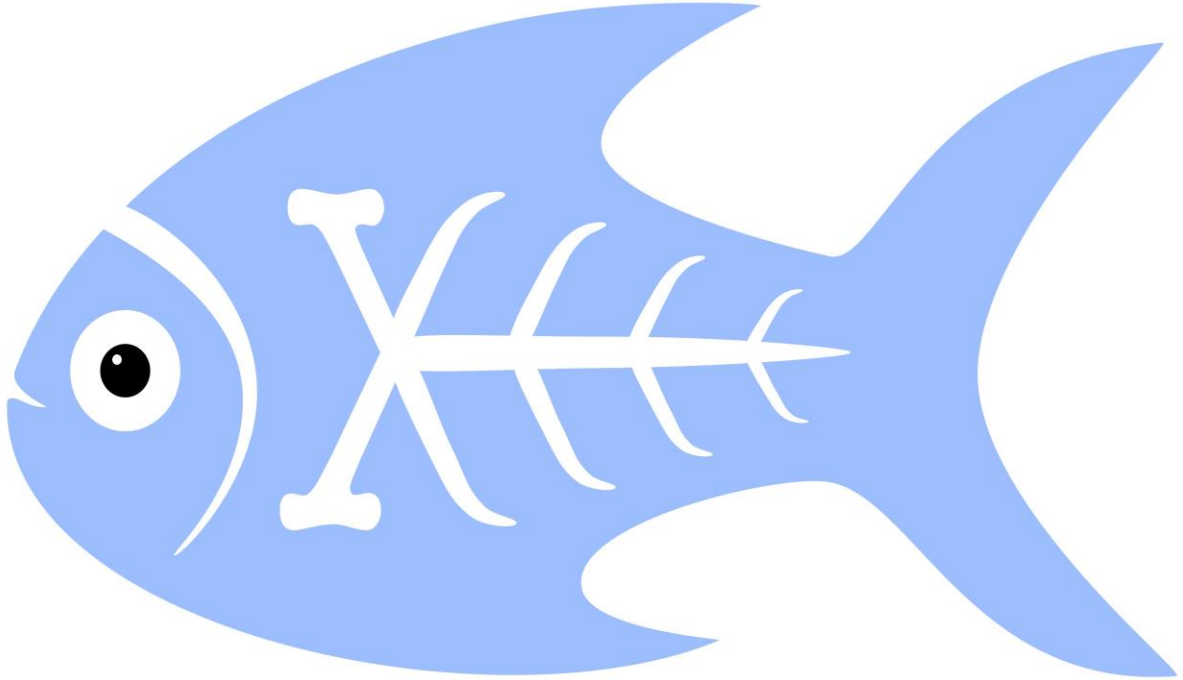
Introduction to XProc 3.0

Markup UK 2023
June 1-3, London



While waiting, maybe you can do some preparations?
Go to **https://mu-2023-xproc.xatapult.com** for instructions!

Who Am I?

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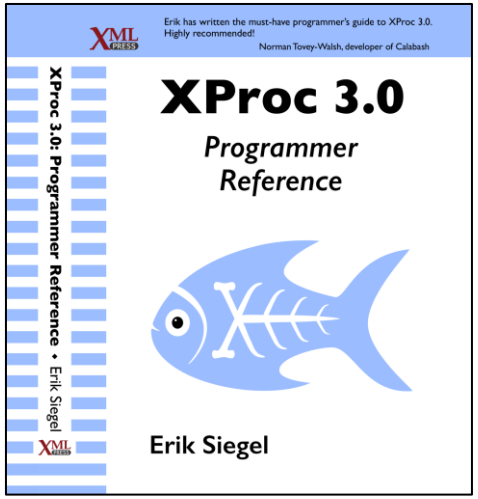
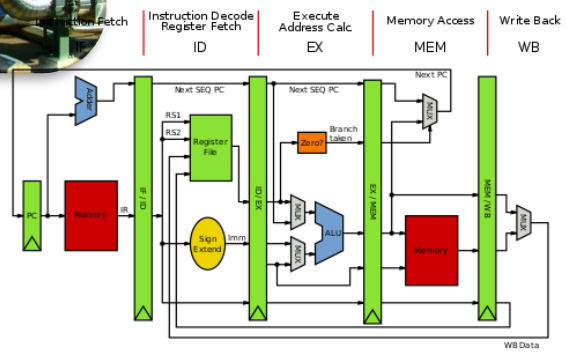


XProc?

- XProc is an XML based programming language for complex data processing - pipelining
- Extensible set of small, sharp tools for creating and transforming XML and other documents
- V1.0 around since 2010 (two processor implementations to run your pipelines)
- Specification of 3.0 in "last call" status
- One working processor (MorganaXProc-IIIse)
- One under way (XML Calabash 3), almost there

My name is Kanava.
I'm XProc's logo!

Why should I bother?



- Pipelines are ubiquitous all around us
- Solve problems with a set of small, sharp tools that combine in many ways
  - Like the UNIX command line
- Compose small tools into something bigger, pipelines…
- Very natural choice for document processing
- XProc beats the alternatives

A successful example of large-scale application of XProc (1.0) pipelines:
https://www.le-tex.de/en/transpect.html

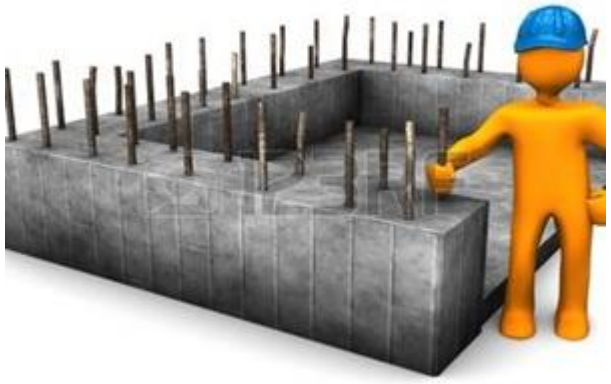
Hands-on: Installation and pre-flight check

- Done all preparations?
  - Download/cloned the GitHub repository for this tutorial? https://github.com/xatapult/mu-2023-xproc
  - Java working on your machine?
  - Download and unpacked MorganaXProc-IIIse? https://sourceforge.net/projects/morganaxproc-iiise/
  - Added Morgana's main directory to the system's path?
- Go to where you cloned/downloaded the tutorial's GitHub repository
- Open a command window in **`exercises/01-hello-xproc/`**
- Command: **`morgana pipeline.xpl`**

```
==================================
MorganaXProc-IIIse 1.1.4
Copyright 2011-2023 by <xml-project /> Achim Berndzen
==================================

<?xml version="1.0" encoding="UTF-8"?>
<hello-xproc timestamp="2023-05-10T11:14:27.21+02:00"/>
```

If it works you've just run your first XProc pipeline!

