XPath (1.0) for web scraping

Paul Tremberth, 17 October 2015, PyCon FR

Who am I?

I'm currently Head of Support at Scrapinghub.

I got introduced to Python through web scraping.

You can find me on StackOverflow: "xpath", "scrapy", "lxml" tags.

I have a few repos on Github.

Talk outline

- What is XPath?
- Location paths
- HTML data extraction examples
- Advanced use-cases

What is XPath?

XPath is a language

"XPath is a language for addressing parts of an XML document" — XML Path Language 1.0

XPath data model is a tree of nodes:

- element nodes (`<p>...</p>`)
- attribute nodes (`href="page.html"`)
- text nodes (`"Some Title"`)
- comment nodes (`<!-- a comment -->`)

(and 3 other types that we won't cover here.)

Why learn XPath?

- navigate **everywhere** inside a DOM tree
- a must-have skill for accurate web data extraction
- more powerful than CSS selectors
  - fine-grained look at the text content
  - complex conditioning with axes
- extensible with custom functions
  (we won't cover that in this talk though)

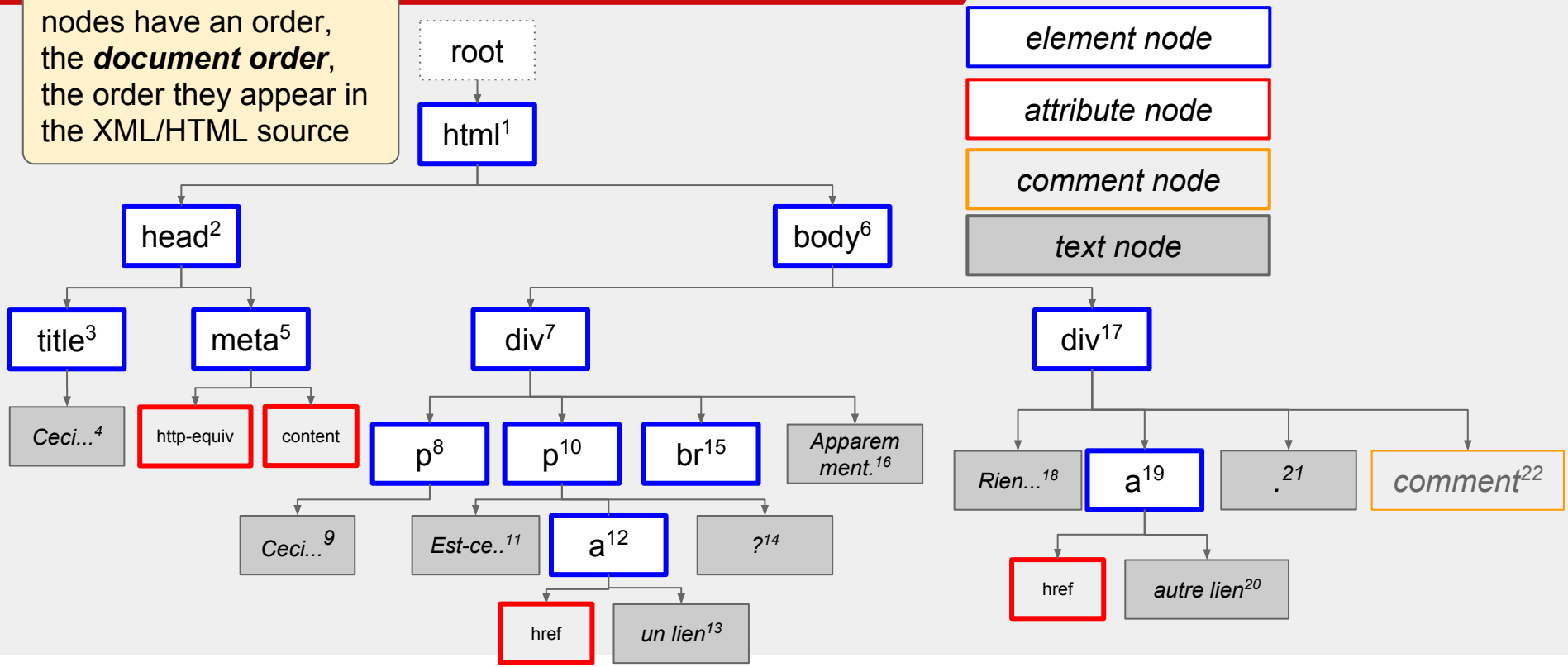
Also, it's kind of fun :-)

