XQuery – Continued.

csc343, Introduction to Databases
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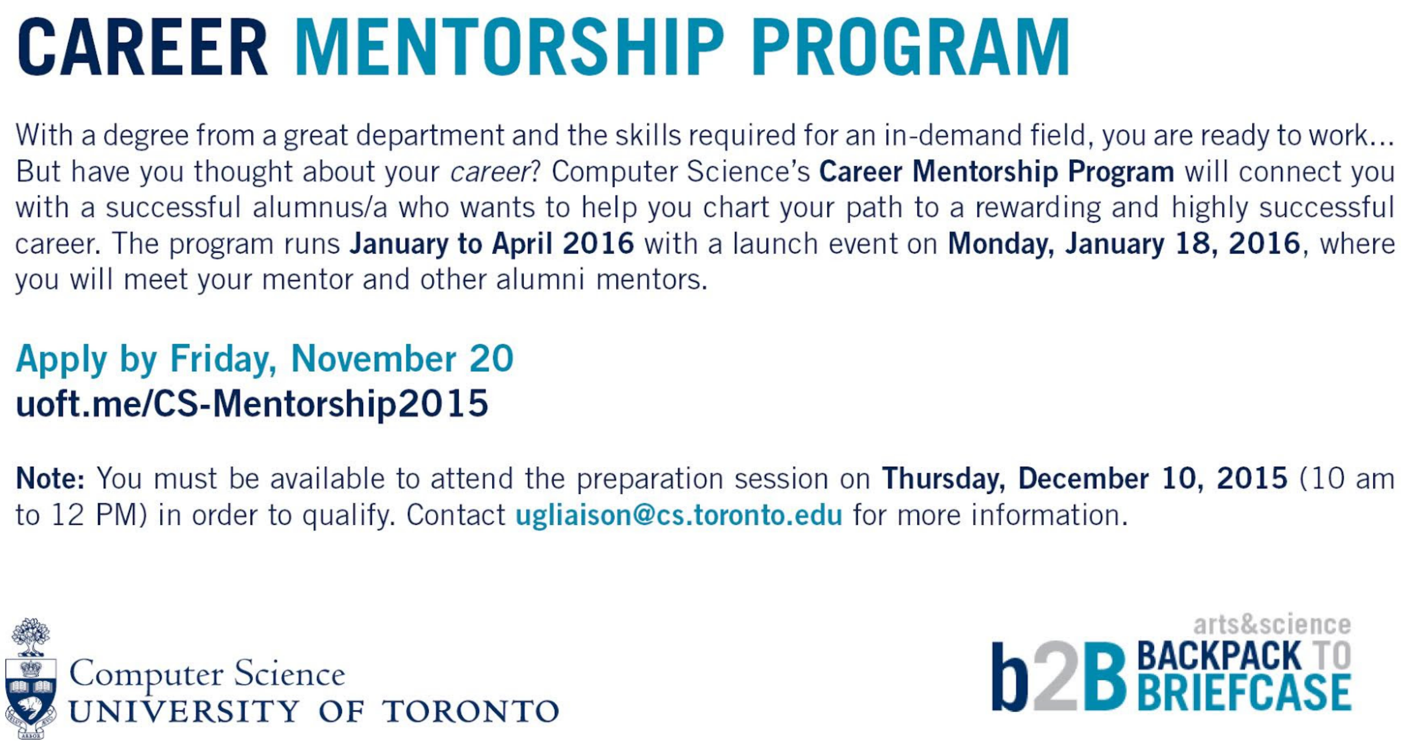
Announcements

- Welcome back from the Fall "Break"
- Q: How are prep exercises graded (7%)?
  - We will consider **the best 7** prep marks you get, out of all preps in the course (~10)



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- Mentorship website has more info: http://web.cs.toronto.edu/program/ugrad/mentor.htm
- This program is intended for undergraduates in a Computer Science Major or Specialist

XQuery

- FLWOR Example:

```
let $d := fn:doc(“bank.xml”)
for $tfq in $d//TFQuestion
where $tfq/@answer=”True”
order by $qid
return $tfq/question
```

- Example:

```
<title>Facts about Canada</title>
<truth>
{ let $d := fn:doc(“bank.xml”)
  return $d//tf-question[@solution=”true”]/question
}
</truth>
```

Generous comparison

- If A and B are sequences, A=B means
  $\exists$ x∈A, y∈B such that x=y.
- Examples:
  - `(1,2) = (2,3)` is true.

