SEEBURGER

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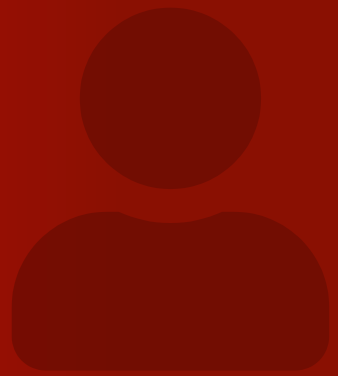
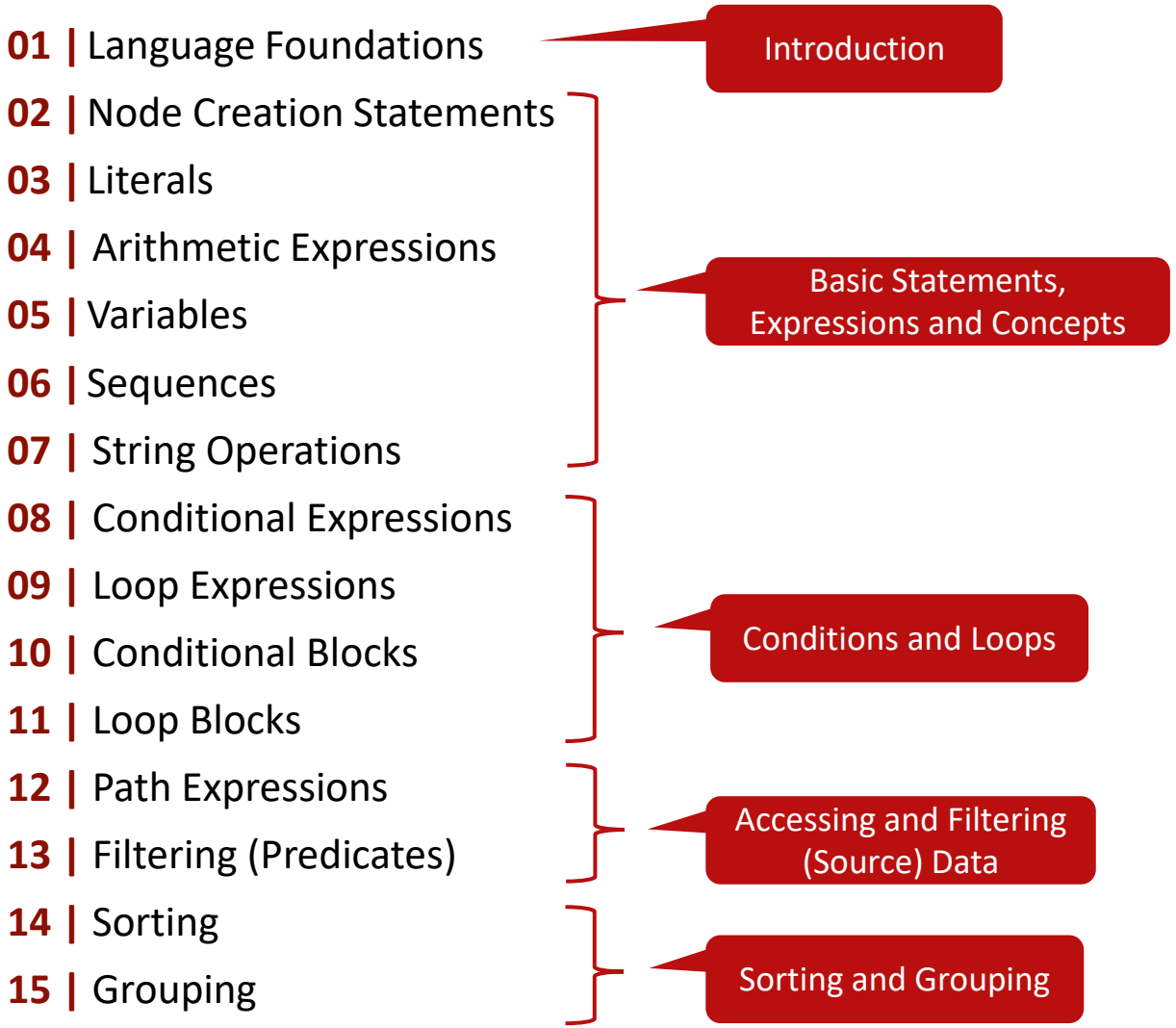
BIS Mapping Language Tutorial