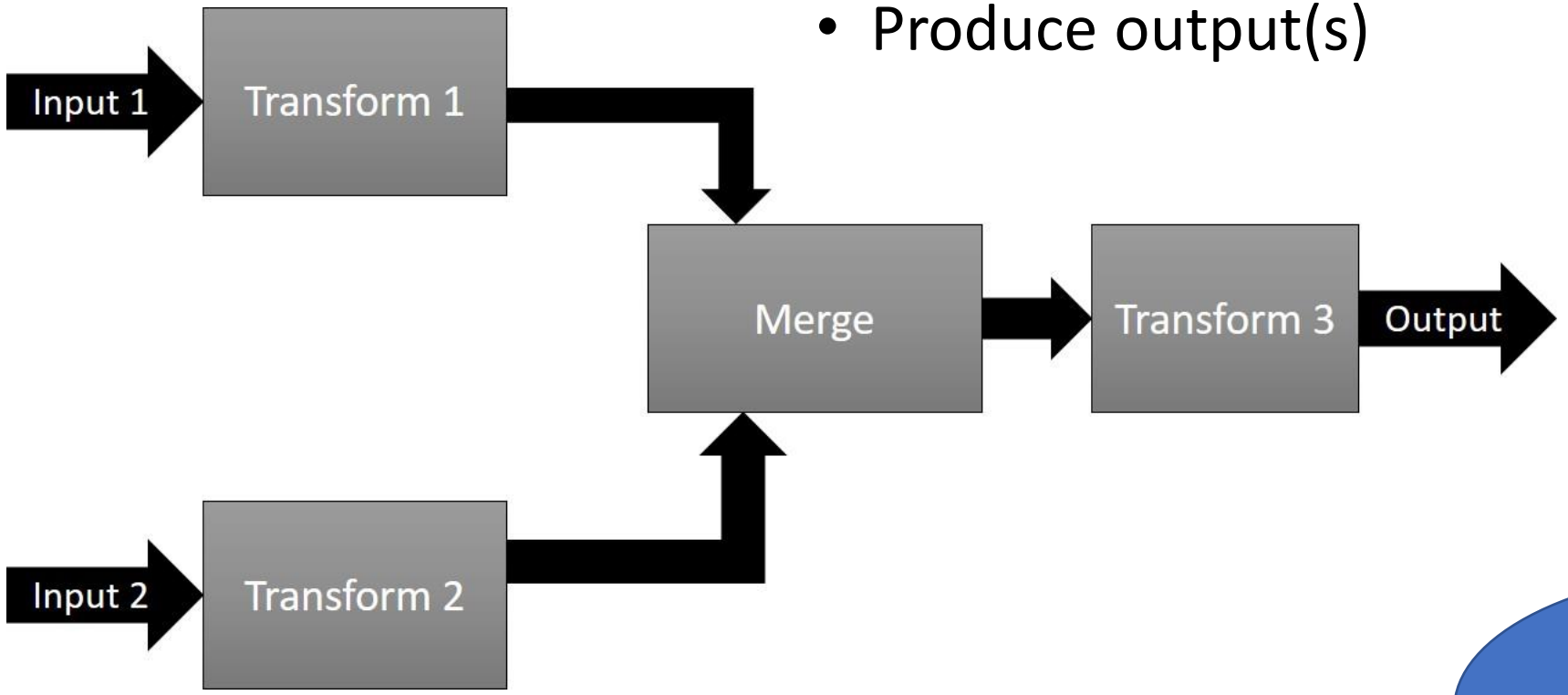
XProc fundamentals



You need to understand this!

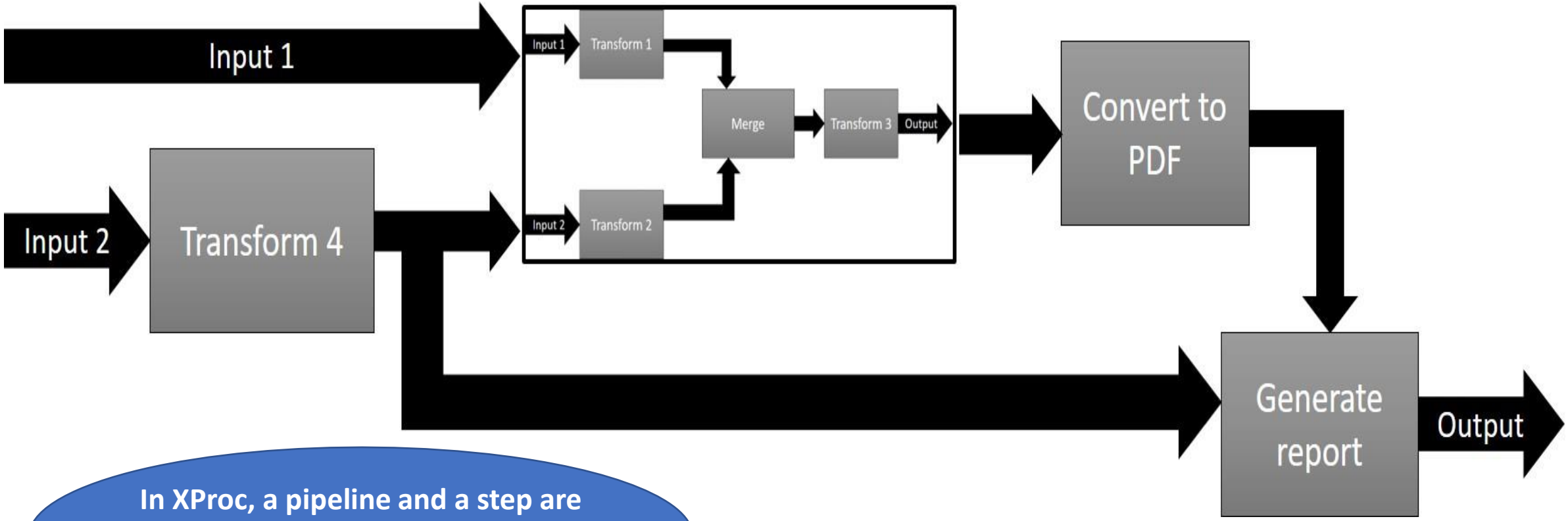
Pipelines, steps

- Document(s) as input
- Process the data flowing through using steps
- Produce output(s)



Documents can be of any type, not just XML!

