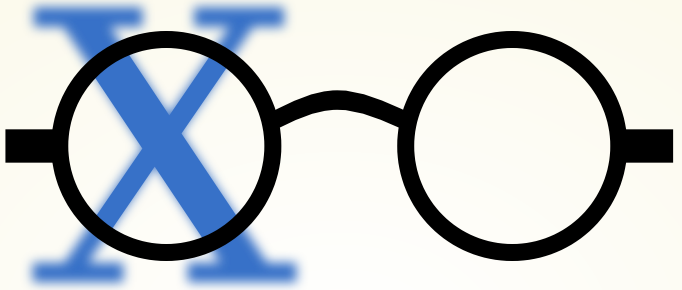
Introduction to XSpec



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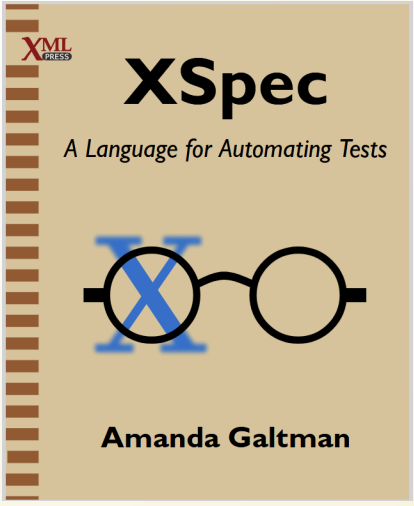
Agenda

- Background
- High-level testing procedure
- How to run XSpec tests
- Explore some XSpec tests
  - XSLT, XQuery, XProc, Schematron
- Along the way...
  - Verification, failure reporting, whitespace

My XSpec Background

- Developing/testing XSLT, XQuery, Schematron
  - Technical pubs
- Contributing to XSpec project since 2018
  - Maintaining since 2022
- medium.com/@xspectacles
- *Soon:* Book from XML Press!



Your Background

- You use one or more of
  - XSLT, XQuery, Schematron, or XProc 3
- You might be new to
  - XSpec
  - Automated testing
- Or, you use XSpec and want to learn it more systematically

XSPEC BACKGROUND

What Is XSpec?

- Open-source software for testing
  - XSLT
  - XQuery
  - Schematron
  - XProc (XSpec v4.0, 2026)
- Created by Jeni Tennison, 2009
- Latest XSpec version is 4.1

Parts of XSpec

1. **XML vocabulary** to express
    - How to call the code you're testing, including inputs
    - What you expect to happen
2. **Software** to automate running tests, i.e.,
    - Calling
    - Verifying: Do results meet expectations?
    - Reporting pass/fail outcomes

This tutorial covers both parts.

XSpec Can Help You...

- Detect regressions
  - Ensure quality in a scalable way
- Use behavior-driven development process
  - BDD not required, though
- Document software behavior
- Investigate defects

BDD Process

Scenarios guide software design/development.

1. **Describe** a desired future behavior, concretely
2. **Execute** the description (test fails)
3. **Code** only enough to make it pass
4. **Refactor** to improve code design, reduce duplication, etc.
    - Maintain passing status
5. **Repeat** for another behavior

HIGH-LEVEL TESTING PROCEDURE

Terminology: Test Target

Section of code you're testing, e.g.,

- XSLT template or function
- XQuery function
- XProc step
- Schematron assertion, report, or rule

Terminology: Test Case

Specific instructions for doing two things:

1. Exercise test target to produce some data
    - "Call" → actual result
2. Verify that actual result meets expectations
    - Pass/fail/pending

(Custom setup/cleanup aren't part of XSpec.)

Testing Procedure

You write instructions. XSpec follows them.

1. Exercise test target to produce some data
   - "Call" → actual result
2. Verify that actual result meets expectations
   - Pass/fail/pending

Repeat as needed.

HOW TO RUN XSPEC TESTS

Two Ways, for this Tutorial

- Choose: Command script or Oxygen
- Both require up-front installation/configuration
  - https://codeberg.org/galtm/xspec-tutorial/

(Other ways to run tests are not covered here.)

