Introduction to XPath

James Cummings

February 2006

Accessing your TEI document

So you've created some TEI XML documents, what now?

- XPath
- XML Query (XQuery)
- XSLT Tranformation to another format (HTML, PDF, RTF, CSV, etc.)
- Custom Applications (Xaira, TEIPubisher, Philologic etc.)

What is XPath?

- It is a syntax for accessing parts of an XML document
- It uses a path structure to define XML elements
- It has a library of standard functions
- It is a W3C Standard
- It is one of the main components of XQuery and XSLT

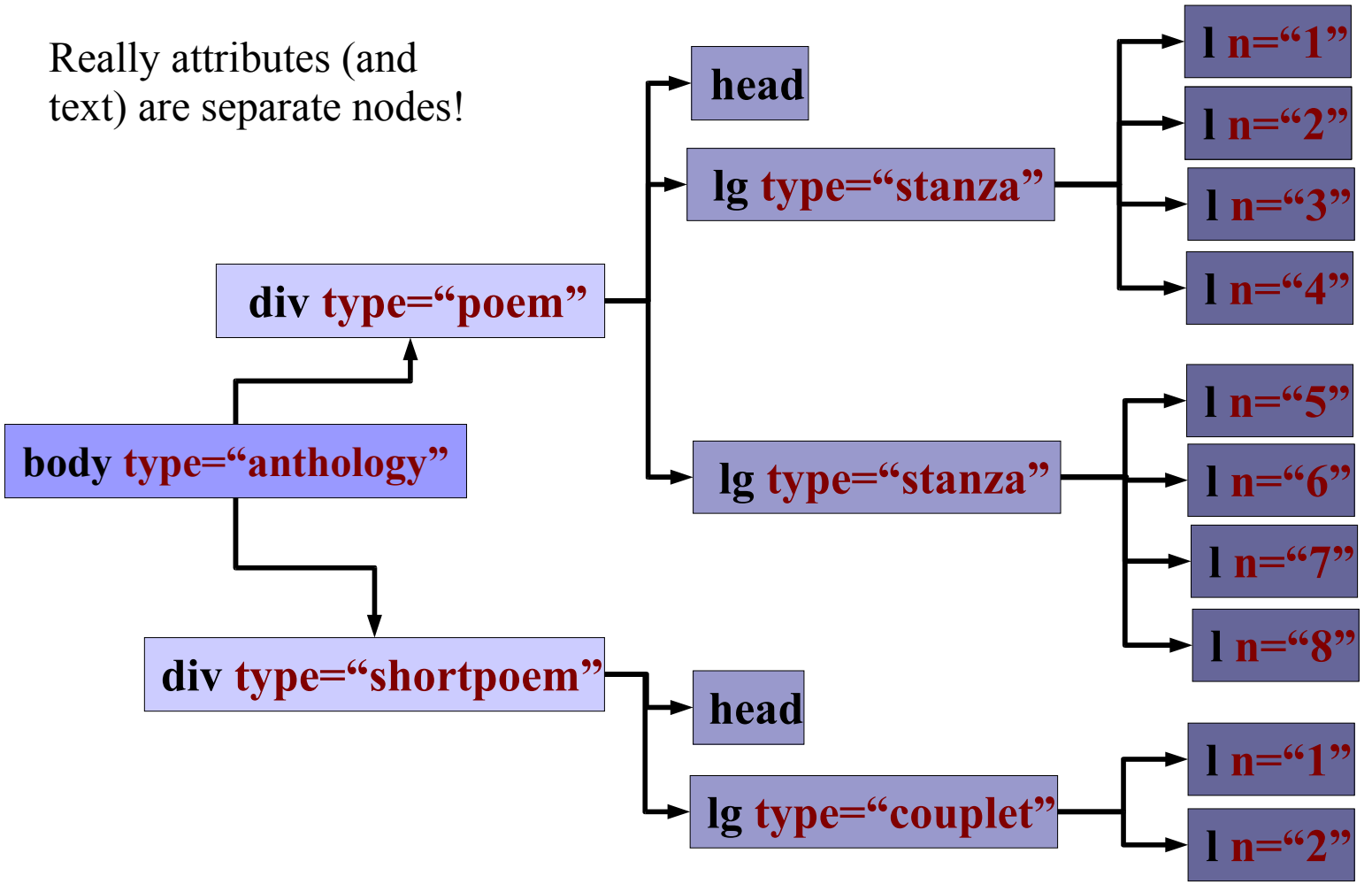
Example text


```
<body type="anthology">
 <div type="poem">
  <head>The SICK ROSE </head>
  <lg type="stanza">
   <l n="1">O Rose thou art sick.</l>
   <l n="2">The invisible worm,</l>
   <l n="3">That flies in the night </l>
   <l n="4">In the howling storm:</l>
  </lg>
  <lg type="stanza">
   <l n="5">Has found out thy bed </l>
   <l n="6">Of crimson joy:</l>
   <l n="7">And his dark secret love </l>
   <l n="8">Does thy life destroy.</l>
  </lg>
 </div>

</body>
```

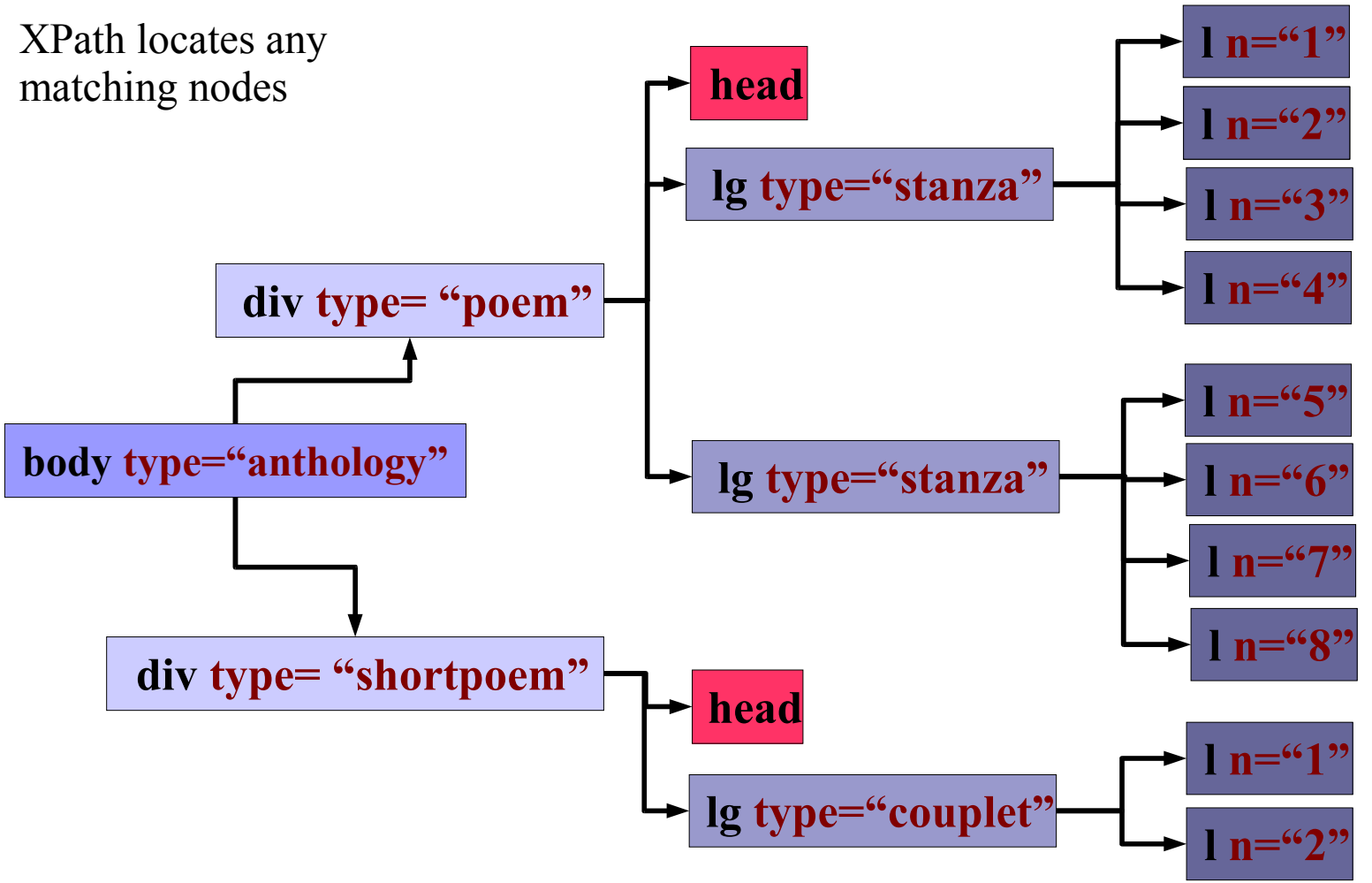
XML Structure

Really attributes (and text) are separate nodes!