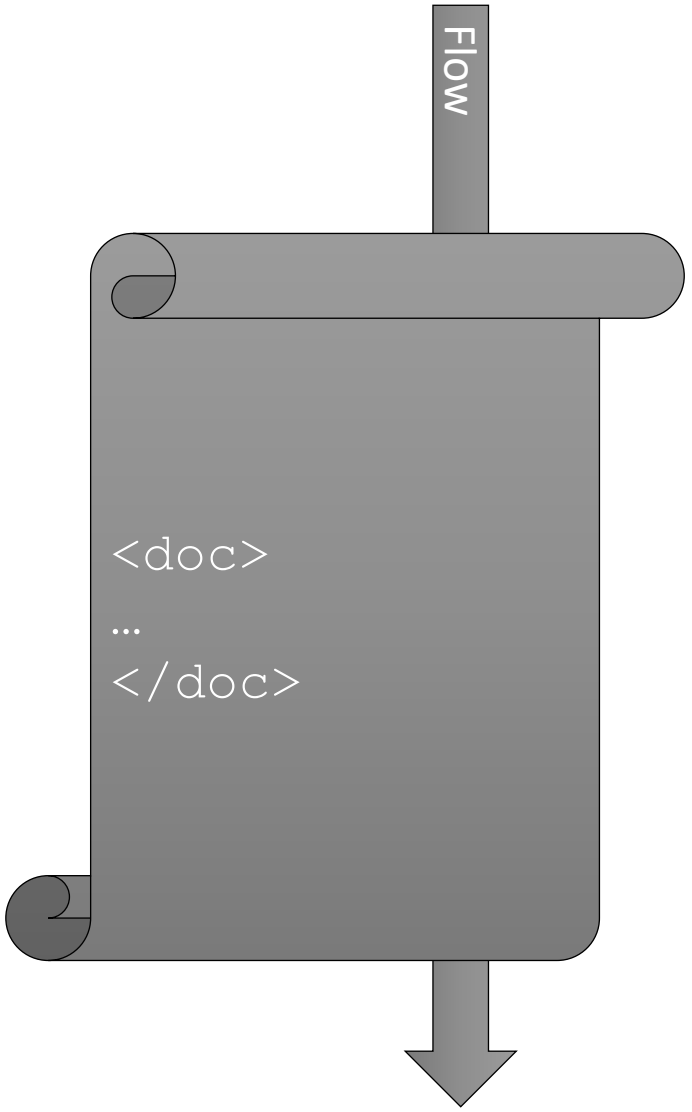
Pipelines, steps



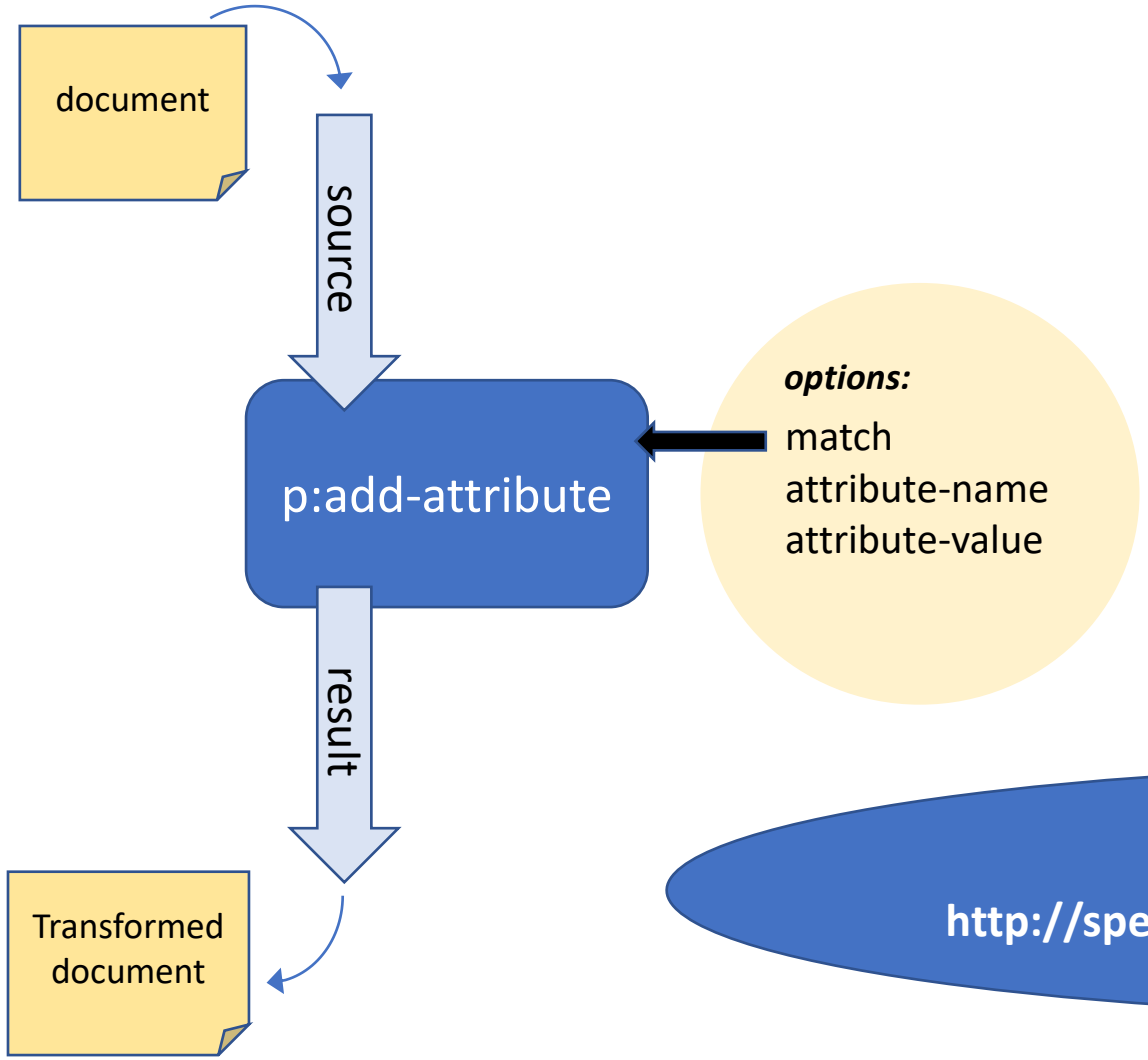
In XProc, a pipeline and a step are essentially the same. The terms can be used interchangeably!

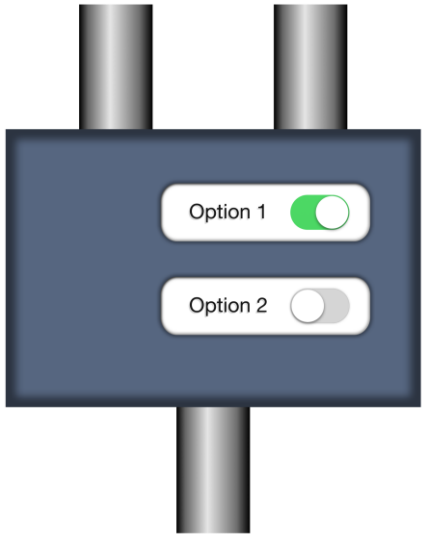
Supported document types

- XML
- HTML
- JSON
- Text
- Binary/other
  - For instance: zip



Steps/pipelines, ports, options





Have a look ate the step specification:
http://spec.xproc.org/master/head/steps/#c.add-attribute

The step libraries

- Standard steps, see http://spec.xproc.org/master/head/steps/
  - These steps *must* be implemented in a conformant XProc processor!

- Additional steps, see http://spec.xproc.org/master/head/#steps/
  - File handling, OS, validation, etc.
  - Implementation is optional (but recommended)
  - If such a step is implemented it must conform to what is written there

There are over 45 standard steps!

Step/pipeline that adds an attribute to the root

Root p:declare-step element

Namespace and preferred prefix (p:)

XProc version

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>

  <p:output port="result"/>

  <p:add-attribute match="/*" attribute-name="timestamp"
      attribute-value="{current-dateTime()}"/>

</p:declare-step>
```

Input port declaration

Output port declaration

A step invocation

You can specify option values as attributes on the step invocation

To compute stuff use Attribute-Value-Templates (AVTs), just like in XSLT.

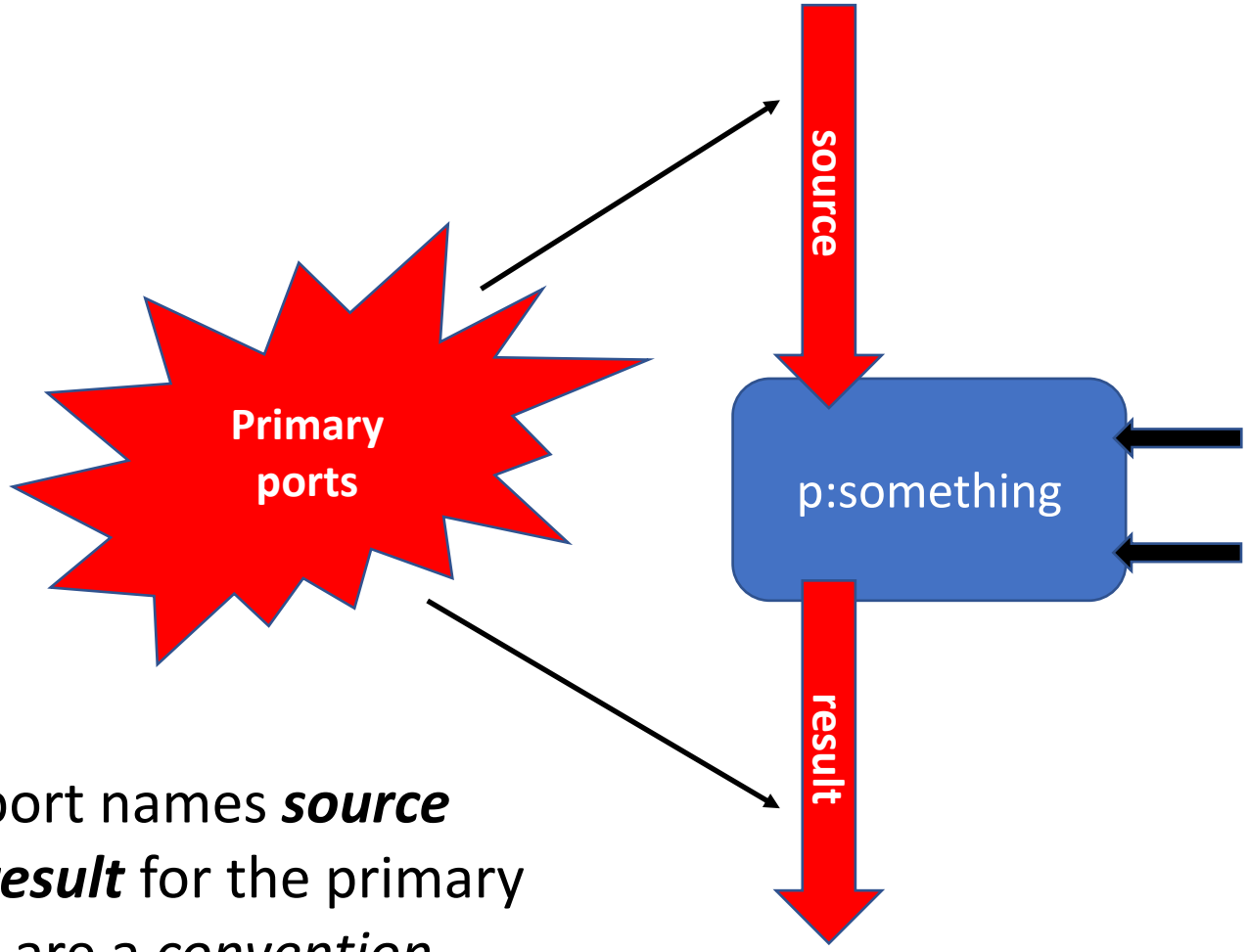
☛ Hands-on: Try it out

- Open a command window in **`exercises/02-add-attribute/`**

- Command: **`morgana pipeline.xpl -input:source=input.xml`**
- Try it!

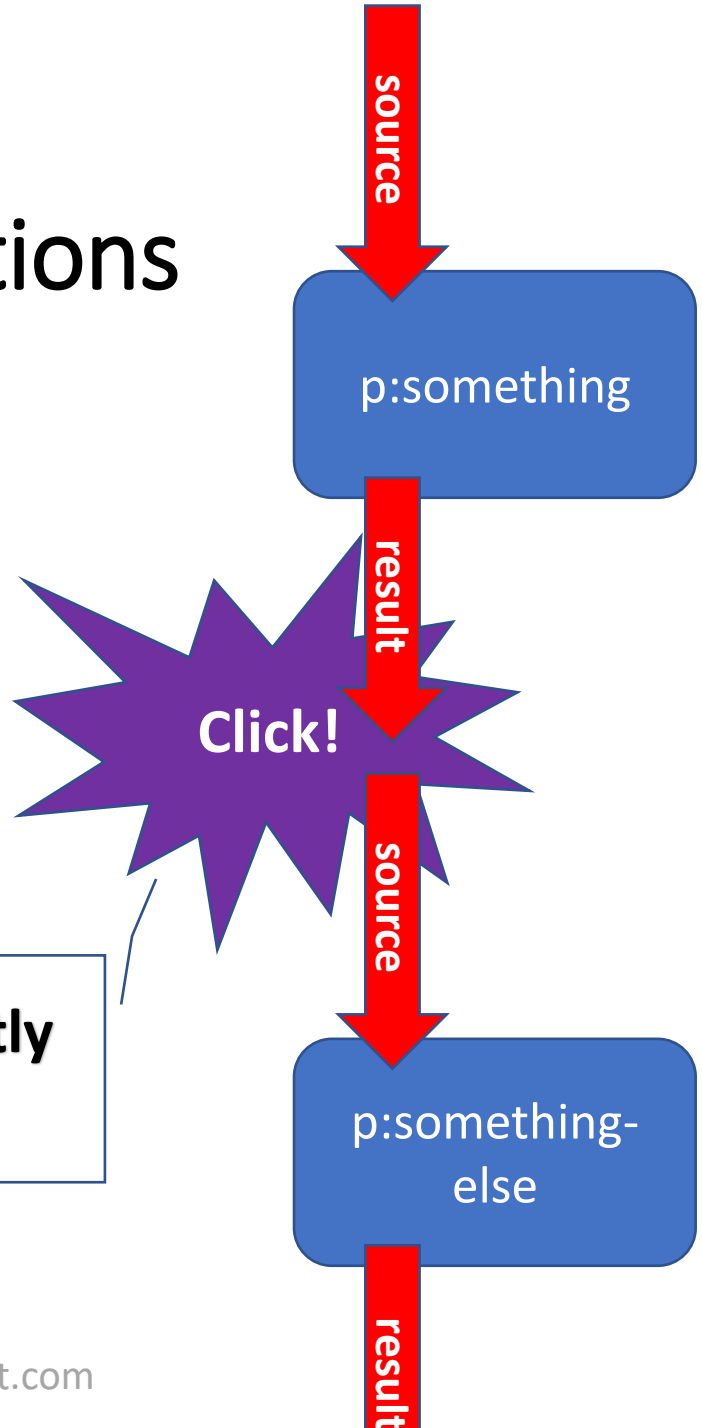
Whow, that's a boring thing to do! I encourage you to experiment a bit …

Primary ports



The port names ***source*** and ***result*** for the primary ports are a *convention*

Primary ports, implicit connections