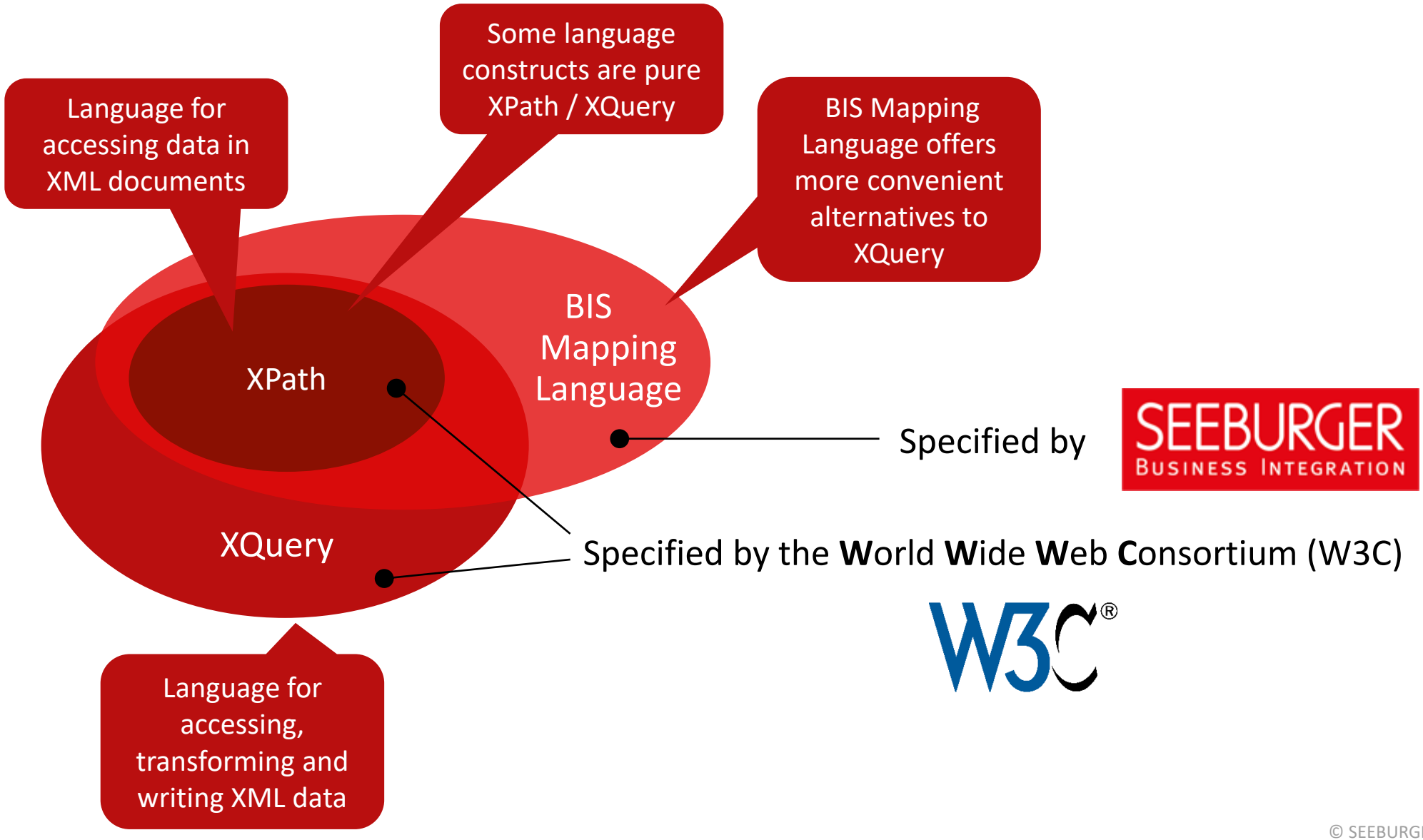
Overview


01 | Language Foundations
02 | Node Creation Statements
03 | Literals
04 | Arithmetic Expressions
05 | Variables
06 | Sequences
07 | String Operations
08 | Conditional Expressions
09 | Loop Expressions
10 | Conditional Blocks
11 | Loop Blocks
12 | Path Expressions
13 | Filtering (Predicates)
14 | Sorting
15 | Grouping
Introduction
Basic Statements, Expressions and Concepts
Conditions and Loops
Accessing and Filtering (Source) Data
Sorting and Grouping

1

Language Foundations

Language Foundations



- BIS Mapping Language is based on **XPath** and **XQuery**
- BIS Mapping Language allows to transform many different formats, not just XML
- BIS Mapping Language offers **easier syntax** for common tasks

2

Node Creation Statements

Node Creation Statements

Creating Complex Nodes

```
root
{
}
```

Node Creation Statement

Creating Leaf Nodes

```
root
{
    output := "Hello, World!"
}
```

Assignment Operator

Target Node Name

Value Assignment

Source Expression

Output

```
<root>
    <output>Hello, World!</output>
</root>
```

3

Literals

String Literals

Comments start with (: and end with :). They can span multiple lines.

```
(: String literals can be enclosed in single or double quotes :)
myString := "Hi!"
myString := 'Hi!'

(: This is especially useful if the string content contains quotation marks :)
myString := "Let's go"
myString := 'Hamlet: "To be, or not to be, that is the question"'

(: Quotation marks inside strings must be escaped with backslashes :)
myString := 'Bertrand Russell: "Science is what you know. Philosophy is what you don\'t know."'
```

Double quotes

Single quotes

Escaped single quote

Output

```
<root>
    <myString>Hi!</myString>
    <myString>Hi!</myString>
    <myString>Let's go</myString>
    <myString>Hamlet: "To be, or not to be, that is the question"</myString>
    <myString>Bertrand Russell: "Science is what you know. Philosophy is what you don't know."</myString>
</root>
```

Integer and Decimal Literals

```
(: Integer literals :)
myInteger := 42
myInteger := -23

(: Native support for big integers :)
myLargeInteger := 123987418753462384721379456189327645891264

(: Decimal literals :)
myDecimal := 3.1415
myDecimal := -6.8

(: Native support for big decimals :)
myLargeDecimal := 867168719871984687169875637841358713.681738735
```

Output

```
<root>
    <myInteger>42</myInteger>
    <myInteger>-23</myInteger>
    <myLargeInteger>123987418753462384721379456189327645891264</myLargeInteger>
    <myDecimal>3.1415</myDecimal>
    <myDecimal>-6.8</myDecimal>
    <myLargeDecimal>867168719871984687169875637841358713.681738735</myLargeDecimal>
</root>
```

