# Web Data Models

## XPath: Syntax, Semantics

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# XPath

- once we have an XML document, we want to query it and retrieve data
- **XPath**: query language to select a sequence of nodes from an XML
- W3C standard — also used in other standards (XQuery, XSLT, XPointer, XLink, …); supported by every modern browser

# XPath

- XPath is a navigational language — specifies how the XML documents should be traversed

- **Main issue**: big volume of nodes can be extracted via XPath, so efficient processing is still an ongoing challenge

# Lecture Outline

- XPath axes
- XPath tests
- XPath nodes

# XPath: Quick Example

Q1 = /bib/book/title

```
<bib>
  <book>
    <author>Abiteboul</author>
    <author>Hull</author>
    <author>Vianu</author>
    <title>Foundations of Databases</title>
    <year>1995</year>
  </book>
  <book>
    <author>Ullmann</author>
    <title>Principles of Database and Knowledge Base Systems</title>
    <year>1998</year>
  </book>
</bib>
```

# XPath: Quick Example

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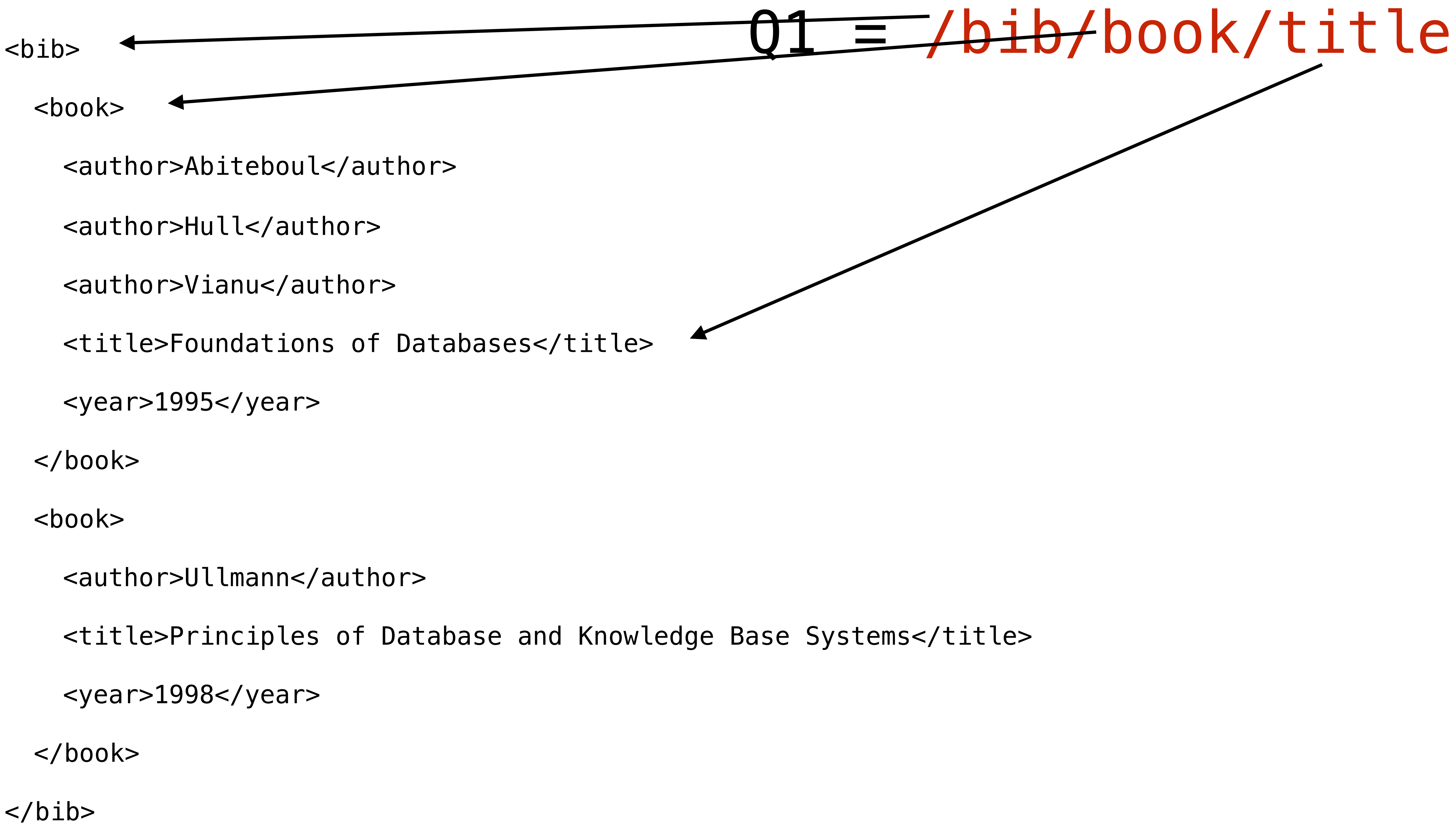
  <book>
    <author>Ullmann</author>
    <title>Principles of Database and Knowledge Base Systems</title>
    <year>1998</year>
  </book>
</bib>
```

# XPath: Quick Example



Q1 = /bib/book/title

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    <author>Vianu</author>
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  <book>
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    <year>1998</year>
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</bib>
```

# XPath: Quick Example

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  </book>
  <book>
    <author>Ullmann</author>
    <title>Principles of Database and Knowledge Base Systems</title>
    <year>1998</year>
  </book>
</bib>
```

Q1 = /bib/book/title

R1 = **<title>Foundations of Databases</title>**

R2 = **<title>Principles of Database and Knowledge Base Systems</title>**

# XPath

XPath is composed of a sequence of context nodes and a step:

$$\mathrm{cs}_0/\mathrm{step}$$

- after the context sequence, take a step in a given direction
- can also have multi-steps:

$$\mathrm{cs}_0/\mathrm{step}_1/\mathrm{step}_2/\ldots$$

$$\mathrm{cs}_1/\mathrm{step}_2/\ldots$$

# XPath: Quick Example

```
Q1 = /bib/book/title
```

```
<bib>
  <book>
    <author>Abiteboul</author>
    <author>Hull</author>
    <author>Vianu</author>
    <title>Foundations of Databases</title>
    <year>1995</year>
  </book>
  <book>
    <author>Ullmann</author>
    <title>Principles of Database and Knowledge Base Systems</title>
    <year>1998</year>
  </book>
</bib>
```

# XPath: Quick Example

Q1 = **/bib**/book/title

```
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    <author>Abiteboul</author>
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  </book>
  <book>
    <author>Ullmann</author>
    <title>Principles of Database and Knowledge Base Systems</title>
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</bib>
```

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    <author>Vianu</author>
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    <year>1995</year>
  </book>
  <book>
    <author>Ullmann</author>
    <title>Principles of Database and Knowledge Base Systems</title>
    <year>1998</year>
  </book>
</bib>
```

# XPath: Quick Example

`Q1 = /bib/book/title`

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    <title>Foundations of Databases</title>
    <year>1995</year>
  </book>
  <book>
    <author>Ullmann</author>
    <title>Principles of Database and Knowledge Base Systems</title>
    <year>1998</year>
  </book>
</bib>
```

# XPath: Syntax

Each step has the syntax:

$$\text{axis} :: \text{ntest}[\text{pred}_1] \cdots [\text{pred}_n]$$

- **axis** specifies the direction of navigation to be followed,
- **ntest** specifies the node test (used to navigate only nodes of a certain kind),
- the optional **pred**, which allows filters on the sequence of nodes we navigate to.

http://www.w3school.com.cn/xpath/xpath_axes.asp

# XPath: Axes

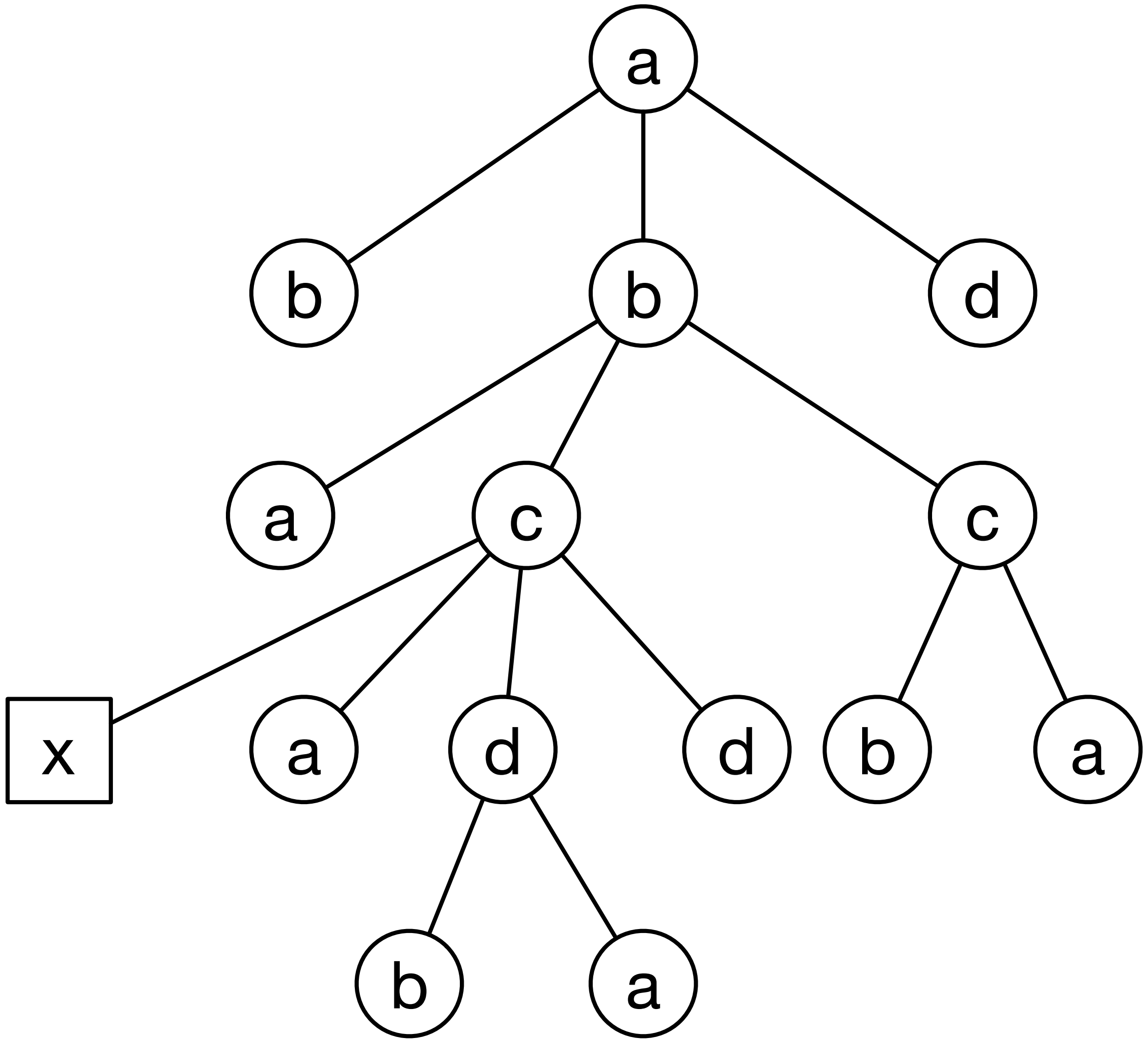
$$\text{axis} :: \text{ntest}[\text{pred}_1] \cdots [\text{pred}_n]$$

XPath has a family of **12 axes** allowing for flexible navigation within the node hierarchy

- forward axes (in document order)
- backward axes (in reverse document order)

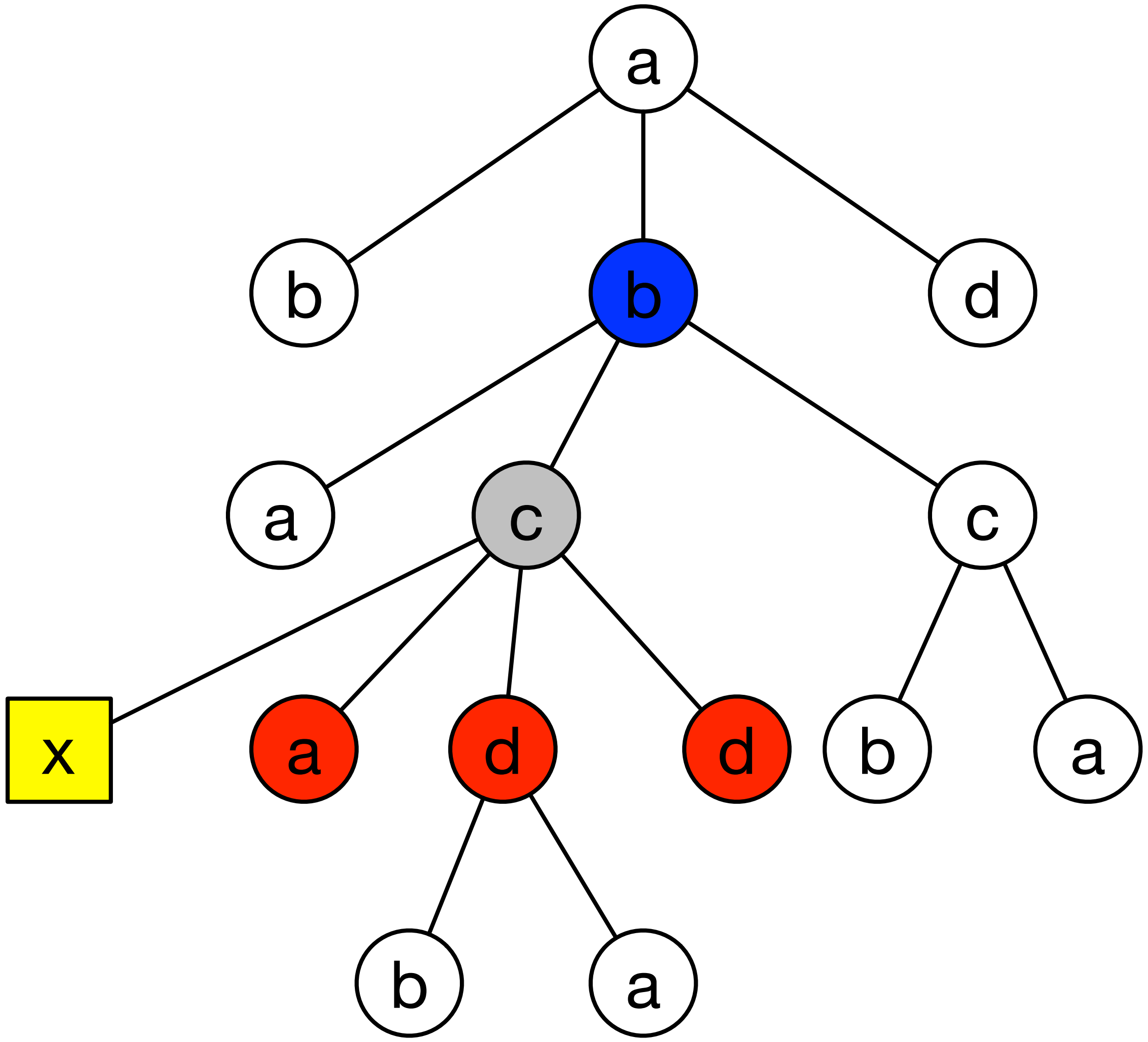
# XPath: Axes

