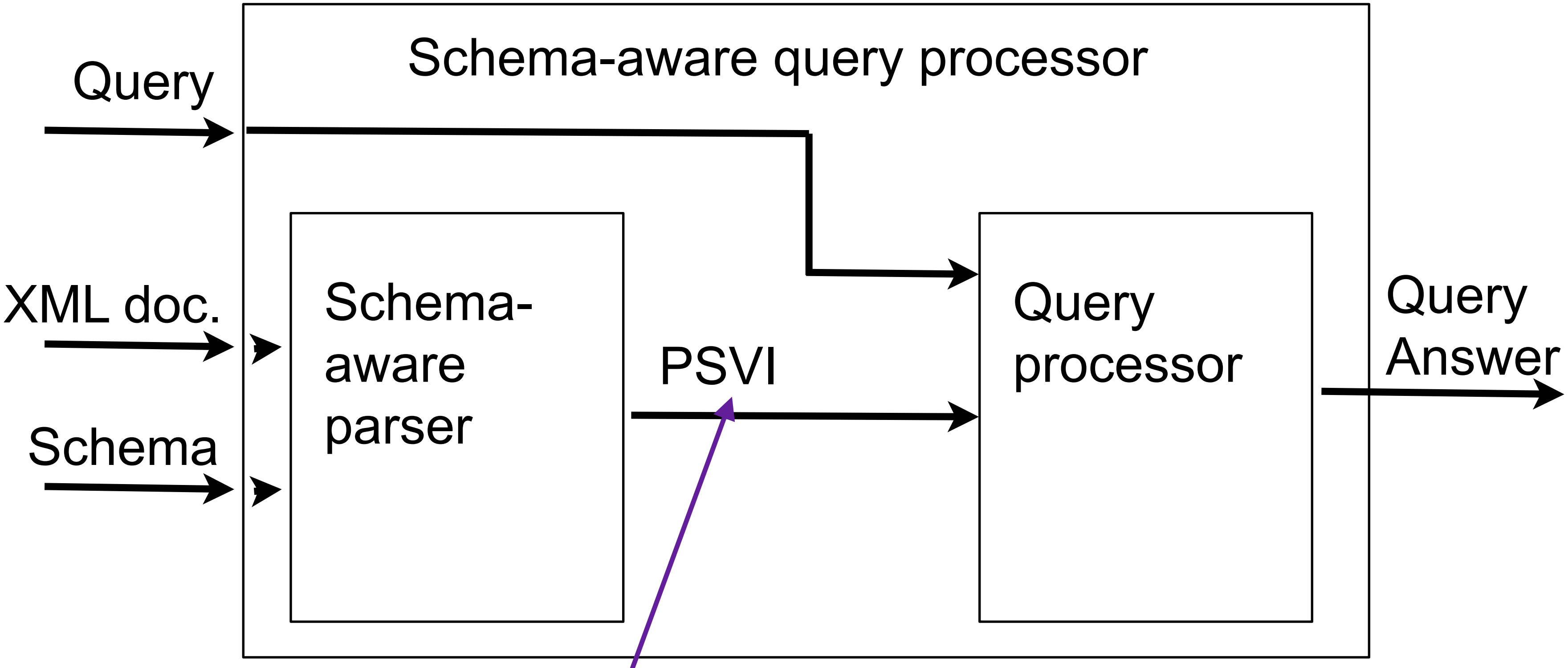
```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs=
       "http://www.w3.org/2001/XMLSchema"
  targetNamespace="www.uli.org"
  xmlns:uliS="www.uli.org"
  elementFormDefault="qualified">

<xs:element name="list" type="uliS:B">
  </xs:element>

<xs:complexType name="A">
  <xs:sequence>
    <xs:element name="friend” type='xs:string'
      minOccurs = '3'  maxOccurs ='5'/>
  </xs:sequence></xs:complexType>

  <xs:complexType name="B">
    <xs:complexContent>
    <xs:restriction base="uliS:A">
    <xs:sequence>
      <xs:element name="friend" type='xs:string'
        minOccurs = '4'  maxOccurs ='5'/>
    </xs:sequence></xs:restriction>
    </xs:complexContent>
  </xs:complexType>
```

# XQuery, schemas, and types: the PSVI

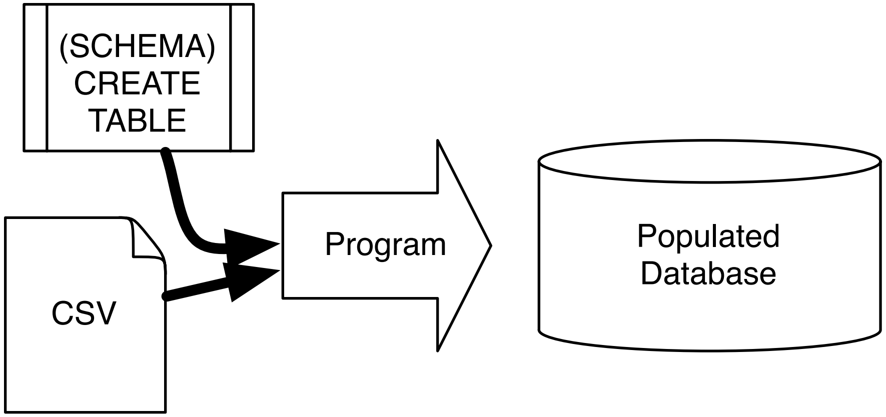


**P**ost-**s**chema-**v**alidation **i**nfoset:
Internal Rep. adorned with schema information
e.g., a tree adorned with default values & types