Boolean Literals

```
root
{
    myBoolean := true()
    myBoolean := false()
}
```

Boolean literals need the `()` suffix to be distinguishable from path expressions

Output

```
<root>
    <myBoolean>true</myBoolean>
    <myBoolean>false</myBoolean>
</root>
```

4

Arithmetic Expressions

Arithmetic Expressions

```
root
{
    additionResult := 23 + 42
    subtractionResult := 42 - 23
    multiplicationReslt := 23 * 42
    divisionResult := 42 div 23


    integerDivisionResult := 42 idiv 23
    moduloResult := 8 mod 3

    result1 := 2 * 3 + 4
    result2 := 2 * (3 + 4)
}
```

Division operator is `div`, not `/`

Integer division cuts off fraction digits

Remainder after division

Use parentheses to prioritize computations against default operator precedence

Output

```
<root>
    <additionResult>65</additionResult>
    <subtractionResult>19</subtractionResult>
    <multiplicationReslt>966</multiplicationReslt>
    <divisionResult>1.8260869565</divisionResult>


    <integerDivisionResult>1</integerDivisionResiult>
    <moduloResult>2</moduloResult>

    <result1>10</result1>
    <result2>14</result2>
</root>
```

Rounding

```
root
{
    floor := floor(1.9)
    ceil := ceil(1.1)
    round := round(1.5)
    advancedRound := round(1.5, 0, "HALF_DOWN")
}
```

Always rounds down

Always rounds up

Advanced `round()` function takes number of fraction digits and rounding mode

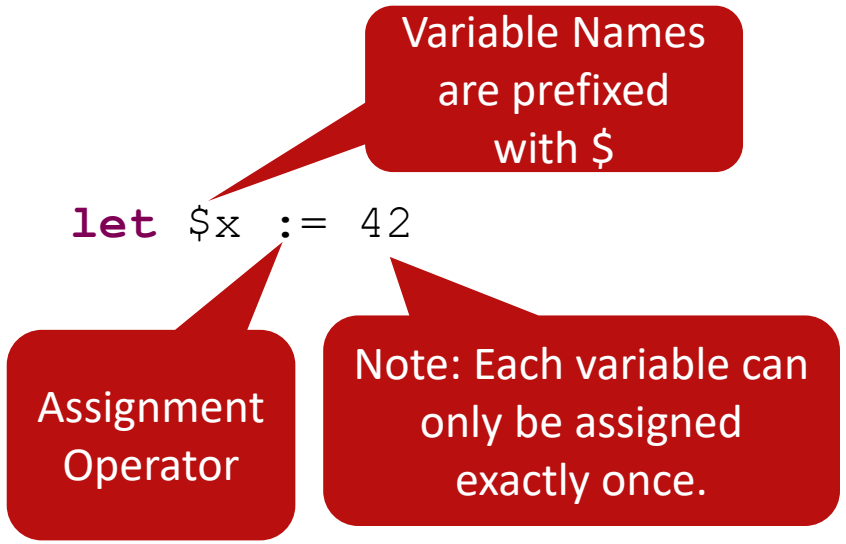
Output

```
<root>
    <floor>1</floor>
    <ceil>2</ceil>
    <round>2</round>
    <advancedRound>1</advancedRound>
</root>
```

5

Variables

Variable Declarations with Let Clauses



Variables cannot be re-assigned (they are **immutable**). The following operations are illegal in functional / declarative languages:

```
let $i := 42
$i := 23
$i := $i + 1
```

How can we aggregate data like sums?
How can we append strings consecutively, if we cannot re-assign variables?

Imperative vs. Functional Code

Imperative Pseudocode

```
$mySum = 0
$x = computeSomething()
$mySum = $mySum + $x
$y = computeSomethingElse()
$mySum = $mySum + $y
```

Functional Pseudocode

```
$x = computeSomething()
$y = computeSomethingElse()
$mySum = sum($x, $y)
OR
$mySum = $x + $y
```

Compute/collect data/operands first, then compute the result at the end

Imperative Pseudocode

```
$myString = ""
$x = computeString()
$myString = $myString + $x
$myString = $myString + " "
$y = computeOtherString()
$myString = $myString + $y
```

Functional Pseudocode

```
$x = computeString()
$y = computeOtherString()
$myString = concat($x, " ", $y)
OR
$myString = $x + " " + $y
```

Compute/collect data/operands first, then compute the result at the end

Variable Scopes

```
root
{
    let $x := 42

    element
    {
        myNumber := $x

        let $y := "test"
        myString := $y
    }

    rootLevelNumber := $x
}
```

Scope of $x

Scope of $y

Output

```
<root>
    <element>
        <myNumber>42</myNumber>
        <myString>test</myString>
    </element>
    <rootLevelNumber>42</rootLevelNumber>
</root>
```

6

Sequences

Sequences

Sequence containing 3 numbers

```
let $myNumbers := (1, 2, 3)

numberCount := count($myNumbers)

firstNumber := $myNumbers[1]

number := $myNumbers
```

count() returns the number of elements in a sequence

Elements in sequences can be accessed with indices in square brackets.
Note: all indices are 1-based, not 0-based!

If a sequence is assigned to a simple target node, the node is repeated automatically.