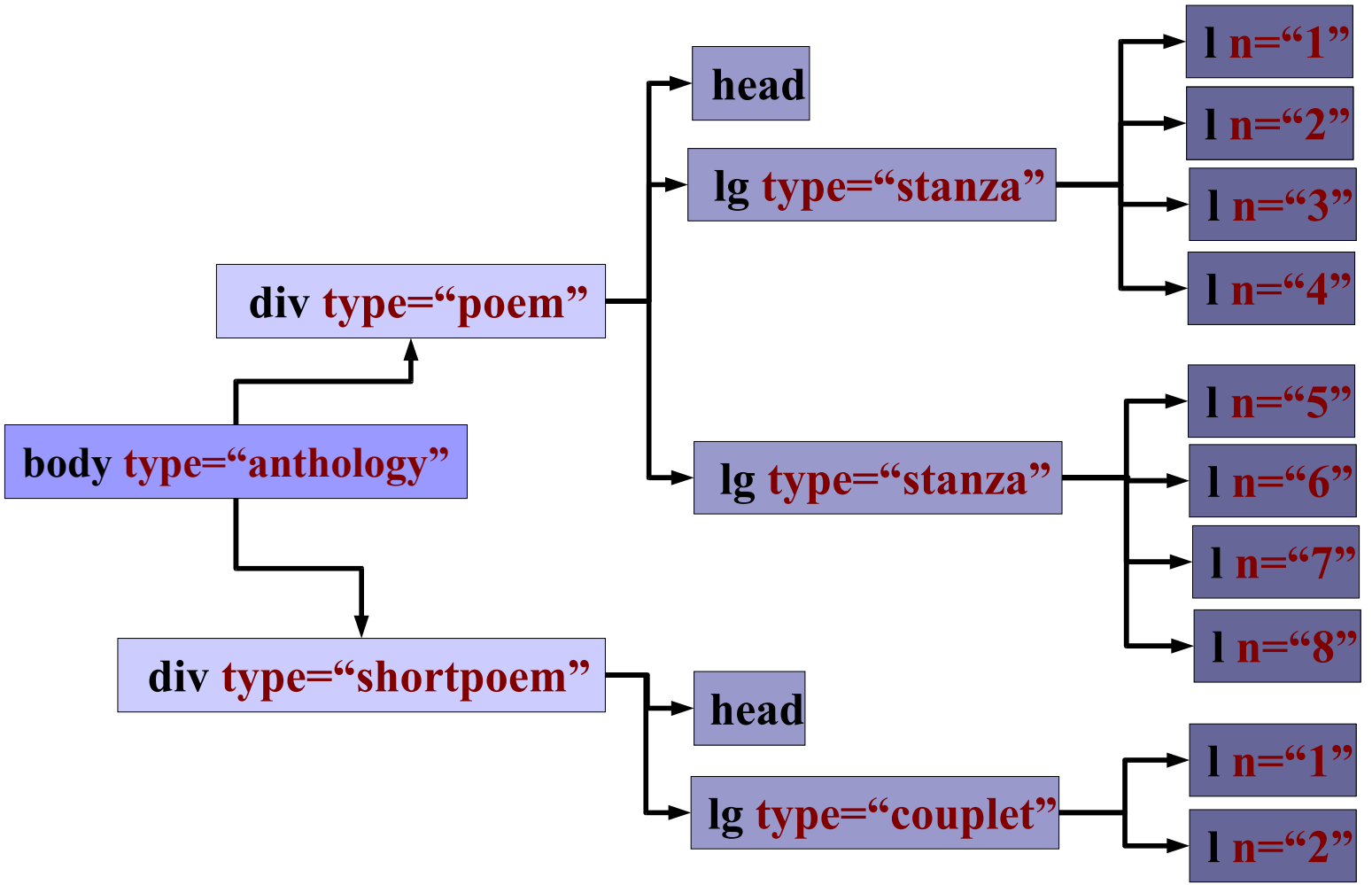


/body/div/head

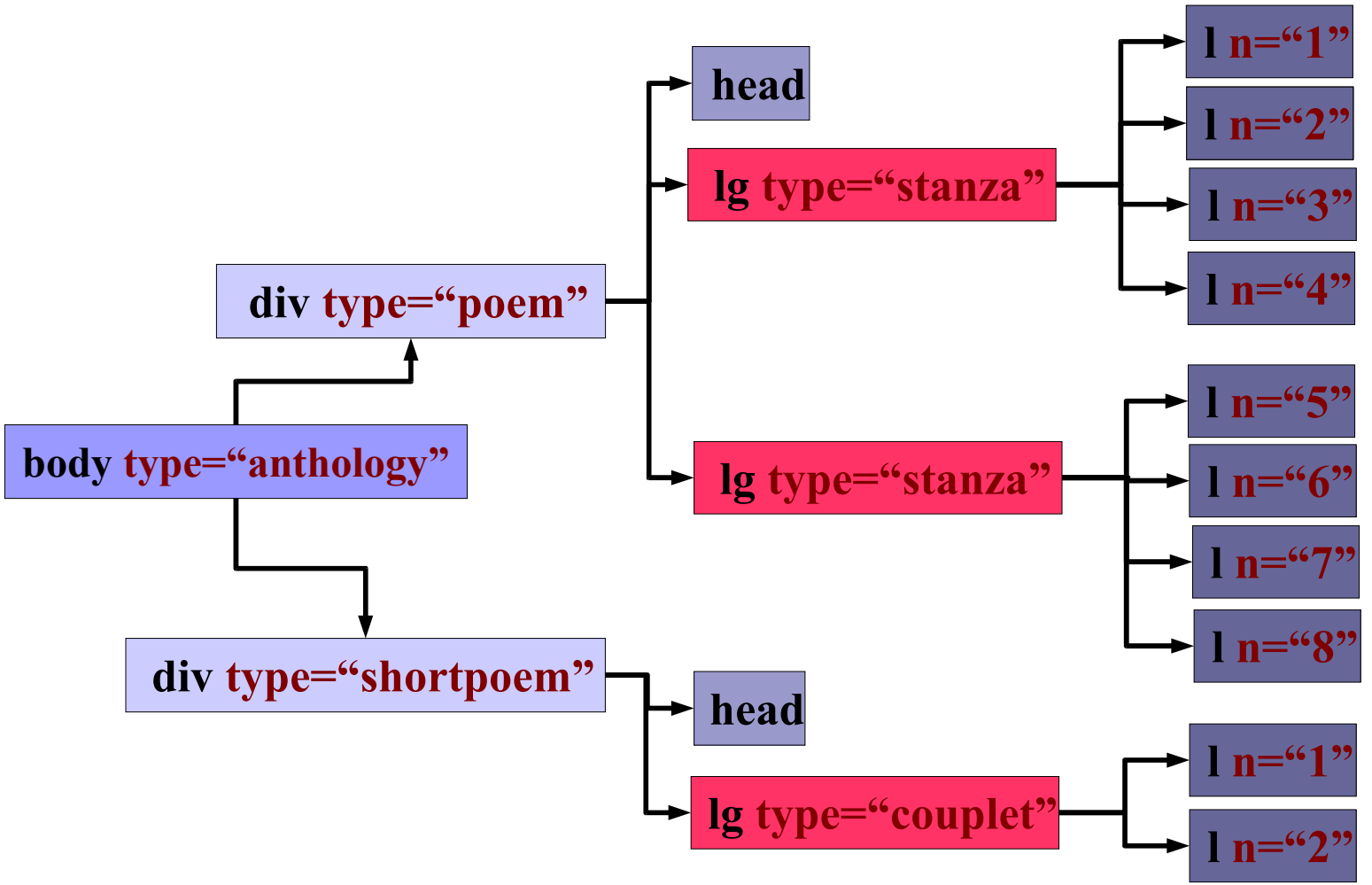
XPath locates any matching nodes



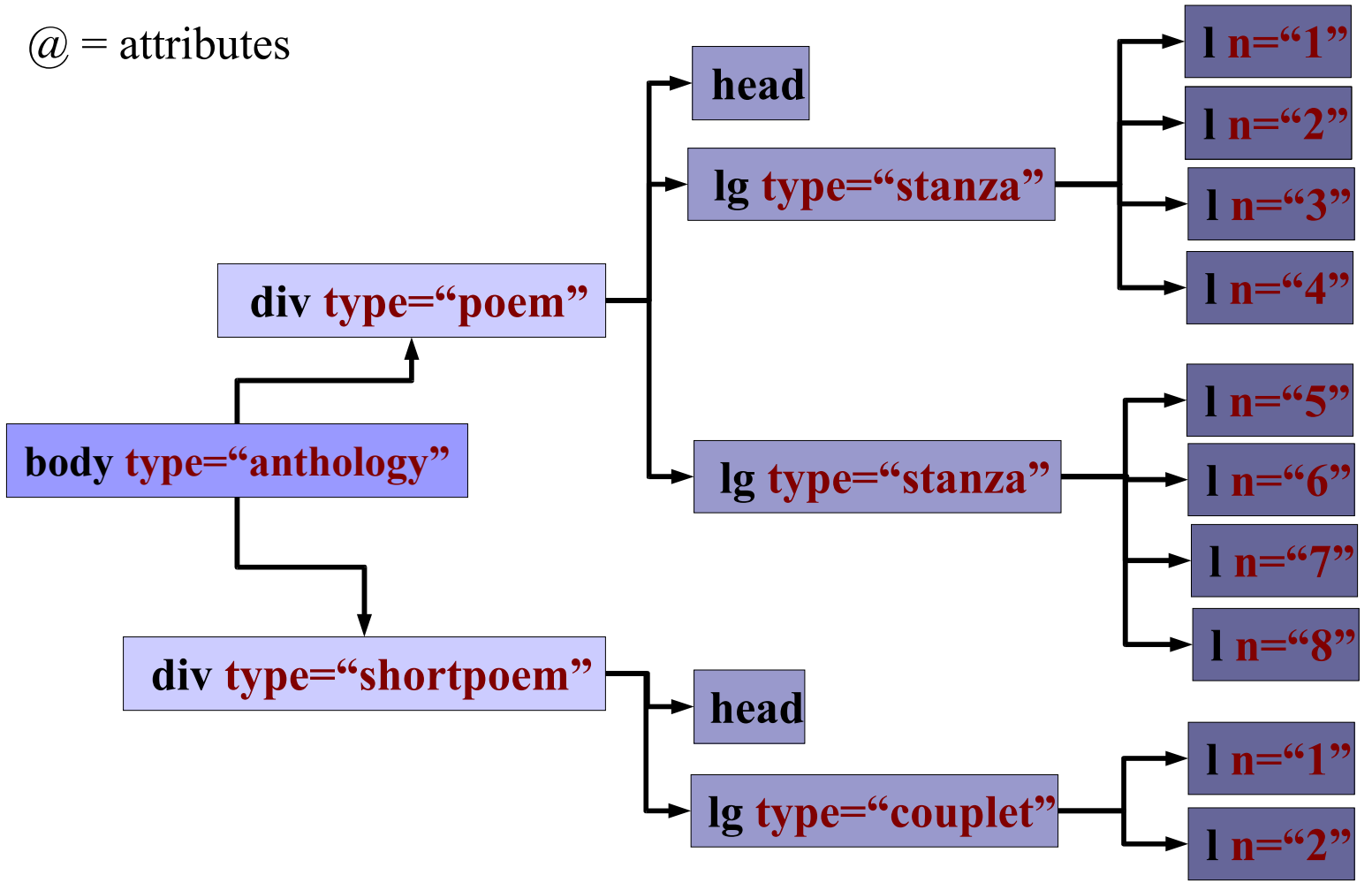
/body/div/lg ?


body type="anthology"
div type="poem"
head
lg type="stanza"
l n="1"
l n="2"
l n="3"
l n="4"
lg type="stanza"
l n="5"
l n="6"
l n="7"
l n="8"
div type="shortpoem"
head
lg type="couplet"
l n="1"
l n="2"

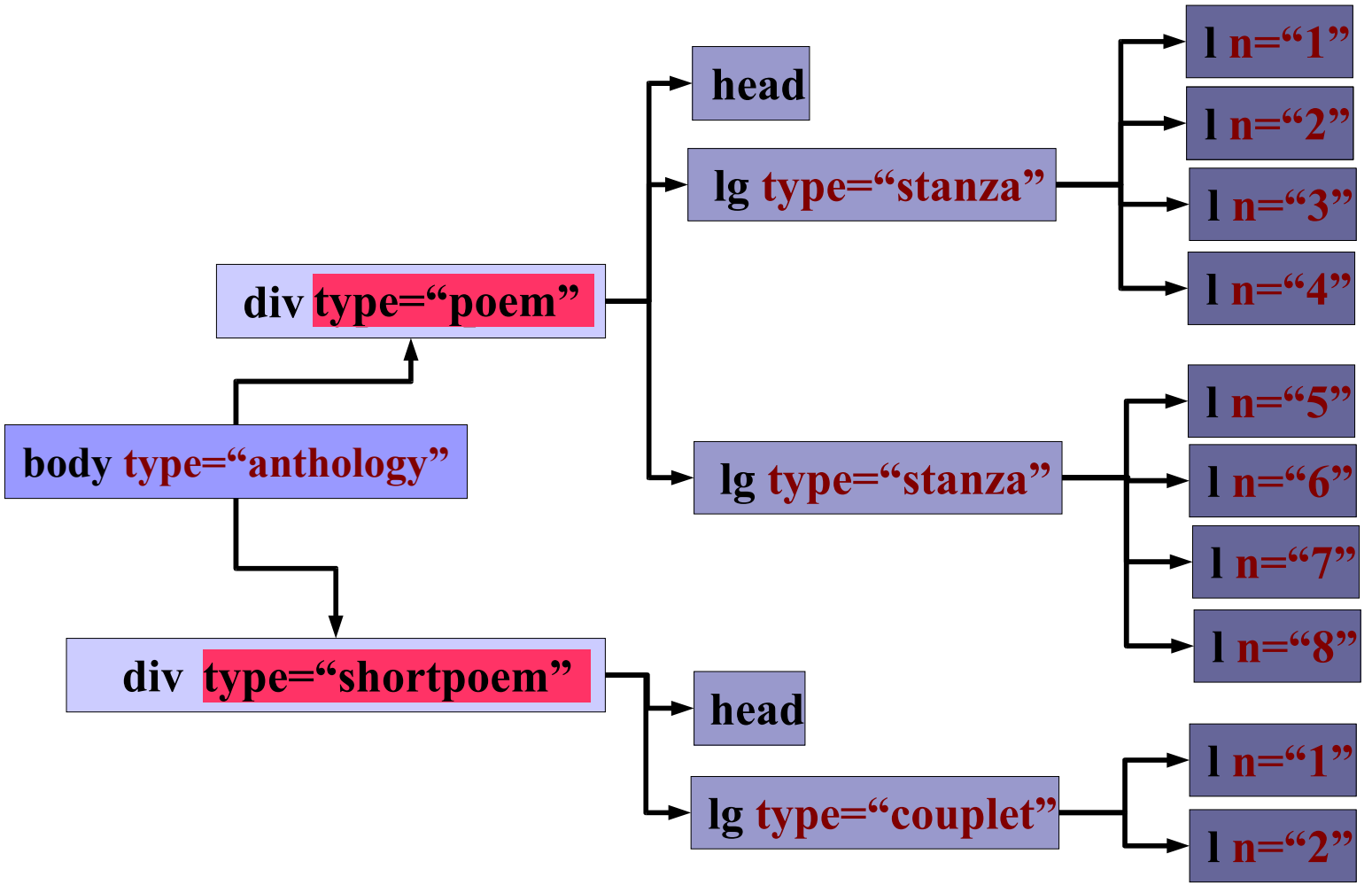
/body/div/lg


body type="anthology"
div type="poem"
head
lg type="stanza"
l n="1"
l n="2"
l n="3"
l n="4"
lg type="stanza"
l n="5"
l n="6"
l n="7"
l n="8"
div type="shortpoem"
head
lg type="couplet"
l n="1"
l n="2"

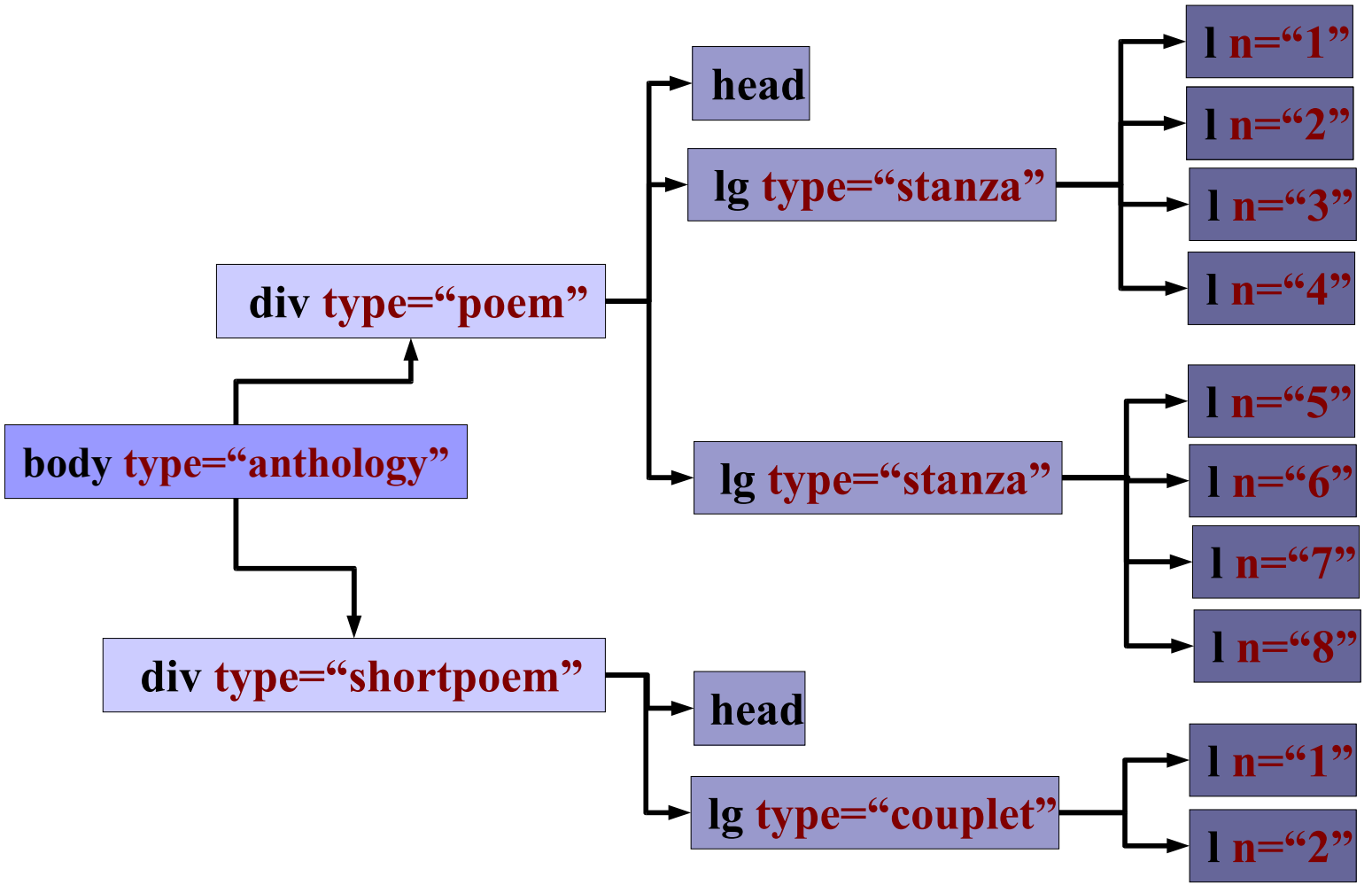
/body/div/@type ?



