

# Processing of XML Documents, XPath - XSLT - XQuery

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**Selezione, Elaborazione e Presentazione di documenti XML-TEI mediante i linguaggi XPath, XSLT e XQuery**

Istituto di Linguistica Computazionale “A. Zampolli”,  
11th November 2024

# Outline

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We talk about

Introduction to processing and visualizing XML documents via  
**XPATH, XSLT and XQuery languages.**

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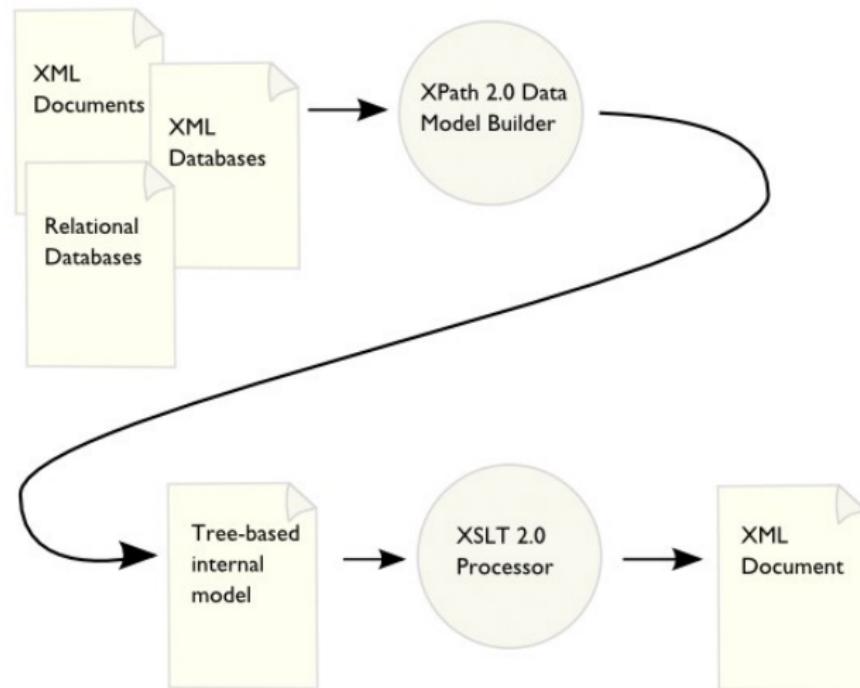
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The screenshot shows the official Java website's homepage. The top navigation bar includes links for Learn, Download, Community, Contribute, News, Future, and Playground. Below the navigation bar, there are two main buttons: "Download Java" and "Java Release History".

## Downloading Java

### Java for Most Use Cases

Downloading Java is simple and straightforward. Oracle offers a simple download with a permissive license at its official download page. Click the button below to be taken to this page.

[Download Java at Oracle.com](#)

### Early-Access Builds

For developers that want to try out early-access builds, or builds by projects like Loom, Valhalla, and Panama, then you can find builds of these at [jdk.java.net](#).

### Install Java via Oracle Java Platform Extension for Visual Studio Code

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XSLT AND XQUERY PROCESSING

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SAXONICA > Download > Java

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### Java platform downloads

The latest release for Java is Saxon 12.5, released on 2 July 2024. Saxon 12 is currently considered the most stable and reliable release. For more information see [Latest releases](#).

The latest maintenance release of 11 is Saxon 11.6, released on 24 August 2023.

To use Saxon-PE or Saxon-EE you need a license key. If you don't have a current license you can request a 30-day evaluation license.

Saxon-HE is open source software and can be downloaded from [GitHub](#) or [Maven](#). (From January 2023, new Saxon-HE releases are no longer available on [SourceForge](#).)

Use the buttons below to download Saxon-PE and Saxon-EE directly from the Saxonica downloads website, or Saxon-HE from GitHub.

Java	Saxon-EE	Saxon-PE	Saxon-HE
	SaxonJ-EE 12.5	SaxonJ-PE 12.5	SaxonJ-HE 12.5
	SaxonJ-EE 11.6	SaxonJ-PE 11.6	SaxonJ-HE 11.6

**On the download info page:**

- Release notes
- Installing the software
- Earlier releases

**See also:**

- Download .NET SaxonCS products
- Download C/C++, PHP and Python SaxonC products
- Download saxon-resources

# Tools - oXygen

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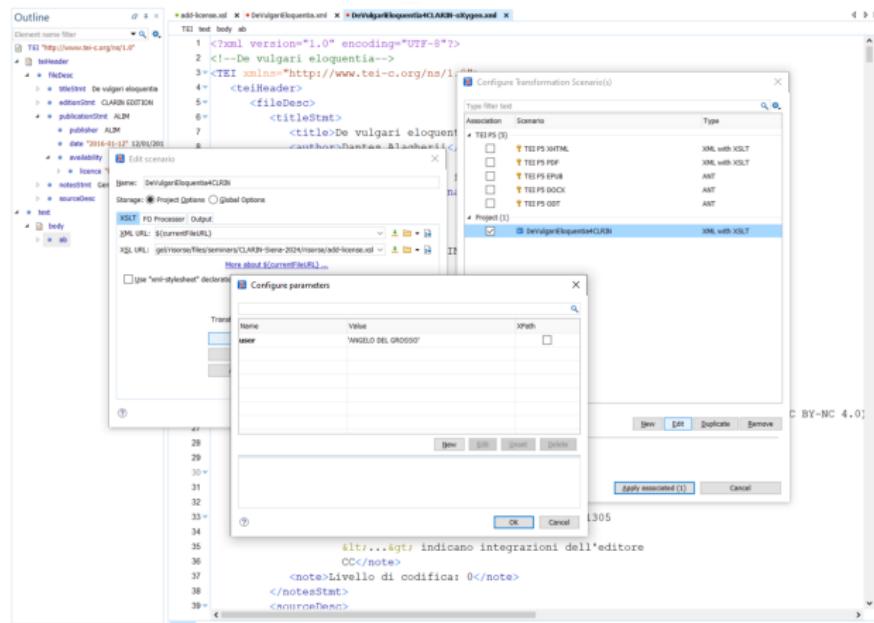
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# Tools - eXist-db

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The screenshot shows the eXist-db XQuery editor interface. At the top, there are three tabs: 'new-document 1', 'transform.xq', and 'htm-tpl-struct-sample.xsl'. The 'transform.xq' tab is active, displaying the following XQuery code:

```
1 xquery version "3.1";
2
3 let $xml := doc("IRT256a.xml")
4 let $xsl := doc("stylesheets-9.4/start-edition.xsl")
5
6 return transform:transform($xml,$xsl,())
7
```

Below the code editor, the URL '/db/apps/asp-aiucd-2023/transform.xq' is shown. To the right of the URL are several checkboxes: 'XHTML Output' (selected), 'Indent', 'Live Preview' (selected), 'Highlight Index Matches' (selected), and a 'Copy' button.

The 'Live Preview' section displays the generated HTML output:

```
<html xmlns:i18n="http://apache.org/cocoon/i18n/2.1">
  <head>
    <title>IRT256a. Christian funerary inscription for Helladios</title>
    <meta http-equiv="content-type" content="text/html; charset=UTF-8" />
    <link rel="stylesheet" type="text/css" media="screen, projection" href="global.css" />
  </head>
  <body>
    <h1>IRT256a. Christian funerary inscription for Helladios</h1>
```

At the bottom of the editor window, there are standard navigation icons for back, forward, search, and refresh.

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# XSL XQuery

## A family of languages

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**XSL is a family of W3C recommendations for defining XML document transformation and presentation.**

## XSL

- **XSL Transformations (XSLT):**  
*a language for transforming XML*
- **The XML Path Language (XPath):**  
*an expression language to refer to parts of an XML document;*
- **XSL Formatting Objects (XSL-FO):**  
*an XML vocabulary for specifying formatting semantics.*

## XQuery

XQuery is a query language for XML to extract data.