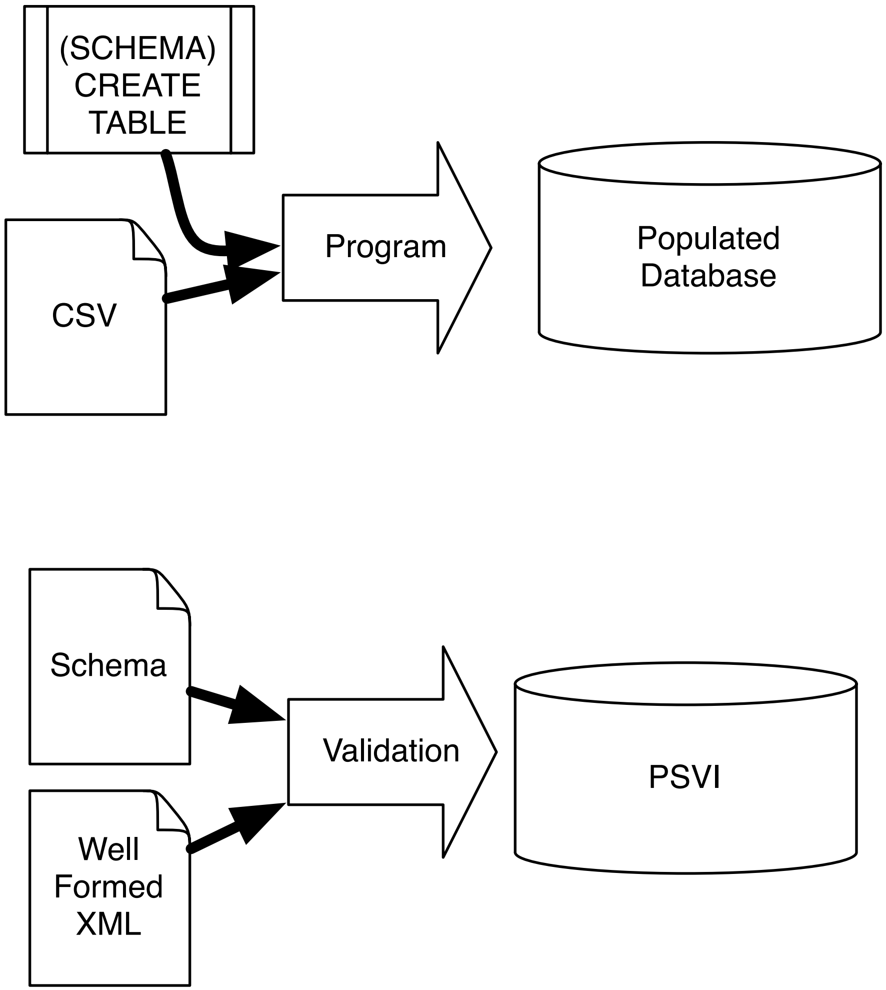
# Quick Note on PSVI

- Post Schema-Validation Infoset
  - First approximation: DOM + Schema Information
    - What kind of information?
      - Default attribute (and other) values
      - Type information
  - Remember node types in the DOM
    - Atomic values are all *text* (string)
    - But WXS lets us have loads of atomic types!
      - As well as simple and complex types!
    - XQuery (and XPath >=2.0) can be sensitive to those types
    - Thus, that type information has to get into the queried data
- PSVIs are known to be valid!
  - Thus we can make some assumptions about their structure

# SQL intuition on PSVI



# SQL intuition on PSVI



# Namespace, schemas, and queries

- schemas and queries can be used together in a powerful way
  - e.g., to retrieve values *and* default values
  - e.g., by exploiting type hierarchy in query: this can have various advantage:
    - we can safe big ‘unions’ of queries through querying for instances of super types
    - should we change our schema/want to work with documents with new kind of elements (see XML/OWL coursework), it may suffice to adapt the schema to new types; queries may remain unchanged!
- usage of namespace, schemas, and queries is a bit tricky:
  - when to use/declare which namespace/prefix where
  - tool support required
- more in coursework and later

# Coursework: SEs

- As you (should) know by now, we use **rubrics** to mark
  - for SEs and others
  - for coursework and exam
- For you to understand these better, you are going to **apply**
  - SE2 rubric to
  - SE2 essay of a friend
  - …we printed rubrics for you:
    - find a friend (or 2)
    - take a rubric each
    - swap your SE2 essays (e.g. via email)
    - mark each other's essays
    - discuss the outcome
    - submit a guess for your own mark for SE2 on BB as GuessSE2
    - …keep this in mind when you write
      - SE3, SE4, SE5
      - exam
      - your thesis

# Coursework this week

- Get to know tools/oxygen better:
  - use it to test your understanding of XPath
  - collect a fine sample of XML docs, XSDs, RNGs, …

- Q3:
  - use tools to answer questions
- CW3:
  - XQuery for arithmetic learning site
- M3: XPath, XQueries, and XSD
  - do this before SE3
- SE3: robustness, schemas, and different query styles
  - think/read about robustness
  - do M3 before you do this