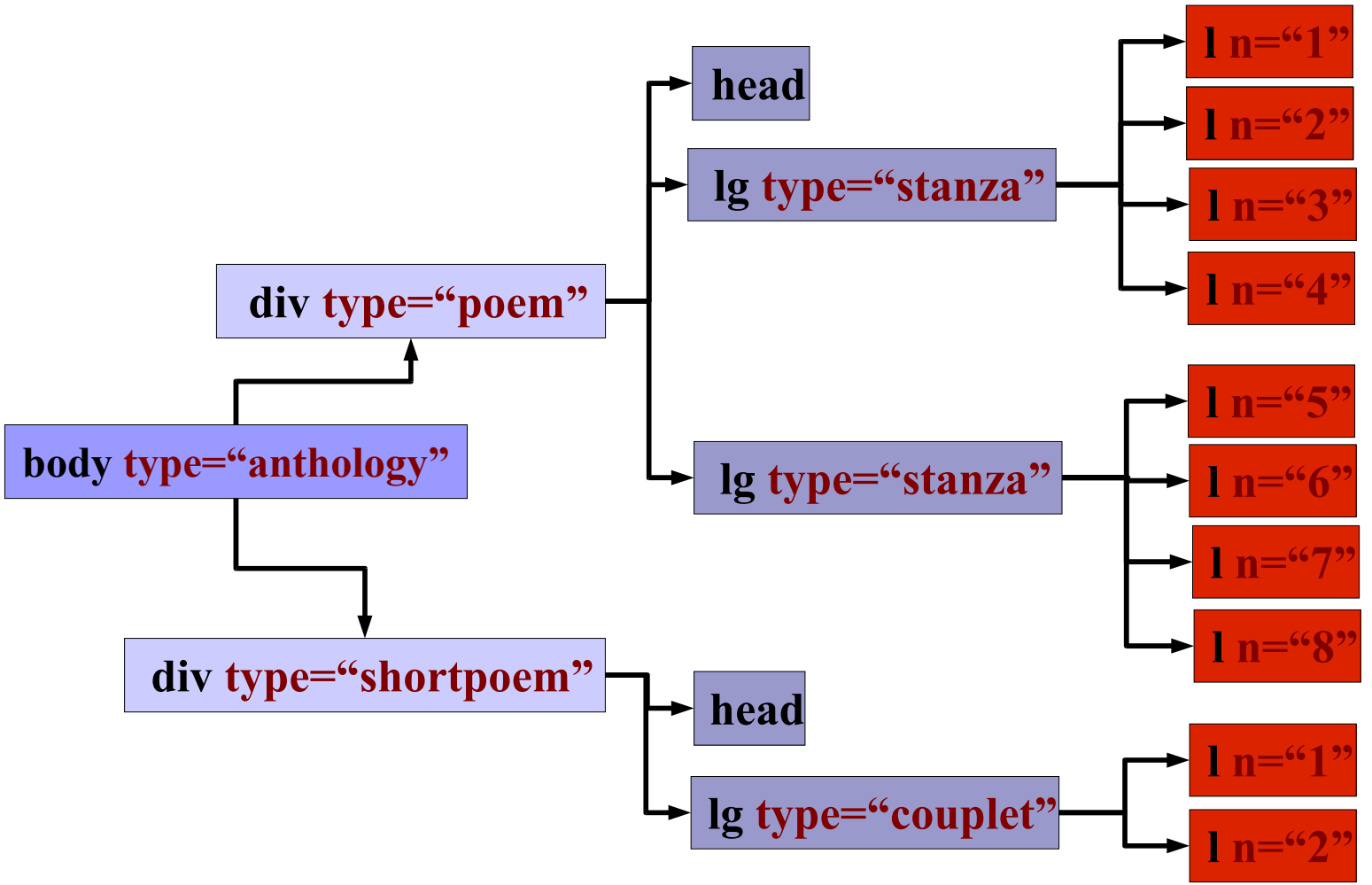
/body/div/@type



/body/div/lg/l ?

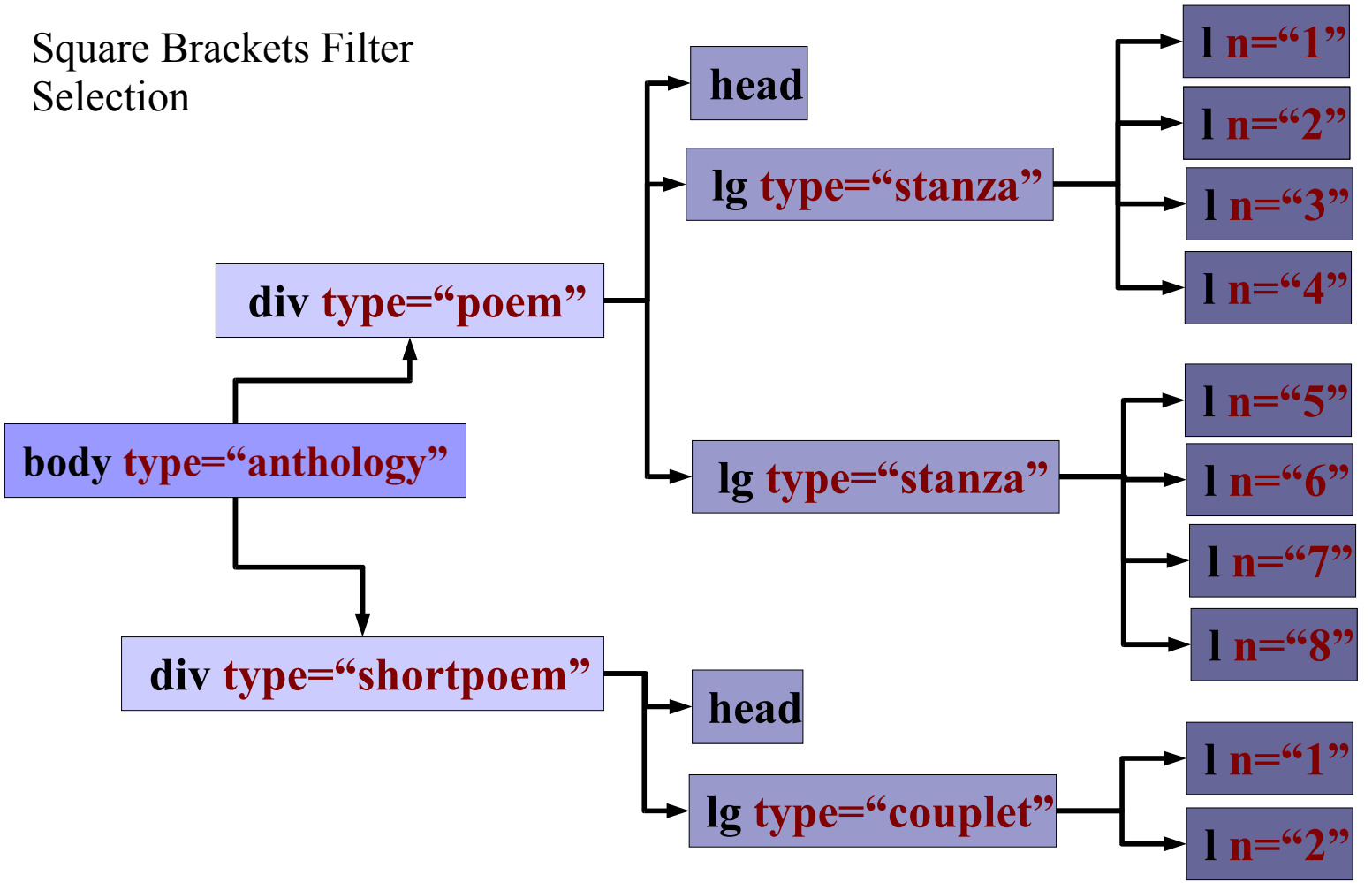

body type="anthology"
div type="poem"
head
lg type="stanza"
l n="1"
l n="2"
l n="3"
l n="4"
lg type="stanza"
l n="5"
l n="6"
l n="7"
l n="8"
div type="shortpoem"
head
lg type="couplet"
l n="1"
l n="2"

/body/div/lg/l

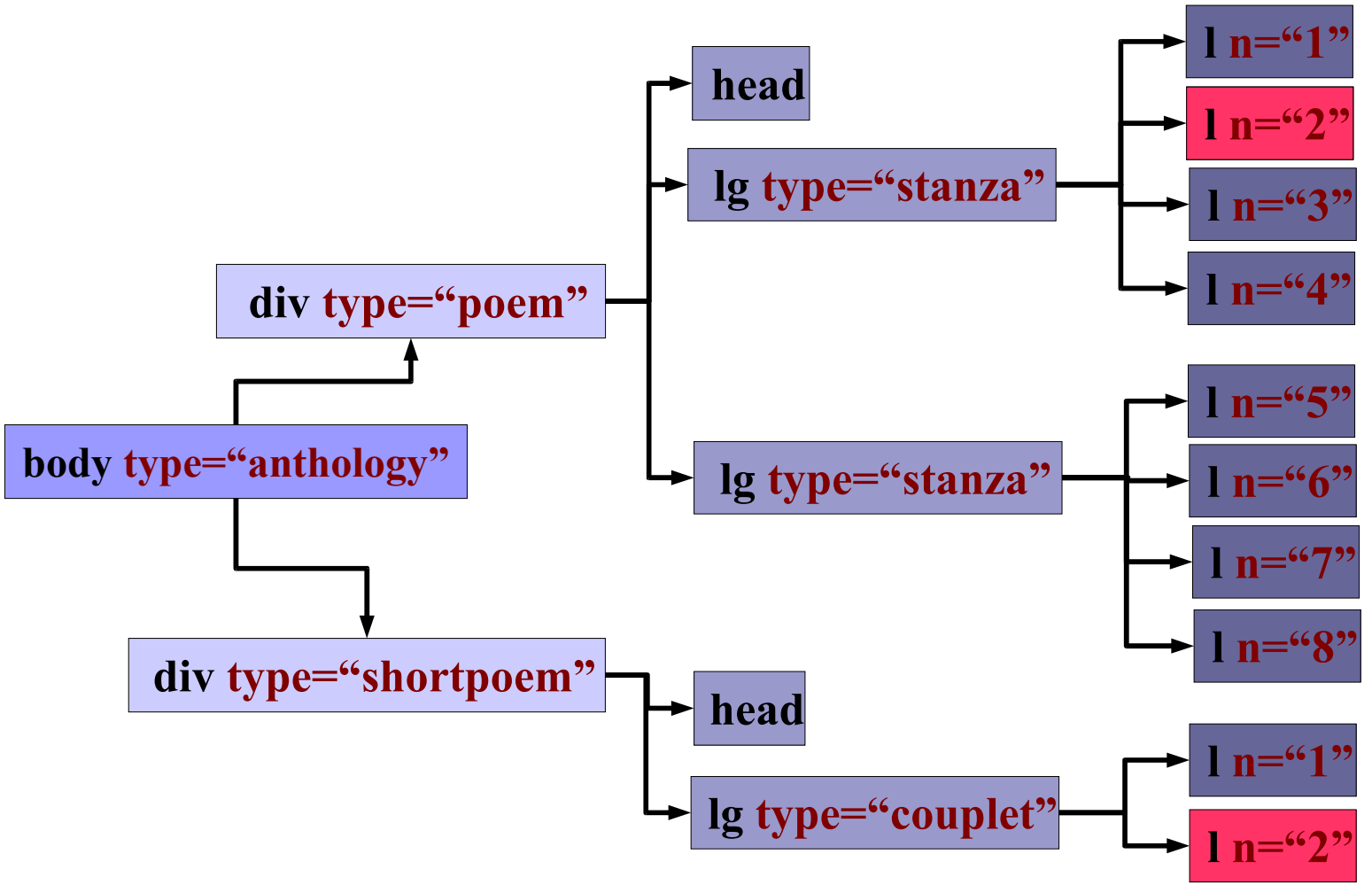

body type="anthology"
div type="poem"
head
lg type="stanza"
l n="1"
l n="2"
l n="3"
l n="4"
lg type="stanza"
l n="5"
l n="6"
l n="7"
l n="8"
div type="shortpoem"
head
lg type="couplet"
l n="1"
l n="2"

/body/div/lg/l[@n="2"] ?