# XSL Transformations

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> Skip <

### XPATH COVER PAGE

2017-03-21	Recommendation	<b>XML Path Language (XPath) 3.1</b> XPath is an expression language that allows the processing of values conforming to the data model defined in the XQuery and Xpath Data Model.
2014-04-08	Recommendation	<b>XML Path Language (XPath) 3.0</b> XPath 3.0 (renamed from XPath 2.1 to align with the family of "3.0" specifications) is an expression language that allows the processing of values conforming to the data model defined in [XQuery and XPath Data Model (XDM) 3.0]. Some of the important new features since XPath 2.0 are: Literal function items, inline functions, dynamic function invocations, and function item coercion Clarification of rules associated with sequence type matching let expressions EQNames (QNames with a namespace URI instead of a namespace prefix) Support for union types in casting and function arguments
2010-12-14	Recommendation	<b>XML Path Language (XPath) 2.0 (Second Edition)</b> XPath is a way to refer to parts of an XML document. XPath 2.0 is based on the XQuery 1.0 and XPath 2.0 Data Model (XDM), and also introduces Schema awareness and data typing.
1999-11-16	Recommendation	<b>XML Path Language (XPath) Version 1.0</b> XPath is a language for addressing parts of an XML document, designed to be used by both XSLT and XPointer.

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### XSLT COVER PAGE

2021-03-30	Recommendation	<b>XSL Transformations (XSLT) Version 2.0 (Second Edition)</b> This specification defines the syntax and semantics of XSLT 2.0, a language for transforming XML documents into other XML documents. XSLT 2.0 is a revised version of the XSLT 1.0 Recommendation [XSLT 1.0] published on 16 November 1999. XSLT 2.0 is designed to be used in conjunction with XPath 2.0, which is defined in [XPath 2.0]. XSLT shares the same data model as XPath 2.0, which is defined in [Data Model], and it uses the library of functions and operators defined in [Functions and Operators]. XSLT 2.0 also includes optional facilities to serialize the results of a transformation, by means of an interface to the serialization component described in [XSLT and XQuery Serialization]. <i>This document contains hyperlinks to specific sections or definitions within other documents in this family of specifications. These links are indicated visually by a superscript identifying the target specification: for example XP for XPath, DM for the XDM data model, FO for Functions and Operators.</i>
2017-06-08	Recommendation	<b>XSL Transformations (XSLT) Version 3.0</b> This specification defines the syntax and semantics of XSLT 3.0, a language for transforming XML documents into other XML documents.
1999-11-16	Recommendation	<b>XSL Transformations (XSLT) Version 1.0</b> This specification defines the syntax and semantics of XSLT, which is a language for transforming XML documents into other XML documents. XSLT is designed for use as part of XSL, which is a stylesheet language for XML. In addition to XSLT, XSL includes an XML vocabulary for specifying formatting. XSL specifies the styling of an XML document by using XSLT to describe how the document is transformed into another XML document that uses the formatting vocabulary. XSLT is also designed to be used independently of XSL. However, XSLT is not intended as a completely general-purpose XML transformation language. Rather it is designed primarily for the kinds of transformations that are needed when XSLT is used as part of XSL.

### RELATED RETIRED SPECIFICATIONS

2001-08-24	Retired	<b>XSL Transformations (XSLT) Version 1.1</b>
------------	---------	---

# XSL Transformations

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## xquery cover page

The specifications below belong to the series 'xquery'

Recommendation

### XQuery 3.1: An XML Query Language

21 March 2017 - [history](#)

Tags: XML

Deliverers: [XML Query Working Group](#)

XQuery 3.1 is a versatile query and application development language, capable of processing the information content of diverse data sources including structured and semi-structured documents, relational databases and tree-based databases. The XQuery language is designed to support powerful optimizations and pre-compilation leading to very efficient searches over large amounts of data, including over so-called XML-native databases that read and write XML but have an efficient internal storage.

Recommendation

### XQuery 3.0: An XML Query Language

8 April 2014 - [history](#)

Tags: XML



# XPath Expression

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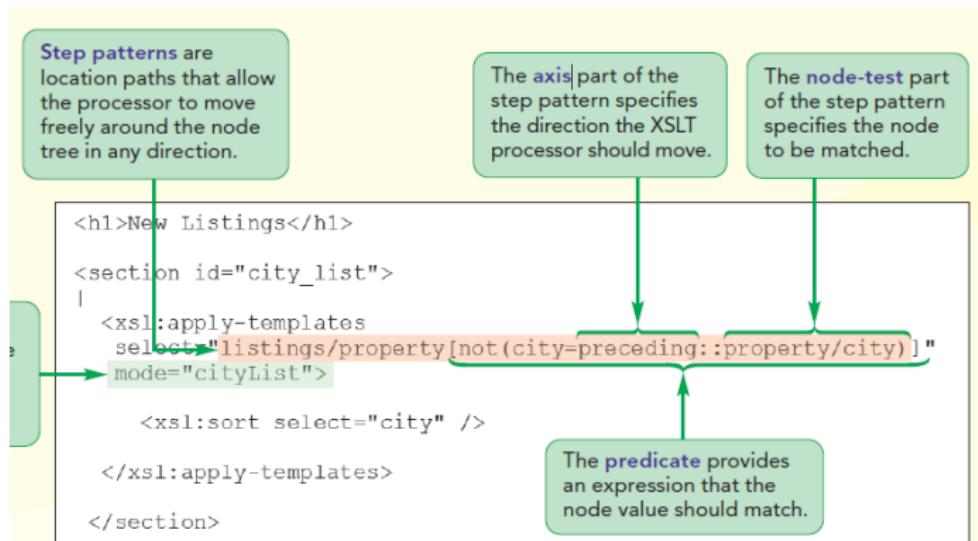
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[adjustdateTime-to-timezone](#)  
[adjust-time-to-timezone](#)  
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### fn:substring

`substring($sourceString as xs:string?, $start as xs:double) → xs:string`

Returns a substring of a given string starting at the given starting position and continuing to the end of the string.

#### Arguments

<code>\$sourceString</code>	<code>xs:string?</code>	The input string
<code>\$start</code>	<code>xs:double</code>	The position of the first character of the input string to be included in the result

#### Result

`xs:string`

`substring($sourceString as xs:string?, $start as xs:double, $length as xs:double) → xs:string`

Returns a substring of a given string starting at the given starting position and continuing to the end of the string, or `$length` characters if shorter.

#### Arguments

<code>\$sourceString</code>	<code>xs:string?</code>	The input string
<code>\$start</code>	<code>xs:double</code>	The position of the first character of the input string to be included in the result
<code>\$length</code>	<code>xs:double</code>	The number of characters to be included in the result

#### Result

`xs:string`

### Namespace

<http://www.w3.org/2005/xpath-functions>

### Links to W3C specifications

[XPath 2.0 Functions and Operators](#)

[XPath 3.0 Functions and Operators](#)

[XPath 3.1 Functions and Operators](#)

# XSL Transformations

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xsl:accept	xsl:copy	xsl:include	xsl:non-matching-substring	xsl:sort
xsl:accumulator	xsl:copy-of	xsl:iterate	xsl:number	xsl:source-document
xsl:accumulator-rule	xsl:decimal-format	xsl:key	xsl:on-completion	xsl:stream
xsl:analyze-string	xsl:document	xsl:map	xsl:on-empty	xsl:strip-space
xsl:apply-imports	xsl:element	xsl:map-entry	xsl:on-non-empty	xsl:stylesheet
xsl:apply-templates	xsl:evaluate	xsl:matching-substring	xsl:otherwise	xsl:template
xsl:assert	xsl:expose	xsl:merge	xsl:output	xsl:text
xsl:attribute	xsl:fallback	xsl:merge-action	xsl:output-character	xsl:transform
xsl:attribute-set	xsl:for-each	xsl:merge-key	xsl:override	xsl:try
xsl:break	xsl:for-each-group	xsl:merge-source	xsl:package	xsl:use-package
xsl:call-template	xsl:fork	xsl:message	xsl:param	xsl:value-of
xsl:catch	xsl:function	xsl:mode	xsl:perform-sort	xsl:variable
xsl:character-map	xsl:global-context-item	xsl:namespace	xsl:preserve-space	xsl:when
xsl:choose	xsl:if	xsl:namespace-alias	xsl:processing-instruction	xsl:where-populated
xsl:comment	xsl:import	xsl:next-iteration	xsl:result-document	xsl:with-param
xsl:context-item	xsl:import-schema	xsl:next-match	xsl:sequence	

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### xsl:template

Defines a processing rule for source elements or other nodes of a particular type.

*Available in XSLT 1.0 and later versions. Available in all Saxon editions.*

- **Category:** declaration
- **Content:** (`xsl:context-item?`, `xsl:param*`, \*sequence-constructor\*)
- **Permitted parent elements:** `xsl:package`; `xsl:stylesheet`; `xsl:transform`; `xsl:override`

### Attributes

`match?`

`pattern`

Pattern to identify the type of node to be processed. The most common form of pattern is simply an element name. However, more complex patterns may also be used: the syntax of patterns is given in more detail in XSLT Pattern Syntax. The following examples show some of the possibilities:

Pattern	Meaning
<code>match?</code>	Identifies the type of node to be processed.
<code>pattern</code>	Identifies the type of node to be processed.