XPath Data Model: sample HTML

```
<html>
<head>
  <title>Ceci est un titre</title>
  <meta content="text/html; charset=utf-8" http-equiv="content-type">
</head>
<body>
  <div>
    <div>
      <p>Ceci est un paragraphe.</p>
      <p>Est-ce <a href="page2.html">un lien</a>?</p>
      <br>
      Apparemment.
    </div>
    <div class="second">
      Rien &agrave; ajouter.
      Sauf cet <a href="page3.html">autre lien</a>.
      <!-- Et ce commentaire -->
    </div>
  </div>
</body>
</html>
```

XPath Data Model (cont.)

nodes have an order, the ***document order***, the order they appear in the XML/HTML source

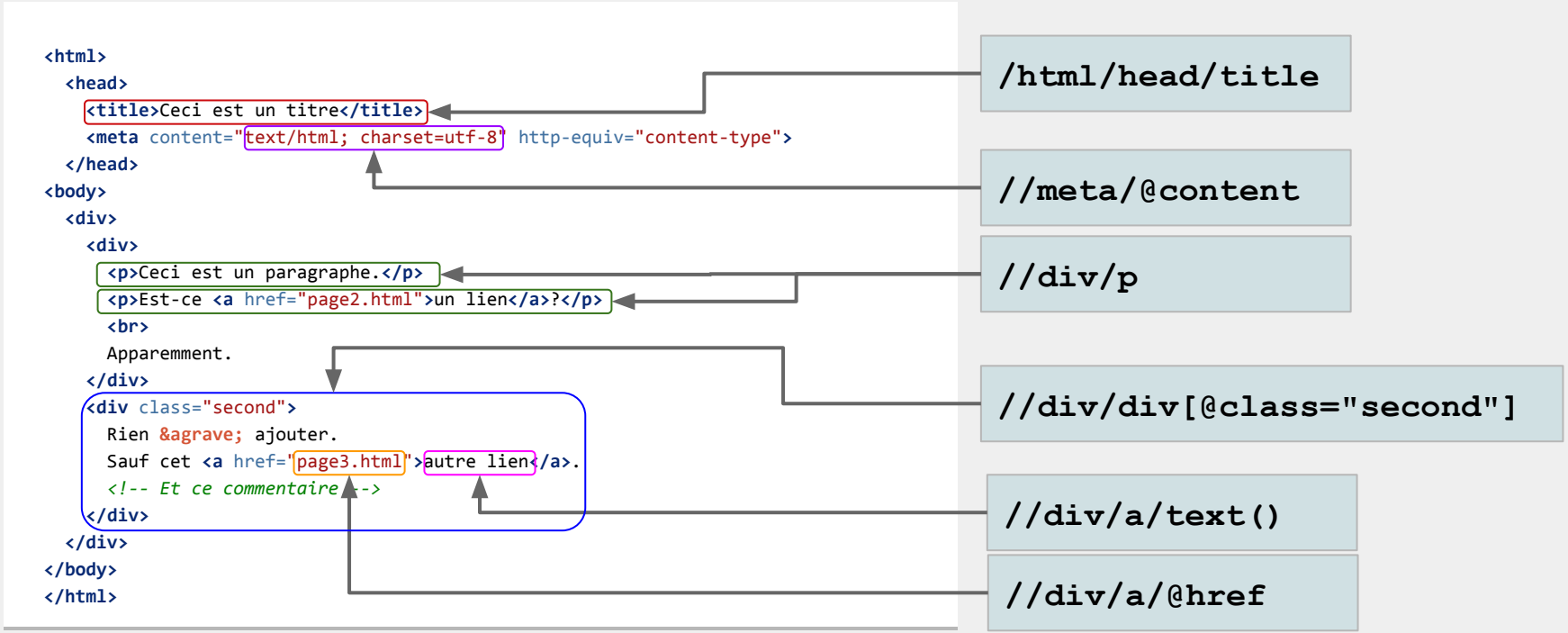


XPath return types

XPath expressions can return different things:

- node-sets (most common case, and most often element nodes)
- strings
- numbers (floating point)
- booleans

Example XPath expressions



Location Paths:
how to move inside the document tree

Location Paths

Location path is the most common XPath expression.

Used to move in any direction from a starting point (*the context node*) to any node(s) in the tree.