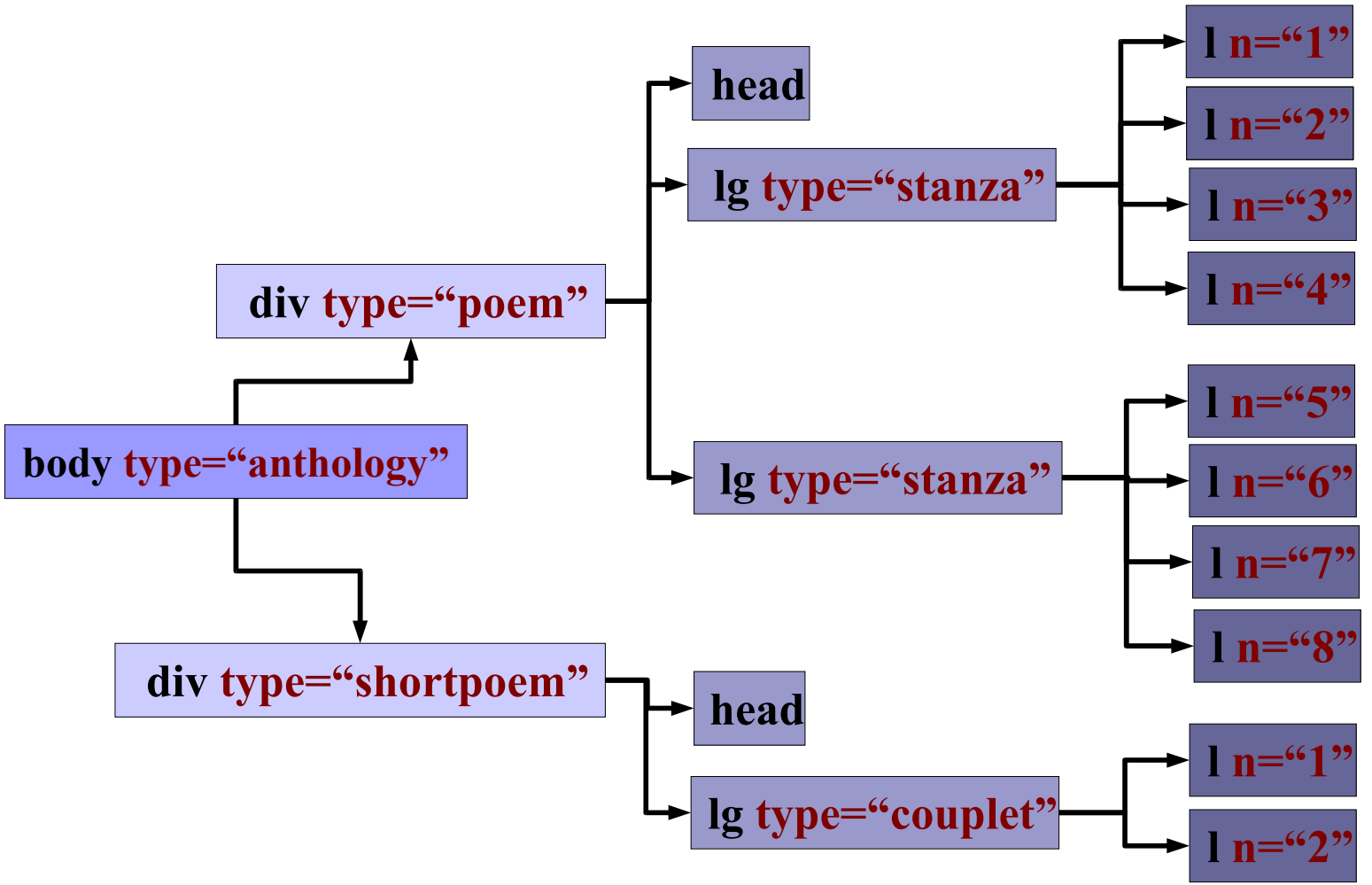
Square Brackets Filter Selection



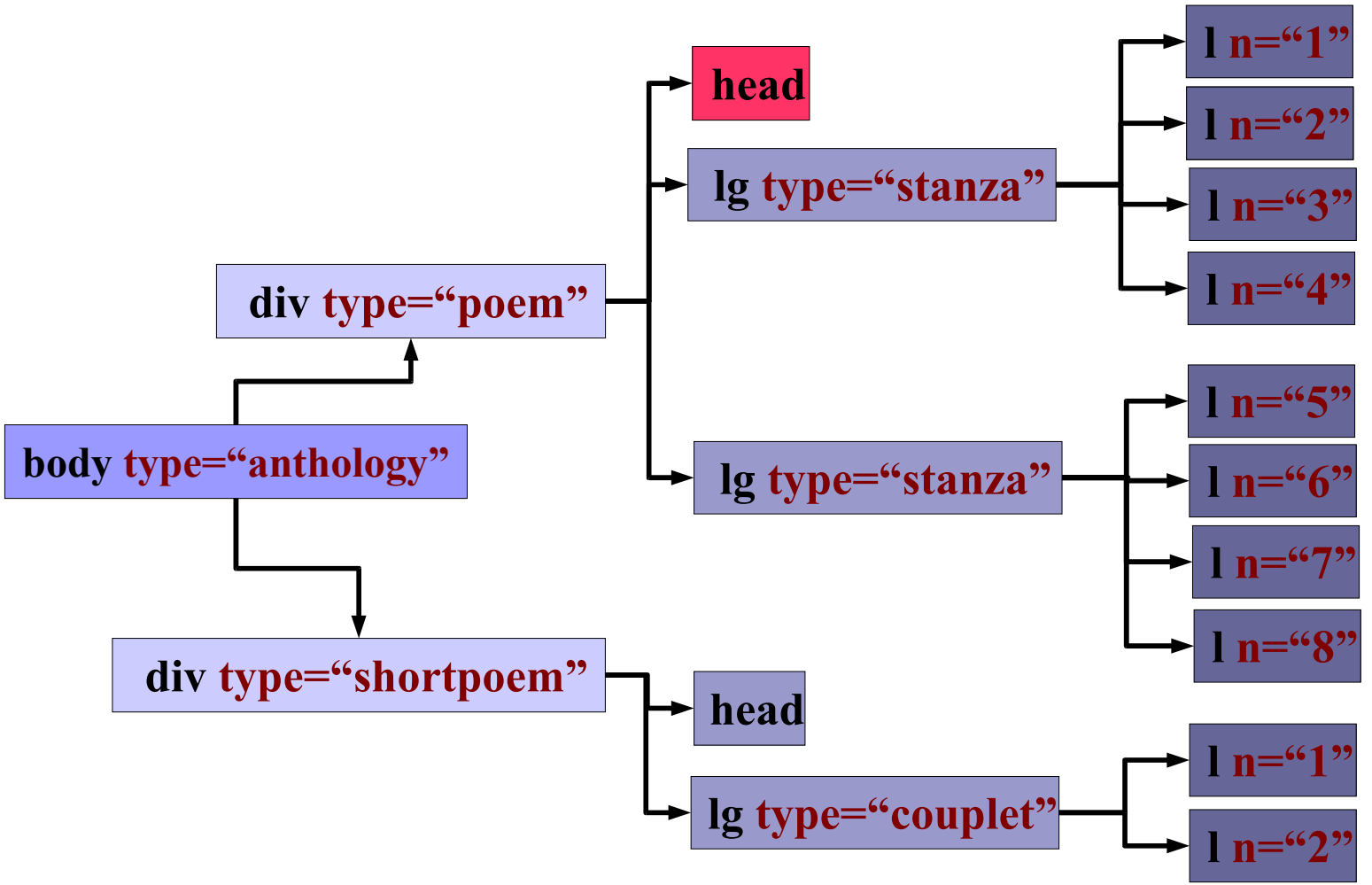
/body/div/lg/l[@n="2"]



/body/div[@type="poem"]/head ?

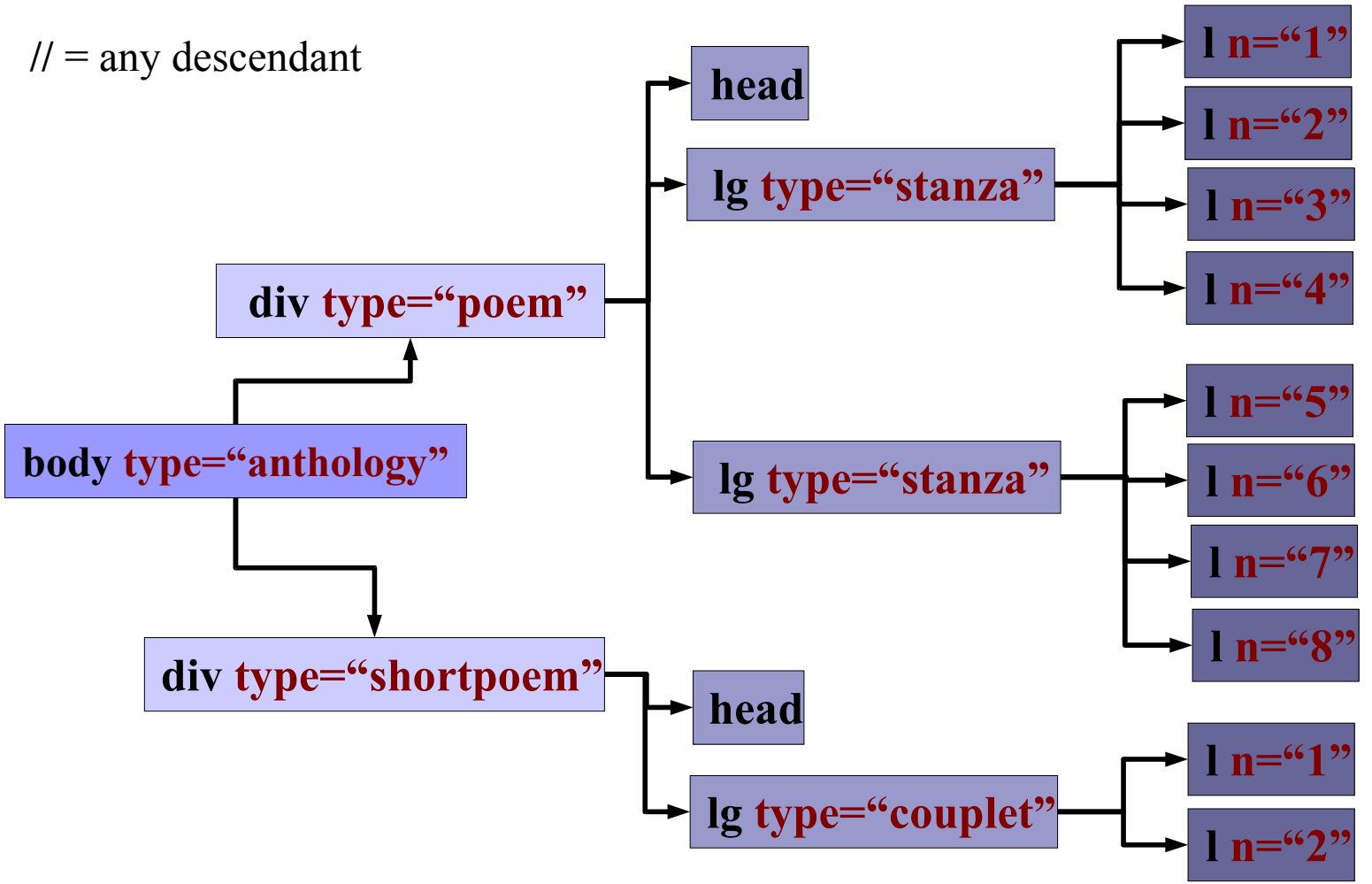


/body/div[@type="poem"]/head

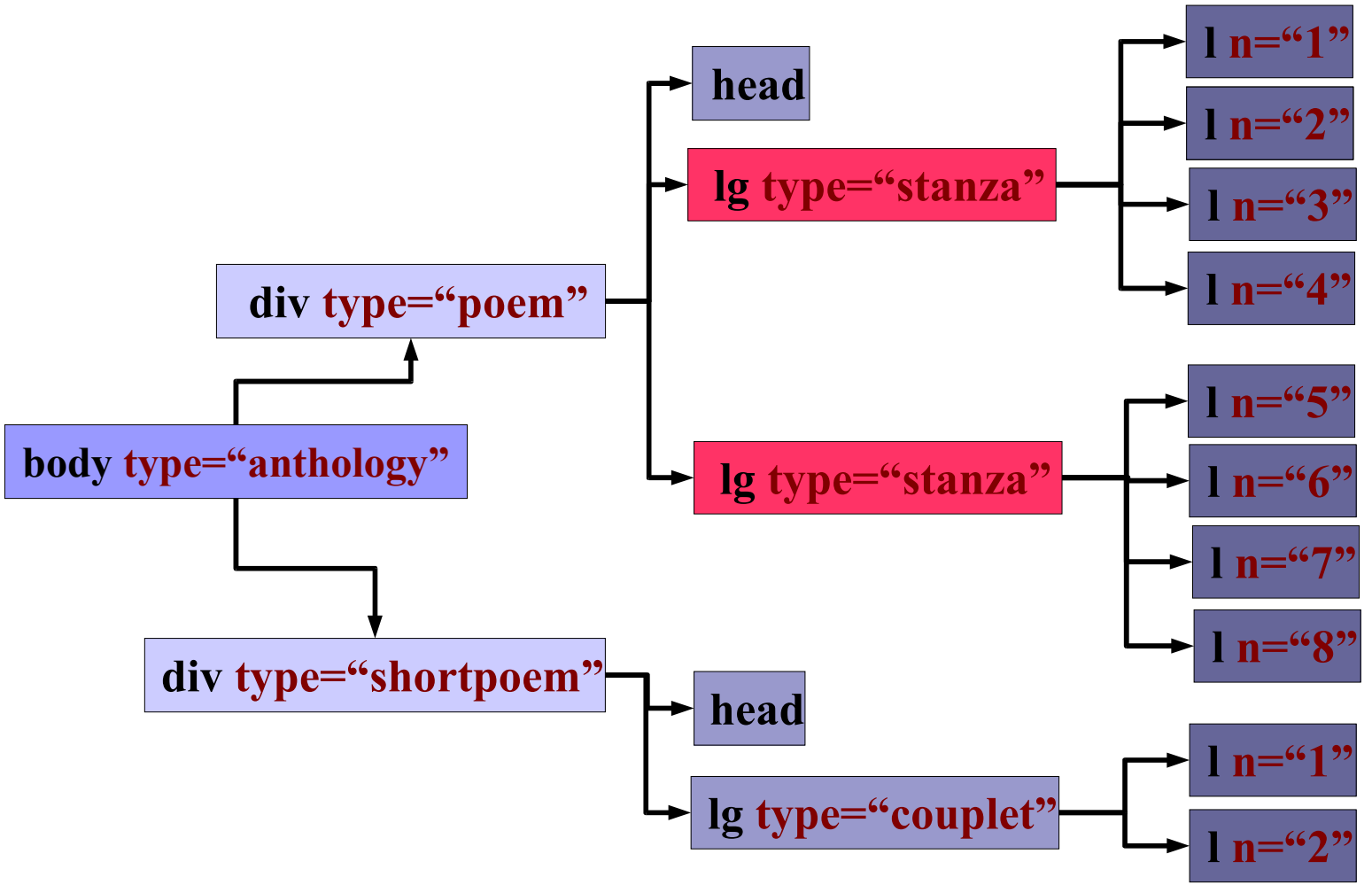


//lg[@type="stanza"] ?