  - Given that a "race" element contains multiple "results",

    this path expression:

    `fn:doc("races.xml")//race[result < 3.50]`

    yields races that include *any* result less than 3.50.

Strict comparison

- Alternative: The comparison operators
  `eq   ne   lt   le   gt   ge`
  succeed only if both sequences have length one.
- Example:

```
fn:doc("races.xml")
                //race[sponsor eq "HarryRosen"]
```

  is true if the LHS yields a sequence of length one that is `"HarryRosen"`.

Eliminating duplicates

- Apply function `distinct-values` to a sequence.
- Subtlety:
  - It strips tags away from elements and compares the string values.
  - But it doesn't restore the tags in the result.
- Example:

```
let $d := fn:doc("races.xml")
return distinct-values($d//result)
```

More kinds of expressions

Branching expressions

- Form: `if («E1») then «E2» else «E3»`
- All three parts are required.
- Value of the if expression is
  - *E2* if the EBV of *E1* is true, and
  - *E3* if the EBV of *E1* is false.

    (EBV = Effective Boolean Value)
- Example:

```
if ($q/@solution="True")
then $q/question else ()
```

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Any type can be treated as boolean

- Like many languages, we can treat anything as boolean.
- The effective boolean value (EBV) of an expression is:
  - the value of the expression, if it is already of type boolean
  - otherwise it is
    - FALSE if the expression evaluates to 0, “”, or ().
    - TRUE if not.
- Example:

```
let $d := fn:doc("races.xml")
return
  if ($d//result[@who="r1"])
  then <yay/>
  else <nay/>
```

Quantifier expressions

- Form: `some` *«variable»* `in` *«E1»* `satisfies` *«E2»*
- Meaning
  - Evaluate *E1*, yielding a sequence.
  - Let the variable be each item in the sequence, and evaluate *E2* for each.
  - The value of the whole expression is true if *E2* has EBV true at least once.
- Form: `every` *«variable»* `in` *«E1»* `satisfies` *«E2»*
- Meaning is analogous.

Comparisons based on document order

- Form: *«E1»* << *«E2»* and *«E1»* >> *«E2»*
- Meaning: comes before (or after) in the document.
- Example:

```
let $d := fn:doc("races.xml")
return
   $d//race[@name="WaterfrontMarathon"]
   <<
   $d//race[@name="HarryRosen"]
```

Output, given our “races.xml” file:
true()

Set operators

- Form:

```
«E1» union «E2»
«E1» intersect «E2»
«E1» except «E2»
```

- Meaning is analogous to SQL.

- Result does not include duplicates.
- Result appears in document order.
- All based on node comparisons, not *values*

Set operators in XQuery - Examples

```
let $group1 := (<a/>,<b/>)
let $group2 := (<b/>,<c/>)
return $group1 union $group2
⇒  (<a/>,<b/>,<b/>,<c/>)

let  $a := <a/>
let  $b := <b/>
let  $c := <c/>
return ($a,$b) union ($b,$c)
⇒(<a/>,<b/>,<c/>)
```

Example

```
for $question in (doc("quiz.xml")//Question)
return if ($question/number(@weight) > 2)
       then <important>{data($question/@QID)}</important>
       else <unimportant>{data($question/@QID)}</unimportant>
```

Result:

```
<unimportant>N-15</unimportant>,
<unimportant>TF-01</unimportant>,
<important>MC-05</important>,
<unimportant>MC-08</unimportant>
```

Example

```
for $question in (doc("quiz.xml")//Question)
return if ($question[data(@weight) = "3"] or
$question[number(@weight) = 1])
        then $question
        else ()
```

Result:

```
<Question QID="TF-01" weight="1"/>, <Question QID="MC-05"
weight="3"/>
```

Example

```
let $bdoc := doc("bank.xml")
for $mcq in $bdoc//MCQuestion
for $option in $mcq//Option
return
(:
($mcq/Text, $option/Text)
:)
<Option>
   {$option/@oID}
   {$mcq/Text}
   {$option/Text}
</Option>
```