- a string, with a series of “steps”:
  - `"step1 / step2 / step3 ..."`
- represents selection & filtering of nodes, processed step by step, from left to right
- each step is:
  - `AXIS :: NODETEST [PREDICATE]*`

whitespace does NOT matter,

except for “//”,
“/ /” is a syntax error.

So don’t be afraid of indenting your XPath expressions

Relative vs. absolute paths

- `"step1/step2/step3"` is relative
- `"/step1/step2/step3"` is absolute
- i.e. an absolute path is a relative path starting with **`"/"` (*`slash`*)**
- in fact, absolute paths are relative to the root node
- **use relative paths** whenever possible
  - prevents unexpected selection of same nodes in loop iterations...

Location Paths: abbreviations

What we've seen earlier is in fact "abbreviated syntax".

Full syntax is quite verbose:

Abbreviated syntax	Full syntax (again, whitespace doesn't matter)
`/html/head/title`	`/child:: html /child:: head /child:: title`
`//meta/@content`	`/descendant-or-self::node()/child::meta/attribute::content`

`//div/div[@class="second"]`	`/descendant-or-self::node()`
	`  /child::div`
	`  /child::div [  attribute::class = "second"  ]`

`//div/a/text()`	`/descendant-or-self::node()` `  /child::div/child::a/child::text()`

Axes: moving around

```
AXIS :: nodetest [predicate]*
```

Axes give the direction to go next.

- self *(where you are)*
- parent, child *(direct hop)*
- ancestor, ancestor-or-self, descendant, descendant-or-self *(multi-hop)*
- following, following-sibling, preceding, preceding-sibling *(document order)*
- attribute, namespace *(non-element)*

Axes: move up or down the tree

```
<body>
  <div>
    <div>
      <p>Ceci est un paragraphe.</p>
      <p>Est-ce <a href="page2.html">un lien</a>?</p>
      <br>
      Apparemment.
    </div>
    <div class="second">
      Rien &agrave; ajouter.
      Sauf cet <a href="page3.html">autre lien</a>.
      <!-- Et ce commentaire -->
    </div>
  </div>
</body>
```

- **self**: context node
- **child**: children of context node in the tree
- **descendant**: children of context node, children of children, ...
- **ancestor**: parent of context node (here, <body>)

Axes: move on same tree level

```
<div>
  <p>Ceci est un paragraphe.</p>
  <p>Est-ce <a href="page2.html">un lien</a>?</p>
  <br>
  Apparemment.
</div>
```

- **preceding-sibling**: same level in tree, but **BEFORE** in document order
- **self**: context node
- **following-sibling**: same level in tree, but **AFTER** in document order

Axes: document partitioning

```
self U (ancestor U preceding)
     U (descendant U following)
== all nodes
```


```
<html>
  <head>
    <title>Ceci est un titre</title>
    <meta content="text/html; charset=utf-8" http-equiv="content-type">
  </head>
<body>
  <div>
    <div>
      <p>Ceci est un paragraphe.</p>
      <p>Est-ce <a href="page2.html">un lien</a>?</p>
      <br>
      Apparemment.
    </div>
    <div class="second">
      Rien &agrave; ajouter.
      Sauf cet <a href="page3.html">autre lien</a>.
      <!-- Et ce commentaire -->
    </div>
  </div>
</body>
</html>
```

- **ancestor**: parent, parent of parent, ...
- **preceding**: before in document order, excluding ancestors
- **self**: context node
- **descendant**: children, children of children, ...
- **following**: after in document order, excluding descendants

Node tests

```
axis :: NODETEST [predicate]*
```

Select nodes types along the axes:

- either a **name test:**
  - element names: “html”, “p”, ...
  - attribute names: “content-type”, “href”, ...
- or a **node type test:**
  - **node()**: ALL nodes types
  - **text()**: text nodes, i.e. character data
  - **comment()**: comment nodes
  - or ***** *(i.e. the axis’ principal node type)*

`text()` is not a function call

Predicates

```
axis :: nodetest [PREDICATE]*
```

Additional **node properties** to filter on:

- simplest are positional *(start at 1, not 0)*:
  `//div[3]` *(i.e. 3rd child div element)*
- can be nested, can use location paths:
  `//div[p[a/@href="sample.html"]]`
- ordered, from left to right:
  `//div[2][@class="content"]`
  vs.
  `//div[@class="content"][2]`

Abbreviations: to remember

Abbreviated step	Meaning
`*` *(asterisk)*	all **element nodes** (excluding text nodes, attribute nodes, etc.) ; `.//*` != `.//node()` *Note that there is no* `element()` *test node.*
`@*`	`attribute::*`, all attribute nodes
`//`	`/descendant-or-self::node()/` (exactly this, so `.//*` != `./descendant-or-self::*`)
`.` *(a single dot)*	`self::node()`, the context node
`..` *(2 dots)*	`parent::node()`

Use cases:
“Show me some Python code!”