```
<p:something …>
  …
</p:something>
```

Click!

```
<p:something-else …>
  …
</p:something-else>
```

Primary ports implicitly connect

Think of primary ports having little magnets that *snap* automagically together

Primary ports, implicit connections

If a step has only a single input or output port, they're primary by default. But you can set the primary status *explicitly* using a primary="true/false" attribute here.

Implicit connection of primary input port to first step

Implicit connection of last step to primary output port

Implicit connection of steps

```
<p:declare-step … >

  <p:input port="source"/>
  <p:output port="result"/>

  <p:something …>
    …
  </p:something>


  <p:something-else …>
    …
  </p:something-else>

</p:declare-step>
```

☛ Hands-on: Add a second attribute

- Open a command window in **`exercises/02-add-attribute/`**
- Change the pipeline and add a *second* **`p:add-attribute`** step that adds another attribute to the root element (or somewhere else).

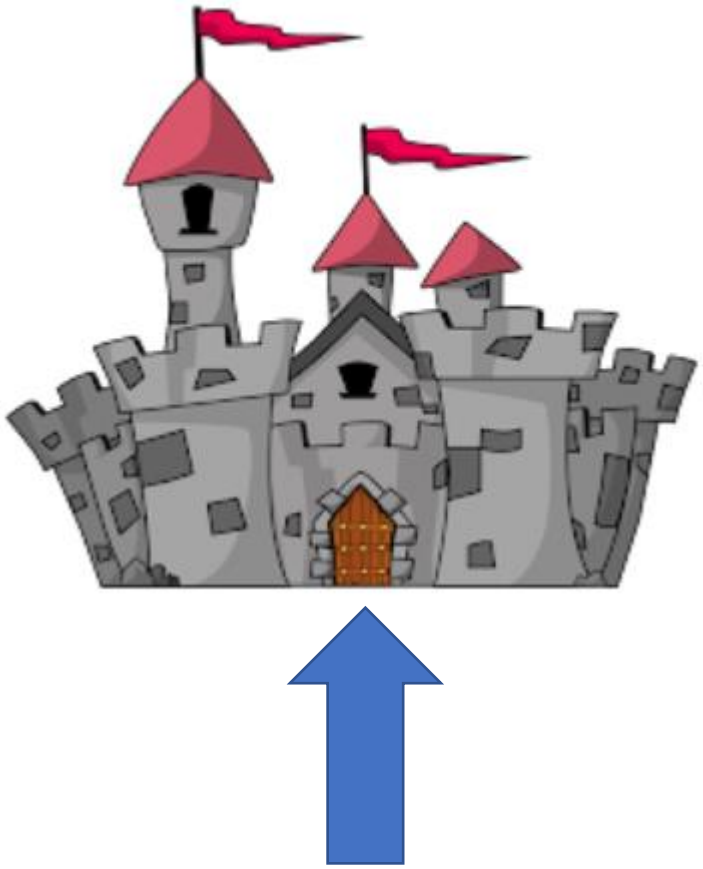
- Command: **`morgana pipeline.xpl -input:source=input.xml`**
- Try it!

Easy….

Solution: Add a second attribute

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:add-attribute match="/*" attribute-name="timestamp"
     attribute-value="{current-dateTime()}"/>

  <p:add-attribute match="/*" attribute-name="enabled"
     attribute-value="true"/>

</p:declare-step>
```

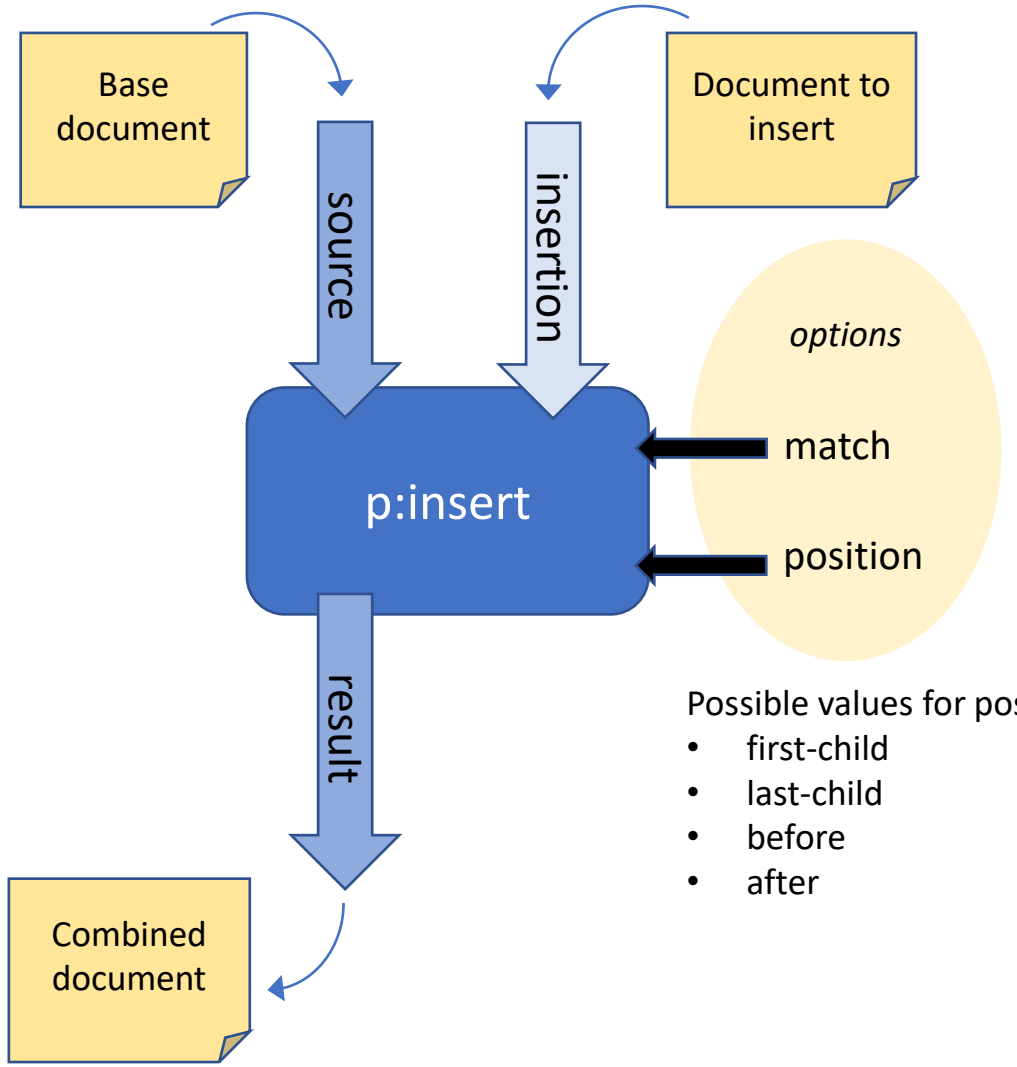
Ports and explicit connections



1. To an inline document
2. To an external document
3. To a port in the pipeline

The p:insert step

See:
http://spec.xproc.org/master/head/steps/#c.insert



Possible values for position:

- first-child
- last-child
- before
- after

The source and result port are primary, the insertion port is not…

Connect a port to an inline document

Explicitly connect something to a port using p:with-input

```
<p:somestep ...>

  <p:with-input port="port-name">
    ... (inline XML document) ...
  </p:with-input>

  ...

</p:somestep>
```

You can use expressions between curly braces {...} in your inline document

Expressions between curly braces are called TVTs (Text-Value-Templates and AVTs (Attribute-Value-Templates)

Hands-on: Add an additional child element using an inline document with p:insert

- Open a command window in **`exercises/03-connect-inline/`**
- Finish the pipeline so it adds a **`<location>London 2023</location>`** element *after* the **`<presenter>`** element
  - Use the **`p:insert`** step with an inline document
  - Options: **`match="/*" position="last-child"`**
  - Connect the inline document to the **`insertion`** port using **`<p:with-input port="…">`**
- Compute the current year using a **`{…}`** construction
  - XPath cheat: `year-from-date(current-date())`

Now you're on your own writing XProc, scary…

- Command: **`morgana pipeline.xpl -input:source=input.xml`**
- Try it!

Insert inline document - solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:insert match="/*" position="last-child">
    <p:with-input port="insertion">
      <location>London {year-from-date(current-date())}</location>
    </p:with-input>
  </p:insert>

</p:declare-step>
```

Connect a port to an external document

```
<p:somestep ...>

  <p:with-input port="port-name" href="reference-to-document"/>

  ...

</p:somestep>
```

The href attribute is an AVT: You can use expressions between curly braces {…} inside

We have no means to add the current year now, like we did in the last exercise…

Hands-on: Add an additional child element using an external document with p:insert

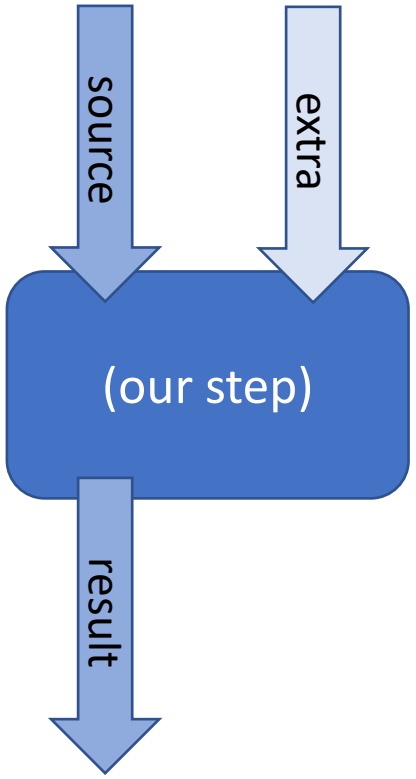
- Open a command window in **`exercises/04-connect-external/`**
- Finish the pipeline so it adds the contents of **`insert.xml`** *after* the **`<presenter>`** element
  - Use the **`p:insert`** step with an href attribute
  - Options: **`match="/*" position="last-child"`**

- Command: **`morgana pipeline.xpl -input:source=input.xml`**
- Try it!

Insert external document - solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:insert match="/*" position="last-child">
    <p:with-input port="insertion" href="insert.xml"/>
  </p:insert>

</p:declare-step>
```

Add another port to our step and connect p:insert to it



The source and result port are primary, the extra port is not…

Add an additional input port to our step

We have more than two ports now: make explicit which ones are primary and which ones are not

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input primary="true" port="source"/>
  <p:output primary="true" port="result"/>

  <p:input primary="false" port="extra"/>

  ...
</p:declare-step>
```

Add another input port to our step using <p:input>

Connect a port to another port in the same pipeline

Name the step/pipeline

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0"
  name="my-pipeline">

  <p:input primary="true" port="source"/>
  <p:output primary="true" port="result"/>

  <p:input primary="false" port="extra"/>

  <p:insert match="/*" position="last-child">
    <p:with-input port="insertion" pipe="extra@my-pipeline"/>
  </p:insert>

</p:declare-step>
```

Use the pipe attribute with "portname@stepname"

Hands-on: Add an external document with p:insert

- Open a command window in **`exercises/05-connect-internal/`**
- Command: **`morgana pipeline.xpl -input:source=input.xml -input:extra=insert.xml`**
- Try it!
- Change this pipeline so it now inserts its primary input document in itself, directly after the inserted **`<location>`** element…

```
<tutorial>
  <name>Introduction to XProc 3.0</name>
  <presenter>Erik Siegel</presenter>
  <location>London</location>
  <tutorial>
    <name>Introduction to XProc 3.0</name>
    <presenter>Erik Siegel</presenter>
  </tutorial>
</tutorial>
```

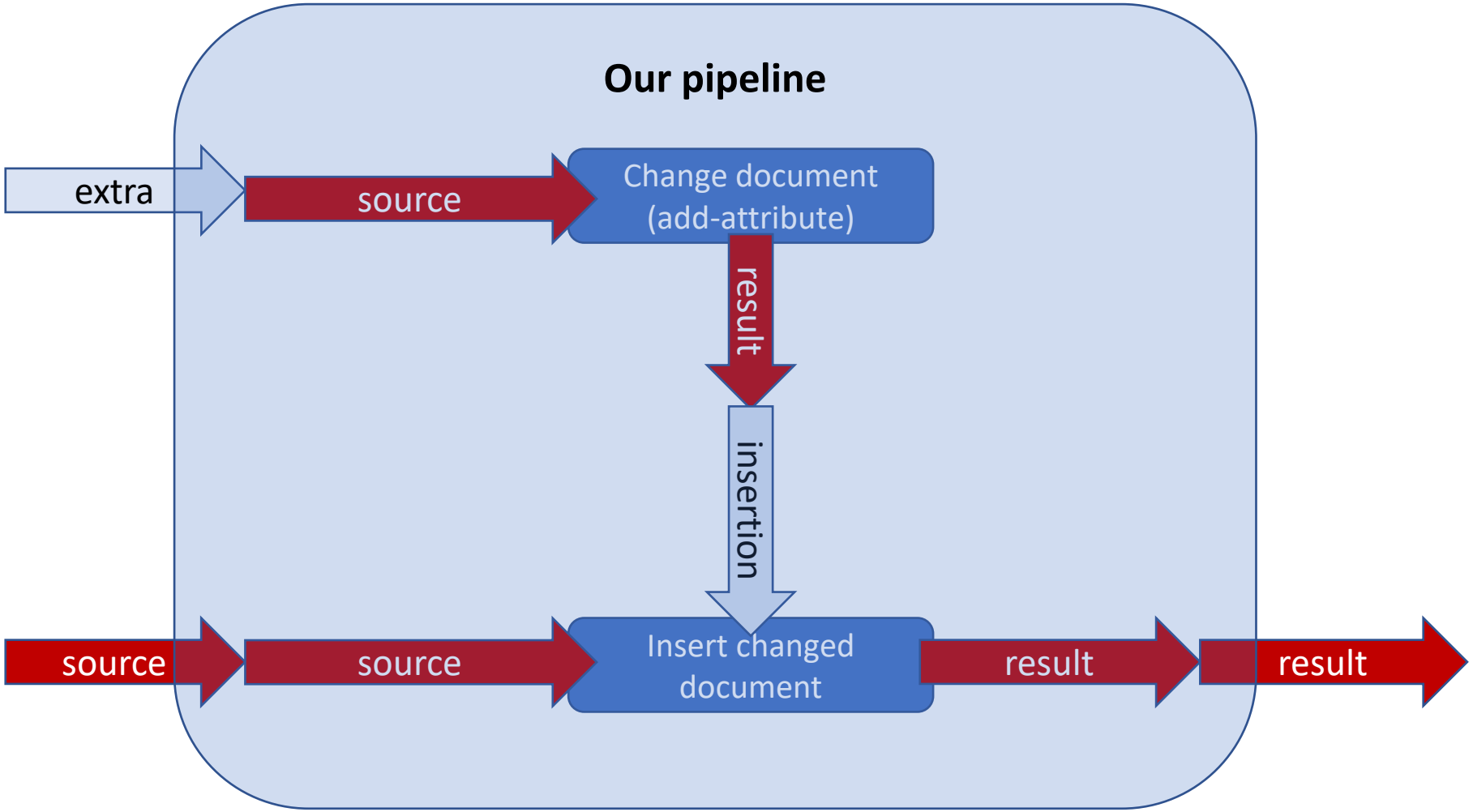
Not very useful but nonetheless insightful