```
<a>
  <b />
  <b>
    <a />
    <c x="1.0">
      <a>text1</a>
      <d>
        <b />
        <a />
      </d>
    </c>
    <c>
      <b />
      <a>text2</a>
    </c>
  </b>
  <d />
</a>
```



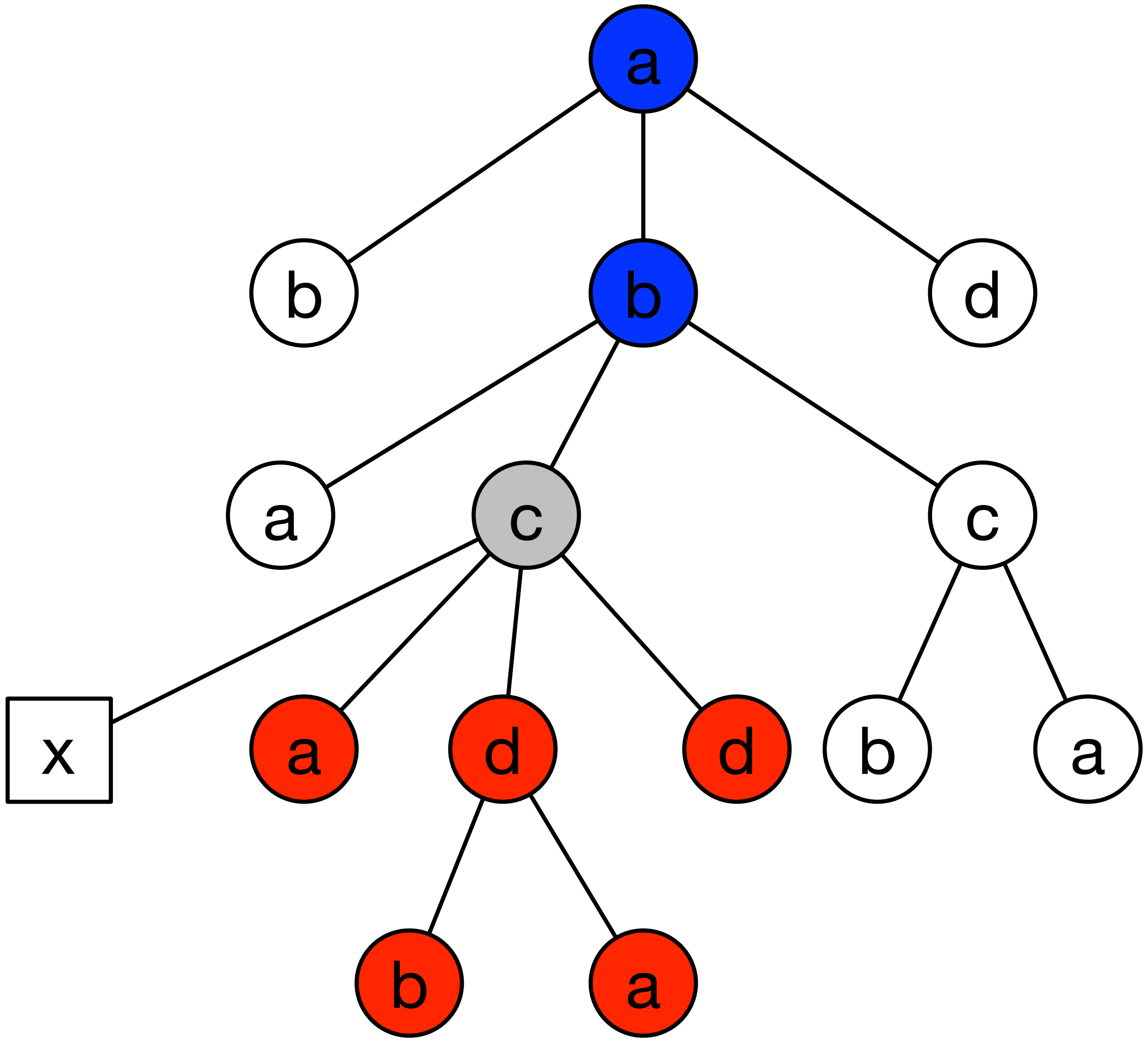
# XPath: Axes

- `self` (fwd)
- `child` (fwd)
- `parent` (back)
- `attribute` (fwd)



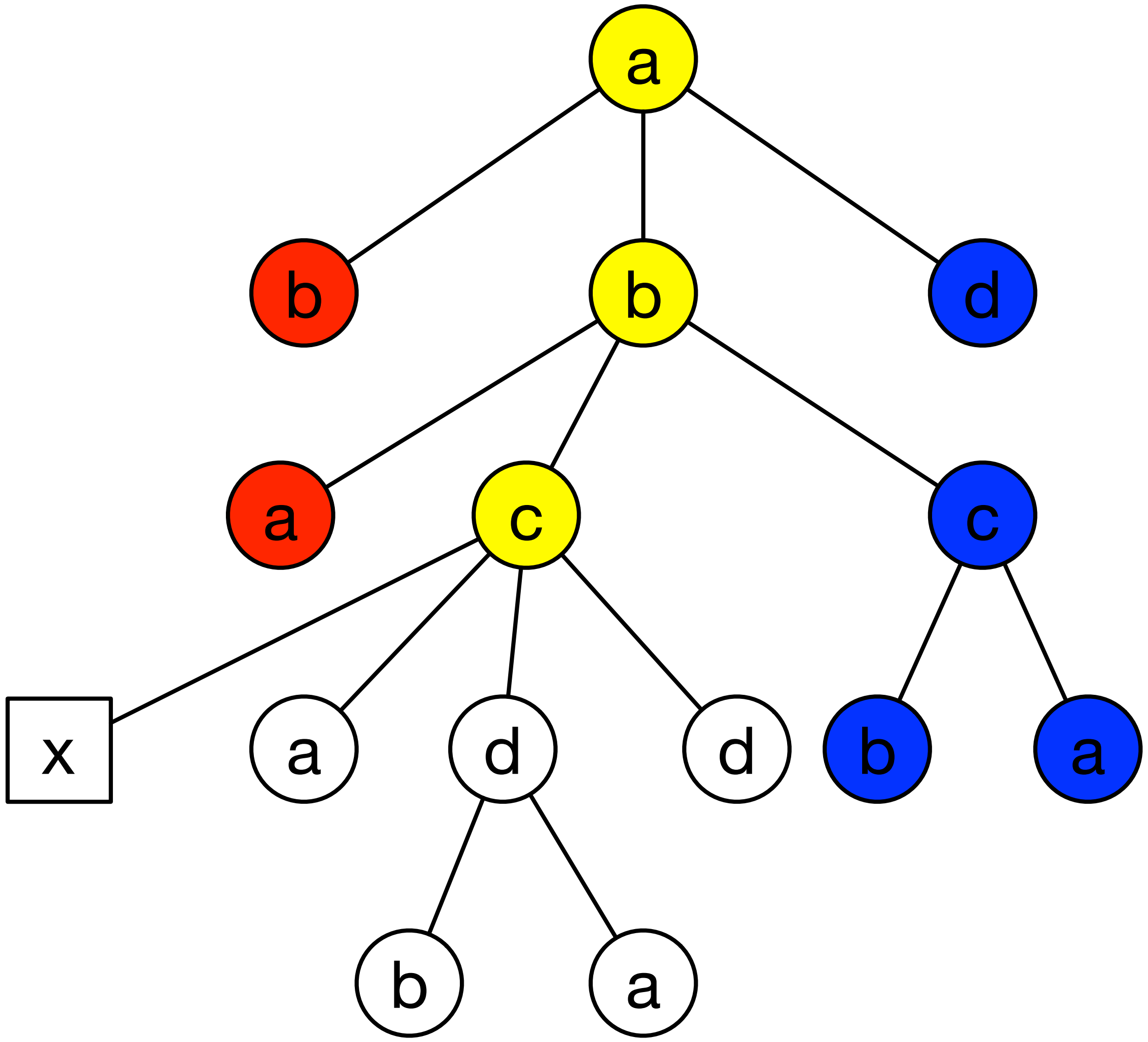
# XPath: Axes

- `self` (fwd)
- `descendant` (fwd)
- `ancestor` (back)



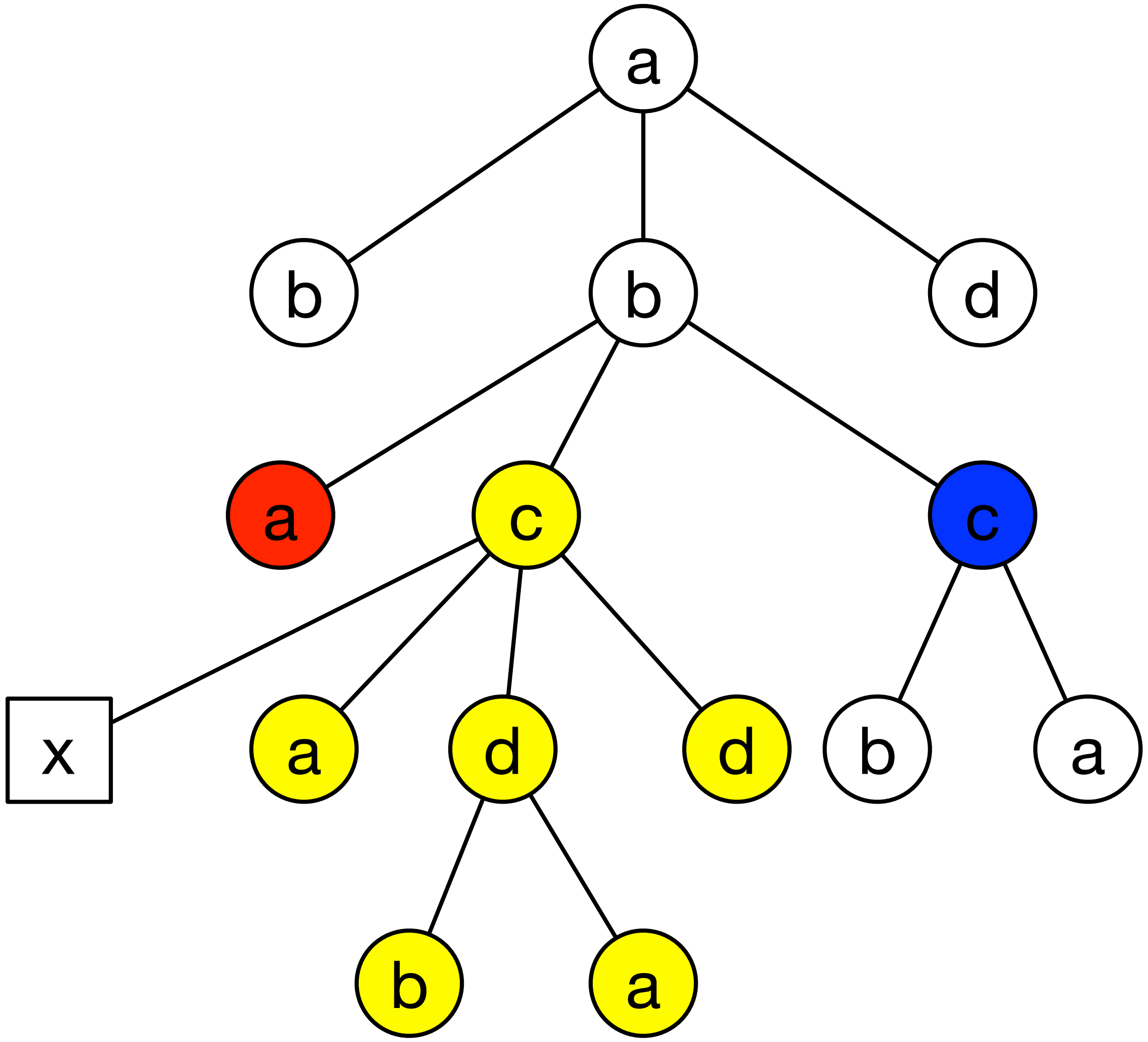
# XPath: Axes

- `preceding` (back)
- `following` (fwd)
- `ancestor-or-self` (back)



# XPath: Axes

- `preceding-sibling` (back)
- `following-sibling` (fwd)
- `descendant-or-self` (fwd)



# XPath: Result Order

The result node sequence of any XPath navigation is returned in document order with no duplicate nodes.

# XPath: Node Tests

$$\text{axis} :: \boxed{\text{ntest}}[\text{pred}_1] \cdots [\text{pred}_n]$$

Can also apply a **node test** to filter nodes based on kind and name.

| Test | Semantics |
|---|---|
| `node()` | let any node pass |
| `text()` | preserve only text nodes |
| `comment()` | preserve only comment nodes |
| `processing-instruction()` | preserve processing instructions |
| `processing-instruction(p)` | preserve processing instructions of the form `<?p …p>` |
| `document-node()` | preserve the document root node |

# XPath: Node Tests

$$\text{axis} :: \boxed{\text{ntest}}[\text{pred}_1] \cdots [\text{pred}_n]$$

Can also apply a **node test** to filter nodes based on kind and name.

| **Test** | **Semantics** |
|---|---|
| *`name`* | preserve element node with tag *name* only |
| * | preserve element nodes with arbitrary tag names |

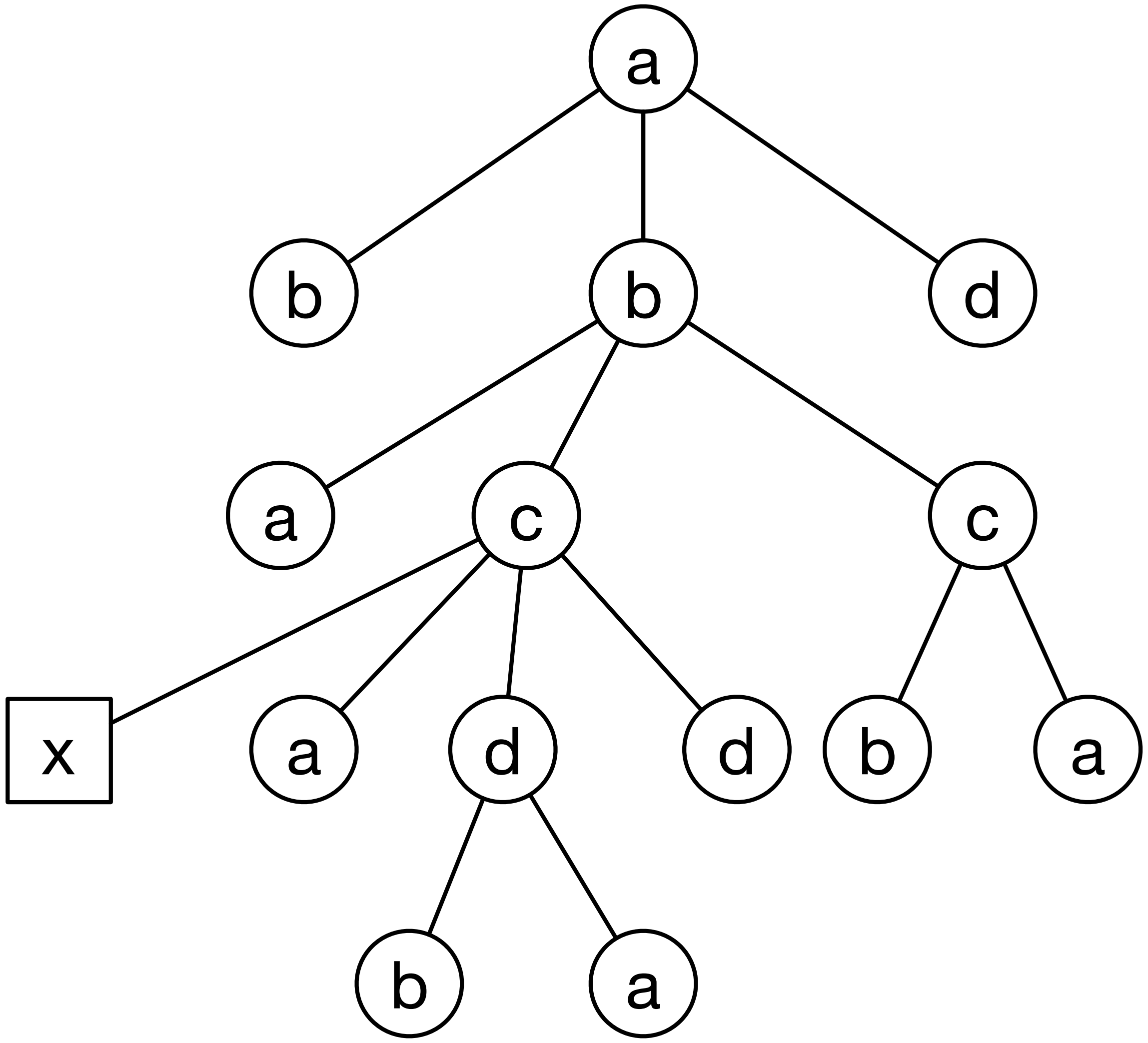
# XPath: Abbreviations

There are a few abbreviations in XPath:

| | |
|---|---|
| `/a` | `/child::a` |
| `//a` | `/descedant-or-self::node()/child::a` |
| `//` | `/descendant-or-self::node()` |
| `.` | `/self::node()` |
| `..` | `/parent::node()` |
| `@` | `attribute::` |

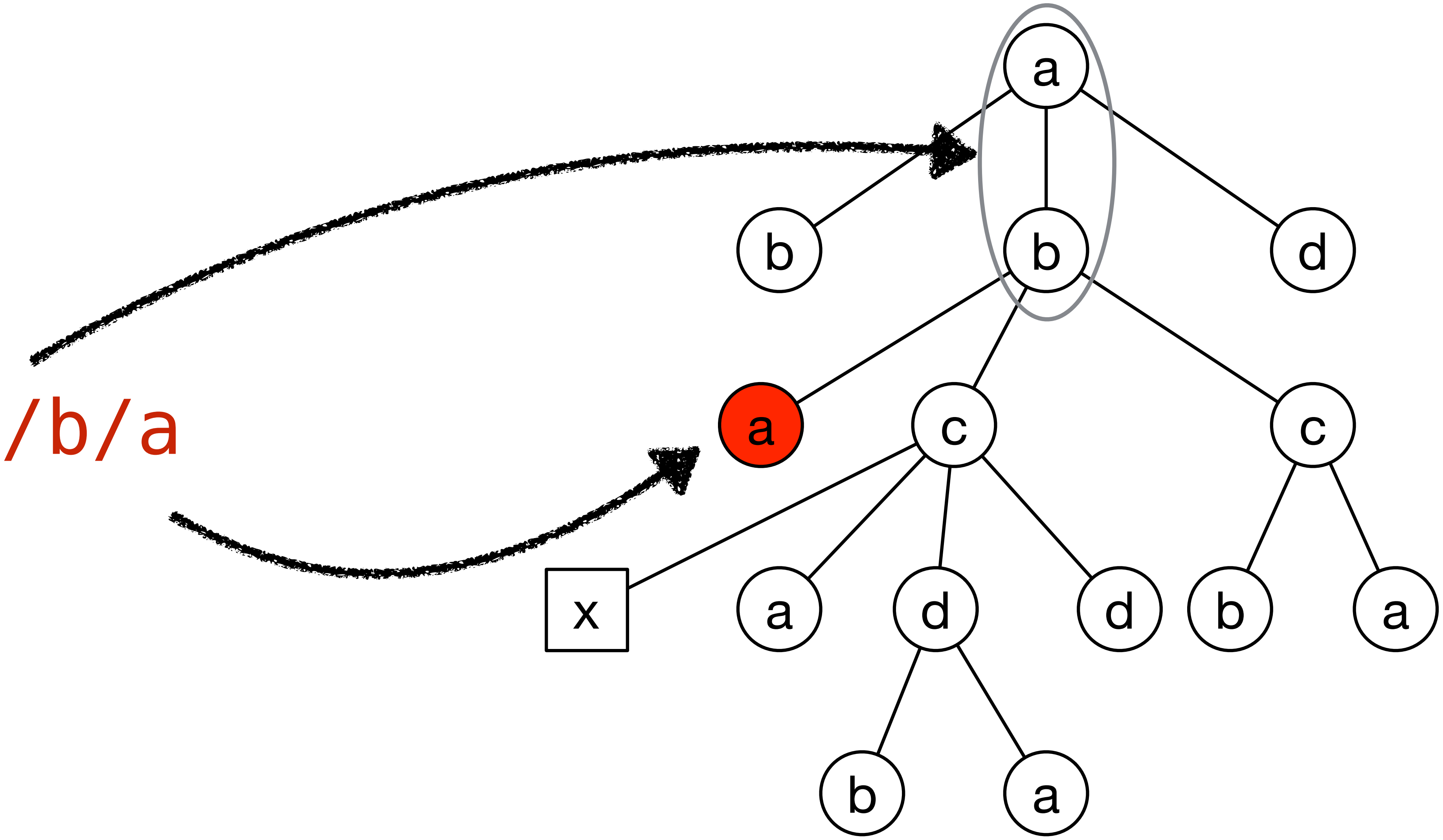
# XPath: Examples