Text extraction

```
    <div class="second">
      Rien &agrave; ajouter.
      Sauf cet <a href="page3.html">autre lien</a>.
      <!-- Et ce commentaire -->
    </div>
```

```
>>> import lxml.html
>>> root = lxml.html.fromstring(htmlsource)

>>> root.xpath('//div[@class="second"]/text()')   # you get back a text nodes node-set
[u'\n      Rien \xe0 ajouter.\n      Sauf cet ', '. \n      ', '\n    ']

>>> root.xpath('//div[@class="second"]//text()')
[u'\n      Rien \xe0 ajouter.\n      Sauf cet ', 'autre lien', '. \n      ', '\n    ']

>>> root.xpath('string(//div[@class="second"])')   # you get back a single string
u'\n      Rien \xe0 ajouter.\n      Sauf cet autre lien. \n      \n    '
```

Attributes extraction

```
<html><head>
    <title>Ceci est un titre</title>
    <meta content="text/html; charset=utf-8" http-equiv="content-type">
</head>...</html>
```

```
>>> import lxml.html
>>> root = lxml.html.fromstring(htmlsource)

>>> root.xpath('/html/head/meta/@content')
['text/html; charset=utf-8']

>>> root.xpath('/html/head/meta/@*')
['text/html; charset=utf-8', 'content-type']
```

Attribute names extraction

```
>>> for element in root.xpath('/html/head/meta'):
...     attributes = []
...
...     # loop over all attribute nodes of the element
...     for index, attribute in enumerate(element.xpath('@*'), start=1):
...
...         # use XPath's name() string function on each attribute,
...         # using their position
...         attribute_name = element.xpath('name(@*[%d])' % index)
...         attributes.append((attribute_name, attribute))
...
>>> attributes
[('content', 'text/html; charset=utf-8'), ('http-equiv', 'content-type')]
>>> dict(attributes)
{'content': 'text/html; charset=utf-8', 'http-equiv': 'content-type'}
```

CSS Selectors

```
<html>
<body>
<ul>
    <li class="a b">apple</li>
    <li class="b c">banana</li>
    <li class="c a lastone">carrot</li>
</ul>
<body>
</html>
```

lxml, scrapy and parsel use cssselect under the hood

```
>>> selector.css('html > body > ul > li:first-child').extract()
[u'<li class="a b">apple</li>']

>>> selector.css('ul li + li').extract()
[u'<li class="b c">banana</li>', u'<li class="c a lastone">carrot</li>']
```

CSS Selectors (cont.)

```
<html>
<body>
<ul>
    <li class="a b">apple</li>
    <li class="b c">banana</li>
    <li class="c a lastone">carrot</li>
</ul>
<body>
</html>
```

```
>>> selector.css('li.a').extract()
[u'<li class="a b">apple</li>', u'<li class="c a lastone">carrot</li>']
>>> selector.css('li.a.c').extract()
[u'<li class="c a lastone">carrot</li>']
>>> selector.css('li[class$="one"]').extract()
[u'<li class="c a lastone">carrot</li>']
```

Loop on elements (rows, lists, ...)

```
<div class='detail-product'>
    <ul>
        <li><strong>Type</strong> Baskets</li>
        <li><strong>Ref</strong> 22369</li>
        <li><strong>Doublure</strong> Textile</li>
    </ul>
</div> <!-- borrowed from spartoo.com... -->
```

```
>>> import parsel
>>> selector = parsel.Selector(text=htmlsource)
>>> dict((li.xpath('string(./strong)').extract_first(),
          li.xpath('normalize-space( \
                   ./strong/following-sibling::text())').extract_first())
          for li in selector.css('div.detail-product > ul > li'))
{u'Doublure': u'Textile',
 u'Ref': u'22369',
 u'Type': u'Baskets'}
```