Output

```
<root>
    <numberCount>3</numberCount>
    <firstNumber>1</firstNumber>
    <number>1</number>
    <number>2</number>
    <number>3</number>
</root>
```

Empty Sequences

There is no `null` concept in XPath / XQuery, instead **empty sequences** are used

```
let $emptySequence := ()

emptySequenceElementCount := count($emptySequence)

emptySequenceOutput := $emptySequence
```

It can be configured whether nodes are created when empty sequences are assigned, or skipped completely

Output

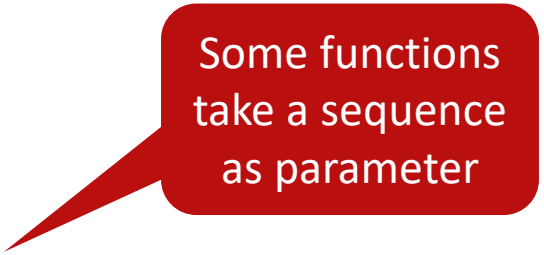
```
<root>
    <emptySequenceElementCount>0</emptySequenceElementCount>
    <emptySequenceOutput/>
</root>
```

In this case the node was created with an empty value

Function with Sequence Parameters

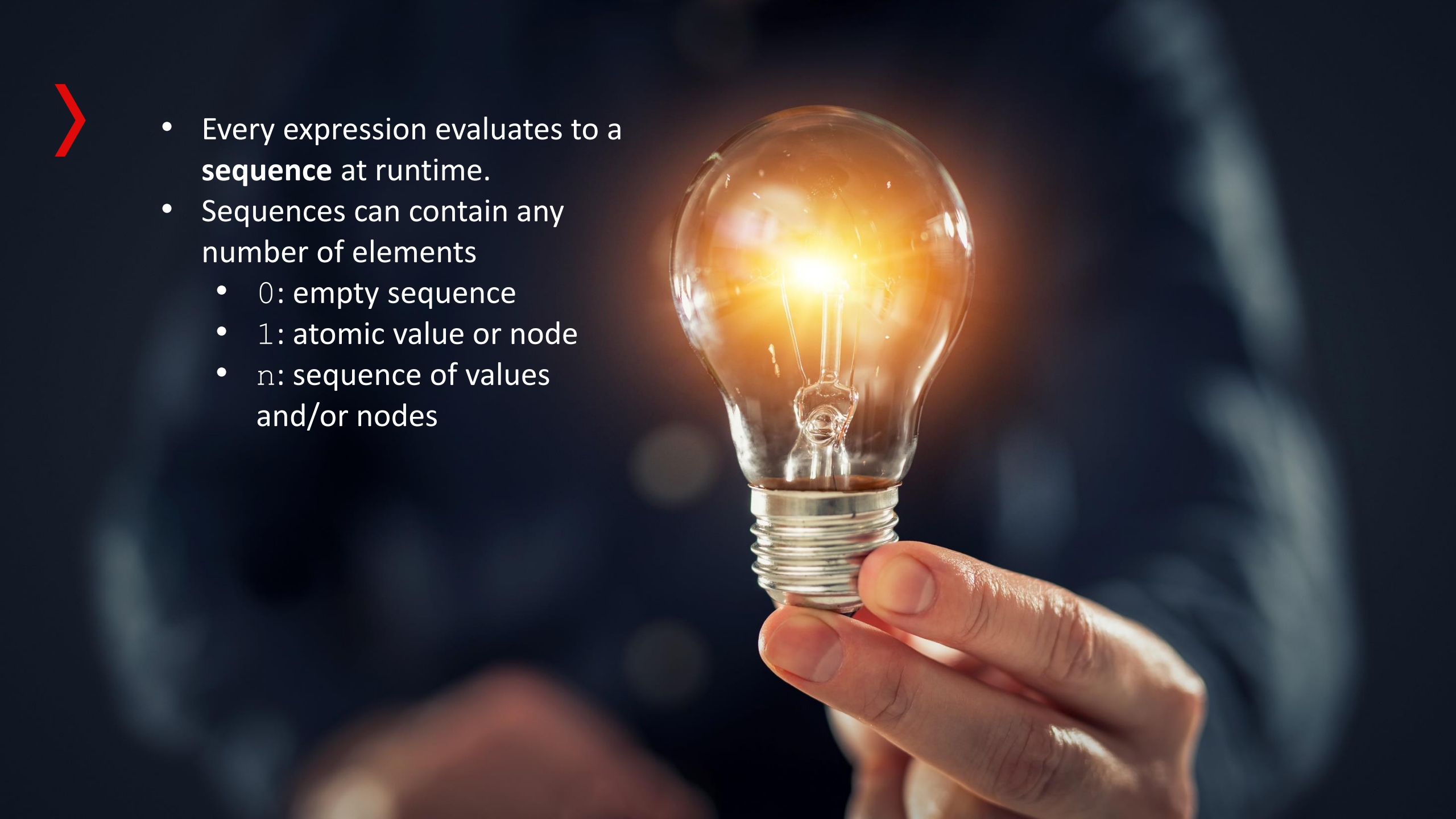
```
let $myNumbers := (1, 2, 3)

sum := sum($myNumbers)
average := avg($myNumbers)
minimum := min($myNumbers)
maximum := max($myNumbers)
```



Output

```
<root>
    <sum>6</sum>
    <average>2</average>
    <minimum>1</minimum>
    <maximum>3</maximum>
</root>
```



- Every expression evaluates to a **sequence** at runtime.
- Sequences can contain any number of elements
  - `0`: empty sequence
  - `1`: atomic value or node
  - `n`: sequence of values and/or nodes

7

String Operations

String Concatenation and Basic String Operations

```
root
{
    concatenatedString := "See" || "burger"
    concatenatedString2 := concat("See", "burger")

    trimmedString := trim(" input with spaces ")

    left := left("Seeburger", 3)
    right := right("Seeburger", 6)
    substring := substring("Seeburger", 4, 4)
    replace := replace("Seeburger", "e", "3")

    length := string-length("Seeburger")
}
```

Native String Concatenation with || Operator

Functional String Concatenation with `concat()` Function

First 3 characters

Last 6 characters

Start index and length.
Remember: indices are 1-based

Common mistake: don't use `length()` for strings, use `string-length()` instead.