```
Q1 := /a/b/a
```



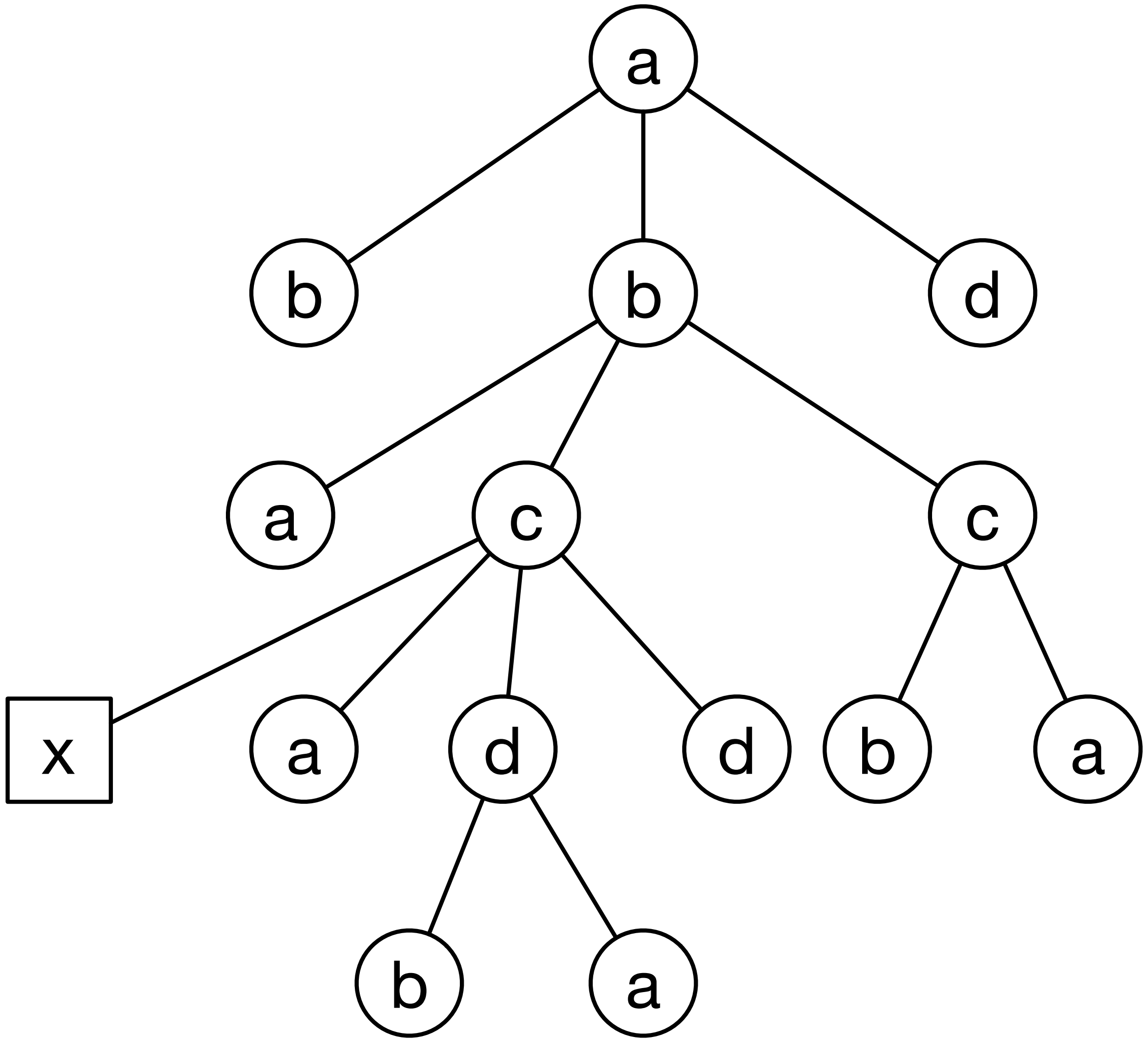
# XPath: Examples