# XQuery

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## Syntax of FLWOR expressions

Last Updated: 2024-02-15

A FLWOR expression is composed of the following clauses, some of which are optional: **for**, **let**, **where**, **order by**, and **return**.



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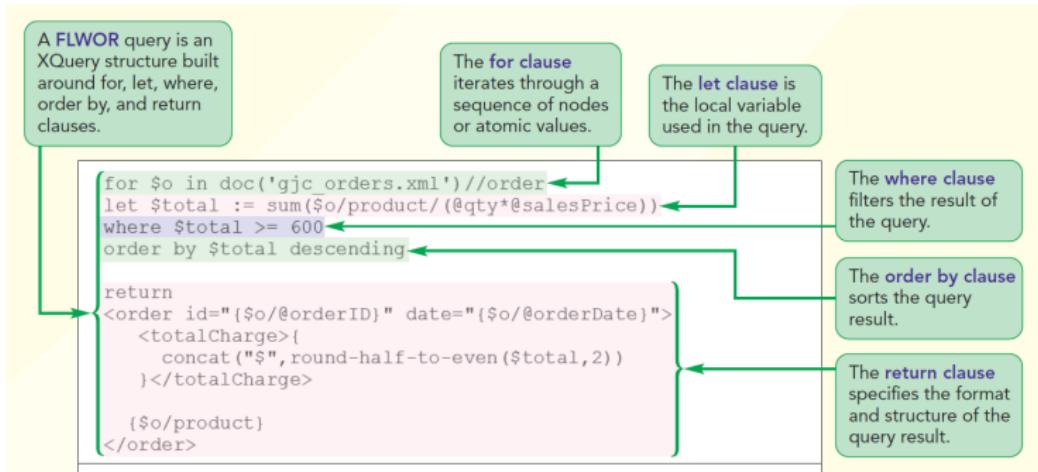
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# W3C XML standards

## XML specs

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`https://www.w3.org/TR/?tag=xml&status=REC&version=latest`

# eXtensible Style Sheet

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```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <xsl:stylesheet version="1.0">
3  |   ... xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
4  |   ... <xsl:output method="text" />
5  |   ... <xsl:template match="/">
6  |       ... <xsl:apply-templates select="current()/descendant::text" />
7  |   ... </xsl:template>
8  |   ... <xsl:template match="div[@type='edition']|div[@type='translation']">
9  |       ... <xsl:value-of select="normalize-space(.)" />
10 |   ... </xsl:template>
11 |   ... <xsl:template match="div" />
12 </xsl:stylesheet>
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

wsl + × ☰ ...

```
angelodel80@LAPTOP-V8V3MLG0:/mnt/c/Users/angel/risorse/universita/corsoCodifica/tools$ java -jar SaxonHE10-3J/
saxon-he-10.3.jar -s:source/IRT030.xml -xsl:source/built-in.xsl
```

Text Imperator Caesar Marci Antonini Pii fili diui Pii nep diui Hadriani pronep diui Traiani Parthici  
abnep diui Neruae adnep Luci Aeli Aureli Commod August

Translation Emperor Caesar case unknown son of Marcus Antonius Pius, grandson of deified Pius, great  
grandson of deified Hadrian, great great grandson of deified Trajan victor in Parthia, great great great grand  
son of deified Nerva, Lucius Aelius Aurelius Commodus Augustus

```
java -cp .\SaxonHE11-6J\* net.sf.saxon.Transform
```

# eXtensible Style Sheet

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```
java -cp .\SaxonHE11-6J\* net.sf.saxon.Transform  
-s:filename.xml -xsl:filename.xsl -o:filename.txt
```

-s:filename	<p>Identifies the source file or directory. Mandatory unless the <code>-it</code> option is used. The source file is parsed to create a tree, and the document node of this tree acts as the initial context item for the transformation.</p> <p>The filename can be given as <code>"-"</code> to take the source from standard input, in which case the base URI is taken from that of the current directory.</p> <p>If the name identifies a directory, all the files in the directory will be processed individually. In this case the <code>-o</code> option is mandatory, and must also identify a directory, to contain the corresponding output files. A directory must be specified as a filename, not as a URL.</p> <p><i>For backwards compatibility the source filename can also be specified immediately before the stylesheet filename, without the <code>-s</code> flag, provided that the <code>-it</code> option is not present.</i></p>
-------------	--

# eXtensible Style Sheet

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```
java -cp .\SaxonHE11-6J\* net.sf.saxon.Transform  
-s:filename.xml -xsl:filename.xsl -o:filename.txt
```

-xsl:filename	Specifies the file containing the principal stylesheet module. Mandatory unless the -a option is used. The value "-" identifies the standard input stream, in which case the static base URI is taken from that of the current directory. If the -u option is specified then the value must be a URI rather than a filename.  The selected file can contain either XSLT source code, or a compiled version of the stylesheet (a SEF file) as produced using the -export option.
---------------	---

# eXtensible Style Sheet

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```
java -cp .\SaxonHE11-6J\* net.sf.saxon.Transform  
-s:filename.xml -xsl:filename.xsl -o:filename.txt
```

-o:filename	<p>Send output to named file.</p> <p>If the source (-s) argument identifies a directory, this option is mandatory and must also identify a directory; on completion it will contain one output file for each file in the source directory.</p> <p>In other cases, this option has two effects: it defines the file where the principal output of the transformation will be written, and it defines the base URI used for resolving the value of the xsl:result-document/@href attribute when secondary result documents are written.</p> <p>In the absence of this option, (a) the principal output is written to the standard output stream, and (b) secondary output file locations are resolved relative to the current working directory.</p> <p>Output files are created if they do not already exist; any necessary directories will also be created. If a file does already exist, it is generally overwritten, though this will not necessarily happen if the transformation fails.</p>
-------------	--

# eXtensible Style Sheet

## CLI Saxon Options

Processing of  
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- XQuery  
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```
java -cp .\SaxonHE11-6J\* net.sf.saxon.Transform  
-s:filename.xml -o:filename.txt
```

### Using the -a option

If the -a option is used, the name of the stylesheet is omitted. The source document must contain a `<?xml-stylesheet?>` processing instruction before the first element start tag; this processing instruction must have a pseudo-attribute `href` that identifies the relative or absolute URL of the stylesheet document, and a pseudo-attribute `type` whose value is `text/xml`, `application/xml`, or `text/xsl`. For example:

```
<?xml-stylesheet type="text/xsl" href="../style3.xsl" ?>
```

It is also possible to refer to a stylesheet embedded within the source document, provided it has an `id` attribute and the `id` attribute is declared in the DTD as being of type `ID`. For example:

# eXtensible Style Sheet

## CLI Saxon Options

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```
java -cp .\SaxonHE11-6J\* net.sf.saxon.Transform  
-s:filename.xml -o:filename.txt
```