Output

```
<root>
    <concatenatedString>Seeburger</concatenatedString>
    <concatenatedString2>Seeburger</concatenatedString2>

    <trimmedString>input with spaces</trimmedString>

    <left>See</left>
    <right>burger</right>
    <substring>burg</substring>
    <replace>S33burg3r</replace>

   <length>9</length>
</root>
```

Splitting and Joining Strings

Decomposes the string and produces a sequence containing three strings: ("a", "b", "c")

```
root
{
     let $tokens := tokenize("a-b-c", "-")
     tokenCount := count($tokens)
     token := $tokens

     joinedString := string-join($tokens, ".")
}
```

Concatenates all elements in the sequence `$tokens`, adding the specified delimiter between each element

Output

```
<root>
    <tokenCount>3</tokenCount>
    <token>a</token>
    <token>b</token>
    <token>c</token>
    <joinedString>a.b.c</joinedString>
</root>
```

8

Conditional Expressions

If Expressions and Comparison Expressions

```
root
{
    let $myNumber := 42
    numberComparisonResult := if ($myNumber < 100)
                              then "smaller than 100"
                              else "greater than or equal to 100"

    let $myString := "test"
    stringComparisonResult := if ($myString = "test")
                              then "string is equal to 'test'"
                              else "strings are not equal"
}
```

Condition (in braces)

Comparison Operators: < <= > >= = !=

If Expression

If expressions always return another expression, depending on the condition. The else part is mandatory.

Output

```
<root>
    <numberComparisonResult>smaller than 100</numberComparisonResult>
    <stringComparisonResult>string is equal to 'test'</stringComparisonResult>
</root>
```

Sequences as Comparison Operands

```
let $myString := "test"
stringToSequenceComparisonResult := if ($myString = ("test", "foo"))
                                    then "found a match"
                                    else "no match found"
```

XPath comparison semantics for sequences: all combinations are checked. If one of the combinations yields `true`, the whole comparison results is `true`.

Output

```
<root>
    <stringToSequenceComparisonResult>found a match</stringToSequenceComparisonResult>
</root>
```

Combining Multiple Conditions

Conditions can be combined using the boolean operators `and` / `or`

```
let $myNumber := 42
let $myString := "test"

multipleConditionsResult := if ($myNumber = 42 and $myString = "test")
                            then "both true"
                            else "at least one false"
```

Output

```
<root>
    <multipleConditionsResult>both true</multipleConditionsResult>
</root>
```

9

Loop Expressions

For Expressions

Note that all strings contain leading and trailing whitespace

Trims each string, producing a new sequence with the same element count

```
root
{
    let $strings := (" a ", " b ", " c ")
    numberOfInputStrings := count($strings)

    let $trimmedStrings := for $string in $strings return trim($string)

    numberOfOutputStrings := count($trimmedStrings)
    output := $trimmedStrings
}
```

Output

```
<root>
    <numberOfInputStrings>3</numberOfInputStrings>
    <numberOfOutputStrings>3</numberOfOutputStrings>
    <output>a</output>
    <output>b</output>
    <output>c</output>
</root>
```

10

Conditional Blocks

If Blocks

If block with `then` block and `else` block. Both blocks are completely independent and can contain arbitrary statements (including nested if blocks).

```
root
{
    let $myNumber := 43
    if ($myNumber = 42)
    {
        result := "The answer to the ultimate question of life, the universe and everything"
        a := "foo"
    }
    else
    {
        result := "It's just a random number"

        let $string := "bar"
        b := $string
    }
}
```

Else branch is optional

Output

```
<root>
    <result>It's just a random number</result>
    <b>bar</b>
</root>
```

If Expressions vs. If Blocks

	If Expression	If Block
Returns an Expression	✓	✗
Mandatory Else Branch	✓	✗
Can Contain Statements	✗	✓
Has Curly Braces {}	✗	✓

If Expressions vs. If Blocks

```
root
{
     if ($myNumber = 42)
     {
          output := "special number"
     }
     else
     {
          output := "random number"
     }

     MORE COMPACT VERSION:

     output := if ($myNumber = 42)
               then "special number"
               else "random number"
}
```

If block that could be re-written as single assignment with if expression

More compact, equivalent code using a single assignment and an if expression

11

Loop Blocks

For Loop Blocks

```
root
{
     for $myNumber in (1, 2, 3)
     {
          number := $myNumber
     }
}
```