```
Q1 := /a/b/a
```



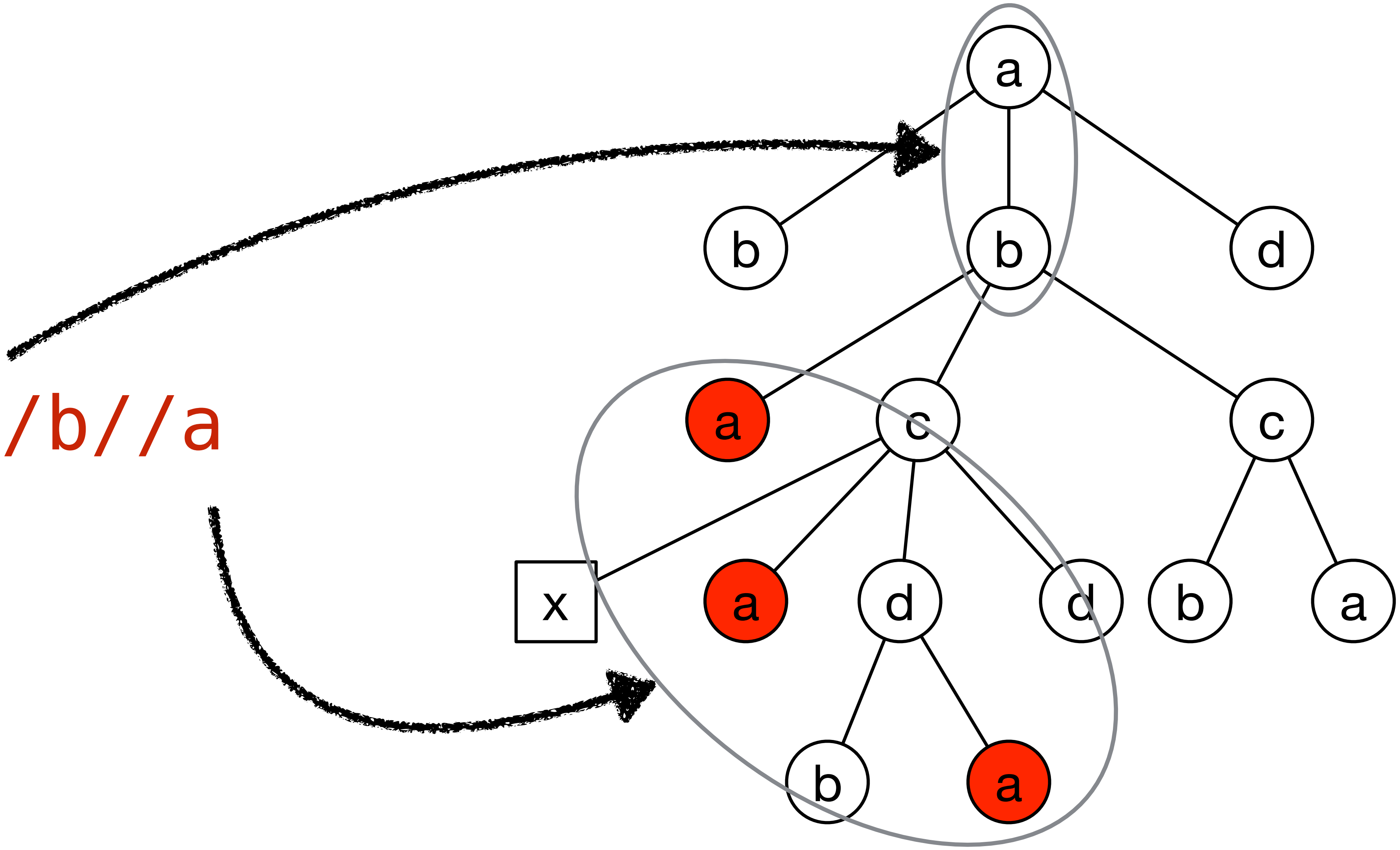
# XPath: Examples

