Database Tutorial 6: XML, DTDs, XPath, XQuery

2015-01-27

1 Repetition

1.1 XML

- Tree structure
- Opening and closing Tags
- Case-sensitive
- Elements, Attributes and Text elements

Example:

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

<!-- put the DTD here -->

<Hogwarts>
 <Rooms>
  <Room name="The_Dungeon" nrSeats="34" />
  <Room name="The_Cabin" nrSeats="163" />
 </Rooms>
 <Teachers>
  <Teacher name="Snape" room="The_Dungeon" >
   <Title>Professor</Title>
  </Teacher>
  <Teacher name="Hagrid" room="The_Cabin" />
 </Teachers>
 <Courses>
  <Course name="Potioncraft" teacher="Snape" nrStudents="28">
   <Class day="Monday" hour="10" />
  </Course>
  <Course name="Handling_of_Wild_Creatures" teacher="Hagrid">
   <Class day="Saturday" hour="13" />
   <Class day="Thursday" hour="7" />
  </Course>
 </Courses>
</Hogwarts>
```

1.2 DTD

- Rules for Elements, Attributes (and Entities).

- Keys and references (ID and IDREF)
- Choice (—) and Cardinalities (? at most one, + one ore more, * zero or more)

```
element ::= '<!ELEMENT' Name content '>'
content ::= 'EMPTY' | 'ANY' | #PCDATA | children
children::= children '+' | children '*' | children '?' | children '|' children | ...

attlist ::= '<!ATTLIST' Name (Name type default)* '>'
type    ::= 'CDATA' | 'ID' | 'IDREF' | ...
default ::= '#REQUIRED' | '#IMPLIED' | ('#FIXED')? value
```

Example:

```
<!DOCTYPE Hogwarts [

<!ELEMENT Hogwarts (Rooms, Teachers, Courses) >

<!ELEMENT Rooms (Room*) >
 <!ELEMENT Room EMPTY >
  <!ATTLIST Room
    name    ID    #REQUIRED
    nrSeats CDATA #IMPLIED >

<!ELEMENT Teachers (Teacher*) >
 <!ELEMENT Teacher (Title*) >
  <!ELEMENT Title (#PCDATA) >
  <!ATTLIST Teacher
    name ID    #REQUIRED
    room IDREF #REQUIRED >

<!ELEMENT Courses (Course*) >
 <!ELEMENT Course (Class*) >
  <!ATTLIST Course
    name       ID    #REQUIRED
    teacher    IDREF #REQUIRED
    nrStudents CDATA #IMPLIED >
  <!ELEMENT Class EMPTY >
   <!ATTLIST Class
     day    CDATA #REQUIRED
     hour   CDATA #REQUIRED >
]>
```

1.3 XPath

Symbol	Meaning
/	Root
.	Current Element
..	Parent Element
//*	All elements anywhere
elem1/elem2	Path
[*test*]	Condition (to filter)
@Att	Attribute

Example:

```
Find all courses that have at least 20 students:
//Course[@nrStudents >= 20]

List all professors at the school:
//Teacher[Title = "Professor"]

Find all rooms that are used on Mondays:
//Room[@name = //Teacher[@name = //Course[Class/@day = "Monday"]/@teacher]/@room]
```

1.4 XQuery

- Basic structure of an XQuery expression is:
  - FOR-LET-WHERE-ORDER BY-RETURN.
  - Called FLWOR expressions (pronounce as flower).
- A FLWOR expression can have any number of FOR (iterate) and LET (assign) clauses, possibly mixed, followed by possibly a WHERE clause and possibly an ORDER BY clause.
- Only required part is RETURN.

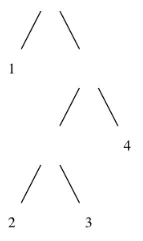
Example:

```
for $class in //Class[@day="Monday"]
for $teacher in $class/../@teacher
for $room in data(//Teacher[@name=$teacher]/@room)
return <room>{$room}</room>
```

2 Exercises

2.1 Exam HT2016

1. (8 points)
   A binary tree is a tree whose every node either branches to two binary trees or is a leaf, i.e. contains a value. Here is an example of a binary tree:



   (a) (3 points) Design a DTD for representing binary trees and nothing but binary trees. The branching nodes should not carry any information, whereas every leaf should carry a value that can be any string (#PCDATA).

   (b) (3 points) Show an XML element representing the above example tree, and which is valid according to your DTD.

   (c) (2 points) Write an XPath query that returns all leaf elements of a binary tree. For the above example, it should return 1,2,3,4 (without any XML tags).

2.2 Exam HT2014

1. (8 points)

```
<Question7>
  <Applicants>
    <Applicant name="Andersson" appNum="a1" />
    <Applicant name="Jonsson" appNum="a2" />
    <Applicant name="Larsson" appNum="a3" />
  </Applicants>
  <Choices>
    <Choice applicant="a1" code="MPSOF" choiceNum="1" meritScore="750" />
    <Choice applicant="a1" code="MPALG" choiceNum="2" meritScore="750" />
    <Choice applicant="a1" code="MPCSN" choiceNum="3" meritScore="800" />
    <Choice applicant="a2" code="MPALG" choiceNum="1" meritScore="700" />
    <Choice applicant="a3" code="MPCSN" choiceNum="1" meritScore="850" />
    <Choice applicant="a3" code="MPALG" choiceNum="2" meritScore="850" />
  </Choices>
</Question7>
```

   (a) (2 points) Write a Document Type Definition (DTD) for the XML that is given above

   (b) (1 point) Write an XPath expression that finds Choice elements where the choice number is 1 and the merit score is greater than 800.

   (c) (2 points) The flexibility of XML enables us to nest elements in a more natural way than in the example shown at the top of this question. Write a piece of XML that contains the same information as in the example shown above, but which uses nesting, and avoids duplication of applicant identifiers.

   (d) (3 points) Assuming that the XML shown above is in file exam.xml, write an XQuery expression that constructs your solution to part (c).