```
PS C:\Users\angel\risorse\files\seminars\lezioni-seminari-fedhlab\fedhlab-xpath-xquery-2024\tools> java -cp .\SaxonHE11-6J\* net.sf.saxon.Transform -s..\xml\IR7030.xml -o..\out\out_a.txt  
No stylesheet file name  
Saxon-HE 11.6 from Saxonica  
Usage: see http://www.saxonica.com/documentation/index.html#using-xsl/commandline  
Format: net.sf.saxon.Transform options params  
Options available: -? -a -catalog -config -cr -diag -dtd -e -expand -explain -export -ext -i -im -init -it -jit -json -l -lib -license -nogo -now -ns -o -opt -or -output -p -quit -r -relocate -repeat  
-s -sa -scmin -strip -t -T -target -TB -threads -TJ -Tlevel -tout -TP -traceout -tree -u -val -versionmsg -warnings -x -xi -xmlversion -xsd -xsiloc -xsl -y --?  
Use -XYZ? for details of option XYZ  
Params:  
param:value      Set stylesheet string parameter  
+param:filename  Set stylesheet document parameter  
?param:expression Set stylesheet parameter using XPath  
$param:value     Set template parameter  
PS C:\Users\angel\risorse\files\seminars\lezioni-seminari-fedhlab\fedhlab-xpath-xquery-2024\tools> java -cp .\SaxonHE11-6J\* net.sf.saxon.Transform -u -s..\xml\IR7030.xml -o..\out\out_a.txt  
PS C:\Users\angel\risorse\files\seminars\lezioni-seminari-fedhlab\fedhlab-xpath-xquery-2024\tools>
```

# Tree data model (XDM)



- The W3C specifications for XSLT, XQuery, and XPath **model an XML document as a tree**. This data model is known as **XDM**, and the nodes of an XDM tree are known as **XDM nodes**.
- XDM defines the information contained in the input to an XSLT processor as well as it defines all **permissible values of expressions** in the XSLT
- The **node-sets of XPath 1.0** are replaced in XPath 2.0 by **sequences of nodes**.

# Tree data model (XDM)



- The W3C specifications for XSLT, XQuery, and XPath **model an XML document as a tree**. This data model is known as **XDM**, and the nodes of an XDM tree are known as **XDM nodes**.
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# Tree data model (XDM)



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- XDM defines the information contained in the input to an XSLT processor as well as it defines all **permissible values of expressions** in the XSLT
- The **node-sets of XPath 1.0** are replaced in XPath 2.0 by **sequences of nodes**.

# XML Trees

## Hierarchical Ordered Nodes

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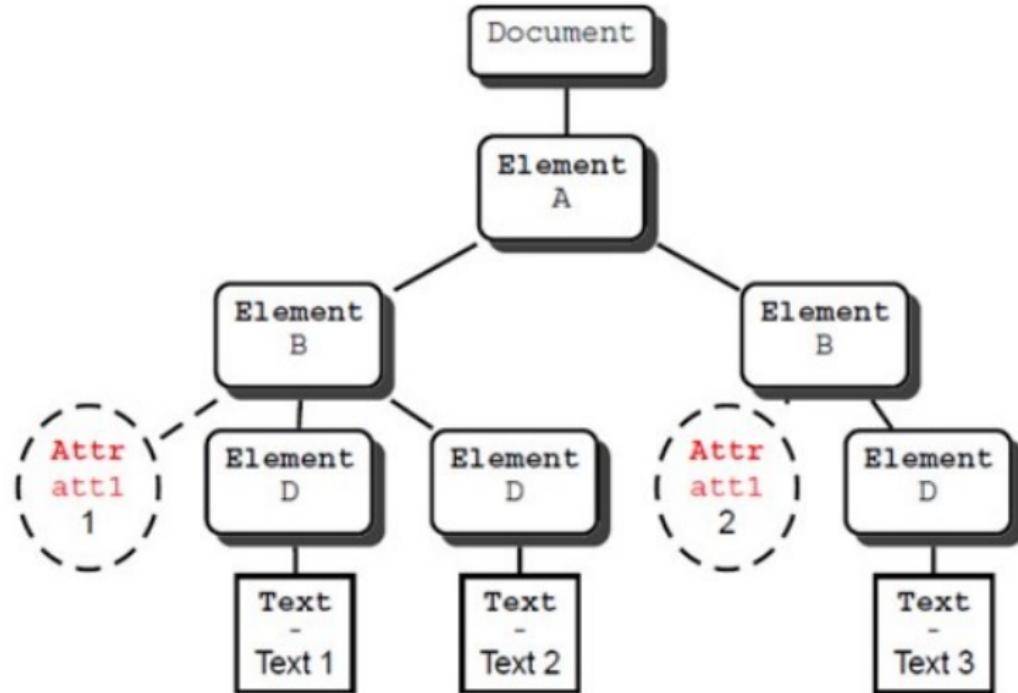
XSL Transformations

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# XPath Data Model

## XDM

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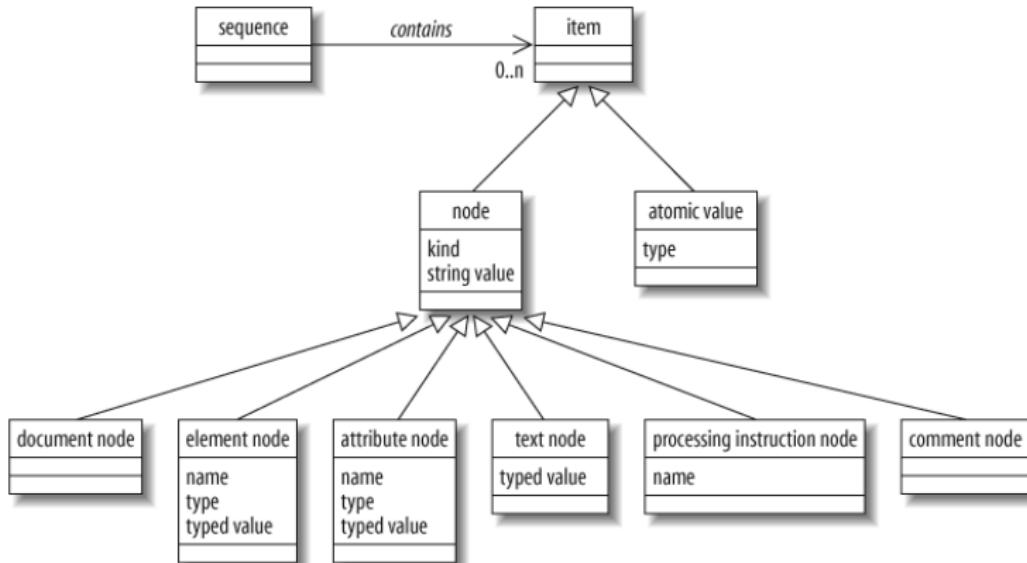
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# Fondamenti Extensible Stylesheet Language

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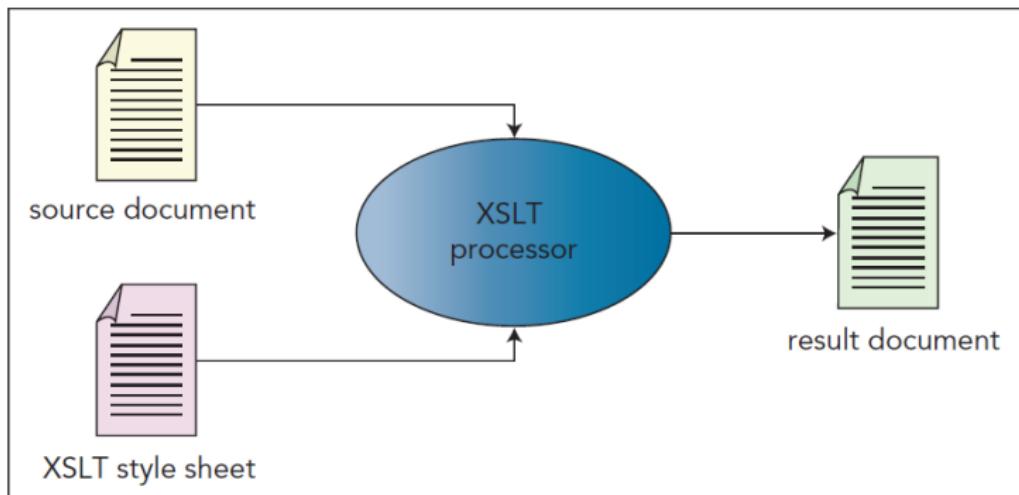
XSL Transformations

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# XML Document

Exemple from The Inscriptions of Roman Tripolitania

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```
<?xml version="1.0" encoding="UTF-8"?>
<TEI xml:lang="en">
  <teiHeader> ...
  </teiHeader>
  <text>
    <body>
      <div type="bibliography"> ...
      </div>
      <div subtype="text-constituted-from" type="history"> ...
      </div>
      <div type="edition" xml:lang="la"><head xml:lang="en">Text</head><ab> ...
      </ab></div>
      <div type="apparatus"> ...
      </div>
      <div type="translation"><head>Translation</head> ...
      </div>
      <div type="commentary"> ...
      </div>
      <div type="figure"> ...
      </div>
    </body>
  </text>
</TEI>
```