Loop over sequence of numbers

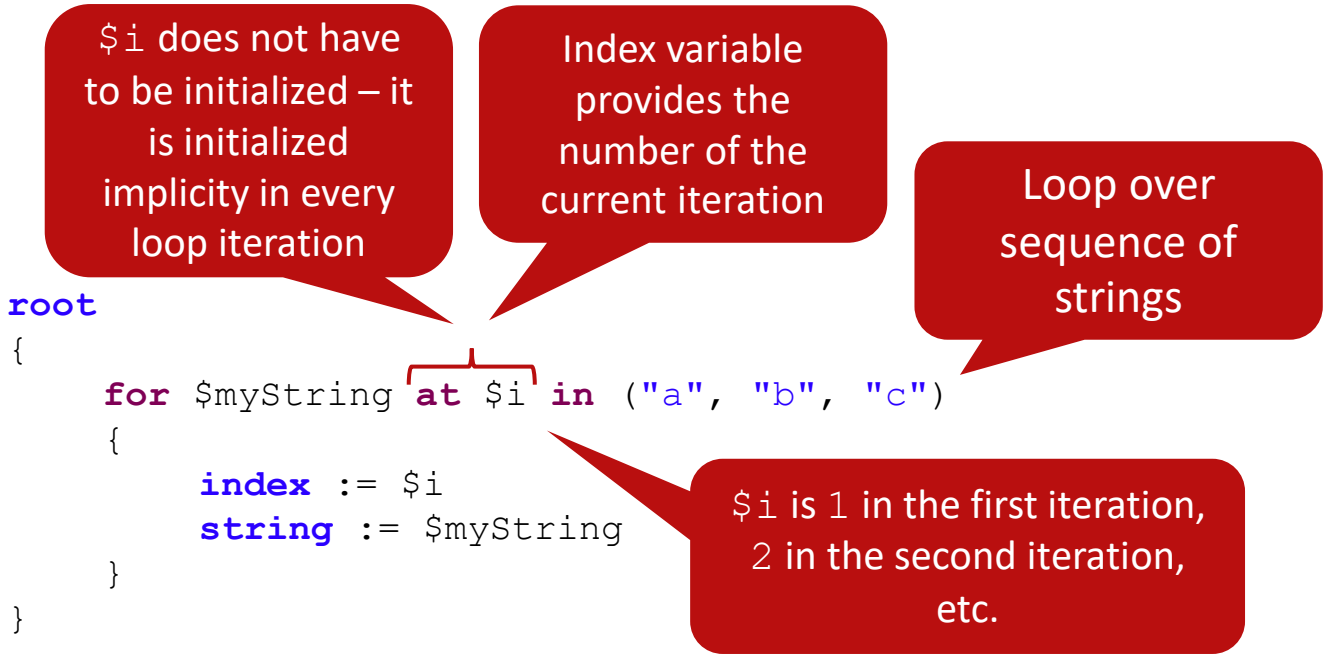
Output

```
<root>
     <number>1</number>
     <number>2</number>
     <number>3</number>
</root>
```

For Expressions vs. For Blocks

	For Expression	For Block
Returns an Expression	✓	✗
Mandatory `return` Clause	✓	✗
Can Contain Statements	✗	✓
Has Curly Braces {}	✗	✓

For Loop Blocks with Index Variable



Output

```
<root>
    <index>1</index>
    <string>a</string>
    <index>2</index>
    <string>b</string>
    <index>3</index>
    <string>c</string>
</root>
```

For Loop Blocks with Node Creation Statements

```
root
{
    for $myNumber in (1, 2, 3)
    {
        output
        {
            number := $myNumber
        }
    }
}
```

Creates an output node in each loop iteration

```
root
{
    output <- $myNumber in (1, 2, 3)
    {
        number := $myNumber
    }
}
```

Target node name

`for` is replaced with "create-for-each" operator `<-`

Equivalent, more compact loop

Output

```
<root>
    <output>
        <number>1</number>
    </output>
    <output>
        <number>2</number>
    </output>
    <output>
        <number>3</number>
    </output>
</root>
```

12

Path Expressions

Absolute Path Expressions

Absolute Path Expressions begin with a /

```
absolutePathOutput := /StoreSalesData/Shops/Shop/ShopAddress/City
```

Results in a sequence of `City` nodes

Semantics:

1. Starting at the root of the input message, select all nodes named `StoreSalesData`
2. From all resulting nodes, select all child nodes named `Shops`
3. From all resulting nodes, select all child nodes named `Shop`
4. From all resulting nodes, select all child nodes named `ShopAddress`
5. From all resulting nodes, select all child nodes named `City`

Output

```
<root>
    <absolutePathOutput>Berlin</absolutePathOutput>
    <absolutePathOutput>Paris</absolutePathOutput>
    <absolutePathOutput>New York</absolutePathOutput>
</root>
```

Relative Path Expressions

```
root <- /StoreSalesData
{
        relativePathOutput := Shops/Shop/ShopAddress/City
}
```

Parent loop provides the context for relative path expressions

Relative Path Expressions do not begin with a /

Results in a sequence of `City` nodes

Semantics:

1. Starting at the current loop context node `StoreSalesData`, select all child nodes named `Shops`
2. From all resulting nodes, select all child nodes named `Shop`
3. From all resulting nodes, select all child nodes named `ShopAddress`
4. From all resulting nodes, select all child nodes named `City`

Output

```
<root>
    <absolutePathOutput>Berlin</absolutePathOutput>
    <absolutePathOutput>Paris</absolutePathOutput>
    <absolutePathOutput>New York</absolutePathOutput>
</root>
```

Relative Path Expressions

```
root <- /StoreSalesData
{
    Stores
    {
        Store <- Shops/Shop
        {
            ID := @id
            Name := ShopAddress/Name
            City := ShopAddress/City
        }
    }
}
```