XPath buckets

```
<h2>My BBQ Invitees</h2>
<p>Joe</p>
<p>Jeff</p>
<p>Suzy</p>
<h2>My Dinner Invitees</h2>
<p>Dylan</p>
<p>Hobbes</p>
```

All elements are at the same level, all siblings.
The idea here is to select <p> and filter them by how many <h2> siblings came before

```
>>> for cnt, h in enumerate(selector.css('h2'), start=1):
...     print h.xpath('string()').extract_first()
...     print [p.xpath('string()').extract_first()
...            for p in h.xpath('''./following-sibling::p[
...                                 count(preceding-sibling::h2) = %d]''' % cnt)]
...
My BBQ Invitees
[u'Joe', u'Jeff', u'Suzy']
My Dinner Invitees
[u'Dylan', u'Hobbes']
```

XPath buckets: generalization

```
>>> all_elements = selector.css('h2, p')
>>> h2_elements = selector.css('h2')
>>> order = lambda e: int(float(e.xpath('count(preceding::*) \
...                                     + count(ancestor::*)').extract_first()))
>>> boundaries = [order(h) for h in h2_elements]
>>> buckets = []
>>> for pos, e in sorted((order(e), e) for e in all_elements):
...     if pos in boundaries:
...         bucket = []
...         buckets.append(bucket)
...     bucket.append((e.xpath('name()').extract_first(),
...                    e.xpath('string()').extract_first()))
>>> buckets
[[(u'h2', u'My BBQ Invitees'),
  (u'p', u'Joe'), (u'p', u'Jeff'), (u'p', u'Suzy')],
 [(u'h2', u'My Dinner Invitees'), (u'p', u'Dylan'), (u'p', u'Hobbes')]]
```

counting ancestors and preceding elements gives you the node position in document order

EXSLT extensions

```
<div itemscope itemtype ="http://schema.org/Movie">
  <h1 itemprop="name">Avatar</h1>
  <div itemprop="director" itemscope itemtype="http://schema.org/Person">
  Director: <span itemprop="name">James Cameron</span> (born <span itemprop="
birthDate">August 16, 1954</span>)
  </div>
  <span itemprop="genre">Science fiction</span>
  <a href="../movies/avatar-theatrical-trailer.html" itemprop="trailer">Trailer</a>
</div>
```

```
_xp_item = lxml.etree.XPath('descendant-or-self::*[@itemscope]')
_xp_prop = lxml.etree.XPath("""set:difference(.//*[@itemprop],
                                              .//*[@itemscope]//*[@itemprop])""",
                                namespaces = {"set": "http://exslt.org/sets"})
```

EXSLT extensions (cont.)

```
{'items': [{'properties': {'director': {'properties': {'birthDate': u'August 16,
1954',
                                                       'name': u'James Cameron'},
                                            'type': ['http://schema.org/Person']},
                          'genre': u'Science fiction',
                          'name': u'Avatar',
                          'trailer': 'http://www.example.com/../movies/avatar-
theatrical-trailer.html'},
            'type': ['http://schema.org/Movie']}]}
```

Scraping Javascript code

```
<div id="map"></div>
<script>
function initMap() {
  var myLatLng = {lat: -25.363, lng: 131.044};
}
</script>
```

```
>>> import js2xml
>>> import parsel
>>>
>>> selector = parsel.Selector(text=htmlsource)
>>> jssnippet = selector.css('div#map + script::text').extract_first()
>>> jstree = js2xml.parse(jssnippet)
>>> js2xml.jsonlike.make_dict(jstree.xpath('//object[1]')[0])
{'lat': -25.363, 'lng': 131.044}
```

XPath tips & tricks

- Use relative XPath expressions whenever possible
- Know your axes
- Remember XPath has string() and normalize-space()
- **text() is a node test**, not a function call
- CSS selectors are very handy, easier to maintain, but also less powerful
- js2xml is easier than regex+json.loads()

XPath resources

- Read http://www.w3.org/TR/xpath/ (it's worth it!)
- XPath 1.0 tutorial by Zvon.org
- Concise XPath by Aristotle Pagaltzis
- XPath in lxml
- cssselect by Simon Sapin
- EXSLT extensions

Thank you!

Paul Tremberth, 17 October 2015

paul@scrapinghub.com
https://github.com/redapple
http://linkedin.com/in/paultremberth

Oh, and we're hiring!
http://scrapinghub.com/jobs