```
Q2 := /a/b//a
```



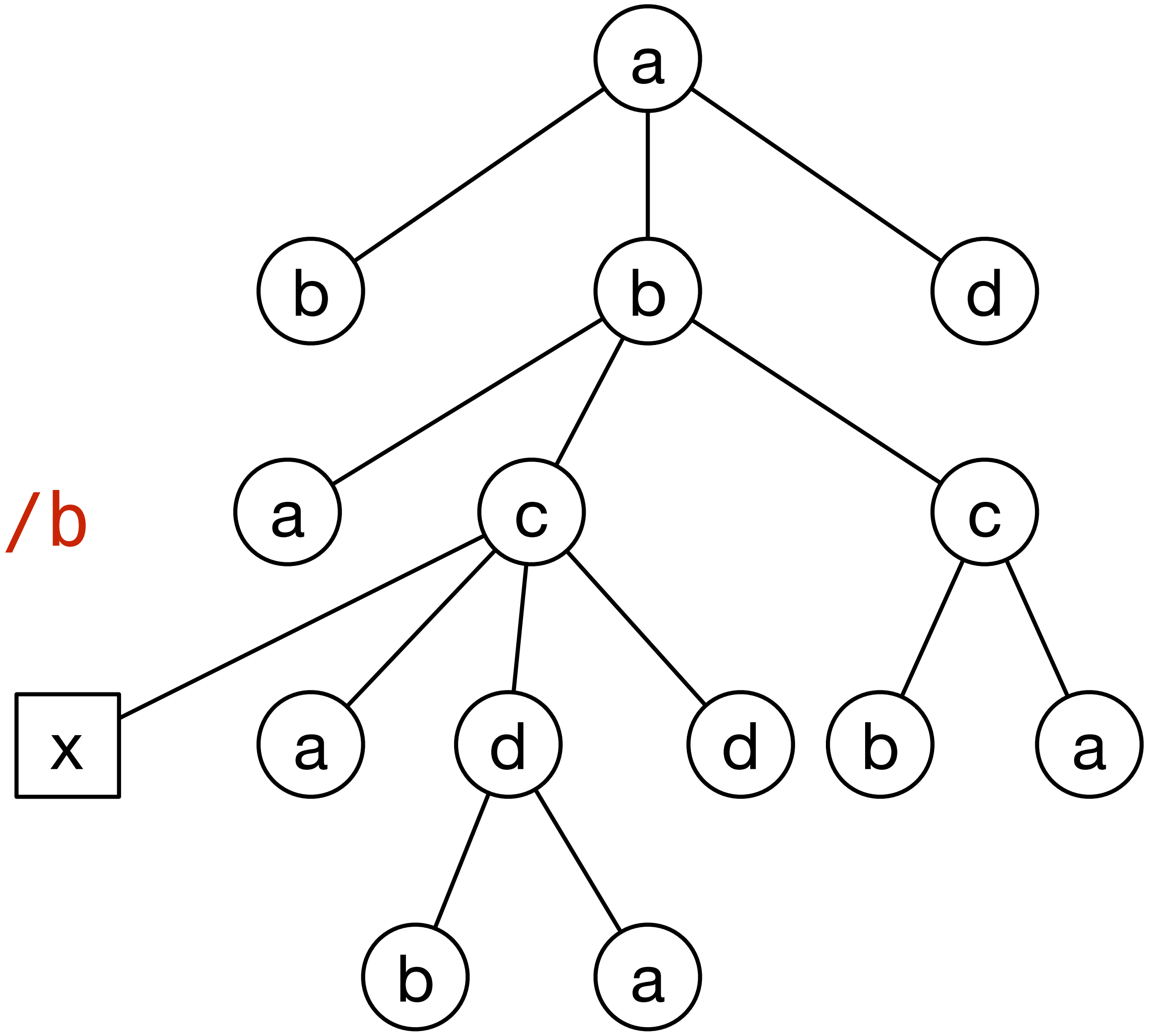
# XPath: Examples

Q2 := /a/b//a



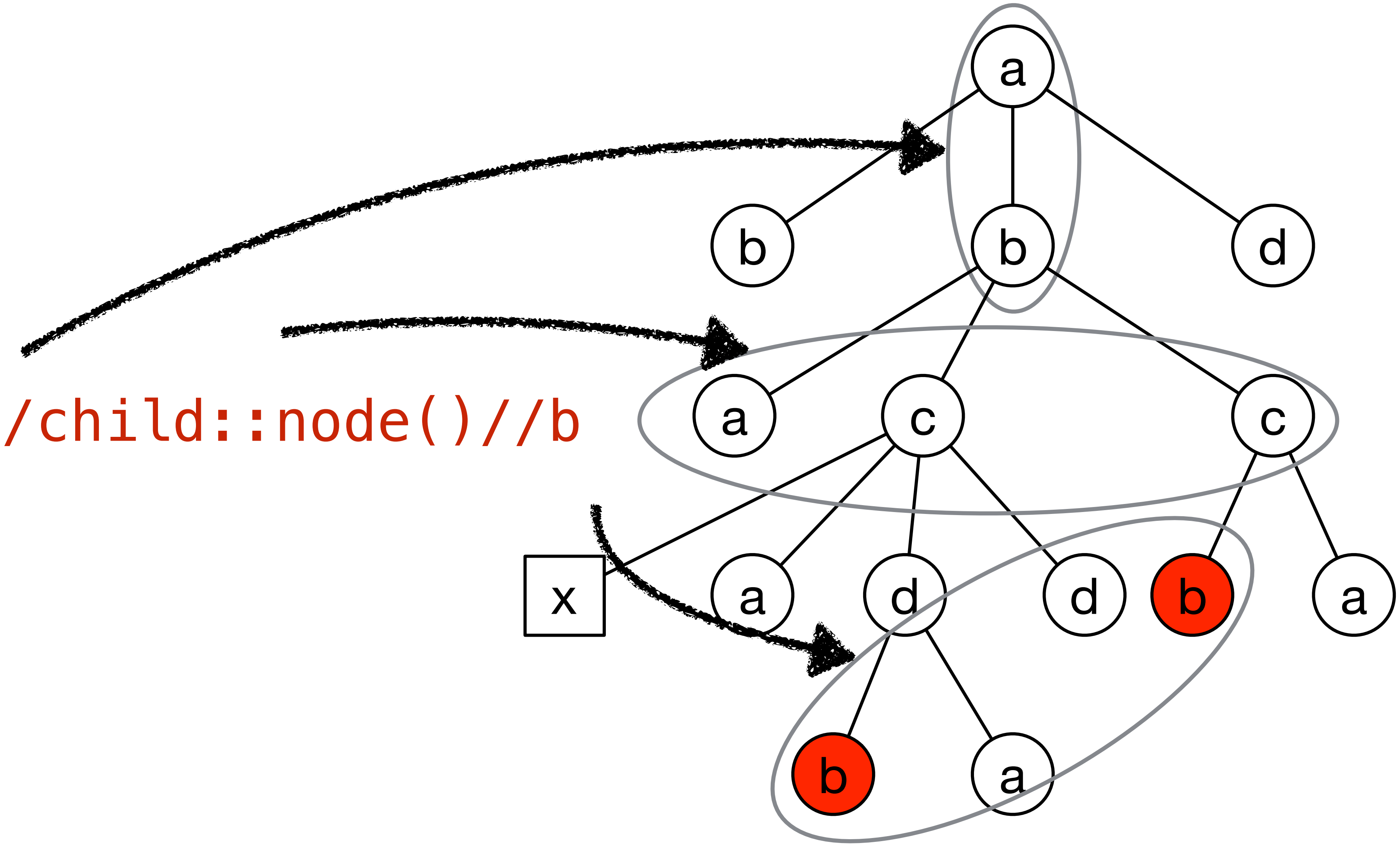
# XPath: Examples

Q3 := /a/b/child::node()//b



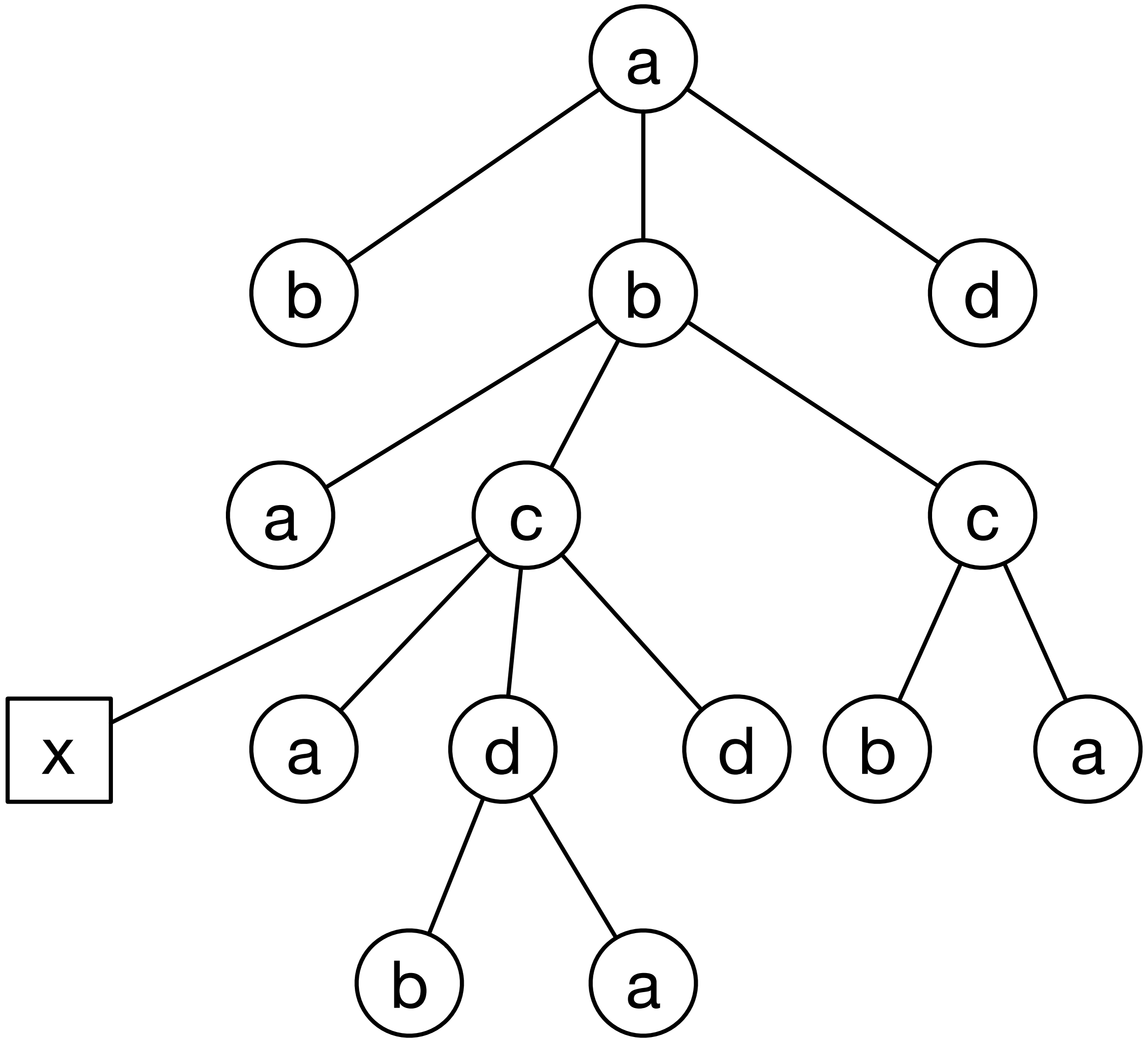
# XPath: Examples

Q3 := /a/b/child::node()//b



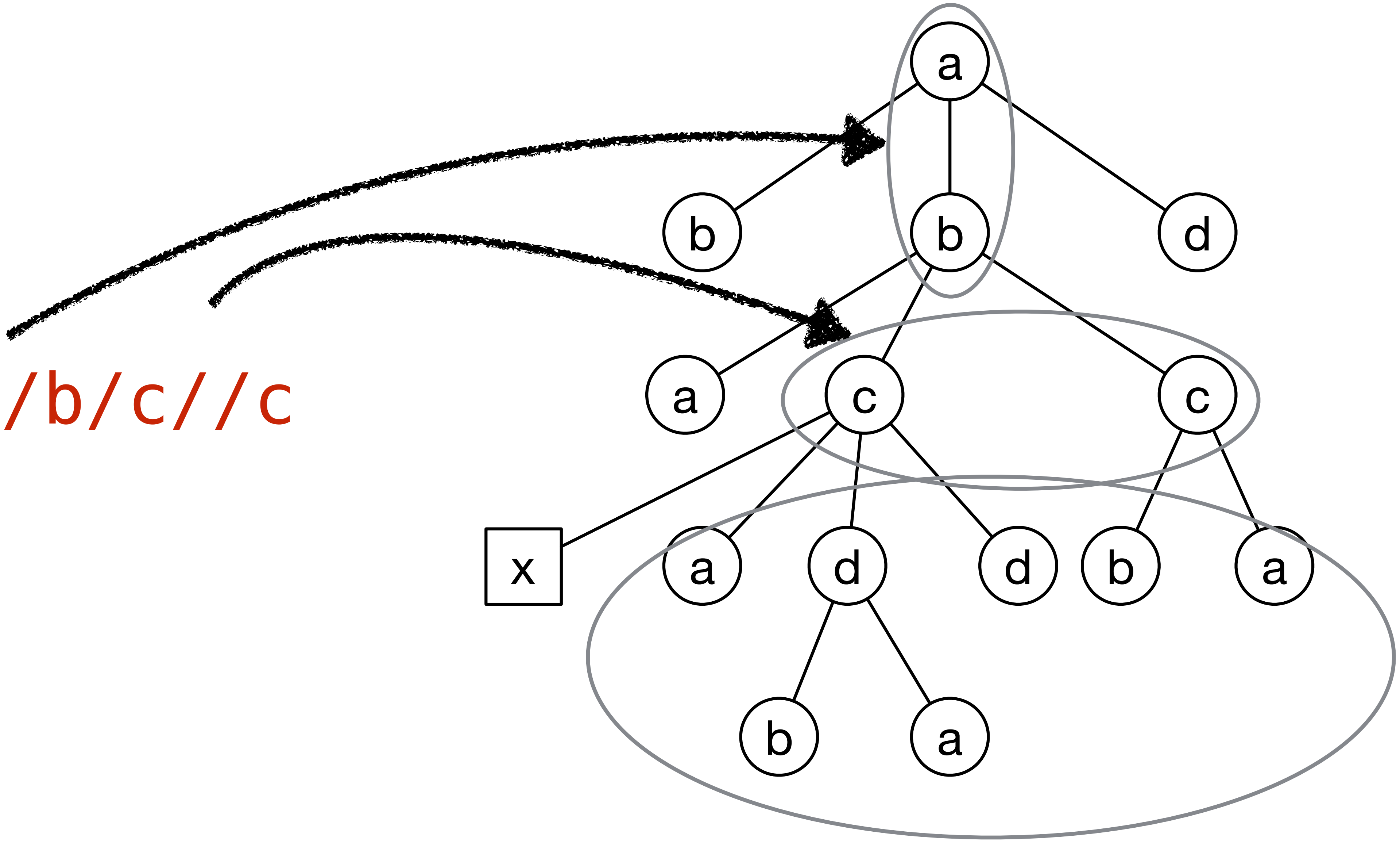
# XPath: Examples

Q4 := /a/b/c//c



# XPath: Examples

Q4 := /a/b/c//c



# XPath: Predicates

$$\text{axis} :: \text{ntest}\boxed{[\text{pred}_1] \cdots [\text{pred}_n]}$$

Predicates are tested against a node, and are optional.

- they  have higher precedence than the XPath step,
- are evaluated left to right,
- they may be any XQuery expression which evaluates to a value *v*

# XPath: Predicates

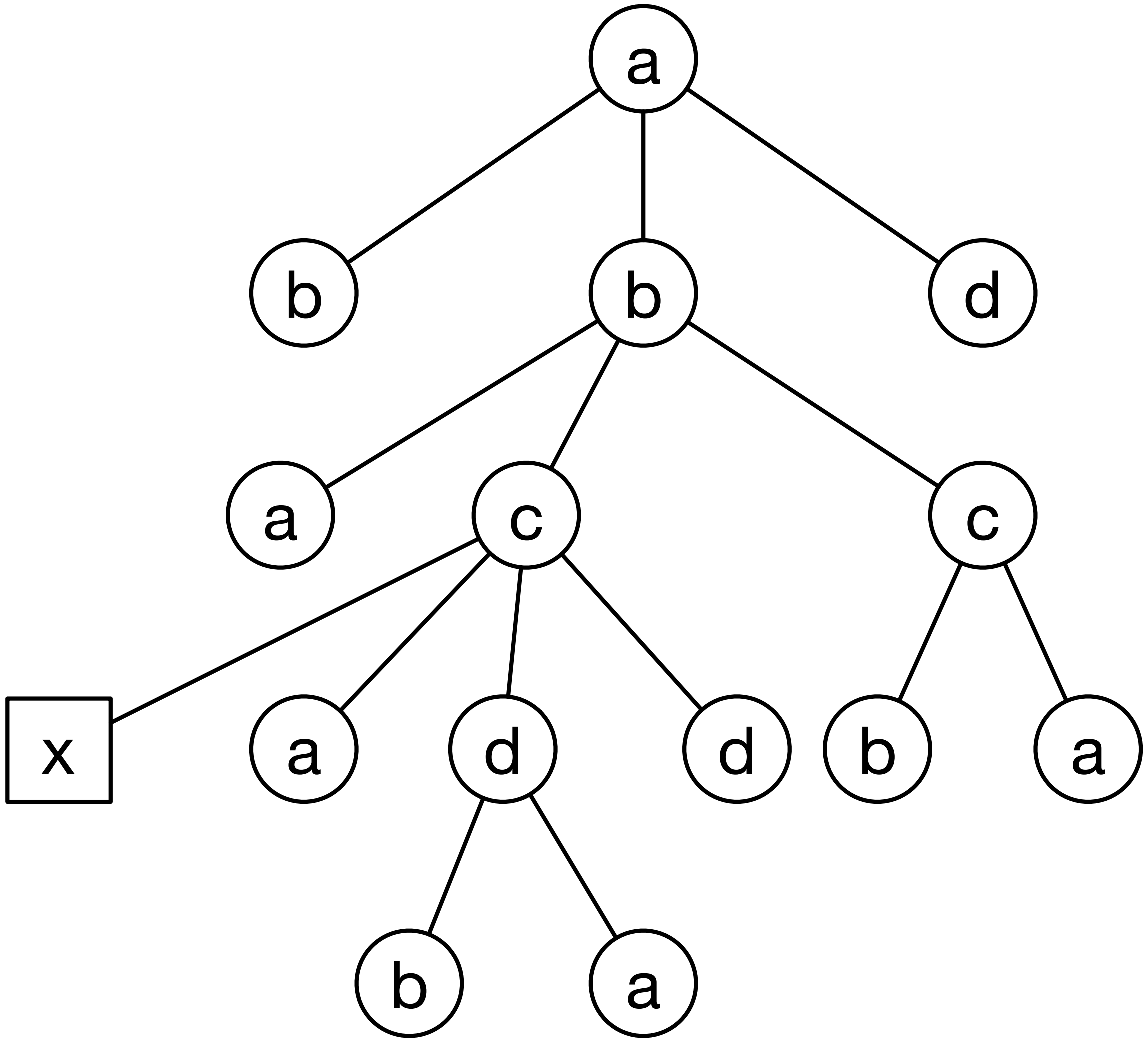
$$\mathrm{axis} :: \mathrm{ntest}[\mathrm{pred}_1] \cdots [\mathrm{pred}_n]$$

XPath calculates an effective boolean value $\mathbf{ebv(v)}$, depending on the value *v*:

| **v** | **ebv(v)** |
|---|---|
| `()` | `false()` |
| `0, NaN` | `false()` |
| `"“` | `false()` |
| `false()` | `false()` |
| `x` | `true()` |
| `(x1,x2,…,xn)` | `true()` |

# XPath: Examples

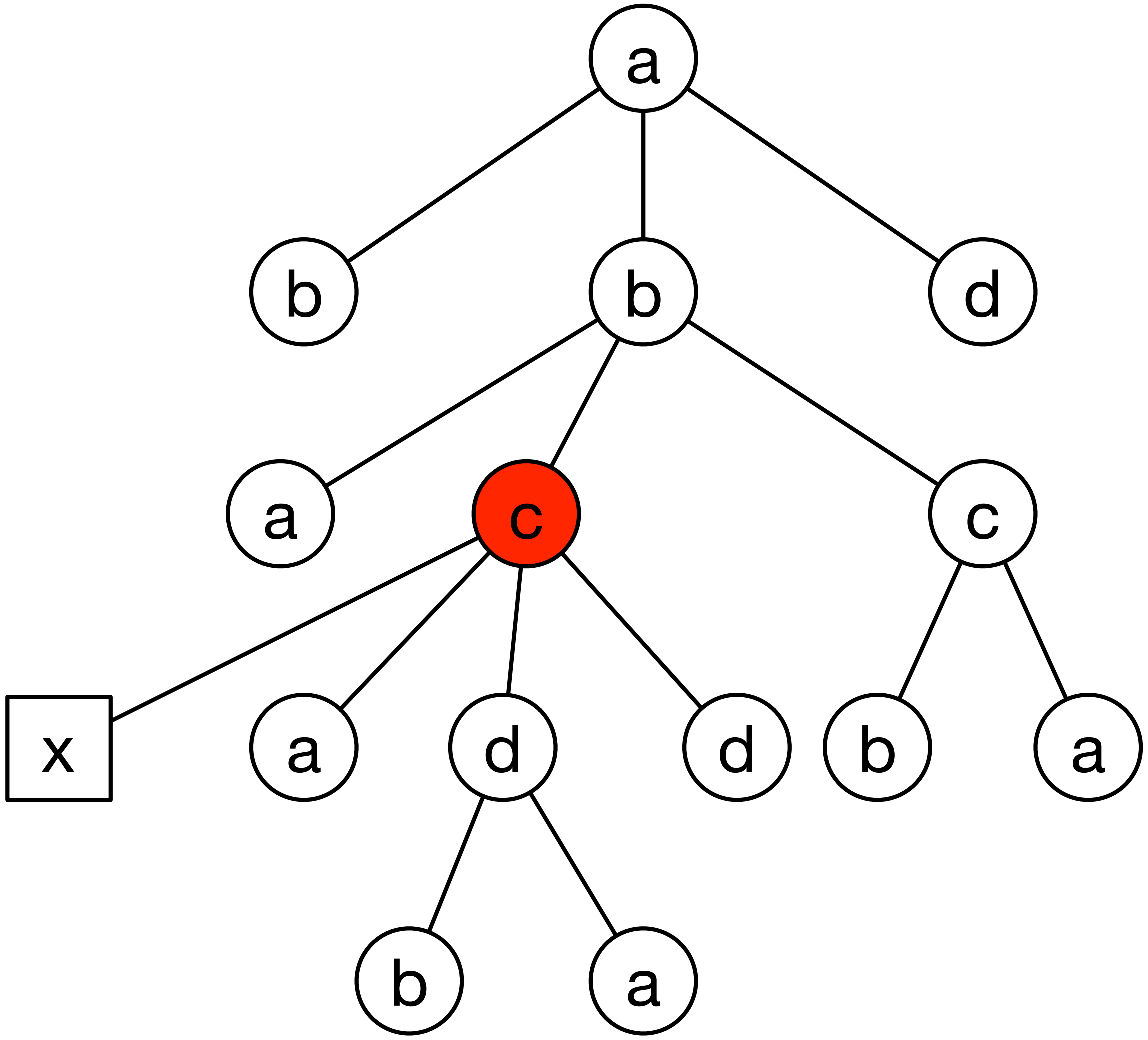
```
Q5 := /a/b/c[./d]
```



# XPath: Examples

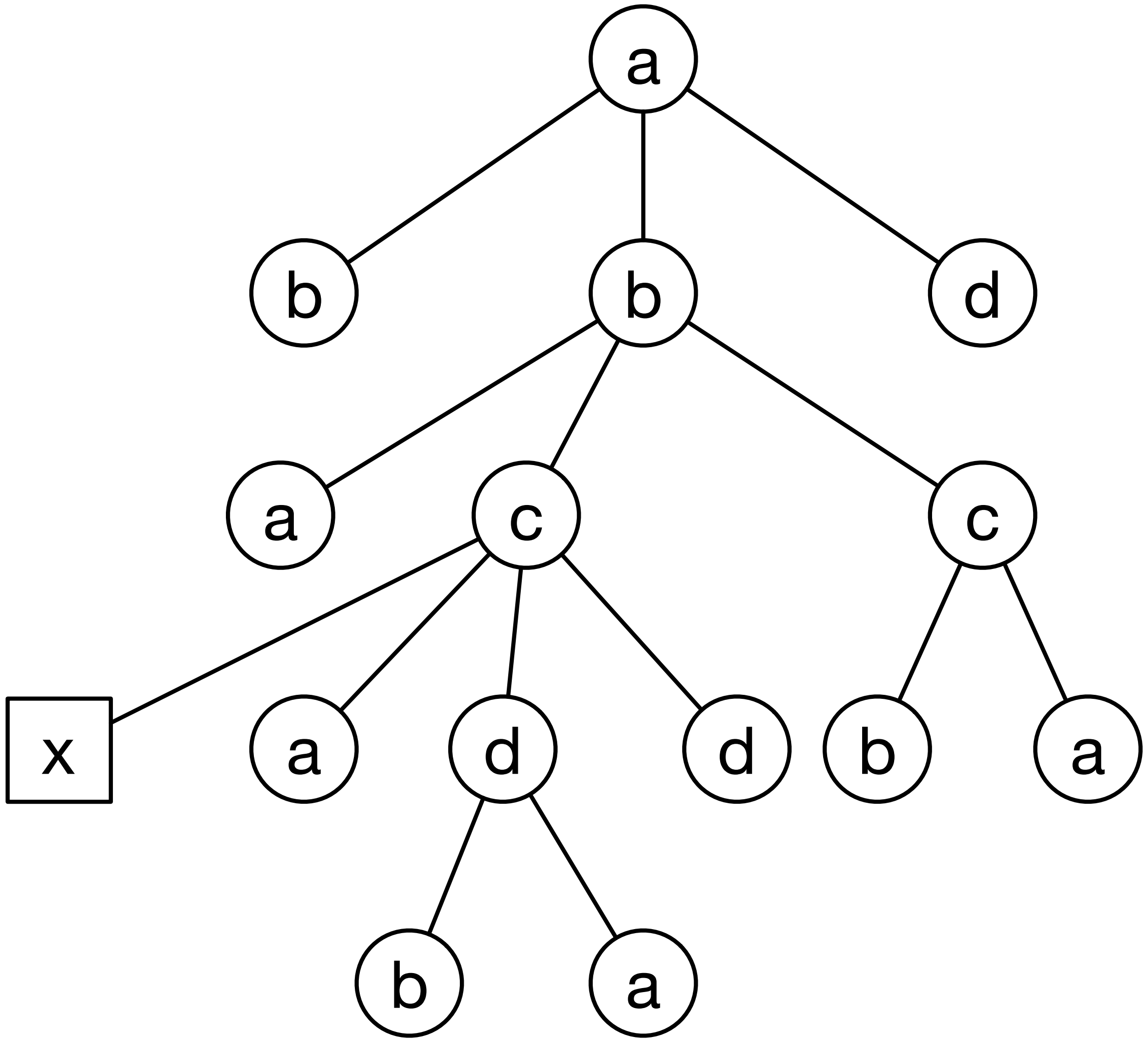
若去掉 ./ 和.有/是一样的