# Fondamenti XML

## eXtensible Markup Language

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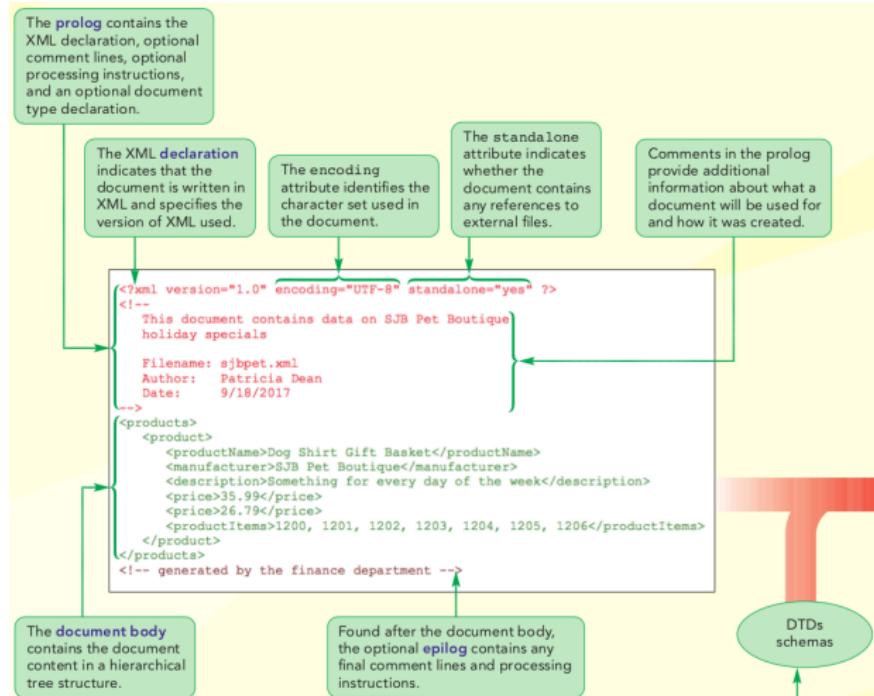


immagine dal libro *New Perspectives on XML, 3rd Edition*

# Fondamenti XML

## eXtensible Markup Language

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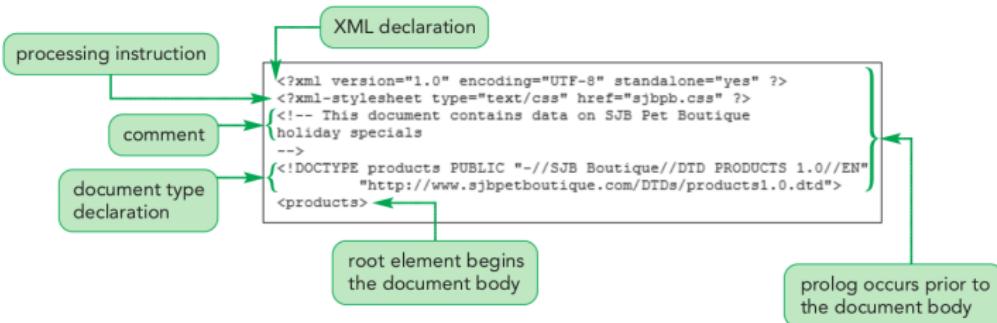
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# Fondamenti XML

## eXtensible Markup Language

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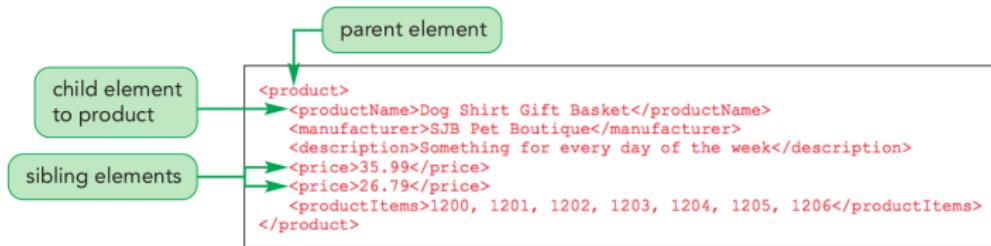
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# Intro Text Encoding Initiative

## TEI

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The screenshot shows the homepage of the Text Encoding Initiative (TEI). The header features the TEI logo and the text "< Text Encoding Initiative >". Below the header is a navigation bar with links for Home, Guidelines, Activities, Tools, Membership, Support, About, and News. A search bar includes a dropdown set to "P5 Guidelines — English" and a "Search" button. The main content area is titled "P5: Guidelines for Electronic Text Encoding and Interchange" and indicates "Version 4.5.0. Last updated on 25th October 2022, revision 3e98e619e". Below this, there are language links for English, Deutsch, Español, Italiano, Français, 日本語, 한국어, and 中文, along with icons for document, XML, and a stylized letter 'a'. The page is divided into sections: "Front Matter" (with links to Releases of the TEI Guidelines, Dedication, Preface and Acknowledgments, About These Guidelines, A Gentle Introduction to XML, and Languages and Character Sets), "Text Body" (with numbered links from 1 to 10 covering The TEI Infrastructure, The TEI Header, Elements Available in All TEI Documents, Default Text Structure, Characters, Glyphs, and Writing Modes, Verse, Performance Texts, Transcriptions of Speech, Dictionaries, and Manuscript Description), and "TEI sourcecode" (with links to Getting and Using the TEI Sources, TEI GitHub Repository, and Bug Reports, Feature Requests, etc.). At the bottom, there are links for Appendix, Model Classes, and a footer with navigation icons.

# eXtensible StyleSheet Language for Transformations

## XSL-T

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### How Does it work

The XSLT processor **uses the instructions** in the Style Sheet to process the input XML document by **traversing the document's hierarchy**.

### How Does it work

XSLT instructions indicate what **portion of the tree should be traversed**, how it should be inspected, and what **output fragment should be generated** at each point.

# Ordered Hierarchy of Content Objects

## OHCO

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### ■ OHCO

The nodes of the tree are ordered. The child nodes of a parent node, which are siblings of one another, **occur in a particular order.**

*This is why XML can be described as representing an ordered hierarchy of content objects.*

# Progress status

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# Selecting and Processing XML Document Trees

## Basic Concepts

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## XPath

Path **expressions** will return **node sequences** whose nodes are in document order

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### Sequence

The group of nodes that an XPath expression returns is a sequence, which is a technical term for an **ordered collection of items** that permits duplicates

# Selecting and Processing XML Document Trees

## XPath expression language

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## XPath

- Select nodes sequence from XML tree
- Process data via functions

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## XPath

XPath expressions are extremely accurate (selection of elements, attributes, texts etc.)

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```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <xsl:stylesheet version="2.0">
3      xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
4      <xsl:output method="text"/>
5
6      <xsl:template match="/">
7          ...
8              <xsl:value-of
9                  select="/TEI/text/body/div/@type"
10             />
11         ...
12     </xsl:template>
13
14 </xsl:stylesheet>
15
```

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1 bibliography history edition apparatus translation commentary figure

# Selecting and Processing XML Document Trees

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## XPath Basics

Path expressions are used to navigate from a current location  
(called the context node) to other nodes in the tree.

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## XPath Basics

Steps in a path expression are indicated with slash characters  
and the context node changes with each step.

## XPath Basics

- "div" (*div child*)
- "div/head" (*child of div*)
- "div/\*/persName" (*child of child*)
- "div//persName" (*descendant*)

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## XPath

The XPath expression can be absolute or relative to the  
**context node**

## XPath

The XPath expression encompasses three components: (**Axes, Test, Predicate**)

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## XPath

XPath expressions navigate the XML tree by using the so called (*expression axes*).

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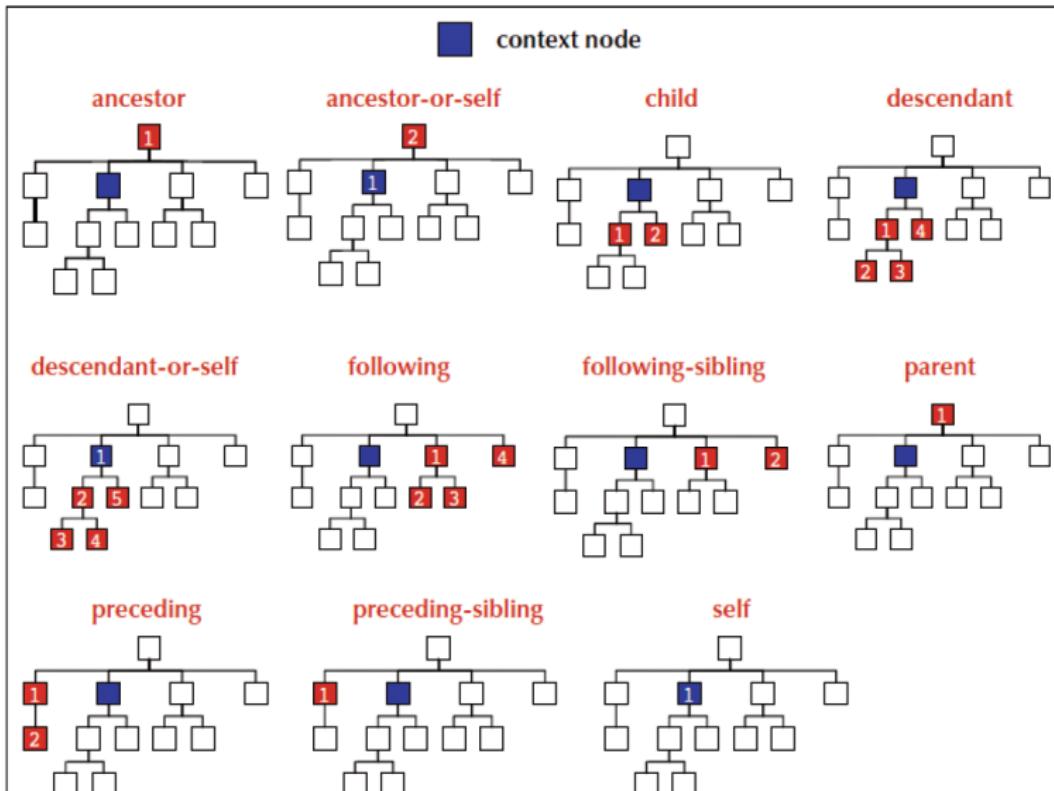
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# Selecting and Processing XML Document Trees

An axis step has the basic form `axis :: node-test`, and selects nodes on a given axis that satisfy the node-test. The axes available are:

ancestor	Selects ancestor nodes starting with the current node and ending with the document node
ancestor-or-self	Selects the current node plus all ancestor nodes
attribute	Selects all attributes of the current node (if it is an element)
child	Selects the children of the current node, in document order
descendant	Selects the children of the current node and their children, recursively (in document order)
descendant-or-self	Selects the current node plus all descendant nodes
following	Selects the nodes that follow the current node in document order, other than its descendants
following-sibling	Selects all subsequent child nodes of the same parent node
namespace	Selects all the in-scope namespaces for an element (this axis is deprecated in the W3C XPath specification, but Saxon will continue to support it)
parent	Selects the parent of the current node
preceding	Selects the nodes that precede the current node in document order, other than its ancestors
preceding-sibling	Selects all preceding child nodes of the same parent node
self	Selects the current node

When the child axis is used, `child::` may be omitted, and when the attribute axis is used, `attribute::` may be abbreviated to `@`. The expression `parent::node()` may be shortened to `..`.

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Symbol	Meaning	Expanded version
.	current context node	<code>self::*</code> (for elements)
..	parent element	<code>parent::*</code>
//	descendant axis	<code>descendant::</code> . At the beginning of a path expression, it means that the path starts at the document node.
@	attribute axis	<code>attribute::</code>

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References

