

XPath

Mario Alviano

University of Calabria, Italy

A.Y. 2018/2019

- 1 Introduction
- 2 XPath expressions
 - Path expressions
 - Value expressions
 - Node set expressions
- 3 Examples
- 4 Exercises

- 1 Introduction
- 2 XPath expressions
 - Path expressions
 - Value expressions
 - Node set expressions
- 3 Examples
- 4 Exercises

- How to access information stored in an XML document?

Why XPath?

- How to access information stored in an XML document?
- XPath is a query language for XML
 - Useful to select parts of an XML document
 - Allows to check whether given conditions are satisfied
 - Thought for the hierarchical structure of XML documents

Why XPath?

- How to access information stored in an XML document?
- XPath is a query language for XML
 - Useful to select parts of an XML document
 - Allows to check whether given conditions are satisfied
 - Thought for the hierarchical structure of XML documents
- XPath has been successful in the XML community
- It is used by many languages
- It will be used for many years! (maybe)

Why XPath?

- How to access information stored in an XML document?
- XPath is a query language for XML
 - Useful to select parts of an XML document
 - Allows to check whether given conditions are satisfied
 - Thought for the hierarchical structure of XML documents
- XPath has been successful in the XML community
- It is used by many languages
- It will be used for many years! (maybe)

Example. XPath expression

```
/company/employee[@id="123"]/salary
```

1 Introduction

2 XPath expressions

- Path expressions
- Value expressions
- Node set expressions

3 Examples

4 Exercises

- The main concept in XPath is that of **expression**
- There are three types of expressions

- The main concept in XPath is that of **expression**
- There are three types of expressions
 - 1 **Value expression:** allow to define propositions on values

- The main concept in XPath is that of **expression**
- There are three types of expressions
 - 1 **Value expression:** allow to define propositions on values
 - 2 **Path expression:** allow to select parts of the XML document

- The main concept in XPath is that of **expression**
- There are three types of expressions
 - 1 **Value expression:** allow to define propositions on values
 - 2 **Path expression:** allow to select parts of the XML document
 - 3 **Node set expression:** allow to combine results of several expressions

1 Introduction

2 XPath expressions

- Path expressions
- Value expressions
- Node set expressions

3 Examples

4 Exercises

- Path expressions can be relative or absolute (if start with /)

Path expressions

- Path expressions can be relative or absolute (if start with /)
- Are made of a sequence of **steps** separated by /

Path expressions

- Path expressions can be relative or absolute (if start with /)
- Are made of a sequence of **steps** separated by /
- Each step has three parts
 - 1 an **axis**
 - 2 a **node-test**
 - 3 zero or more **predicates**

```
axis::node-test [predicates]
```


Path expressions

- Path expressions can be relative or absolute (if start with /)
- Are made of a sequence of **steps** separated by /
- Each step has three parts
 - 1 an **axis**
 - 2 a **node-test**
 - 3 zero or more **predicates**

```
axis::node-test [predicates]
```

At each step, the context (i.e., the result) is modified following the axis, then restricted to the elements with name equal to `node-test`, and eventually filtered by predicates.

Path expressions: axis

- Axis modify the context

Path expressions: axis

- Axis modify the context
- Valid axis are
 - child (default) and descendant (roughly /)
 - parent (..) and ancestor
 - following-sibling and preceding-sibling
 - self (.), descendant-or-self and ancestor-or-self
 - following and preceding
 - attribute (@) and namespace

Path expressions: axis

- Axis modify the context
- Valid axis are
 - child (default) and descendant (roughly /)
 - parent (..) and ancestor
 - following-sibling and preceding-sibling
 - self (.), descendant-or-self and ancestor-or-self
 - following and preceding
 - attribute (@) and namespace

Examples

- All the ancestors of professors that were professors
`//professor/ancestor::professor`
Note: we used the / abbreviation. It is similar to descendant, but according to the W3C specification “// is short for /descendant-or-self::node() /”
- Titles of movies
`movies/title`

- Node-tests restrict the context

- Node-tests restrict the context
- Valid node-tests are
 - The name of an element
 - The wildcard *
 - `comment()`
 - `text()`
 - `processing-instruction()`
 - `node()`

Path expressions: node-tests

- Node-tests restrict the context
- Valid node-tests are
 - The name of an element
 - The wildcard *
 - `comment()`
 - `text()`
 - `processing-instruction()`
 - `node()`

Warning!

The node-test * restricts the context to elements only, while `node()` restricts the context to elements and attributes only.