```
Q5 := /a/b/c[./d]
```



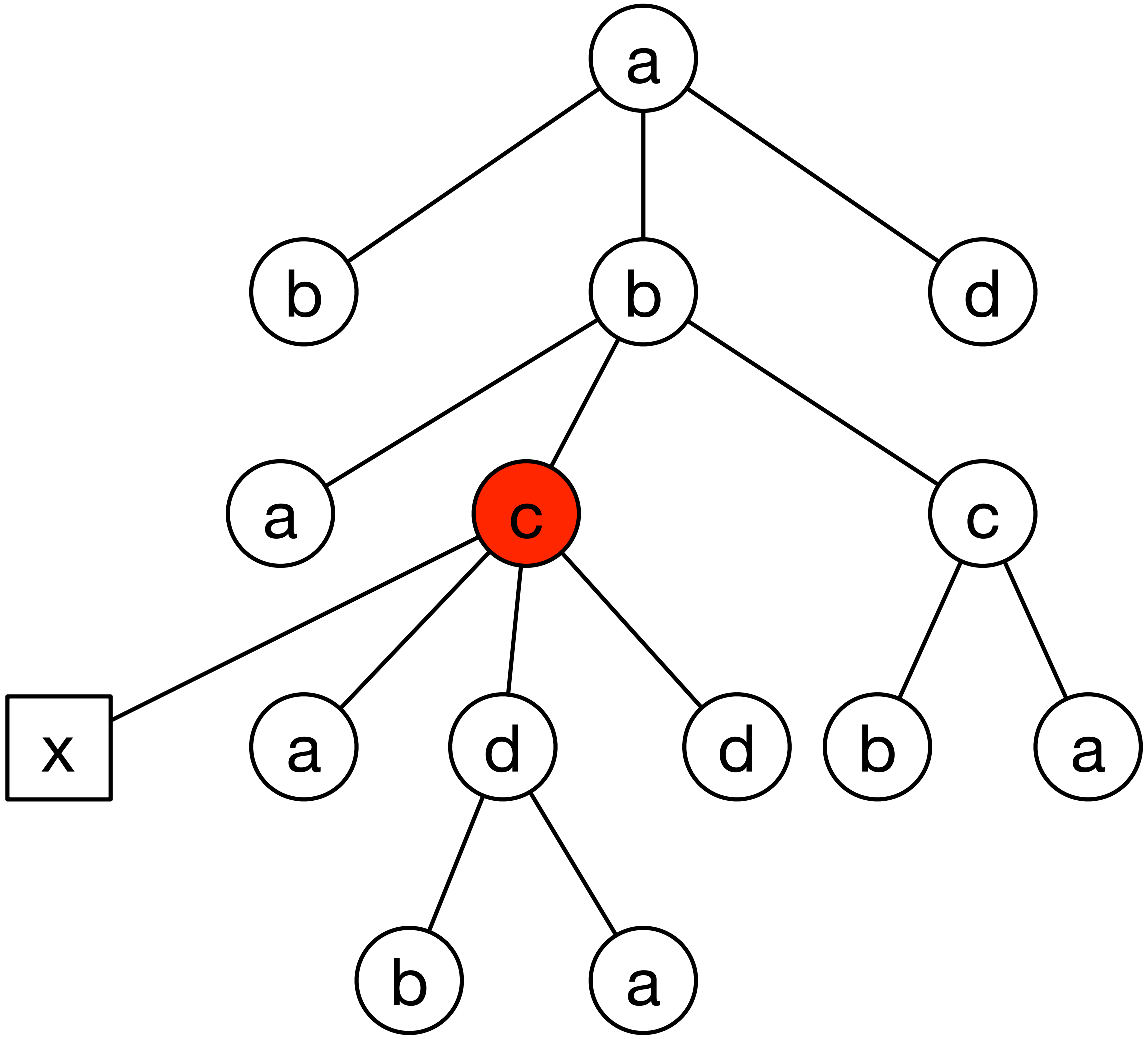
# XPath: Examples

```
Q6 := /a/b/c[a and d]
```



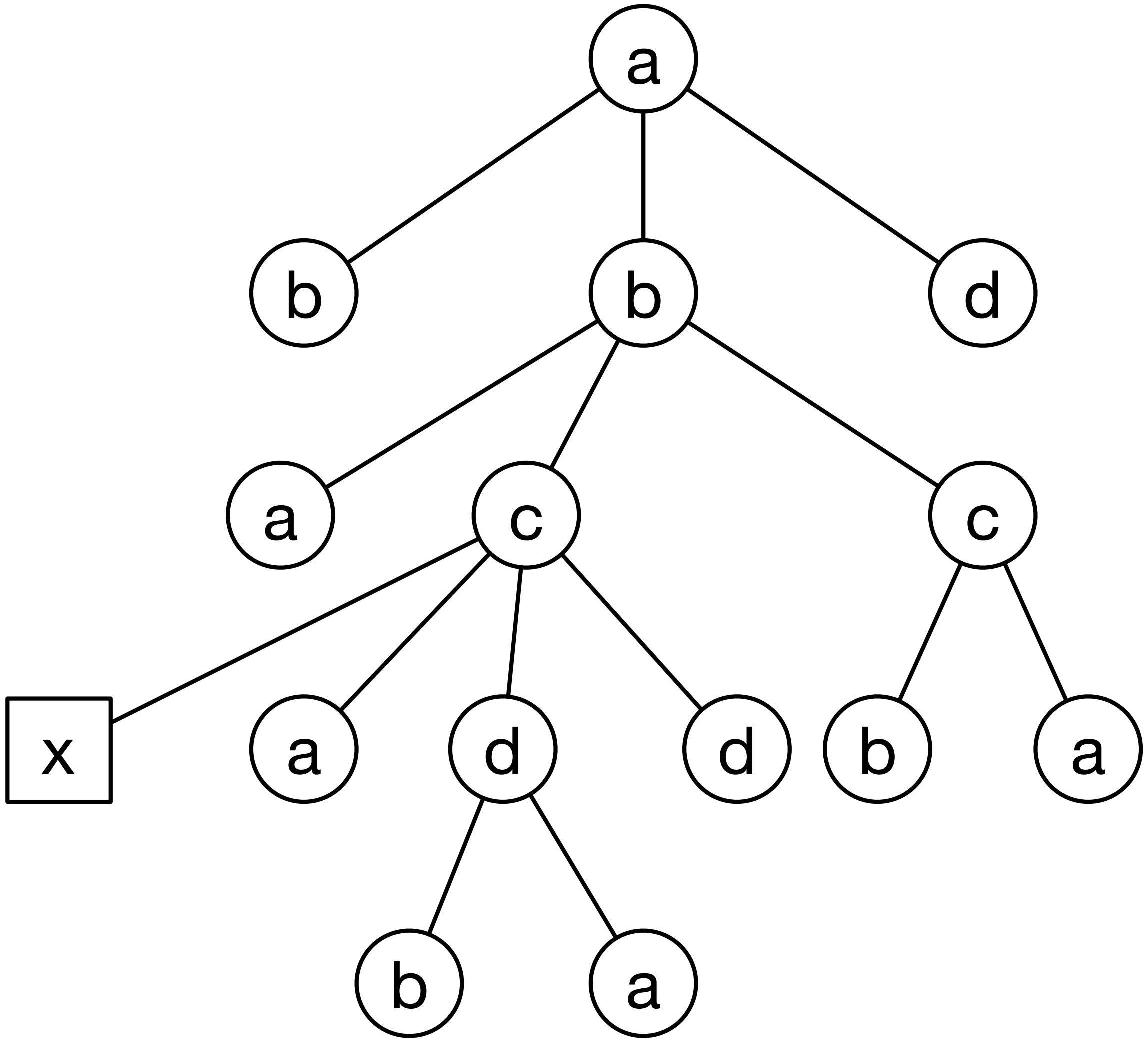
# XPath: Examples