```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <xsl:stylesheet version="2.0"
3  .... xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
4  .... <xsl:output method="text" encoding="UTF-8" />
5  ....
6  .... <xsl:template match="/">
7  ....
8  ....     <xsl:value-of select="TEI/descendant::langUsage/language" />
9  ....
10 ....
11 </xsl:template>
12 </xsl:stylesheet>
```

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1 Arabic English French German Ancient Greek Transliterated Greek Modern Greek Hebrew Italian Latin Punic

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## XPath Predicate

Predicates are **conditional expression** and are used to **filter the results** of the path expression.

## XPath Predicate

Predicate expression are written in **square brackets after the step** in the path expression to which they apply

**Any expression in square brackets that filters a step in a path expression is a predicate**

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References

```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <xsl:stylesheet version="2.0">
3      xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
4      <xsl:output method="text" encoding="UTF-8" />
5
6      <xsl:template match="/">
7          <xsl:value-of select="//div[1]" />
8      </xsl:template>
9
10 </xsl:stylesheet>
```

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```
1
2      Bibliography
3          Not previously published.
4
```

# Selecting and Processing XML Document Trees

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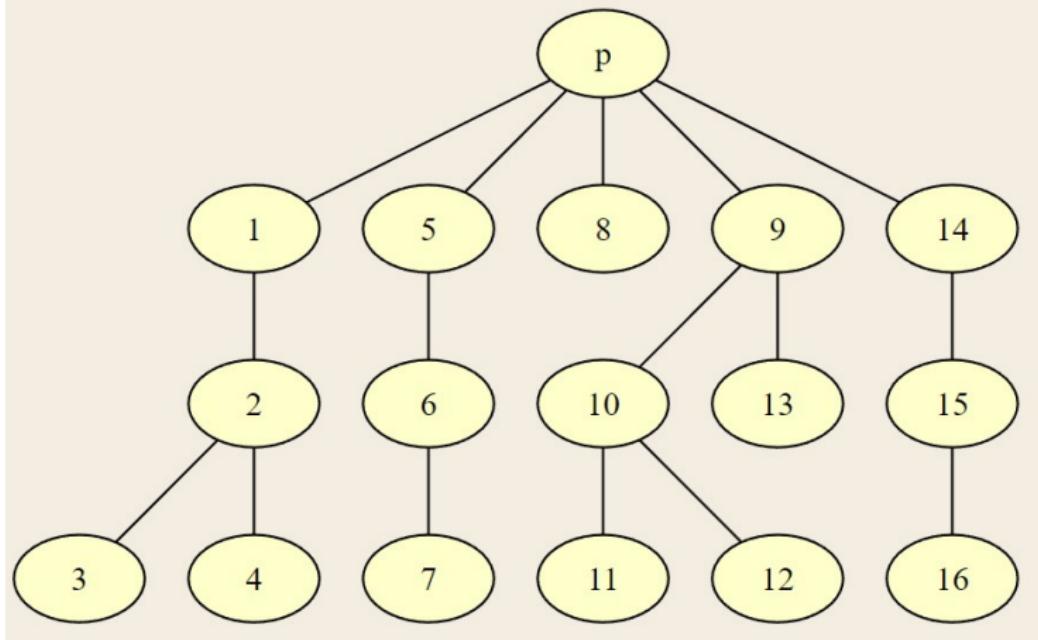
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Description	Value	General
Equal to	eq	=
Not equal to	ne	!=
Greater than	gt	> (&gt;)
Greater than or equal to (not less than)	ge	>= (&gt;=)
Less than	lt	< (&lt;)
Less than or equal to (not greater than)	le	<= (&lt;=)

# Selecting and Processing XML Document Trees

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## Selecting and Processing XML Document Trees

### Examples of Predicates

- `div[@type]`
- `div[@type="edition"]`

# Selecting and Processing XML Document Trees

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## XPath Basics

### "jolly" element selection

- \*
- \*[@type]
- \*[@type="book"]

# Selecting and Processing XML Document Trees

## XPath: functions

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### Esempio predicati

- `//div[@type="edition"]`
- `//div[@type!="translation"]`
- `//div[@n > 2]`
- `//div[1]`
- `//div[last()]`
- `//div[position() = last() - 1]`
- `//div[position() mod 2 = 0]`

# Selecting and Processing XML Document Trees

## XPath location path

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## XPath Basics

Use of OR to select more than one named elements and ID  
function to select the element with the given ID

- "title | author"
- id("irt1952")