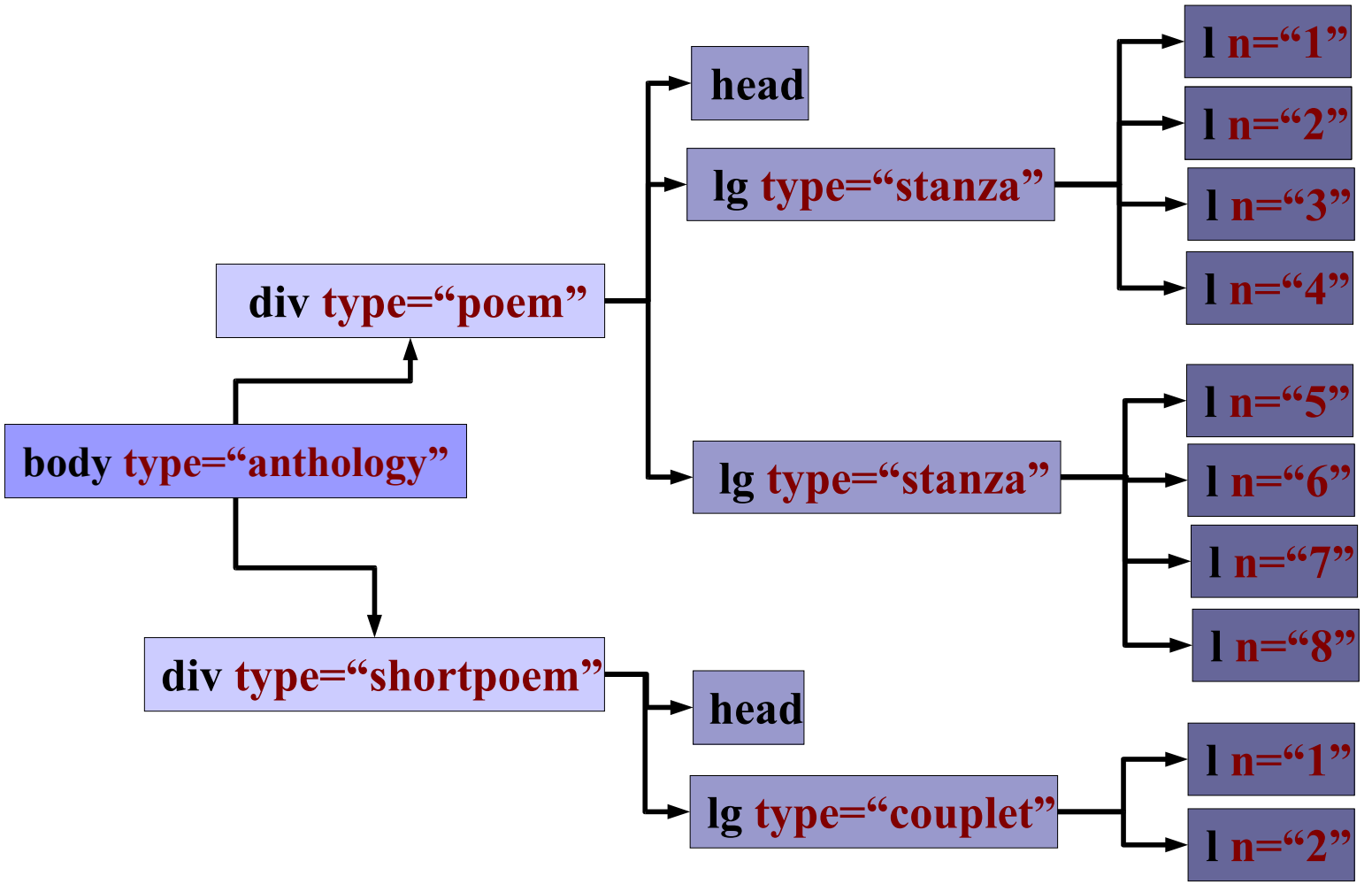
// = any descendant



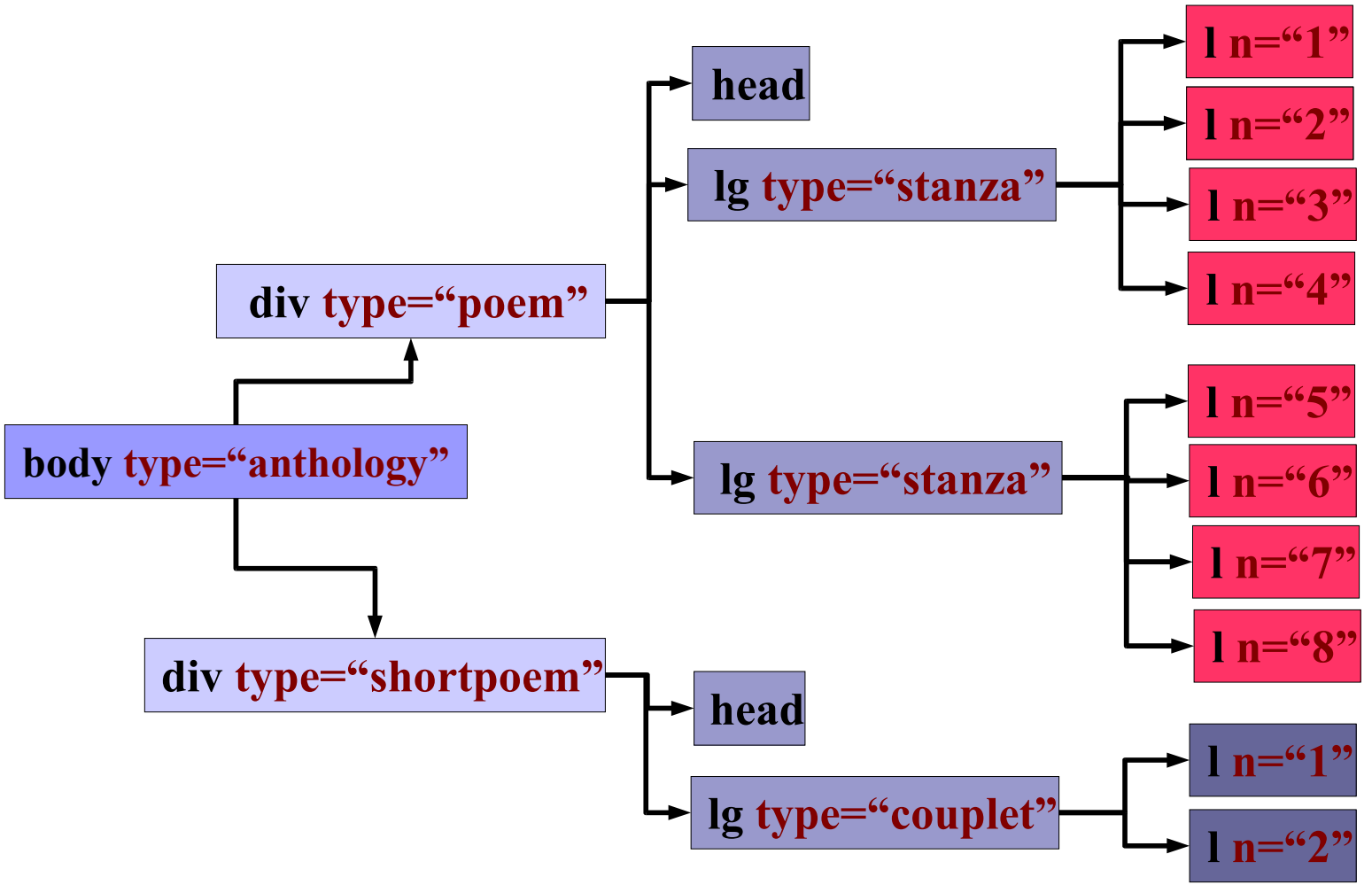
//lg[@type="stanza"]



//div[@type="poem"]//l ?