Parent loop provides the context for relative path expressions

3 relative path expressions

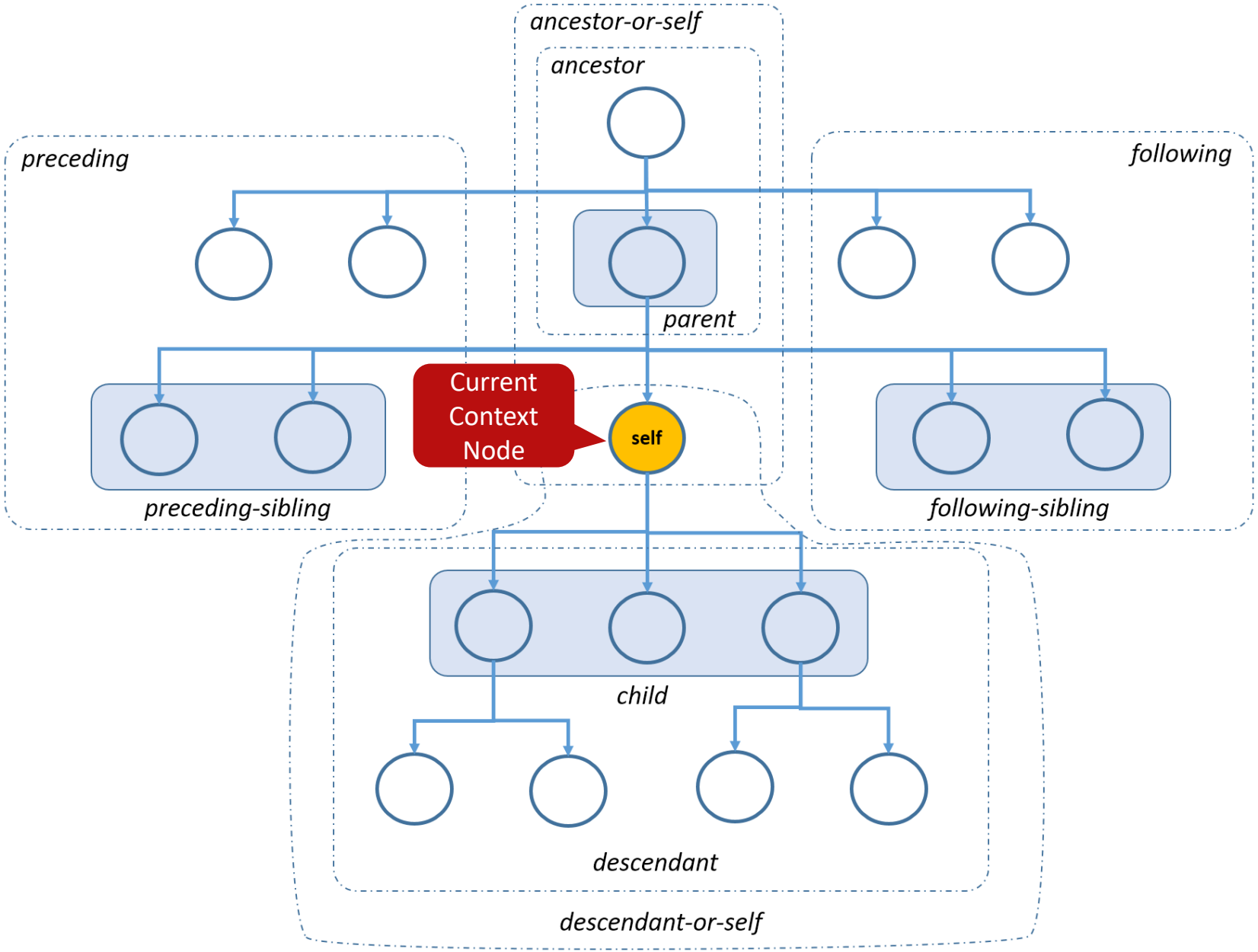
These relative path expressions will only select the nodes below the **current** Shop in the loop iteration

Output

```
<root>
    <Stores>
        <Store>
            <ID>8852662</ID>
            <Name>Shop Floor Berlin</Name>
            <City>Berlin</City>
        </Store>
        <Store>
            <ID>000005</ID>
            <Name>Shop Floor Paris</Name>
            <City>Paris</City>
        </Store>
        <Store>
            <ID>888888881</ID>
            <Name>Shop Floor New York</Name>
            <City>New York</City>
        </Store>
    </Stores>
</root>
```

- Path expressions can be interpreted as nested loops
- Each step produces a new result sequence
- Each step builds upon all results of the previous step

XPath Axes


ancestor-or-self
ancestor
preceding
following
parent
Current Context Node
self
preceding-sibling
following-sibling
child
descendant
descendant-or-self

XPath Axes

```
root <- /StoreSalesData
{
      Stores
      {
            Store <- Shops/Shop
            {
                  ID := @id
                  ID2 := attribute::id

                  for ShopAddress
                  {
                        Name := Name
                        Name2 := child::Name

                        City := City

                        ShopId := ../@id

                        AncestorShopId := ancestor::Shop/@id
                  }

                  DescendantName := descendant::Name

                  FollowingSiblingCount := count(following-sibling::Shop)
                  PrecedingSiblingCount := count(preceding-sibling::Shop)

            }
      }
}
```