Demo

EXPLORE XSPEC TESTS

Basic Structures

Identical for XSLT and Schematron,...

```
1 <x:description xmlns:x="http://www.jenitennison.com/xslt/xspec"
2     stylesheet="identity.xsl">
3     <x:scenario label="When the input is 1">
4         <!-- scenario content -->
5     </x:scenario>
6 </x:description>
```

```
1 <x:description xmlns:x="http://www.jenitennison.com/xslt/xspec"
2   schematron="got-here.sch">
3   <x:scenario label="The input reaches a 'Got here' message">
4     <!-- scenario content -->
5   </x:scenario>
6 </x:description>
```

...as well as XQuery and XProc.

Scenarios Can Nest

<x:scenario> is for organizing code, too.

```
 1 <x:scenario label="When section has a title">
 2     <x:scenario label="and a subtitle">
 3         <!-- scenario content -->
 4     </x:scenario>
 5     <x:scenario label="and no subtitle">
 6         <!-- scenario content -->
 7     </x:scenario>
 8 </x:scenario>
 9 <x:scenario label="When section has no title">
10     <!-- scenario content -->
11 </x:scenario>
```

Inner Scenarios Can Inherit

Ex: Define variable, use in inner scenarios

```
1 <x:scenario label="When section has a title">
2     <x:variable name="my:title" select="//title"/>
3     <x:scenario label="and a subtitle">
4         <!-- scenario content using $my:title -->
5     </x:scenario>
6     <x:scenario label="and no subtitle">
7         <!-- scenario content using $my:title -->
8     </x:scenario>
9 </x:scenario>
```

EXPLORE XSPEC TESTS: XSLT/XQUERY FUNCTIONS

An Example Function

`eg:attr-ids`

- Input: One XML node
- Output: String values of `@id` and `@xml:id`
  - Self + descendants
  - Zero or more
  - Sequence of values

Recall the Two-Step Instructions

1. Exercise test target to produce some data
    - "Call" → actual result
2. Verify that actual result meets expectations
    - Pass/fail/pending

How does this look when you test a function?

Elements

1. `x:call` with `function` attribute
    - "Call" → actual result
2. `x:expect`
    - Choices of attributes/content
    - Verify that actual result meets expectations

Same elements for XSLT function vs. XQuery

Demo

Exercise 1: Function

1. Save a copy of `example1/find-ids_xslt_before_exercise.xspec`
    - In same directory, so file paths still work
2. Remove `pending="EXERCISE"`
3. Fill in the scenario labeled `"with multiple id attributes"`
4. Run the test

Pause

EXPLORE XSPEC TESTS: XSLT TEMPLATES

Testing Template vs. Function

1. Exercise test target... is *different*
2. Verify... is *the same*

Look at how to invoke templates in XSpec...

Named Template

```
1 <x:call template="attr-ids">
2   <x:param name="tree">
3     <root id="a1"/>
4   </x:param>
5 </x:call>
```

- `x:call` element with `template` attribute
- `x:param` requires `name` attribute
  - Order isn't well-defined

Template Rule

```
1 <x:context mode="attr-ids">
2   <x:param name="p1">xyz</x:param>
3   <root id="a1"/>
4 </x:context>
```

- `x:context` element instead of `x:call`
  - "Call" → actual result
  - Get `xsl:apply-templates` behavior
- Choices of attributes/content, as in `x:param`
- Optional `mode` attribute
- Optional `x:param` with `name` attribute

Named Template with Context

```
1 <x:context>
2   <root id="a1"/>
3 </x:context>
4 <x:call template="context-attr-ids">
5   <x:param name="p1">xyz</x:param>
6 </x:call>
```

- Optional `x:context` followed by `x:call`
- Template parameters go in `x:call`

Exercise 2: Template

1. From `example1/` folder, open `find-ids.xsl` to see templates:
    - Named template with parameter
    - Template rule
    - Named template with context item
2. Save a copy of `find-ids_xslt_after_exercise.xspec`
3. Replace `x:call` with XSpec code for testing one of the templates

(Solutions in `example1/exercise2` folder)

Pause

MORE ABOUT VERIFICATION AND REPORTING

Three x:expect Patterns

- Match against actual result (deep-equal)
  - You provide expected result
  - Content or `href`; `select`
- Check that boolean condition is true
  - No expected result
  - `test` = XPath for true/false
- Match against data derived from actual result
  - `test` = XPath for derivation
  - Filter, normalize, pick subtree, etc.
  - You provide expected result of derivation

Example 2

```
1 <xsl:template match="/" as="element(html)">
2   <html>
3     <head>
4       <title>HTML document</title>
5     </head>
6     <xsl:apply-templates select="." mode="body"/>
7   </html>
8 </xsl:template>
```

- Produces HTML element tree
- Imagine that result of `xsl:apply-templates` is verified elsewhere
- Can you verify outer `html` element and `head`?