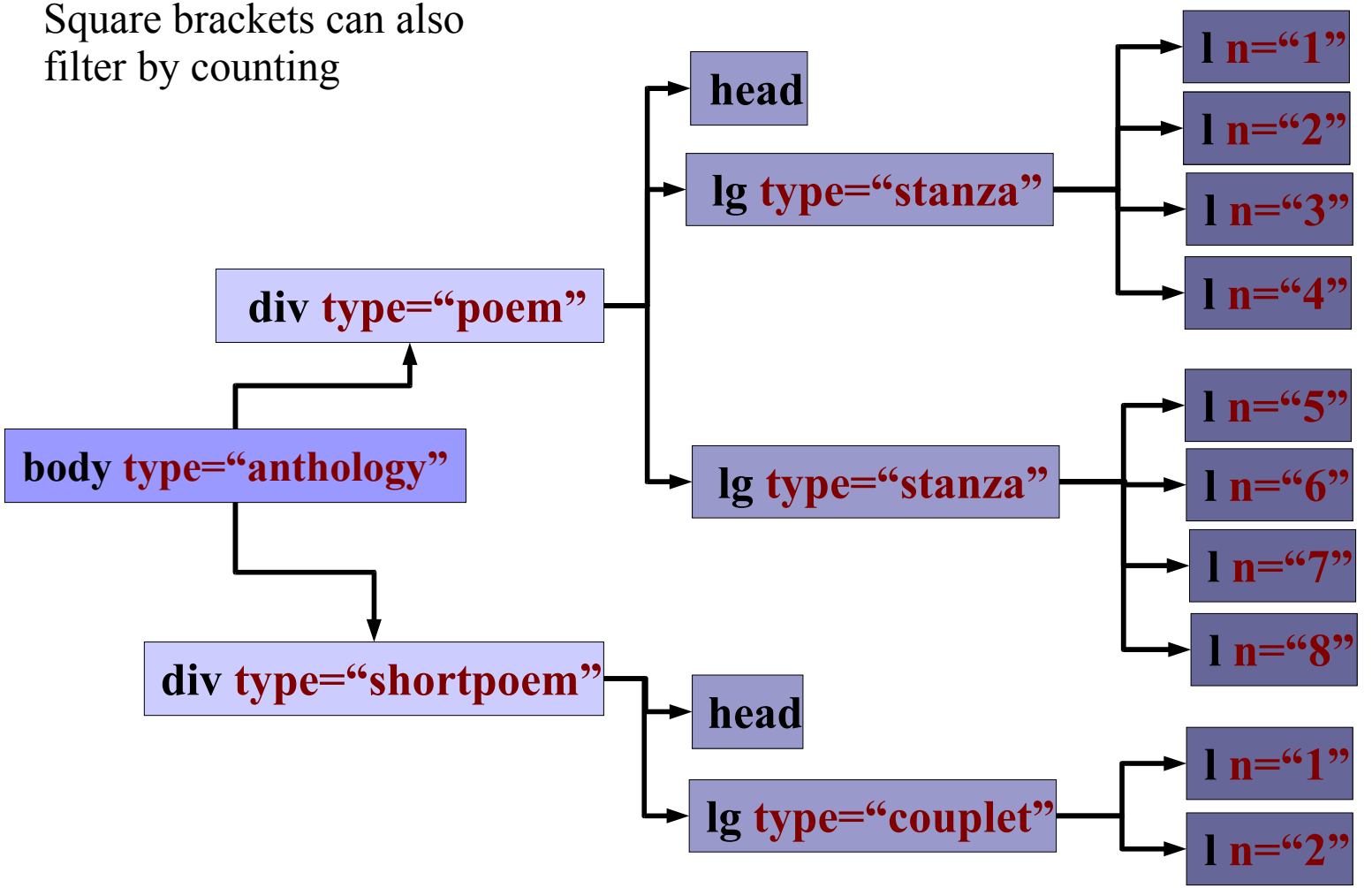


//div[@type="poem"]//l

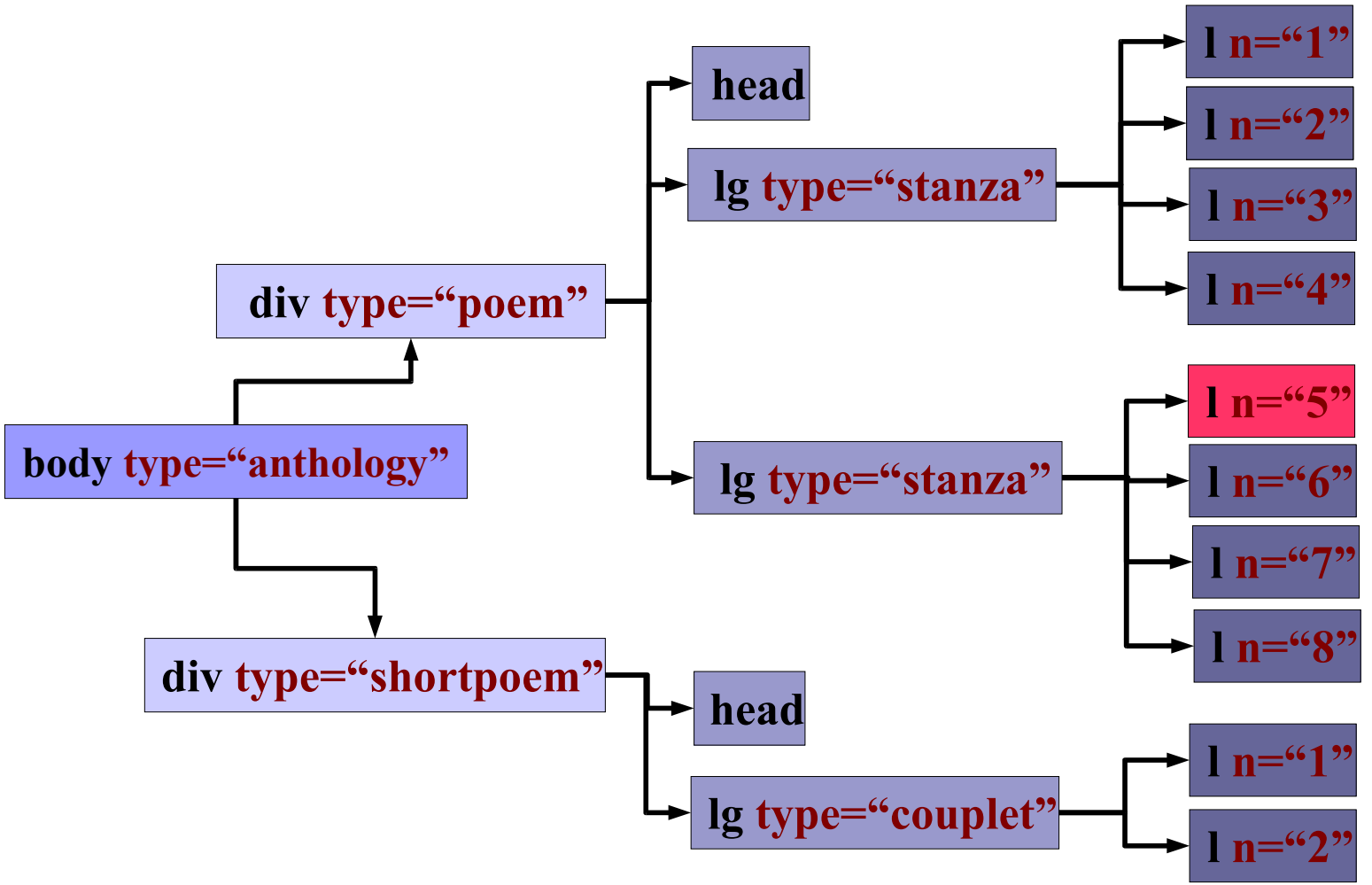


//l[5] ?

Square brackets can also filter by counting



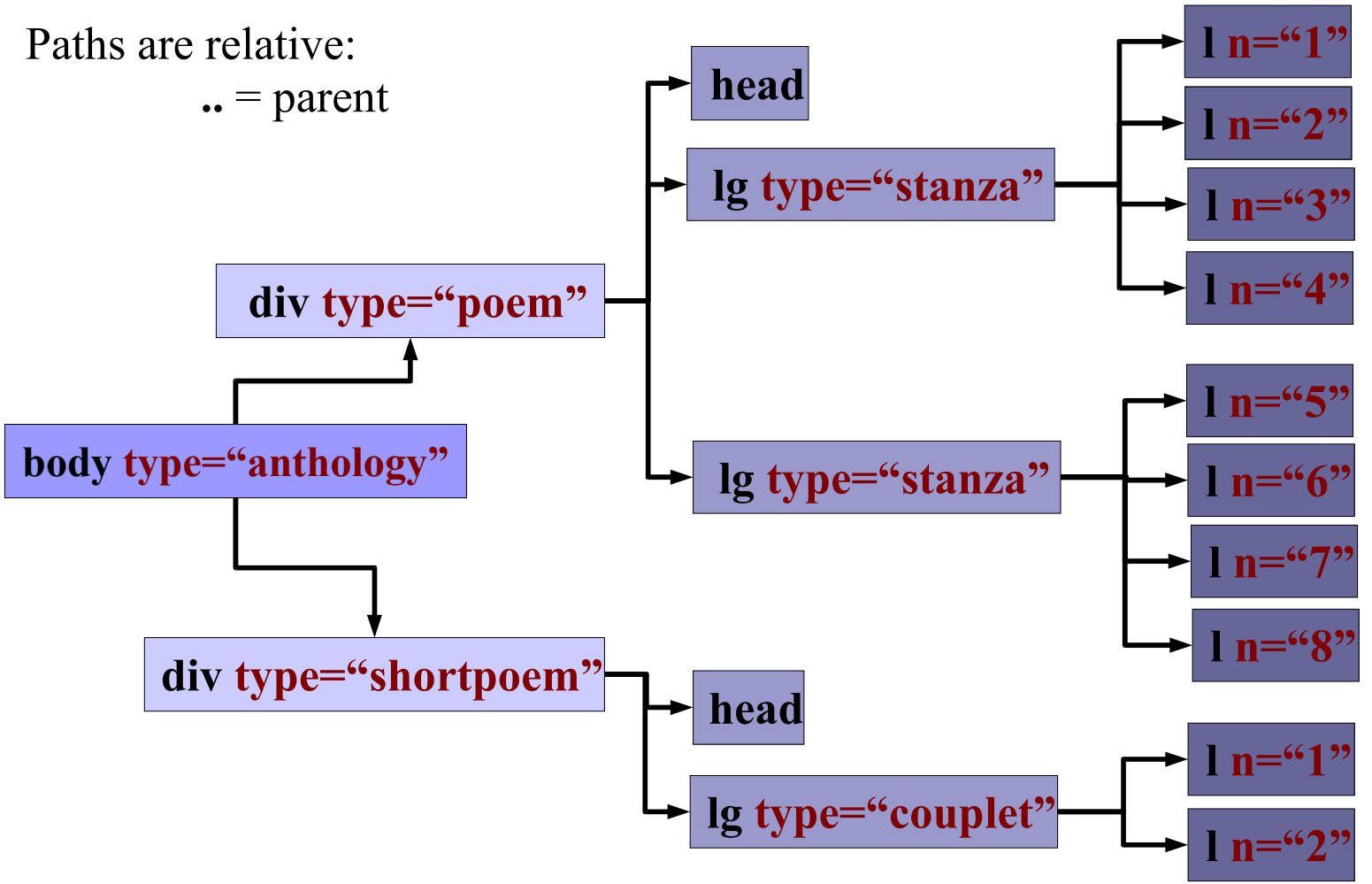
//l[5]


body type="anthology"
div type="poem"
head
lg type="stanza"
l n="1"
l n="2"
l n="3"
l n="4"
lg type="stanza"
l n="5"
l n="6"
l n="7"
l n="8"
div type="shortpoem"
head
lg type="couplet"
l n="1"
l n="2"

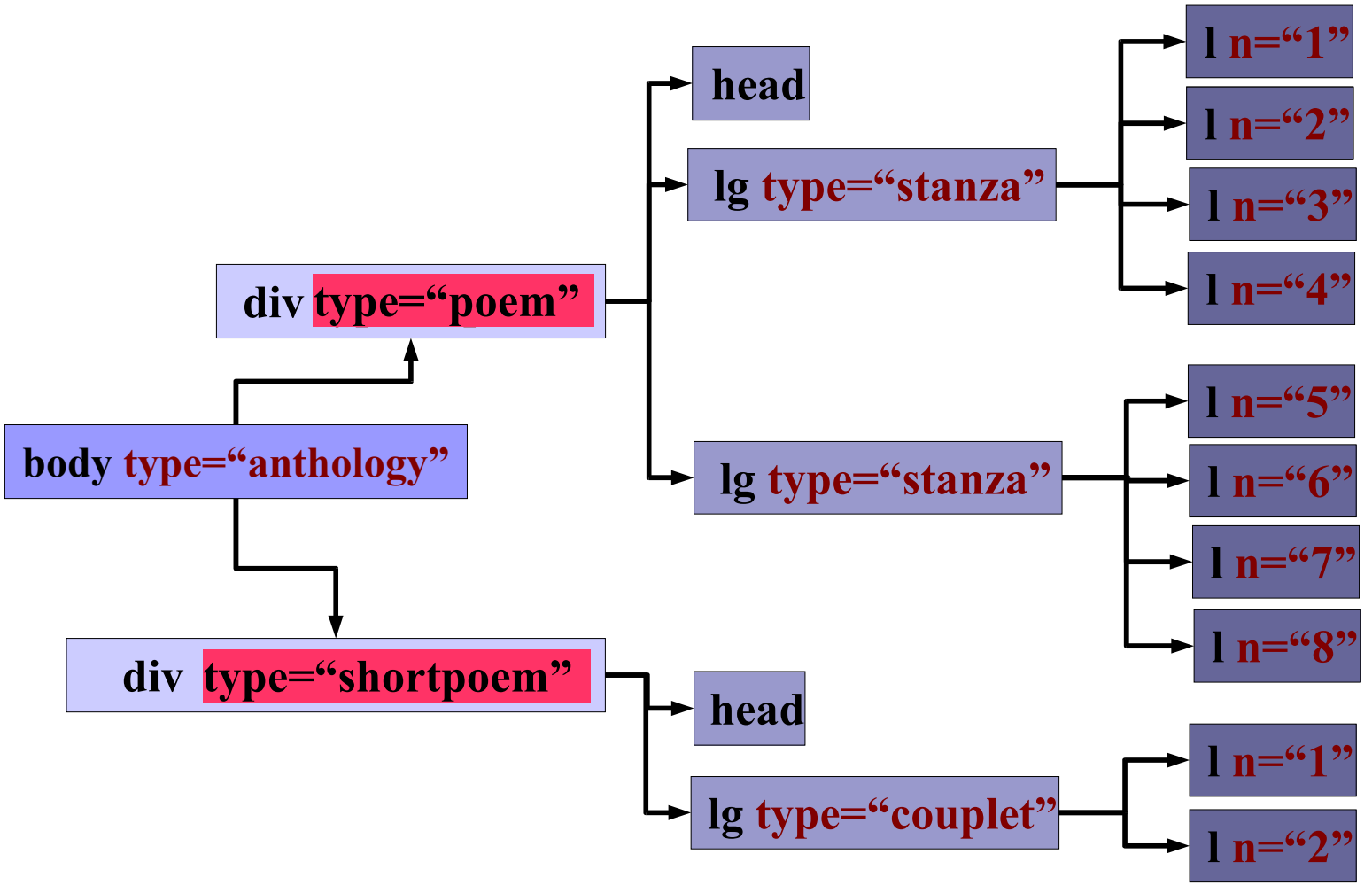
//lg/../@type ?

Paths are relative:

.. = parent

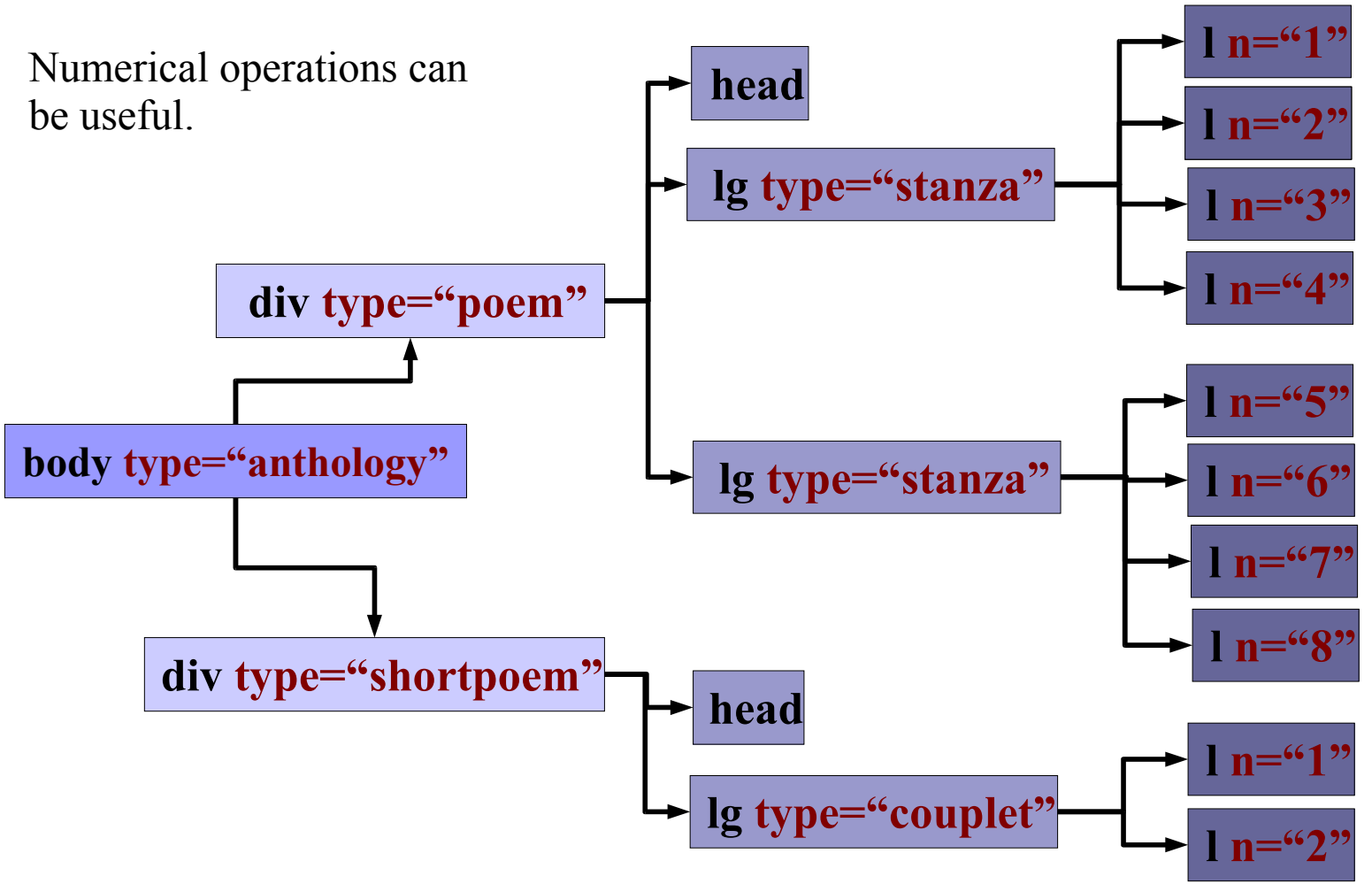


//lg/../@type

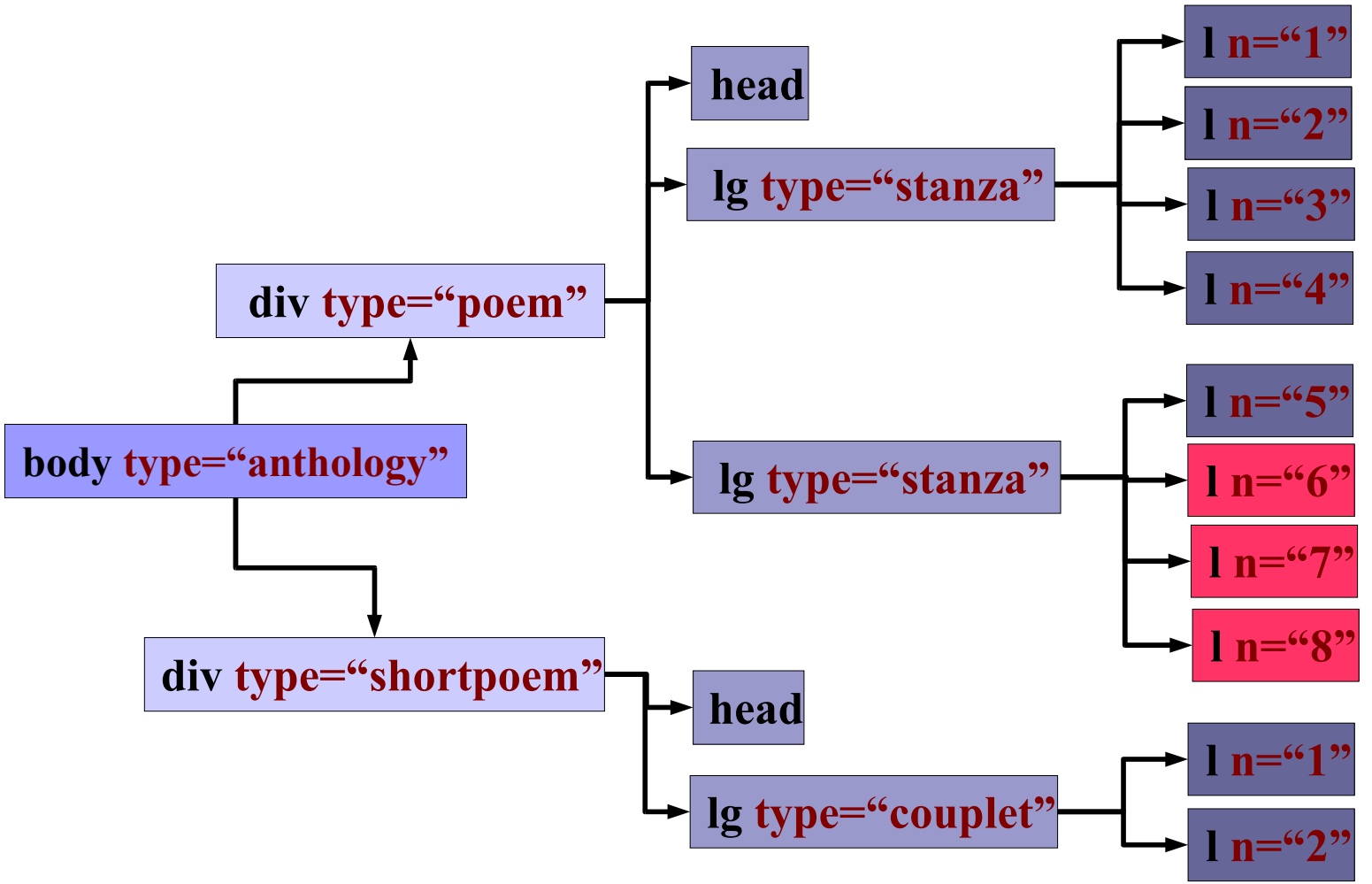

body type="anthology"
div type="poem"
head
lg type="stanza"
l n="1"
l n="2"
l n="3"
l n="4"
lg type="stanza"
l n="5"
l n="6"
l n="7"
l n="8"
div type="shortpoem"
head
lg type="couplet"
l n="1"
l n="2"

//l[@n > 5] ?

Numerical operations can be useful.

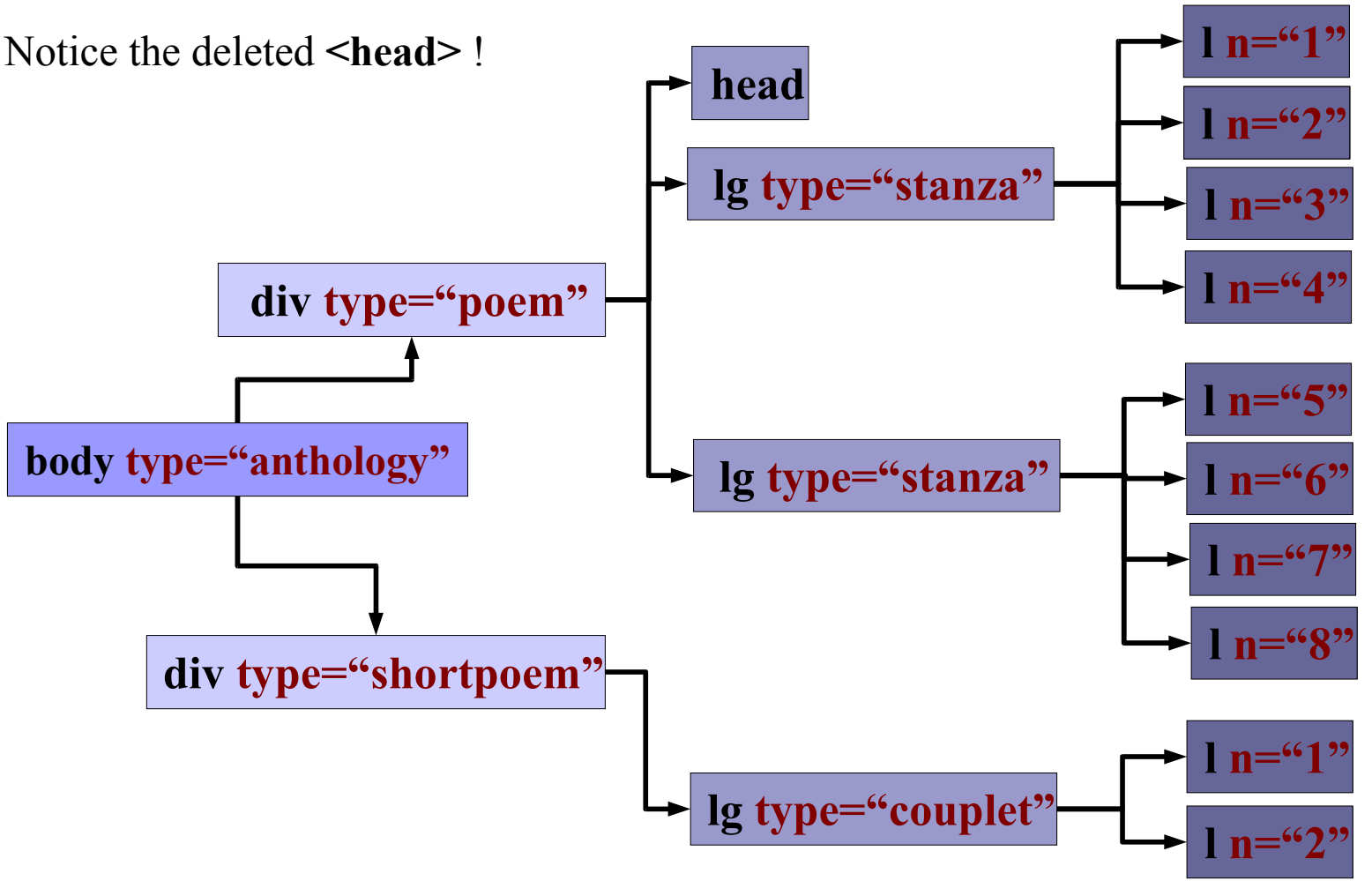


//l[@n > 5]

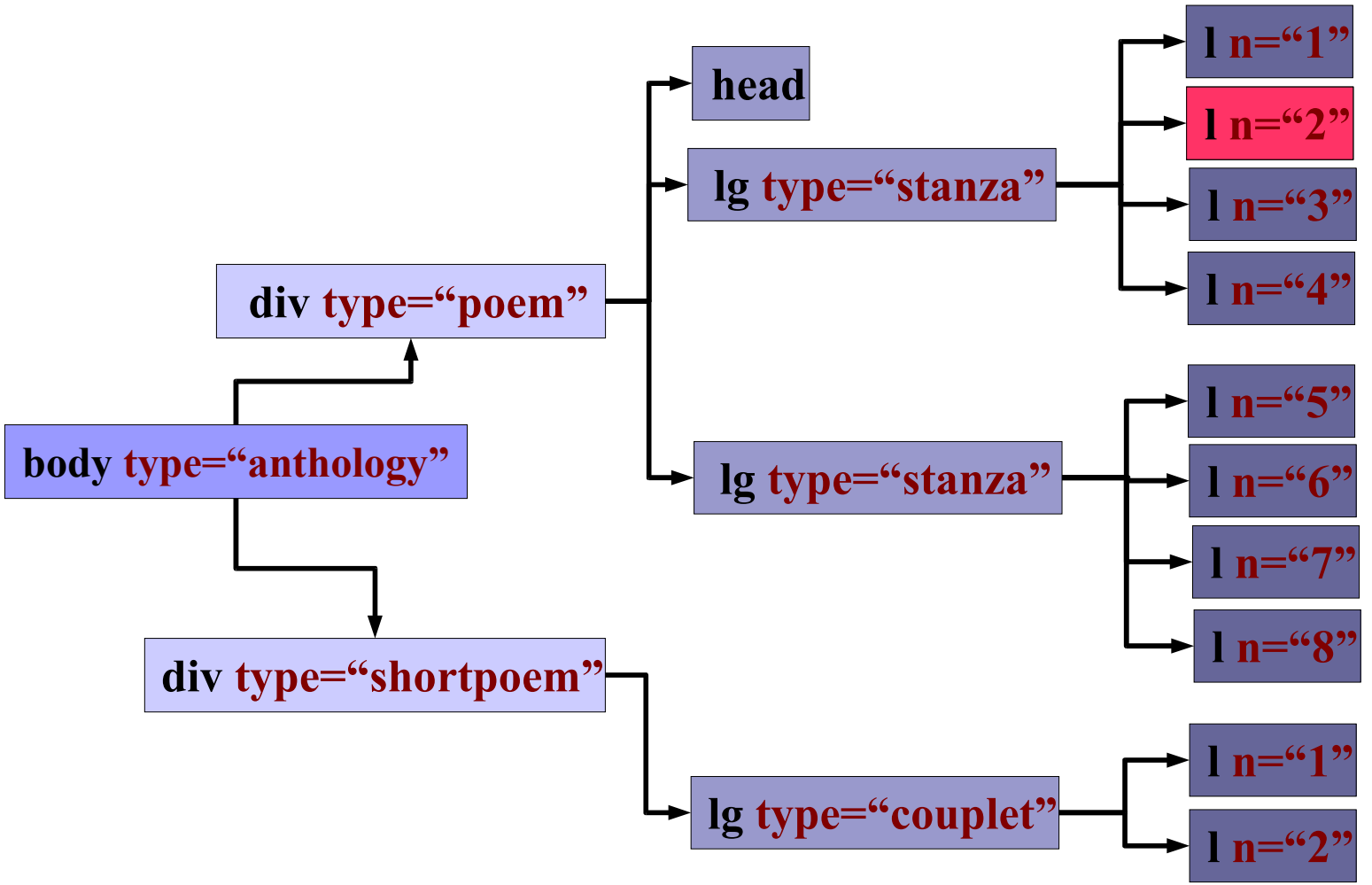

body type="anthology"
div type="poem"
head
lg type="stanza"
l n="1"
l n="2"
l n="3"
l n="4"
lg type="stanza"
l n="5"
l n="6"
l n="7"
l n="8"
div type="shortpoem"
head
lg type="couplet"
l n="1"
l n="2"

//div[head]/lg/l[@n="2"] ?

Notice the deleted **<head>** !