The two path expressions are equivalent

The two path expressions are equivalent

Parent Node

Selects parents, grandparents etc. with the name Shop

Selects children, grandchildren etc. with the name Name

Selects following/preceding siblings of the current Shop with the name Name

Output

```
<root>
    <Stores>
        <Store>
            <ID>8852662</ID>
            <ID2>8852662</ID2>
            <Name>Shop Floor Berlin</Name>
            <Name2>Shop Floor Berlin</Name2>
            <City>Berlin</City>
            <ShopId>8852662</ShopId>
            <AncestorShopId>8852662</AncestorShopId>
            <DescendantName>Shop Floor Berlin</DescendantName>
            <FollowingSiblingCount>2</FollowingSiblingCount>
            <PrecedingSiblingCount>0</PrecedingSiblingCount>
        </Store>
        <Store>
            <ID>000005</ID>
            <ID2>000005</ID2>
            <Name>Shop Floor Paris</Name>
            <Name2>Shop Floor Paris</Name2>
            <City>Paris</City>
            <ShopId>000005</ShopId>
            <AncestorShopId>000005</AncestorShopId>
            <DescendantName>Shop Floor Paris</DescendantName>
            <FollowingSiblingCount>1</FollowingSiblingCount>
            <PrecedingSiblingCount>1</PrecedingSiblingCount>
        </Store>
        <Store>
            <ID>888888881</ID>
            <ID2>888888881</ID2>
            <Name>Shop Floor New York</Name>
            <Name2>Shop Floor New York</Name2>
            <City>New York</City>
            <ShopId>888888881</ShopId>
            <AncestorShopId>888888881</AncestorShopId>
            <DescendantName>Shop Floor New York</DescendantName>
            <FollowingSiblingCount>0</FollowingSiblingCount>
            <PrecedingSiblingCount>2</PrecedingSiblingCount>
        </Store>
    </Stores>
</root>
```

13

Filtering (Predicates)

Filtering Data using Predicates

Filters (Predicates) can be added at any step in path expressions in square brackets

```
root <- /StoreSalesData
{
     firstShopId := Shops/Shop[1]/@id

     lastShopId := Shops/Shop[last()]/@id

     parisShopStreet := Shops/Shop/ShopAddress[City = "Paris"]/Street

     newYorkShopReportDate := Shops/Shop[ShopAddress/CountryCodeIso = "US" and ShopAddress/City = "New York"]/ReportDate
}
```

This predicate will filter the first Shop, the other Shops will be ignored

Filters the last shop. `last()` is a contextual function that returns the index of the last child under the current context node

Filters all ShopAddresses with a specific City, then selects the Street

Filters all Shops by CountryCodeIso and City, then selects the resulting report date(s)

Output

```
<root>
     <firstShopId>8852662</firstShopId>
     <lastShopId>888888881</lastShopId>
     <parisShopStreet>Rue du Jour 1</parisShopStreet>
     <newYorkShopReportDate>2019-05-06T23:57:31.000-04:00</newYorkShopReportDate>
</root>
```

14

Sorting

Sorting Data using Order By Clauses

Every loop can have an `order by` clause with one or more sorting criteria

```
ShopsOrderedByCity
{
    Shop <- $shop in Shops/Shop order by $shop/ShopAddress/City
    {
        name := ShopAddress/Name
        city := ShopAddress/City
    }
}
```

Output

```
<root>
    <ShopsOrderedByCity>
        <Shop>
            <name>Shop Floor Berlin</name>
            <city>Berlin</city>
        </Shop>
        <Shop>
            <name>Shop Floor New York</name>
            <city>New York</city>
        </Shop>
        <Shop>
            <name>Shop Floor Paris</name>
            <city>Paris</city>
        </Shop>
    </ShopsOrderedByCity>
</root>
```

Sorting Data using Order By Clauses

Sort criteria can be arbitrarily complex

Each order criteria can have the flag `ascending` (default) or `descending`

```
ShopsOrderedByNumberOfItemsSold
{
     Shop <- $shop in Shops/Shop order by sum($shop/ItemSales/Item/Quantity) descending
     {
          name := ShopAddress/Name
          city := ShopAddress/City
          totalItemSales := sum($shop/ItemSales/Item/Quantity)
     }
}
```

Output

```
<root>
    <ShopsOrderedByNumberOfItemsSold>
        <Shop>
            <name>Shop Floor New York</name>
            <city>New York</city>
            <totalItemSales>1447</totalItemSales>
        </Shop>
        <Shop>
            <name>Shop Floor Berlin</name>
            <city>Berlin</city>
            <totalItemSales>191</totalItemSales>
        </Shop>
        <Shop>
            <name>Shop Floor Paris</name>
            <city>Paris</city>
            <totalItemSales>96</totalItemSales>
        </Shop>
    </ShopsOrderedByNumberOfItemsSold>
</root>
```

15

Grouping

Grouping Data using Group By Clauses

```
root <- /StoreSalesData
{
      itemGroup <- $items in Shops/Shop/ItemSales/Item group by $id := $items/@id
      {
            itemId := $id
            itemName := $items[1]/Desc
            numberOfItemSaleRecords := count($items)
            numberOfItemsSold := sum($items/Quantity)
      }
}
```

Every loop can have a `group by` clause with one or more grouping criteria

Groups items by `@id` and loops over the resulting groups

Grouping criteria can be assigned to variables directly in the `group by` clause

`$items` is a sequence containing **all** items in the group (it has at least one element in each iteration)

Output

```
<root>
    <itemGroup>
        <itemId>8546665252</itemId>
        <itemName>Lumberjack Shirt</itemName>
        <numberOfItemSaleRecords>3</numberOfItemSaleRecords>
        <numberOfItemsSold>173</numberOfItemsSold>
    </itemGroup>
    ...
</root>
```

- Loops in XQuery are also called **FLWOR** Statements:
  - **F**or
  - **L**et
  - **W**here
  - **O**rder By (+ Group By)
  - **R**eturn
- The BIS Mapping Language offers the same capabilities for loops with an easier syntax.

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