Demo

EXERCISES 3 AND 4

Exercise 3: Verification

1. Save a copy of `example2/make-html_xslt_before_exercise3.xspec`
2. Verify outermost element name in two ways
    - Boolean `test`
    - `test` deriving something from `$x:result`
        - Verify local name only, for simplicity

(Solutions in `example2/exercise3` folder)

Pause

Exercise 4: Report

1. Open `example2/exercise4/make-html_xslt_failures.xspec`
2. Run the test
    - Has deliberate failures
3. Examine the HTML test report to see how it describes the failures
    - How are they different?
    - Are some easier to understand?

Pause

EXPLORE XSPEC TESTS: XPROC STEPS

An Example Step

`eg:make-html`

- `source` input: JSON document
- `body-id` option: String to use as `id`
- `result` output: HTML document containing
  - `head` with `title`, text from the JSON file
  - `body` created by another step

Similar to the XSLT template rule in `example2/`

Markup for Testing XProc

- `x:call` element with `step` attribute
- `x:input` element with `port` attribute
  - Use like `x:param`
  - Or, embed `p:document`
- `x:option` element with `name` attribute
- `x:expect` with optional `port` attribute

Demo

Exercise 5: XProc Verification

1. Save a copy of `example2/make-html_xproc_before_exercise5.xspec`
2. Fill in the `x:expect` element labeled `"with a head element containing a title"`
3. Run the test

   (Solution in `example2/exercise5` folder)

Pause

A WHITESPACE TANGENT

Not XProc-specific

Demo

EXPLORE XSPEC TESTS: SCHEMATRON

Schematron Testing Concept

- "Call" = Validate a document
- Verify that the validation process
  - Triggers the assertions/reports you expect
  - Not those you don't expect
  - Fires rules you expect

Test with invalid documents *and* valid ones

Schematron Implementations

XSpec v4.0+ distribution includes:

- SchXslt2, XSLT-based
  - https://codeberg.org/schxslt/schxslt2
- XQS, XQuery-based
  - https://github.com/AndrewSales/XQS

Pick based on schema's `queryBinding` attribute (e.g., `"xslt3"` vs. `"xquery31"`).

An Example Schema

- If parent and child both have `id` attribute, the child's id must start with the parent's id.
  - e.g., `parent1` and `parent1-child1`
- Every `id` attribute value must be at least 5 characters

Markup for Testing Schematron

- `x:context` similar to testing XSLT
- `x:param` child of `x:description`

Markup for Testing Schematron (cont'd.)

- `x:expect-assert`, `...-report`
  - Text content
  - Attributes `id`, `role`, `location`, `count`
- `x:expect-not-assert`, `...-report`
  - Attributes `id`, `role`, `location`
- `x:expect-rule`
- `x:expect-valid`

HTML Report

- Automatic verification labels
  - Preceded by optional custom label
- Failures expose SVRL document

Demo

Exercise 6: Schematron

1. Save a copy of `example3/id-validation_before_exercise6.xspec`
2. Test the assertion that has `id="length"`
    - `"id is 5 characters"` should *not* trigger this assertion
    - `"id is 4 characters"` *should* trigger this assertion
3. Run the test

(Solution in `example3/exercise6` folder)

Pause

XSPEC HAS MORE

No time now to cover...

- Global XSLT parameters
- Three-dot syntax
- Testing for errors
- XSpec variables
- Reusing XSpec code
- Context item in `@test` (XSLT)
- Document properties (XProc)
- Wrapping in document nodes (XProc)
- Non-XML content outside XProc
- ...and more

Other Resources

- XSpec wiki: Official documentation
  - Presentations and Demos: Conference talks, etc.
- XSpec book: Paperback, PDF, ePub

Image Credits

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Go forth and write high-quality code!