```
Q6 := /a/b/c[a and d]
```



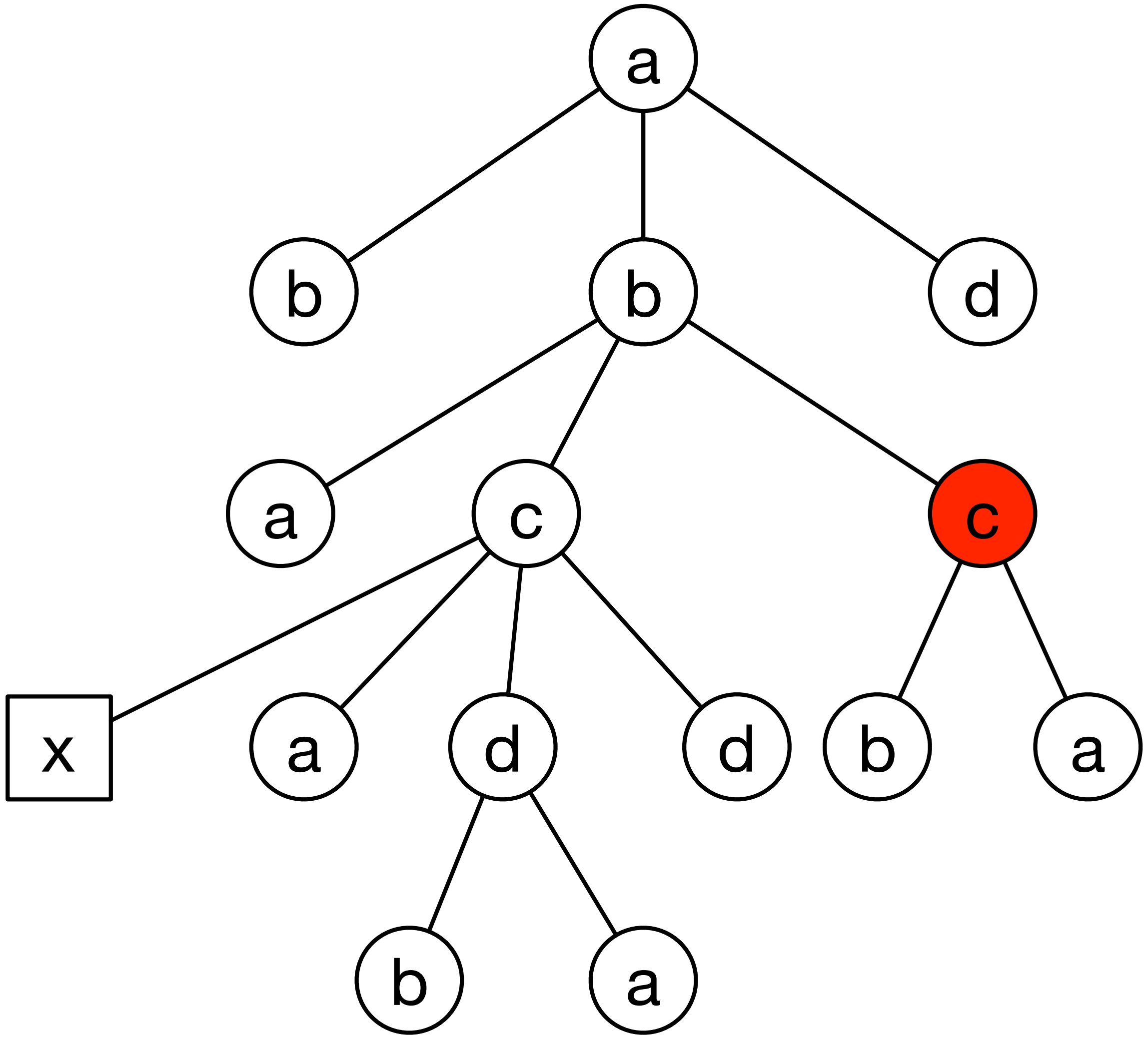
# XPath: Examples

```
Q7 := /a/b/c[not(d)]
```



# XPath: Examples

```
Q7 := /a/b/c[not(d)]
```



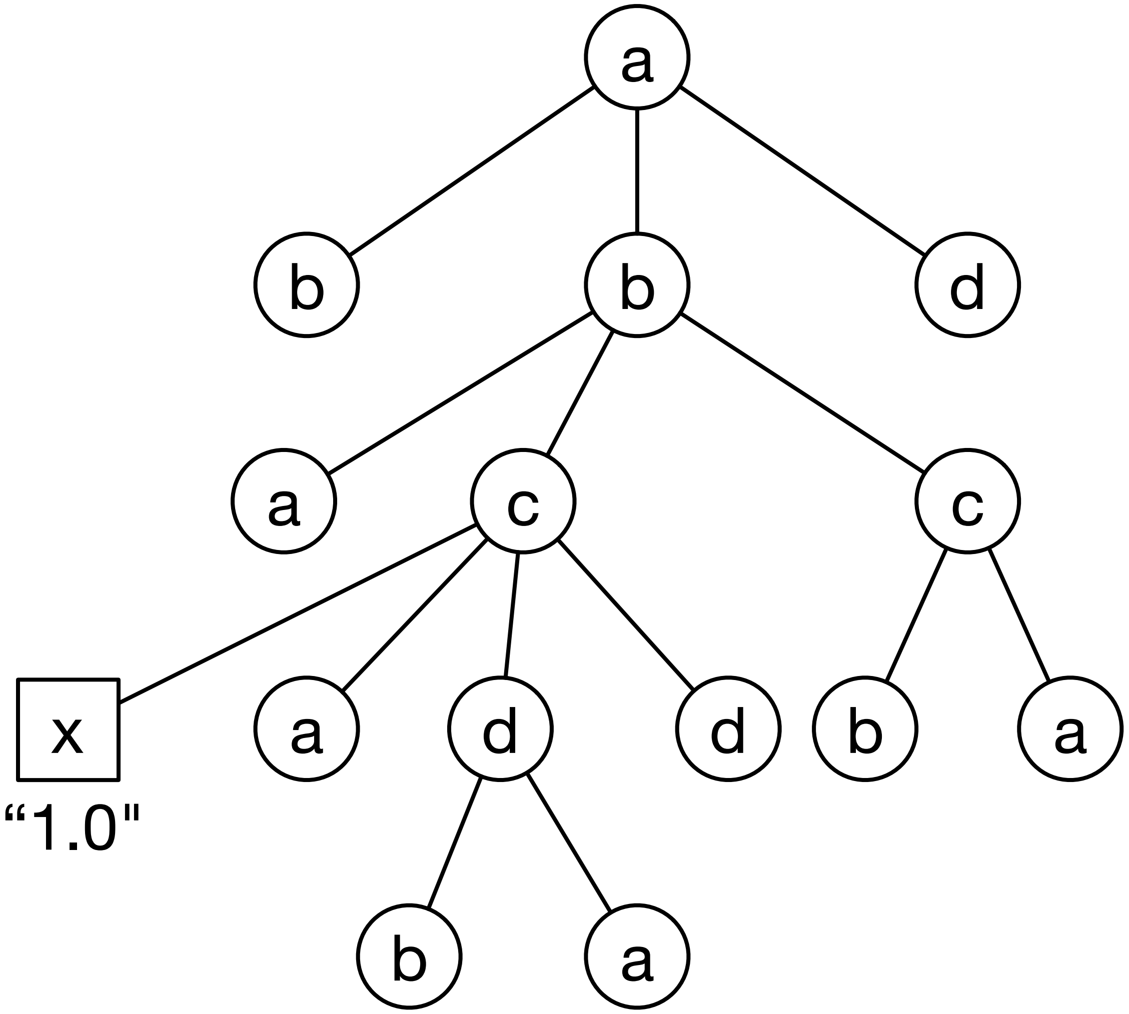
# XPath: Predicates

$$\text{axis} :: \text{ntest}\boxed{[\text{pred}_1]\cdots[\text{pred}_n]}$$

Predicates allow testing for attribute values.

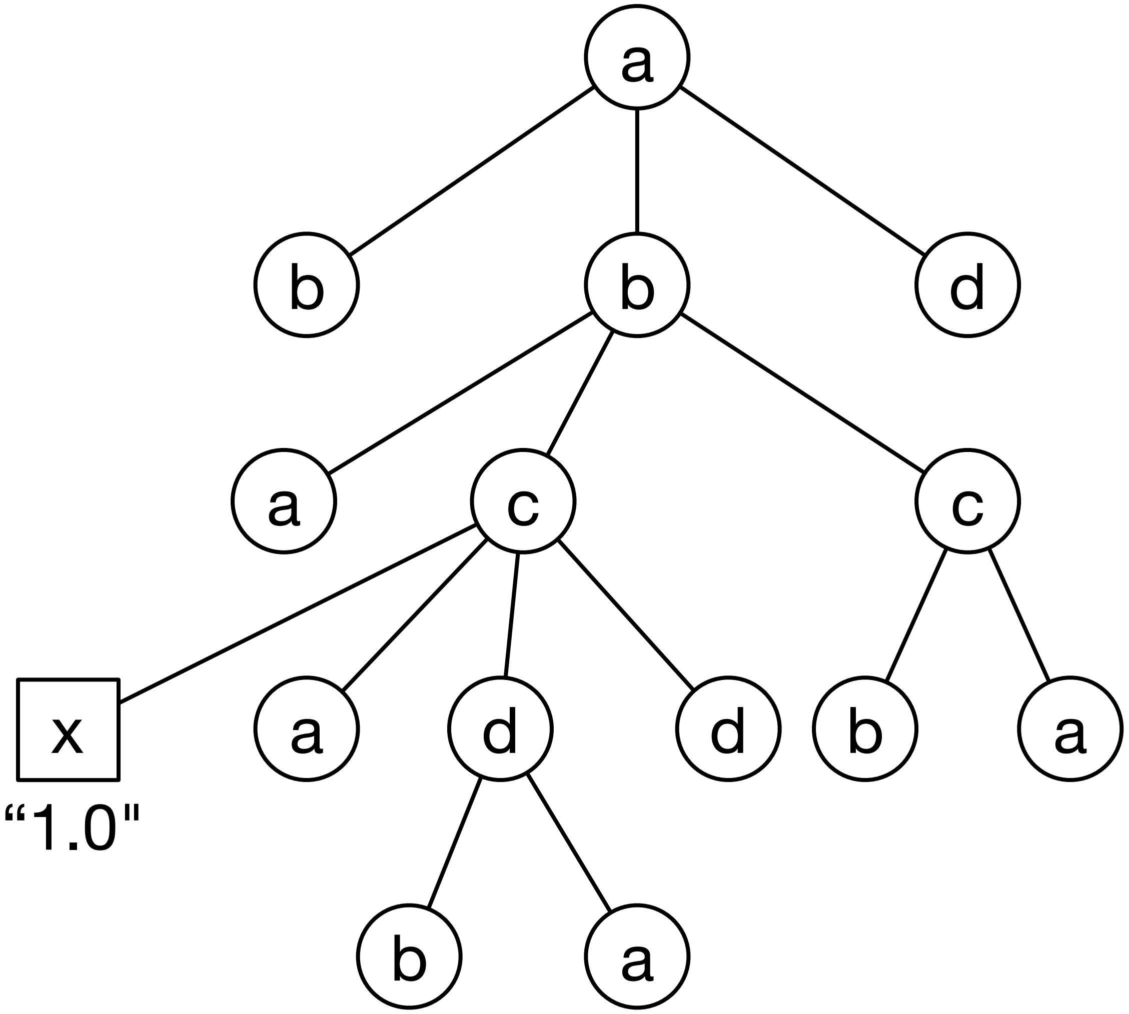
# XPath: Examples

Q8 := /a/b/c[@x=1]



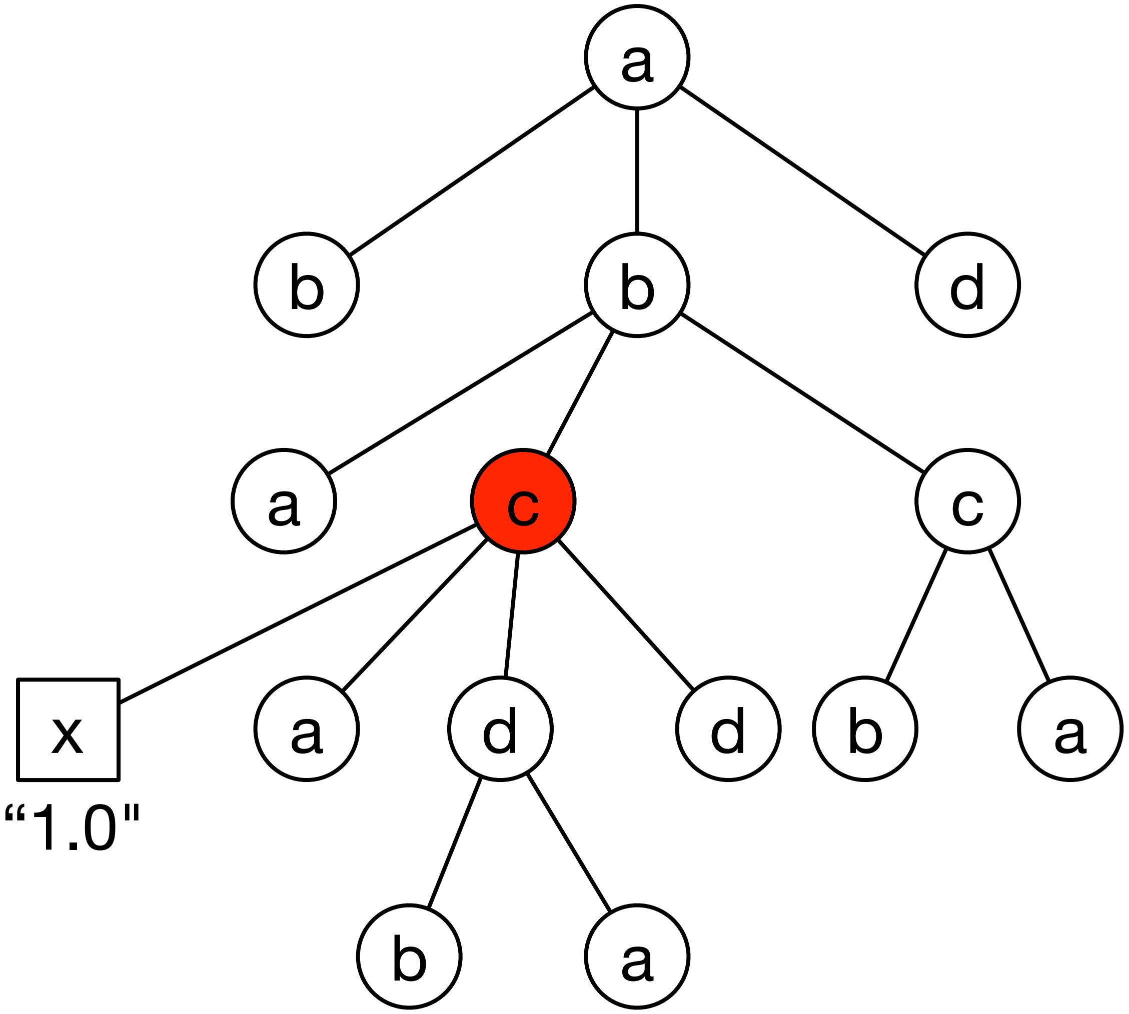
# XPath: Examples