Insert external document - solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0"
   name="my-pipeline">

  <p:input primary="true" port="source"/>
  <p:output primary="true" port="result"/>

  <p:input primary="false" port="extra"/>

  <p:insert match="/*" position="last-child">
    <p:with-input port="insertion" pipe="extra@my-pipeline"
  </p:insert>

  <p:insert match="/*" position="last-child">
    <p:with-input port="insertion" pipe="source@my-pipeline"/>
  </p:insert>

</p:declare-step>
```

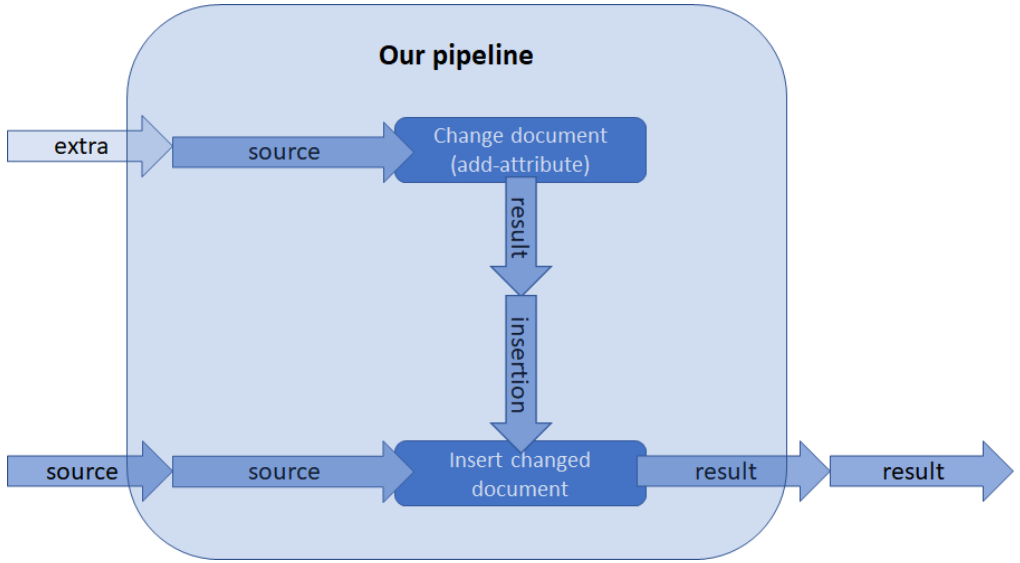
Re-read the document from the step's source port

Hands-on: Change a document and insert it into the primary document



Hands-on: Change a document and insert it into the primary document

- Open a command window in **`exercises/05b-connect-internal/`**
- Change this pipeline so the extra document is changed first before the insert
- Command: **`morgana pipeline.xpl -input:source=input.xml -input:extra=insert.xml`**
- Try it!

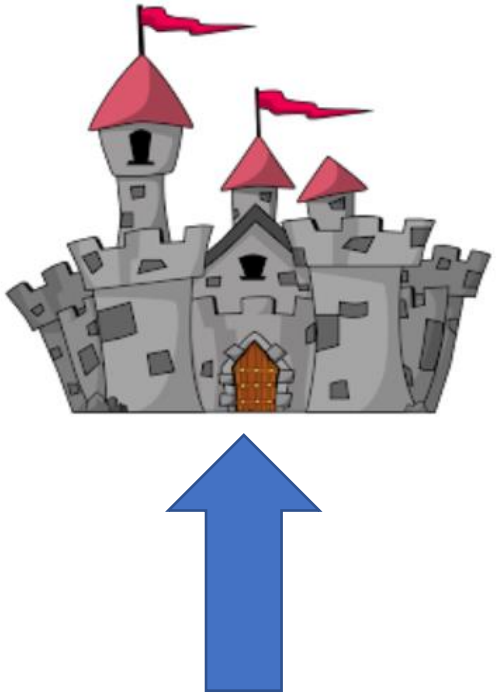


Change a document and insert it into the primary document - solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0" name="my-pipeline">

  <p:input primary="true" port="source"/>
  <p:output primary="true" port="result"/>

  <p:input primary="false" port="extra"/>

  <p:add-attribute match="/*" attribute-name="extra" attribute-value="true"
    name="change-extra-document">
    <p:with-input port="source" pipe="extra@my-pipeline"/>
  </p:add-attribute>

  <p:insert match="/*" position="last-child">
    <p:with-input port="source" pipe="source@my-pipeline"/>
    <p:with-input port="insertion" pipe="result@change-extra-document"/>
  </p:insert>

</p:declare-step>
```

Explicit connection because p:insert is no longer the first step!

Ports and implicit connections



1. To an inline document
   - Add the XML inside the **`<p:with-input>`**
2. To an external document
   - Use the **`href`** attribute on **`<p:with-input>`**
3. To a port in the pipeline
   - Name the steps you want to read from and use the **`pipe`** attribute on **`<p:with-input>`**

Options and variables

1. Add an option to your pipeline
2. Variables
3. Other ways to set options

Your own options

- We've seen that built-in steps can have options
- What if you want to add an option to your own step?

Declare the option in the prolog of your step

Optionally add a default value (XPath expression!)

```
p:declare-step xmlns:p="http  ww.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:option name="username" select="'erik'"/>

  <p:add-attribute match="/*" attribute-name="username"
      attribute-value="{upper-case($username)}"/>

</p:declare-step>
```

Reference the option using the $... notation, just like XSLT and XQuery

You can make an option required, set a datatype, supply a default, etc.

Hands-on: Add options

- Open a command window in **`exercises/06-add-option/`**
- Command: **`morgana pipeline.xpl -input:source=input.xml -option:username=`***`(your-name)`*
- Try it!

- Change this pipeline so the *name* of the username attribute can be changed also, using an option called **`aname`**

Add an option - solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:option name="username" select="'erik'"/>
  <p:option name="aname" select="'username'"/>

  <p:add-attribute match="/*" attribute-name="{$aname}"
     attribute-value="{upper-case($username)}"/>

</p:declare-step>
```

Variables

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:option name="username"/>

  <p:variable name="id" select="upper-case($username) || '-' ||
     p:system-property('p:episode')" />

  <p:add-attribute match="/*" attribute-name="id" attribute-value="{$id}"/>

</p:declare-step>
```

Declare the variable anywhere

Reference the variable using the $... notation, just like XSLT and XQuery

Variables can be of *any* datatype, just like in XSLT or XQuery

Variables values from the documents flowing through

```
<some-root status="final">
  …
</some-root>
```

Read values from the document flowing through!

```
<p:variable name="status" select="/*/@status" />
```

Hands-on: Use a variable

- Open a command window in **`exercises/07-use-variable/`**
- Add a variable that catches the value of the **`<presenter>`** element
  - **`<p:variable name="…" select="…"/>`**
- Add this value as an attribute to the root
- Command: **`morgana pipeline.xpl -input:source=input.xml`**
- Try it!

Use a variable - solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:variable name="presenter" select="//presenter[1]"/>

  <p:add-attribute match="/*" attribute-name="presenter"
     attribute-value="{$presenter}"/>

</p:declare-step>
```

Get some value from the document flowing through

Reference the variable using the $... notation

Alternative…

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:add-attribute match="/*" attribute-name="presenter"
     attribute-value="{//presenter[1]}"/>

</p:declare-step>
```

How to set an option?