Result:

```
<Option oID="MC-01.a"><Text>What do you promise when you take the oath of citizenship?</
Text><Text>To pledge your loyalty to Queen Elizabeth II</Text></Option>,
<Option oID="MC-01.b"><Text>What do you promise when you take the oath of citizenship?</
Text><Text>To fulfill the duties of a Canadian</Text></Option>,
<Option oID="MC-01.c"><Text>What do you promise when you take the oath of citizenship?</
Text><Text>To pledge your allegiance to the flag</Text></Option>,
<Option oID="MC-01.d"><Text>What do you promise when you take the oath of citizenship?</
Text><Text>To pledge your loyalty to Canada from sea to sea</Text></Option>,
….
…
```

Note

Defining an element that has both a text (PCDATA) part but also subelements:

```
<!ELEMENT element (#PCDATA|subelement1|subelement2)*>
```

Summary of some XPath/XQuery Functionalities

Axes: Special Constructs

- Non-element axes
  - attribute: retrieve attributes of the context node
  - => e.g. <book in-print="true" >/attribute::* returns 'in-print' • namespace: retrieve node namespace(s)
  - => e.g. <amazon:book-list>/namespace::* returns 'amazon' •
- Selecting elements vs. text
- Example: <foo>abc<bar>d</bar></foo>
  - foo/child::* returns child elements only: <bar>d</bar>
  - foo/child::text() selects text children only: abc
  - foo/child::node() selects everything: abc<bar>d</bar>
- Element positions (1-based, in document order)
  - elem::position() returns position of elem w.r.t. its parent
  - elem::last() returns the number of nodes in elem

Short Forms

- Make queries more compact, easier to read
- * = all elements of current axis
- . = self::node()
- .. = parent::node()
- elem = child::elem •@ = attribute::
- // = /descendant-or-self::node()/
- [3] = [position()=3]
- [last()] = [position()=last()]

Absolute vs. Relative Paths

- Child of current context node: book/title
- At document root: /book/title
- Anywhere in document: //book/title

Predicates

- [$expr] applies boolean predicate to a node set
  - Return subset of nodes for which $expr is true
- Boolean values can be any of
  - Boolean constant: true() or false()
  - Numbers (false if -0, +0, or NaN)
  - Strings (false if zero-length)
  - Result of comparison (=, !=, <, >, etc.) => /book-list/book[price < 50]
  - Node set (true if exists/non-empty) => /book-list/book[@special-offer]
  - Compound expressions => A and B, A or B, not(A)

Nesting Path Steps and Predicates

- Path step: one segment of a path
  - e.g. /book-list/book/author/last-name has 5 path steps
- OK to chain path steps and/or predicates
  - /book-list/book[price < 50][npages > 100][3]
  - Order matters when position() is involved.
- Also OK to mix and match
  - /book-list/book[price < 50]/author[last-name='Asimov']
- Full nesting also works
  - /book-list/book[author[last-name='Asimov']]
  - Like SQL, often possible to simplify nested queries
  - => /book-list/book[author/last-name='Asimov']

Parentheses and Union Operator

- Occasionally need parenthesis for grouping
  - Often due to positional predicates: [1], [last()], etc.
  - => elem/preceding-sibling[1] != (elem/preceding-sibling)[1]
  - => //elem[1] != (//elem)[1]
- Union: combine results of 2+ XPath queries
  - Syntax: (a | b | ...)
  - e.g. title and publisher of all books written by Isaac Asimov
  - => //book[author/last-name='Asimov']/(title | publisher)
  - e.g. books whose keyword or title mentions 'robot'
  - => //book[(keyword | title)[contains(text(), 'robot')]]

Standard Functions

- Node-related
  - count($node-set) returns the cardinality of $node-set
  - id($idarg) returns the element having the specified ID (if any)
  - name($node-set) returns the tag name of $node-set[1]
- Number-related
  - number($arg?) convert $arg or . into a number
  - sum($node-set) converts the nodes to numbers and sums them
  - floor, round, and ceil all do what you'd expect

Standard Functions

- String manipulation
  - string($arg?) converts $arg or . into a string
  - starts-with($str, $prefix)
  - contains($haystack, $needle)
  - substring($str, $beg, $len?) uses 1-based indexing!
  - normalize-space($arg?) turns "\n\t ab \n\t cd \n\t" into "ab cd"
  - string-length($arg?) and concat($a,$b, ...) do what you'd expect

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Axes

- Other axes include:
  - `parent`
  - `ancestor`
  - `ancestor-or-self`
  - `following-sibling`
  - `preceding-sibling`
- See section 2.2 of the documentation for more: `http://www.w3.org/TR/xpath/#axes`