```
Q9 := /a/b/c[@x=“1.0”]
```



# XPath: Examples

Q9 := /a/b/c[@x=“1.0”]



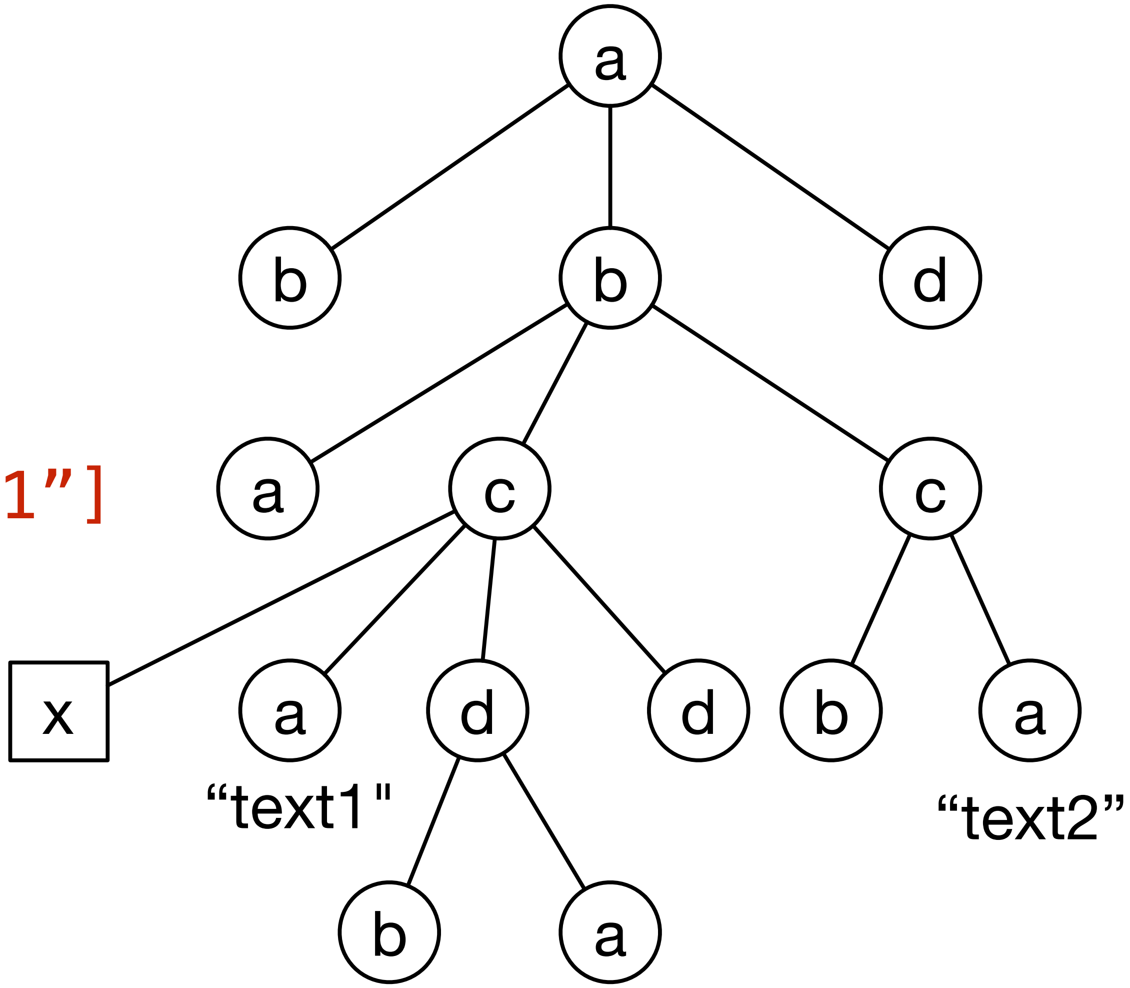
# XPath: Predicates

$$\text{axis} :: \text{ntest}[\text{pred}_1] \cdots [\text{pred}_n]$$

Predicates allow testing for text in nodes.

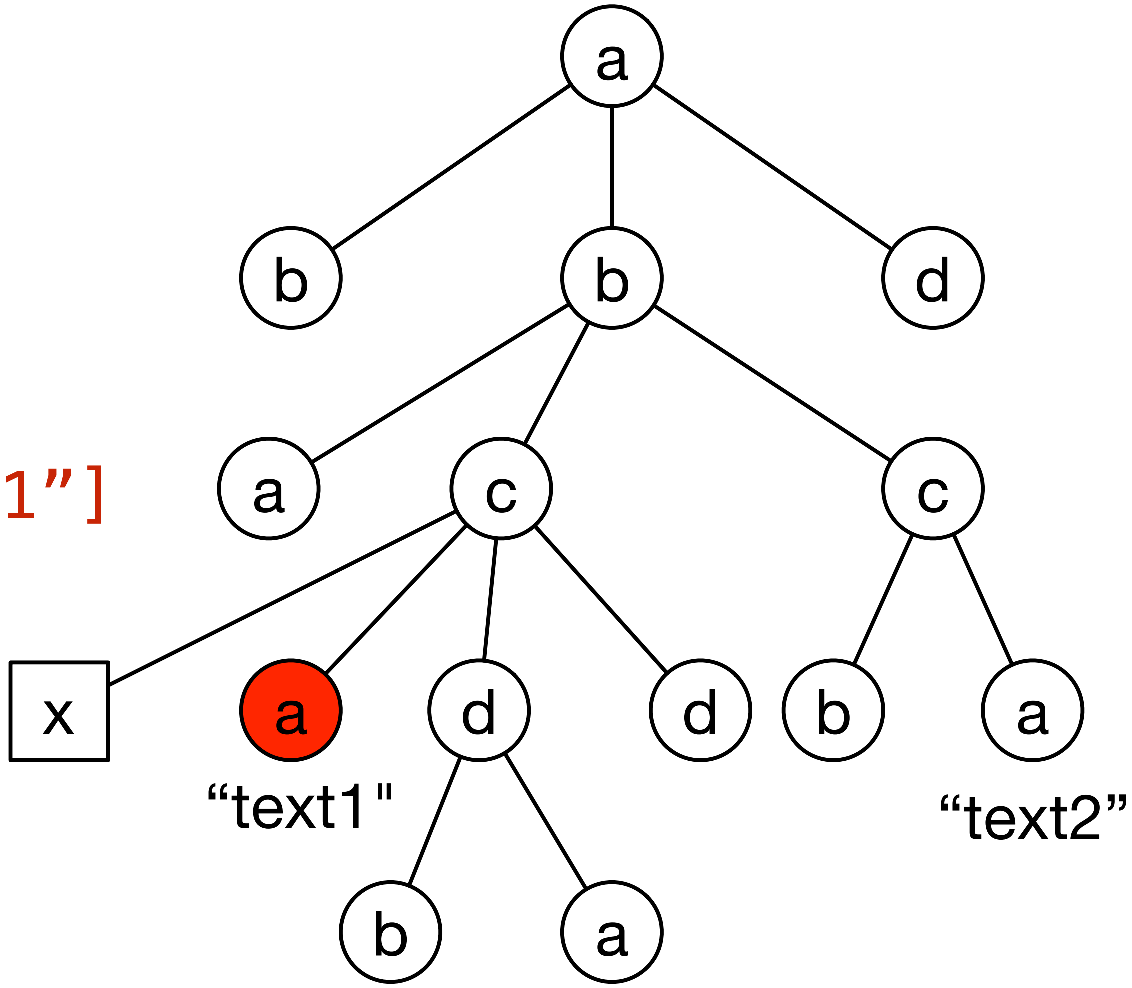
# XPath: Examples

```
Q10 := /a/b/c//*[text()=“text1”]
```



# XPath: Examples

Q10 := /a/b/c//*[text()="text1"]



# XPath: Useful Predicate Functions

$$\text{axis} :: \text{ntest}[\text{pred}_1] \cdots [\text{pred}_n]$$

Predicates allow functions for testing on node sets:

| Function | Semantics |
|---|---|
| `count(ex)` | counts number of results |
| `last()` | returns context size from the evaluation context |
| `position()` | returns context position from the evaluation context |
| … | |

# XPath: Useful Predicate Functions

$$\text{axis} :: \text{ntest}\boxed{[\text{pred}_1]\cdots[\text{pred}_n]}$$

Predicates allow functions for testing on strings:

| Function | Return value |
|---|---|
| `concat(s1,…,sn)` | concatenated string |
| `startswith(str,pre)` | `true()` if `str` starts with `pre` |
| `contains(str,substr)` | `true()` if `str` contains `substr` |
| `substring(str,i,j)` | the substring of `str` from `i` to `j` |
| `stringlength(str)` | the length of `str` |
| … | |

# Useful Reading

- XPath Reference http://www.w3.org/TR/xpath/
- March Schol's slides on XPath http://www.inf.uni-konstanz.de/dbis/teaching/ws0506/database-xml/P8.pdf
- Sebastian Maneth's slides on XPath http://www.cse.unsw.edu.au/~cs4317/10s1/lectures/06.pdf