# Selecting and Processing XML Document Trees

## XPath location path

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```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <xsl:stylesheet version="2.0">
3  ... xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
4  ... <xsl:output method="text" />
5  ...
6  ... <xsl:template match="/">
7  ...
8  ...   <xsl:value-of
9  ...     select="descendant::langUsage/language[@ident='it']/preceding-sibling::*[1]/text()"
10 ...
11 ...
12   </xsl:template>
13 
14 </xsl:stylesheet>
15 
```

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1 Hebrew

# XPath Expression example

## Voyant-tools

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The screenshot shows the Voyant-tools interface with the following details:

- Opzioni (Options) section:**
  - Formato di input: TEI: Text Encoding Initiative
  - Text Encoding Initiative documentation link: [Per maggiori informazioni sulle opzioni avanzate disponibili, vedi la documentazione su creare un corpus.](#)
- XML section:**

Definisci le espressioni XPath per i seguenti:

  - Contenuto: `//p | //`
  - Titolo: `concat("ecogla", //head/title/text())`
  - Autore:
  - Documento: `/TEI/text/body/div1[@type="section"]`
  - Raggruppa per:
- Additional Metadata section:**
  - Publication Date:
  - Publisher:
  - Location:
  - Keywords:
  - Collection:
  - User-Defined Metadata:
- Aggiungi Testi (Add Text) section:**

Inserisci uno o più URL separati
- Bottom navigation:**
  - HTML
  - JSON
  - Tabelle

# XPath Expression example

Voyant-tools

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The screenshot shows the Voyant-tools interface with a large 'V' and 'T' logo on the left and right respectively, and the word 'text' below them. On the left, there's a sidebar with navigation links. The main area has a sidebar titled 'Opzioni' with various dropdowns and sections like 'Corpus', 'Text', 'XML', 'HTML', 'JSON', 'Tabelle', 'Processing', and 'Opzioni accesso'. A central panel shows an 'Aggiungi Testi' section with fields for 'Contenuto' (containing the XPath expression //u//seg), 'Titolo', 'Autore', and 'Documento'. Below these are sections for 'Additional Metadata', 'HTML', 'JSON', 'Tabelle', 'Processing', and 'Opzioni accesso'. A blue 'Mostra' button is at the bottom right. At the bottom, there's a footer with credits: 'Traduzione italiana a cura di Meschini' and 'Durban, Federico Caria, Federico Ziana Mancinelli'. A search bar is at the very bottom right.

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- Functions operate on the information returned by a path expression or another function
- Functions can be nested
- functions can be used in predicates to filter expressions

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```
2  <xsl:stylesheet version="2.0">
3      xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
4      <xsl:output method="text" encoding="UTF-8" />
5      <xsl:template match="/">
6          <xsl:value-of select="concat(
7              name(TEI/descendant::langUsage/language[1]), ',',
8              count(TEI/descendant::langUsage/language), ',',
9              //w[contains(., 'filii')]/@lemma, ',',
10             upper-case(
11                 substring(TEI/descendant::langUsage/language[@ident eq 'it'],0,4)
12             ), ','
13         )"
14     "/>
15  </xsl:template>
16 </xsl:stylesheet>
```

out-text.txt U X

```
1  language 12 filius ITA
```

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### fn:count

Counts the number of items in a sequence.

`count($arg as item()*) → xs:integer`

#### Arguments

\$arg      item()\*

The sequence whose items are  
to be counted

#### Result

xs:integer

### Namespace

<http://www.w3.org/2005/xpath-functions>

### Links to W3C specifications

[XPath 2.0 Functions and Operators](#)

[XPath 3.0 Functions and Operators](#)

[XPath 3.1 Functions and Operators](#)

### Saxon availability

Available in XPath 2.0, XSLT 2.0, XQuery 1.0, and later versions. Available in all Saxon

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## fn:name

`name() → xs:string`

Returns the name of the context node, as a string in the lexical form of a QName.

*There are no arguments*

<i>Result</i>	xs:string
---------------	-----------

`name($arg as node())? → xs:string`

Returns the name of the supplied node, as a string in the lexical form of a QName.

*Arguments*

\$arg	node()?	The node whose name is required
-------	---------	---------------------------------

<i>Result</i>	xs:string
---------------	-----------

## Namespace

<http://www.w3.org/2005/xpath-functions>

## Links to W3C specifications

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## fn:concat

Concatenates the string-values of the arguments into a single string. There must be at least two arguments.

`concat($arg1 as xs:anyAtomicType?, $arg2 as xs:anyAtomicType?, $etc... as xs:anyAtomicType?) → xs:string`

### Arguments

\$arg1	xs:anyAtomicType?	The first string
\$arg2	xs:anyAtomicType?	The second string
\$etc...	xs:anyAtomicType?	The third and subsequent strings (as many as required)

### Result

xs:string

## Namespace

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## fn:contains

Returns true if the second string is a substring of the first.

`contains($arg1 as xs:string?, $arg2 as xs:string?) → xs:boolean`

Arguments		
\$arg1	xs:string?	The containing string
\$arg2	xs:string?	The contained string
Result		xs:boolean

`contains($arg1 as xs:string?, $arg2 as xs:string?, $collation as xs:string) → xs:boolean`

Arguments		
\$arg1	xs:string?	The containing string
\$arg2	xs:string?	The contained string
\$collation	xs:string	The collation to be used for comparing the strings
Result		xs:boolean

## Namespace

<http://www.w3.org/2005/xpath-functions>

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References

## fn:upper-case

Converts a string to upper case.

`upper-case($arg as xs:string?) → xs:string`

### Arguments

\$arg	xs:string?	The string to be converted to upper-case
-------	------------	--

### Result

xs:string

## Namespace

<http://www.w3.org/2005/xpath-functions>

## Links to W3C specifications

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## Saxon availability

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## fn:lower-case

Translates characters in a string to lower case.

**lower-case(\$arg as xs:string?) → xs:string**

Arguments		
\$arg	xs:string?	The string to be converted to lower-case
Result		
		xs:string

## Namespace

<http://www.w3.org/2005/xpath-functions>

## Links to W3C specifications

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## Saxon availability

Available in XPath 2.0, XSLT 2.0, XQuery 1.0, and later versions. Available in all Saxon editions. Available for all platforms.

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## fn:substring

`substring($sourceString as xs:string?, $start as xs:double) → xs:string`

Returns a substring of a given string starting at the given starting position and continuing to the end of the string.

### Arguments

<code>\$sourceString</code>	<code>xs:string?</code>	The input string
<code>\$start</code>	<code>xs:double</code>	The position of the first character of the input string to be included in the result

### Result

`xs:string`

`substring($sourceString as xs:string?, $start as xs:double, $length as xs:double) → xs:string`

Returns a substring of a given string starting at the given starting position and continuing to the end of the string, or `$length` characters if shorter.

### Arguments

<code>\$sourceString</code>	<code>xs:string?</code>	The input string
<code>\$start</code>	<code>xs:double</code>	The position of the first character of the input string to be included in the result
<code>\$length</code>	<code>xs:double</code>	The number of characters to be included in the result

### Result

`xs:string`

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## fn:string-length

`string-length() → xs:integer`

Returns the number of characters in the string value of the context item.

*There are no arguments*

<i>Result</i>	<code>xs:integer</code>
---------------	-------------------------

`string-length($arg as xs:string?) → xs:integer`

Returns the number of characters in the specified string.

*Arguments*

<code>\$arg</code>	<code>xs:string?</code>	The input string
--------------------	-------------------------	------------------

<i>Result</i>	<code>xs:integer</code>
---------------	-------------------------

## Namespace

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## fn:substring-after

Returns that part of the given input string that occurs after the first occurrence of the string given in \$arg2.

$\text{substring-after}(\$arg1 \text{ as xs:string?}, \$arg2 \text{ as xs:string?}) \rightarrow \text{xs:string}$

### Arguments

\$arg1      xs:string?

\$arg2      xs:string?

The input string

A substring of the input  
string; the function returns  
the rest of the input string  
after this substring

*Result*      xs:string

$\text{substring-after}(\$arg1 \text{ as xs:string?}, \$arg2 \text{ as xs:string?}, \$collation \text{ as xs:string}) \rightarrow \text{xs:string}$

### Arguments

\$arg1      xs:string?

\$arg2      xs:string?

The input string

A substring of the input  
string; the function returns  
the rest of the input string  
after this substring

\$collation      xs:string

The collation to be used for  
comparing characters

*Result*      xs:string

## Namespace

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## fn:substring-before

Returns that part of the given input string that occurs before the first occurrence of the string given in \$arg2.

**substring-before(\$arg1 as xs:string?, \$arg2 as xs:string?) → xs:string**

### Arguments

\$arg1	xs:string?	The input string
\$arg2	xs:string?	A substring of the input string; the function returns the part of the input string before this substring

**Result** xs:string

**substring-before(\$arg1 as xs:string?, \$arg2 as xs:string?, \$collation as xs:string) → xs:string**

### Arguments

\$arg1	xs:string?	The input string
\$arg2	xs:string?	A substring of the input string; the function returns the part of the input string before this substring
\$collation	xs:string	The collation to be used for comparing characters

**Result** xs:string

## Namespace

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## fn:starts-with

Tests whether one string starts with another string.

$\text{starts-with}(\$arg1 \text{ as xs:string?}, \$arg2 \text{ as xs:string?}) \rightarrow \text{xs:boolean}$

Arguments		
$\$arg1$	$\text{xs:string?}$	The containing string
$\$arg2$	$\text{xs:string?}$	The supposed initial part of the string
<i>Result</i>		$\text{xs:boolean}$

$\text{starts-with}(\$arg1 \text{ as xs:string?}, \$arg2 \text{ as xs:string?}, \$collation \text{ as xs:string}) \rightarrow \text{xs:boolean}$

Arguments		
$\$arg1$	$\text{xs:string?}$	The containing string
$\$arg2$	$\text{xs:string?}$	The supposed initial part of the string
$\$collation$	$\text{xs:string}$	The collation to be used for comparing characters
<i>Result</i>		$\text{xs:boolean}$

## Namespace

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## fn:ends-with

Returns true if the first string ends with the second string.