- Predicates allow to further filter the context

Path expressions: predicates

- Predicates allow to further filter the context
- Any value expression can be used (see the next slide)

- Predicates allow to further filter the context
- Any value expression can be used (see the next slide)
- Non-boolean expressions are interpreted as follows:
 - integers: equivalent to `position() = the-result-of-the-expression`
 - strings: true if the string is nonempty
 - node sets: true if the node set is nonempty

- 1 Introduction
- 2 XPath expressions
 - Path expressions
 - **Value expressions**
 - Node set expressions
- 3 Examples
- 4 Exercises

- Value expressions include
 - Strings and numeric literals: "home", 42, 1.23, ...
 - Variable references: \$x, \$y, \$myVar, ...
 - Function invocation: fn:upper-case(\$x), ...
 - Logic and arithmetic comparison: \$x < 10,
\$x > 5 or \$x < 2, ...
 - Path expressions

Value expressions: functions

- Value expressions can use several functions
- XPath functions are defined in the namespace

`http://www.w3.org/2005/xpath-functions`

- `last()`: position of the last element in the context
- `position()`: position of each element in the context
- `string(arg)`, `concat(s1, s2, ...)`,
`starts-with(s1, s2)`, `contains(s1, s2)`,
`substring(s, start, len?)`, `string-length(s)`,
`normalize-space(s)`
- `Boolean(arg)`, `not(arg)`, `true()`, `false()`
- `lang(lang)`: true if the language of the current node is that given in the argument
- `number(arg)`, `floor(number)`, `ceiling(number)`,
`round(number)`
- `count(arg, arg, ...)`, `sum(arg, arg, ...)`,
`min(arg, arg, ...)`, `max(arg, arg, ...)`,
`avg(arg, arg, ...)`
- **Convention:** use the prefix `fn`

1 Introduction

2 XPath expressions

- Path expressions
- Value expressions
- Node set expressions

3 Examples

4 Exercises

- Allow to combine contexts obtained by several expressions
 - | (union)
 - intersect
 - except
 - , (concatenation)

- 1 Introduction
- 2 XPath expressions
 - Path expressions
 - Value expressions
 - Node set expressions
- 3 Examples**
- 4 Exercises


```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: /Library

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: /Library/Book/Chapter

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Chapter

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Part [@title="Kilo"]/Chapter

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression:

```
/descendant::Part[attribute::title="Kilo"]/child::Chapter
```

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: `//*[name()!="Part"]/Chapter`

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Part[Chapter="Indus to the Ganges"]

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Chapter[@title="Papa"]/ancestor::*


```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Part[@title="Golf"]/ancestor::*

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Part[@title="Golf"]/descendant::*

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Part[@title="Golf"]/following::*

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Part[@title="Golf"]/preceding::*

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Part[@title="Golf"]/self::*

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Book[@title="Juliet"]/preceding-sibling::*

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Chapter[@title="Papa"]/..

```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Chapter[@title="Papa"]/ancestor::*[1]


```
<Library title="Alpha">
  <Book title="Bravo">
    <Chapter title="Charlie">Traveling with a poodle</Chapter>
    <Chapter title="Delta">Mouth of the Mississippi</Chapter>
  </Book>
  <Book title="Echo">
    <Chapter title="Foxtrot">Dance to four-quarters time</Chapter>
    <Part title="Golf">
      <Chapter title="Hotel">Check in, but not out</Chapter>
      <Chapter title="India">Indus to the Ganges</Chapter>
    </Part>
  </Book>
  <Book title="Juliet">
    <Part title="Kilo">
      <Chapter title="Lima">Peru is here too</Chapter>
      <Chapter title="Mike">Decorated Sistine Chapel</Chapter>
    </Part>
    <Part title="November">
      <Chapter title="Oscar">Academy Awards</Chapter>
      <Chapter title="Papa">To me he was so wonderful</Chapter>
    </Part>
  </Book>
</Library>
```

XPath expression: //Chapter[contains(@title, "r")]

- 1 Introduction
- 2 XPath expressions
 - Path expressions
 - Value expressions
 - Node set expressions
- 3 Examples
- 4 Exercises

- XPath with libxml

- `xmllint -xpath XPathExpression XMLfile`

- **There is also an interactive shell**

- `xmllint -shell`

- XPath with libxml

- `xmllint -xpath XPathExpression XMLfile`

- There is also an interactive shell

- `xmllint -shell`

- XPath with Eclipse EE

- XPath expressions are applied from the element on which the cursor is placed

■ XPath with libxml

- `xmllint -xpath XPathExpression XMLfile`
- There is also an interactive shell
`xmllint -shell`

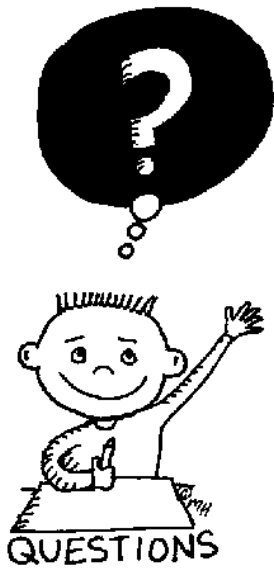
■ XPath with Eclipse EE

- XPath expressions are applied from the element on which the cursor is placed

1 Try the examples on **library.xml**

2 There are several, interesting exercises at

<http://learn.onion.net/language=en/35426/w3c-xpath>



END OF THE
LECTURE