1. As attribute on a step's invocation:
   `<p:add-attribute match="…" …/>`
   - Works for data types that can be cast from a string (strings, booleans, integers doubles, etc.)
   - If the option's data type is a *map* you can use a map constructor:
     `parameters="map{ 'par1':'value-for-par1' }"`

2. Using the `<p:with-option>` child element… but be careful!

Using <p:with-option>

```
<p:add-attribute match="/*" attribute-name="x" attribute-value="{1 + 2}"/>
```

The match expression should be interpreted *by the step* (and not by the *pipeline*), so it must be passed as a string!

```
<p:add-attribute>
  <p:with-option name="match" select="'/*'"/>
  <p:with-option name="attribute-name" select="'x'"/>
  <p:with-option name="attribute-value" select="1 + 2"/>
</p:add-attribute>
```

The select attribute(s) contain **XPath** expressions

Hands-on: Use p:with-option

- Open a command window in **`exercises/08-use-with-option/`**
- Replace the attributes on the **`<p:add-attribute>`** by **`<p:with-option>`** elements
- Command: **`morgana pipeline.xpl -input:source=input.xml`**
- Try it!

- Try what happens when you forget to make the **`match`** option a string…

Use p:with-option - solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:add-attribute>
    <p:with-option name="match" select="'/*'"/>
    <p:with-option name="attribute-name" select="'timestamp'"/>
    <p:with-option name="attribute-value"
       select="string(current-dateTime())"/>
  </p:add-attribute>

</p:declare-step>
```

When to use what for setting options?

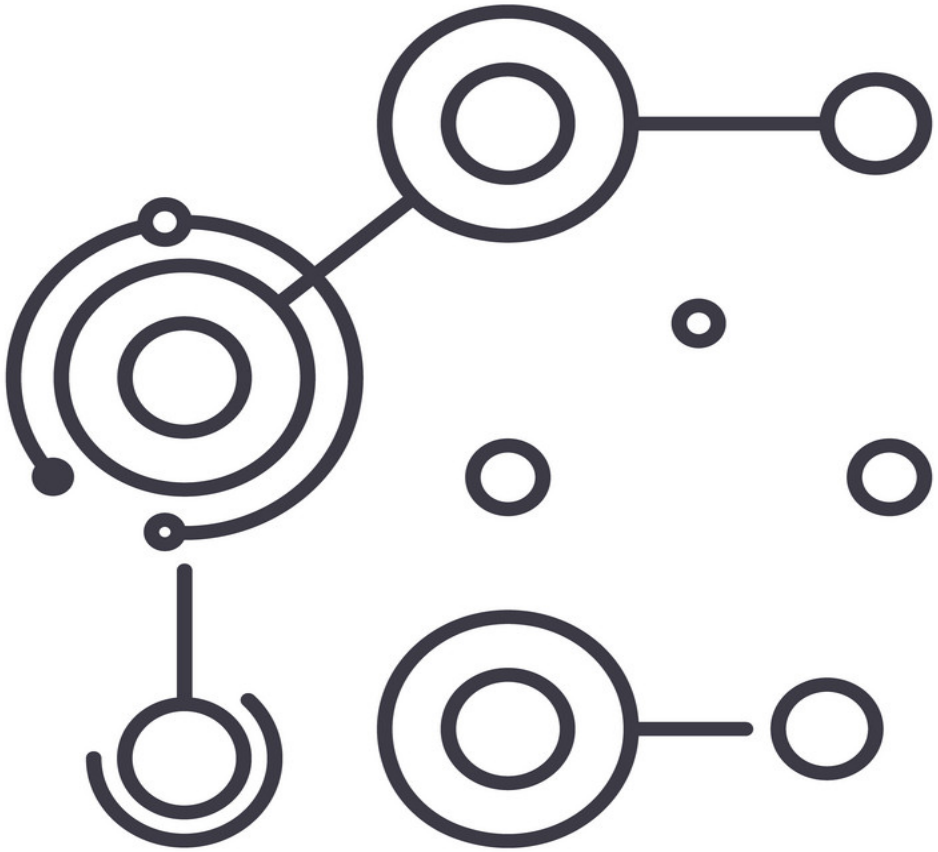
- Style…
  - Attributes are easier (?)
  - `<p:with-option>` is more explicit (?)

- When the datatype of an option cannot be cast from a string, you *must* use `<p:with-option>`
  - For instance, when the option requires a *sequence* as value:
    `<p:with-option name="…" select="(…, …, …)"/>`

Options and variables

1. Add an option to your pipeline
   - **`<p:option>`** in the prolog
   - Reference option as a variable
2. Variables
   - Declare them anywhere using **`<p:variable>`**
3. Other ways to set options
   - Either attribute or **`<p:with-option>`**

Compound steps



1. What are compound steps?
2. What steps do we have?
3. Example of using the p:for-each step

The core (or compound) steps

- **`p:for-each`**: loop over multiple documents, or parts of a document
- **`p:choose / p:when / p:otherwise`**: Make choices
- **`p:if`**: Make a single choice (no else)
- **`p:viewport`**: Work on only a part of a document
- **`p:try / p:catch`**: Error catching and handling
- **`p:group`**: Grouping of instructions

Regrettably, there is no time to look at them all…

Use p:if to make a decision

```
<p:if test="…">


</p:if>
```

The code here only executes when the test expression is true

When the expression is false, the input simply "falls through", without change

👉 Hands-on: Use p:if to make a decision

- Open a command window in **`exercises/09-use-if/`**
- The input document **`input.xml`** has a **`status`** attribute
- Write the code for **`pipeline.xpl`** so that:
  If **`/*/@status`** has the value **`error`**, add an additional attribute to the root: **`special-handling="true"`**
- Try it!
- Command: **`morgana pipeline.xpl -input:source=input.xml`**

Use p:if to make decision – Solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:if test="/*/@status eq 'error'">
    <p:add-attribute match="/*" attribute-name="special-handling" attribute-value="true"/>
  </p:if>

</p:declare-step>
```

Multiple decisions? Use p:choose

```
<p:choose>
  <p:when test="…">
    …
  </p:when>
  <p:when test="…">
    …
  </p:when>
  <p:otherwise>
    …
  <p:otherwise>
</p:when>
```

Use p:for-each to split a document - Input

```
<documents>

  <doc filename="output1.xml">
    <contents>This is document number 1</contents>
  </doc>

  <doc filename="output2.xml">
    <contents>This is document number 2</contents>
    <more>It has some more...</more>
  </doc>

</documents>
```

Split this in multiple documents

The filenames are in filename attributes

Boring contents
Erik

Use p:for-each to split a document – Basic pipeline

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:for-each>
    <p:with-input select="//doc"/>

    <p:store href="{/*/@filename}"/>
  </p:for-each>

</p:declare-step
```

p:for-each has an anonymous input port…

The p:store step stores a document to disk. The href attribute tells it where

p:store emits on its result port the same document as it received on its source port

select is a standard attribute of p:with-input

👉 Hands-on: Use p:for-each to split a document - 1

- Open a command window in **`exercises/10-for-each/`**
- Command: **`morgana pipeline.xpl -input:source=input.xml`**
- Try it!
- It does not run… why? What does the error message tell you?

- Make the **`result`** port of the pipeline accept a sequence by adding a **`sequence="true"`** attribute
- What is the result of this pipeline?

So how many documents flow out of this step now?

Use p:for-each to split a document – Solution

Make the output port accept a sequence

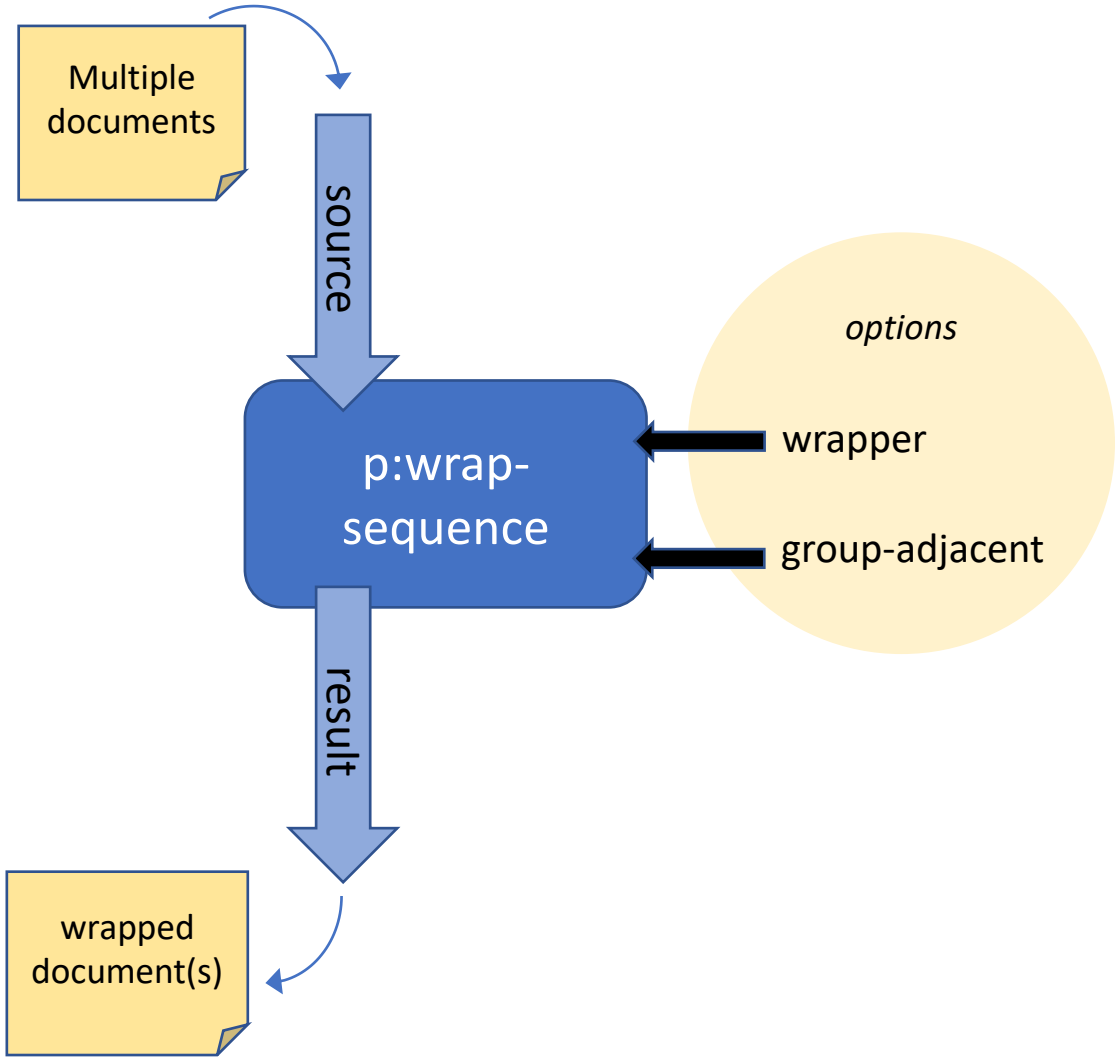
```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc version="3.0">