**ends-with(\$arg1 as xs:string?, \$arg2 as xs:string?) → xs:boolean**

### Arguments

\$arg1	xs:string?	The containing string
\$arg2	xs:string?	The supposed ending of the string

### Result

xs:boolean

**ends-with(\$arg1 as xs:string?, \$arg2 as xs:string?, \$collation as xs:string) → xs:boolean**

### Arguments

\$arg1	xs:string?	The containing string
\$arg2	xs:string?	The supposed ending of the string
\$collation	xs:string	The collation to be used for comparing characters

### Result

xs:boolean

## Namespace

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## fn:compare

`compare($comparand1 as xs:string?, $comparand2 as xs:string?) → xs:integer?`

C.compares two strings using the default collation.

### Arguments

\$comparand1	xs:string?	The first string to be compared
\$comparand2	xs:string?	The second string to be compared

### Result

xs:integer?

`compare($comparand1 as xs:string?, $comparand2 as xs:string?, $collation as xs:string) → xs:integer?`

C.compares two strings using the specified collation.

### Arguments

\$comparand1	xs:string?	The first string to be compared
\$comparand2	xs:string?	The second string to be compared
\$collation	xs:string	The collation to be used for the comparison

### Result

xs:integer?

## Namespace

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## fn:normalize-space

**normalize-space() → xs:string**

Eliminates redundant spaces from the string value of the context item.

*There are no arguments*

<i>Result</i>	xs:string
---------------	-----------

**normalize-space(\$arg as xs:string?) → xs:string**

Eliminates redundant spaces from the supplied string.

*Arguments*

\$arg	xs:string?	The string to be normalized
-------	------------	-----------------------------

<i>Result</i>	xs:string
---------------	-----------

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## fn:string-join

`string-join($arg1 as xs:anyAtomicType*) → xs:string`

Returns a string created by concatenating all the items in the given sequence (casting each item to a string), with no separator.

*Available in XPath 3.0, XSLT 3.0, XQuery 3.0, and later versions.*

### Arguments

\$arg1	xs:anyAtomicType*	A sequence of strings to be joined into one
--------	-------------------	---

### Result

xs:string

`string-join($arg1 as xs:anyAtomicType*, $arg2 as xs:string) → xs:string`

Returns a string created by concatenating all the items in the given sequence (casting each item to a string), separated by the given separator.

*Available in XPath 2.0, XSLT 2.0, XQuery 1.0, and later versions.*

### Arguments

\$arg1	xs:anyAtomicType*	A sequence of strings to be joined into one
\$arg2	xs:string	The separator to be used between adjacent strings

### Result

xs:string

## Namespace

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## fn:sort

Sorts a supplied sequence, based on the value of a sort key supplied as a function, using the supplied collation. Calling the single-argument version of the function is equivalent to calling the 3-argument form with `fn:default-collation()` as the second argument and `fn:data#1` as the third argument: that is, it sorts a sequence of items according to the typed value of the items.

`sort($input as item()* → item()*)`

Arguments		
\$input	item()*	The input sequence to be sorted
Result		
	item()*	

`sort($input as item()*, $collation as xs:string?) → item()*`

Arguments		
\$input	item()*	The input sequence to be sorted
\$collation	xs:string?	The collation
Result		
	item()*	

`sort($input as item()*, $collation as xs:string?, $key as function(item()) as xs:anyAtomicType*) → item()*`

Arguments		
\$input	item()*	The input sequence to be sorted
\$collation	xs:string?	The collation
\$key	function(item()) as xs:anyAtomicType*	The sort key
Result		
	item()*	

## Namespace

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## fn:tokenize

Returns a sequence of strings formed by breaking the input string at any substring that matches the given regular expression.

**tokenize(\$input as xs:string?) → xs:string\***

*Available in XPath 3.1, XSLT 3.0, and XQuery 3.1.*

### Arguments

\$input	xs:string?	The input string to be tokenized
---------	------------	----------------------------------

### Result

xs:string\*

**tokenize(\$input as xs:string?, \$pattern as xs:string) → xs:string\***

*Available in XPath 2.0, XSLT 2.0, XQuery 1.0, and later versions.*

### Arguments

\$input	xs:string?	The input string to be tokenized
\$pattern	xs:string	Regular expression matching the separators between tokens

### Result

xs:string\*

**tokenize(\$input as xs:string?, \$pattern as xs:string, \$flags as xs:string) → xs:string\***

*Available in XPath 2.0, XSLT 2.0, XQuery 1.0, and later versions.*

### Arguments

\$input	xs:string?	The input string to be tokenized
\$pattern	xs:string	Regular expression matching the separators between tokens
\$flags	xs:string	Flags controlling how the



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## fn:translate

Returns a string formed by replacing individual characters that appear in the second argument with the characters that appear at the corresponding position in the third argument.

`translate($arg as xs:string?, $mapString as xs:string, $transString as xs:string) → xs:string`

Arguments		
\$arg	xs:string?	The string to be translated
\$mapString	xs:string	Characters to be replaced if they appear in the input string
\$transString	xs:string	Characters to be used as the replacement for corresponding characters in the second argument
Result		
xs:string		

## Namespace

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## fn:matches

Returns true if the given string matches the given regular expression.

**matches(\$input as xs:string?, \$pattern as xs:string) → xs:boolean**

Arguments		
\$input	xs:string?	The string to be matched against a regular expression
\$pattern	xs:string	The regular expression

**matches(\$input as xs:string?, \$pattern as xs:string, \$flags as xs:string) → xs:boolean**

Arguments		
\$input	xs:string?	The string to be matched against a regular expression
\$pattern	xs:string	The regular expression
\$flags	xs:string	Flags that control the interpretation of the regular expression

## Namespace

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## fn:replace

Replaces sequences of characters within a string that match a given regular expression.

`replace($input as xs:string?, $pattern as xs:string, $replacement as xs:string) → xs:string`

### Arguments

\$input	xs:string?	The input string, parts of which are to be replaced
\$pattern	xs:string	The regular expression matching parts of the string that are to be replaced
\$replacement	xs:string	The replacement string
<i>Result</i>		xs:string

`replace($input as xs:string?, $pattern as xs:string, $replacement as xs:string, $flags as xs:string) → xs:string`

### Arguments

\$input	xs:string?	The input string, parts of which are to be replaced
\$pattern	xs:string	The regular expression matching parts of the string that are to be replaced
\$replacement	xs:string	The replacement string
\$flags	xs:string	Flags controlling how the regular expression is interpreted
<i>Result</i>		xs:string

## Namespace

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## fn:analyze-string

Analyzes a string using a regular expression, returning an XML structure that identifies which parts of the input string matched or failed to match the regular expression, and in the case of matched substrings, which substrings matched each capturing group in the regular expression.

`analyze-string($input as xs:string?, $pattern as xs:string) → element(fn:analyze-string-result)`

### Arguments

\$input	xs:string?	The input string
\$pattern	xs:string	A regular expression

### Result

`element(fn:analyze-string-result)`

`analyze-string($input as xs:string?, $pattern as xs:string, $flags as xs:string) → element(fn:analyze-string-result)`

### Arguments

\$input	xs:string?	The input string
\$pattern	xs:string	A regular expression
\$flags	xs:string	Flags controlling the interpretation of the regular expression

### Result

`element(fn:analyze-string-result)`

## Namespace

<http://www.w3.org/2005/xpath-functions>

## Links to W3C specifications

[XPath 3.0 Functions and Operators](#)

[XPath 3.1 Functions and Operators](#)

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## map:get

Gets an entry from a map. Returns the value associated with the given key if present, or the empty sequence otherwise.

`get($map as map(*), $key as xs:anyAtomicType) → item()*`

### Arguments

\$map	map(*)	The input map
\$key	xs:anyAtomicType	The candidate key
<i>Result</i>		item()*

### Namespace

<http://www.w3.org/2005/xpath-functions/map>

### Links to W3C specifications

[XPath 3.1 Functions and Operators](#)

[XSLT 3.0 Specification](#)

### Saxon availability

Available in XPath 3.1, XSLT 3.0, and XQuery 3.1. From Saxon 9.7, available in all editions. Available for all platforms.

### Notes on the Saxon implementation

Available as defined in XSLT 3.0 since Saxon 9.4; in XSLT, XPath, and XQuery, whether or not 3.0 is available.

XPath 3.1 version implemented since Saxon 9.7.

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