  <p:input port="source"/>
  <p:output port="result" sequence="true"/>

  <p:for-each>
    <p:with-input select="//doc"/>

    <p:store href="{/*/@filename}"/>
  </p:for-each>

</p:declare-step>
```

What flows out of the p:for-each are *a sequence* of documents!

You can also define what document types a port will accept

The p:wrap-sequence step

See: http://spec.xproc.org/master/head/steps/#c.wrap-sequence



With the group-adjacent option you can group incoming documents based on an XPath expression. We're not going to try that now

👉 Hands-on: Use p:for-each to split a document - 2

- (Re)Open a command window in **`exercises/10-for-each/`**
- Add a **`p:wrap-sequence`** step to wrap the sequence of result documents in a **`<result>`** element
- Command: **`morgana pipeline.xpl -input:source=input.xml`**
- Try it!

Use p:for-each to split a document 2 – Solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:for-each>
    <p:with-input select="//doc"/>

    <p:store href="{/*/@filename}"/>
  </p:for-each>

  <p:wrap-sequence wrapper="result"/>

</p:declare-step>
```

Wrap the results in a <result> element

Use p:viewport to change parts of a document - Input

```
<documents>
  <doc keep="true">
    <p>Hi there!</p>
  </doc>
  <doc keep="false">
    <p>Nonsense!</p>
  </doc>
  <doc keep="true">
    <p>Hi there again!</p>
  </doc>
</documents>
```

Replace every doc with @keep="false" with <DELETED/>

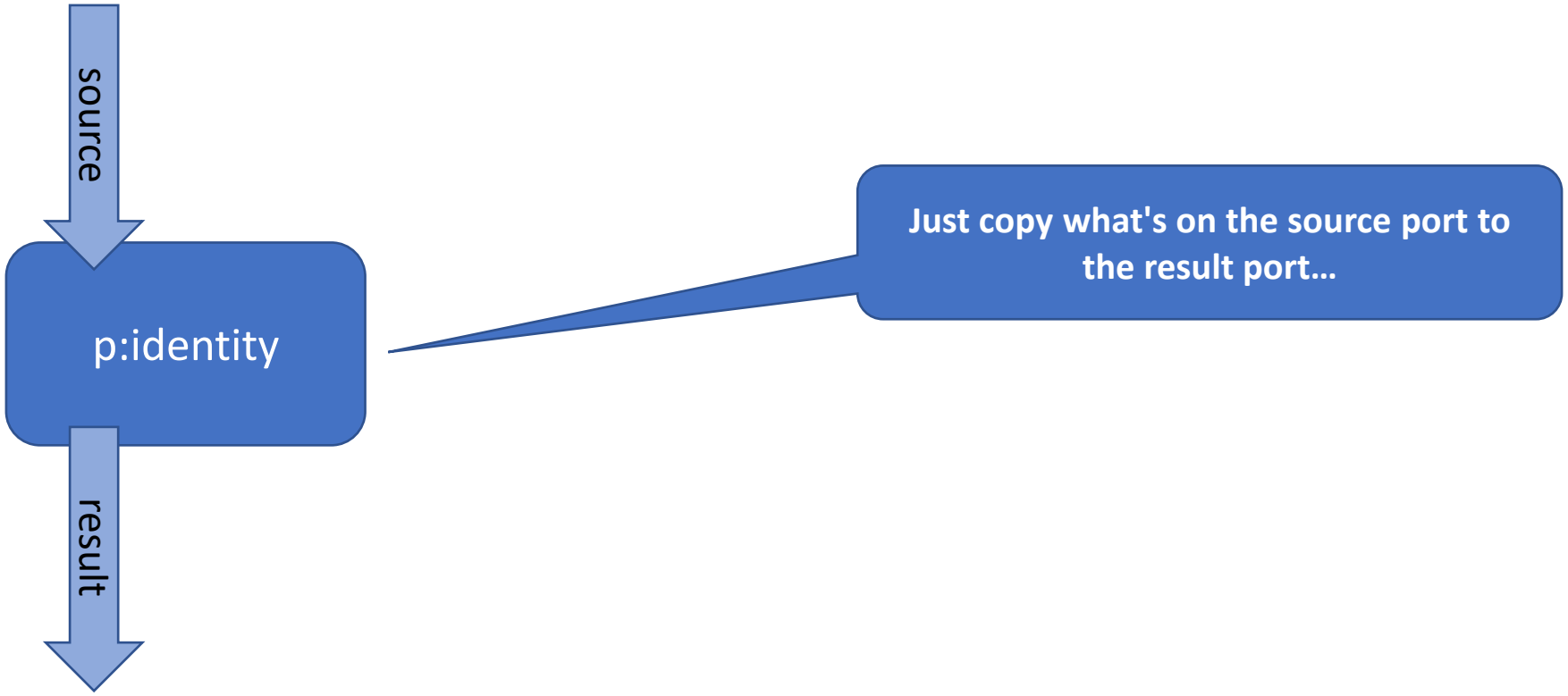
p:viewport

```
<p:viewport match="…">



</p:viewport>
```

Replace the matched nodes with what you produce in here

The p:identity step

See: https://spec.xproc.org/master/head/steps/#c.identity



Hands-on: Use p:viewport to change parts of a document

- Open a command window in **`exercises/11-viewport/`**
- Finish the code so every **`<doc>`** with **`@keep="false"`** is replaced by a **`<DELETED/>`** element
- Try it!
- Command: **`morgana pipeline.xpl -input:source=input.xml`**

Use p:viewport to change parts of a document – Solution

```
<p:declare-step xmlns:p="http://www.w3.org/ns/xproc" version="3.0">

  <p:input port="source"/>
  <p:output port="result"/>

  <p:viewport match="doc[not(xs:boolean(@keep))]">
    <p:identity>
      <p:with-input port="source">
        <DELETED/>
      </p:with-input>
    </p:identity>
  </p:viewport>

</p:declare-step>
```

Use p:identity to create an element

Wrap up

- Fundamentals
  - Steps
  - Ports
  - Primary ports, implicit port connections
  - Explicit port connections
    - To an inline document, external document or some port elsewhere in the pipeline
  - Options and variables
    - Declare options and variables
    - Use attributes or **`<p:with-option>`**
  - Compound steps

But there is much more to explore!

Goodbye and thank the fish!

- Main site: https://xproc.org/
- Two processor implementations
  - https://www.xml-project.com/ (MorganaXProc)
  - https://xmlcalabash.com/ (XML Calabash, 3.0 work in progress)
- Programmer Reference: https://xmlpress.net/publications/xproc-3-0/
- Your guide today: Erik Siegel – erik@xatapult.nl

- **Kanava stickers: FREE!**

Goodbye!
And remember, Kanava says:
XProc rocks…