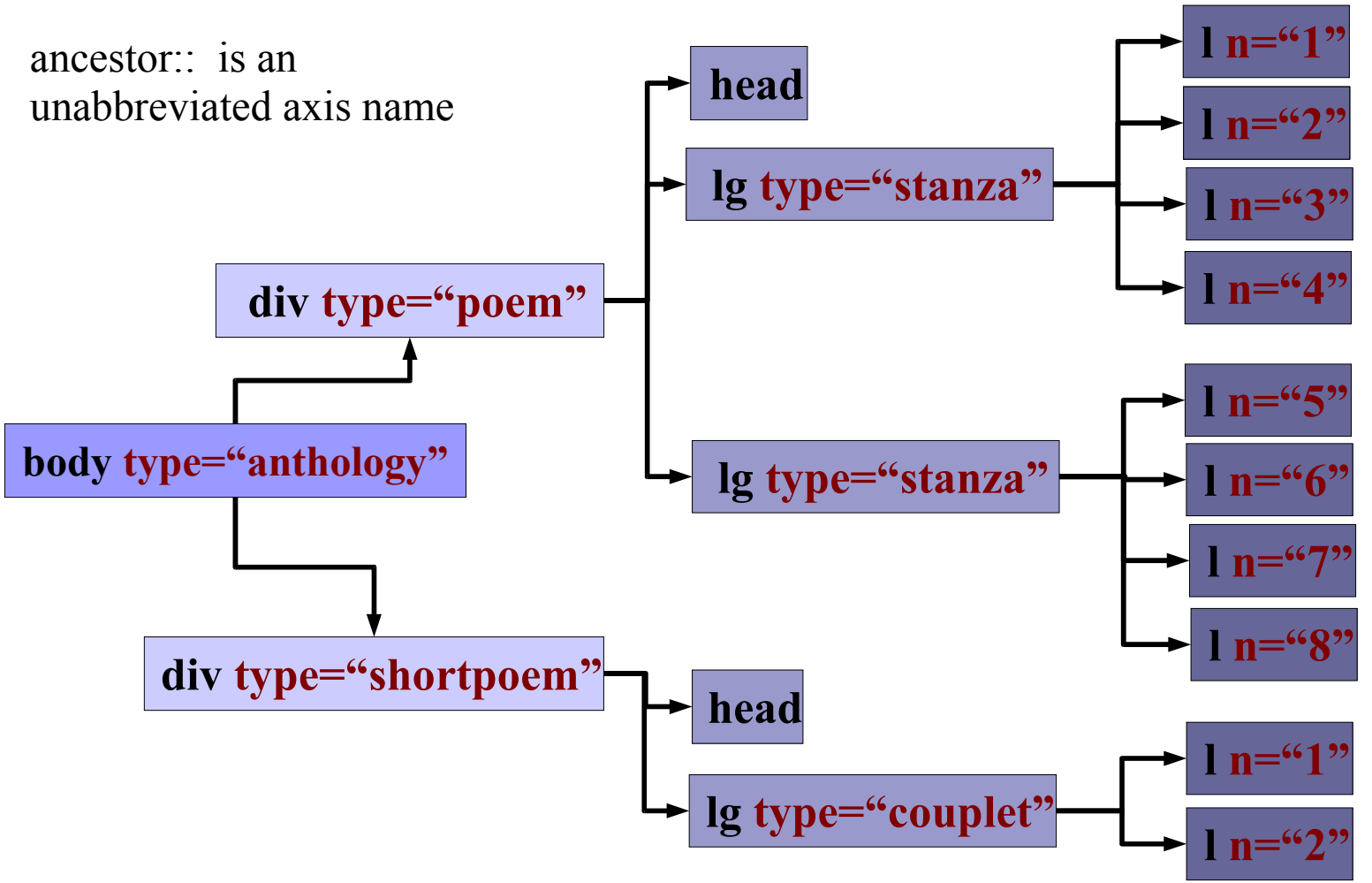


//div[head]/lg/l[@n="2"]

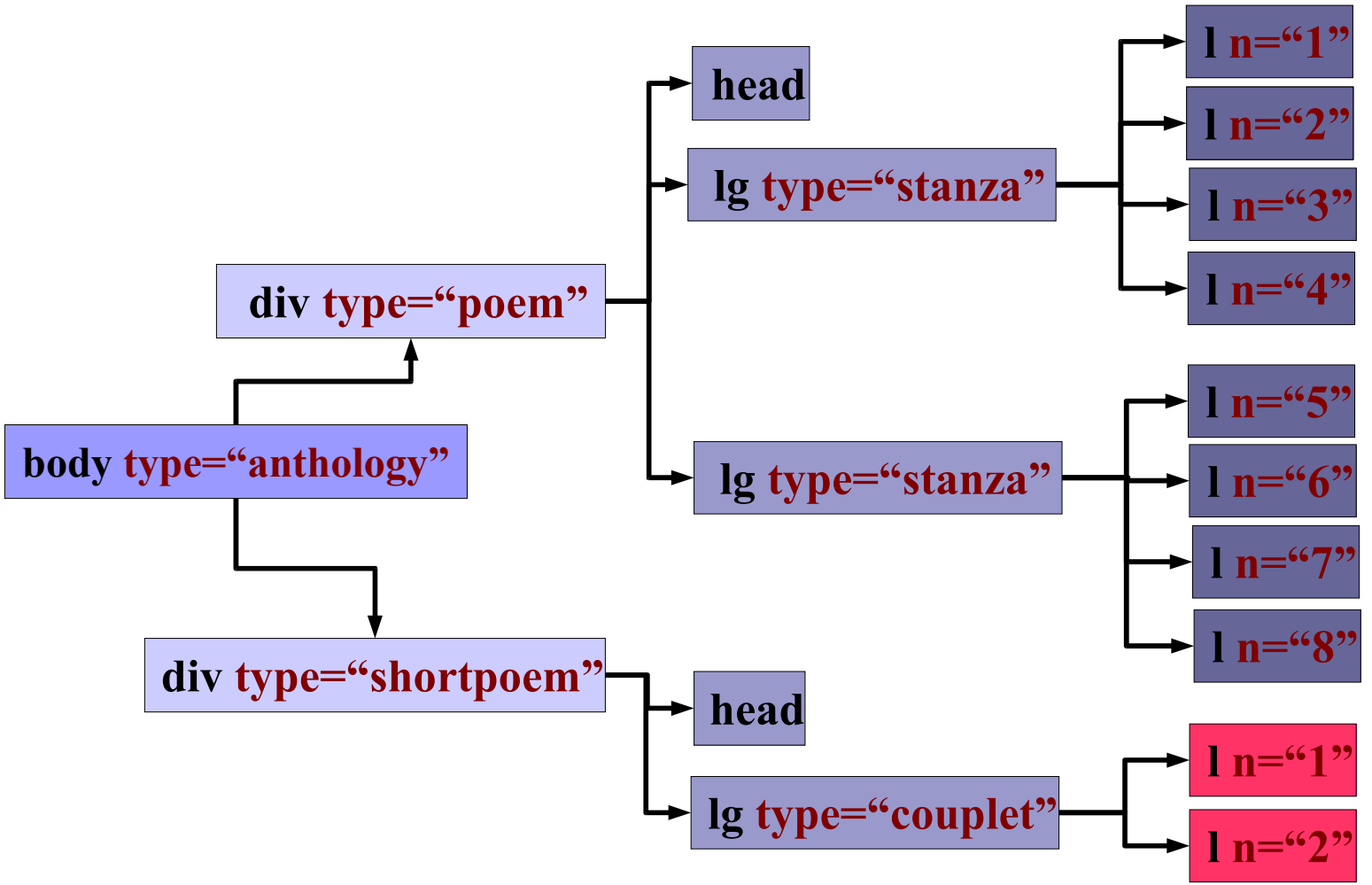


//l[ancestor::div/@type="shortpoem"] ?

ancestor:: is an unabbreviated axis name



//l[ancestor::div/@type="shortpoem"]



XPath: More About Paths

- A location path results in a node-set
- Paths can be absolute (`/div/lg[1]/l`)
- Paths can be relative (`l/../../head`)
- Formal Syntax: (`axisname::nodetest[predicate]`)
- For example:`child::div[contains(head, 'ROSE')]`

XPath: Axes

ancestor:: Contains all ancestors (parent, grandparent, etc.) of the current node

ancestor-or-self:: Contains the current node plus all its ancestors (parent, grandparent, etc.)

attribute:: Contains all attributes of the current node

child:: Contains all children of the current node

descendant:: Contains all descendants (children, grandchildren, etc.) of the current node

descendant-or-self:: Contains the current node plus all its descendants (children, grandchildren, etc.)

XPath: Axes (2)

following:: Contains everything in the document after the closing tag of the current node

following-sibling:: Contains all siblings after the current node

parent:: Contains the parent of the current node

preceding:: Contains everything in the document that is before the starting tag of the current node

preceding-sibling:: Contains all siblings before the current node

self:: Contains the current node

Axis examples

- `ancestor::lg` = all `<lg>` ancestors
- `ancestor-or-self::div` = all `<div>` ancestors or current
- `attribute::n` = n attribute of current node
- `child::l` = `<l>` elements directly under current node
- `descendant::l` = `<l>` elements anywhere under current node
- `descendant-or-self::div` = all `<div>` children or current
- `following-sibling::l[1]` = next `<l>` element at this level
- `preceding-sibling::l[1]` = previous `<l>` element at this level
- `self::head` = current `<head>` element

XPath: Predicates

- `child::lg[attribute::type='stanza']`
- `child::l[@n='4']`
- `child::div[position()=3]`
- `child::div[4]`
- `child::l[last()]`
- `child::lg[last()-1]`

XPath: Abbreviated Syntax

- nothing is the same as `child::`, so `lg` is short for `child::lg`
- @ is the same as `attribute::`, so `@type` is short for `attribute::type`
- . is the same as `self::`, so `./head` is short for `self::node()/child::head`
- .. is the same as `parent::`, so `../lg` is short for `parent::node()/child::lg`
- // is the same as `descendant-or-self::`, so `div//l` is short for `child::div/descendant-or-self::node()/child`

XPath: Operators

XPath has support for numerical, equality, relational, and boolean expressions

+	Addition	3 + 2 = 5
-	Subtraction	10 - 2 = 8
*	Multiplication	6 * 4 = 24
div	Division	8 div 4 = 2
mod	Modulus	5 mod 2 = 1
=	Equal	@age = '74'
or	Boolean OR	@age = '74' or @age = '64'

XPath: Operators (cont.)

<	Less than	@age < '84'	True
!=	Not equal	@age != '74'	False
<=	Less than or equal	@age <= '72'	False
>	Greater than	@age > '25'	True
>=	Greater than or equal	@age >= '72'	True
and	Boolean AND	@age <= '84' and @age > '70'	True

XPath Functions: Node-Set Functions

- `count()` Returns the number of nodes in a node-set: `count(person)`
- `id()` Selects elements by their unique ID : `id('S3')`
- `last()` Returns the position number of the last node : `person[last()]`
- `name()` Returns the name of a node: `//*[name('person')]`
- `namespace-uri()` Returns the namespace URI of a specified node: `namespace-uri(persName)`
- `position()` Returns the position in the node list of the node that is currently being processed : `//person[position()=6]`

XPath Functions: String Functions

- `concat()` Concatenates its arguments: `concat('http://', $domain, '/', $file, '.html')`
- `contains()` Returns true if the second string is contained within the first string: `//persName[contains(surname, 'van')]`
- `normalize-space()` Removes leading and trailing whitespace and replaces all internal whitespace with one space: `normalize-space(surname)`
- `starts-with()` Returns true if the first string starts with the second: `starts-with(surname, 'van')`
- `string()` Converts the argument to a string: `string(@age)`

XPath Functions: String Functions (2)

- `substring` Returns part of a string of specified start character and length: `substring(surname, 5,4)`
- `substring-after()` Returns the part of the string that is after the string given: `substring-after(surname, 'De')`
- `substring-before` Returns the part of the string that is before the string given: `substring-before(@date, '-')`
- `translate()` Performs a character by character replacement. It looks at the characters in the first string and replaces each character in the first argument by the corresponding one in the second argument: `translate('1234', '24', '68')`

XPath Functions: Numeric Functions

- `ceiling()` Returns the smallest integer that is not less that the number given: `ceiling(3.1415)`
- `floor()` Returns the largest integer that is not greater than the number given: `floor(3.1415)`
- `number()` Converts the input to a number: `number('100')`
- `round()` Rounds the number to the nearest integer: `round(3.1415)`
- `sum()` Returns the total value of a set of numeric arguments: `sum(//person/@age)`
- `not()` Returns true if the condition is false: `not(position() >5)`

XPath: Where can I use XPath?

Learning all these functions, though a bit tiring to begin with, can be very useful as they are used throughout XML technologies, but especially in XSLT and XQuery.

Namespaces

- The Namespace of an element is the scope within which it is valid.
- Elements without Namespaces may collide when we combine bits of multiple documents together (e.g. tei:div vs. html:div). XML Namespaces enable use of other schemas within yours.
- An XML Namespace is identified by a URI reference.
- XML Namespaces prefixes are separated from element names by a single colon. The prefix is mapped to a URI. (e.g. `tei:teiHeader`, `svg:line`, `html:p`)
- Child elements inherit the namespace declaration of their parents.
- The current TEI namespace is `http://www.tei-c.org/ns/1.0`

Namespaced XML


```
<TEI xmlns="http://www.tei-c.org/ns/1.0">
    <teiHeader><!-- lots omitted --></teiHeader>
    <text>
      <body>
<div xml:lang="en" xml:id="abc123">
  <p>Some scientific text with a formula:
  <formula notation="MathML">
    <math xmlns="http://www.w3.org/1998/Math/MathML">
      <mi>x</mi><mo>=</mo><mn>2</mn><mi>a</mi>
    </math>
  </formula>
  </p>
</div>
    </body>
    </text>
  </TEI>
```

XPath Queries with Namespaces

- Declare the namespace
- All element names must use namespace prefix
- XQuery interface allows comments and limiting to collection or document

```
(: This is a comment :)
declare namespace tei="http://www.tei-c.org/ns/1.0";
collection('/db/pc')//tei:person[@sex='2']/
    tei:persName/tei:surname
```

Practice Data: Protestant Cemetery

- Data we will be querying comes from a collection of stone information and transcriptions from the Protestant Cemetery of Rome
- Root element is `<teiCorpus>` with each stone being contained as a `<TEI>` inside that
- Each stone contains its own `<teiHeader>` which contains a `<particDesc>` with one or more `<person>`element
- The `<teiHeader>` also contains a description of the stone
- Inside the `<body>` element there is one `<div>` for each inscription on the stone

Stone Example (1)

A sample <person> record:

```
<person sex="2" age="17">
 <persName>
  <forename>Sarah</forename>
  <surname>Barnard</surname>
 </persName>
 <birth date="1800-01-04">
  <placeName>
   <settlement>Madeira</settlement>
   <country>Portugal</country>
  </placeName>
 </birth>
 <death date="1817-08-24">
  <placeName>
   <settlement>Rome</settlement>
   <country>Italy</country>
  </placeName>
 </death>
 <nationality target="#GB"/>

</person>
```

Stone Example (2)

A sample stone text:

```
<div lang="en">
 <ab>THIS STONE</ab>
 <ab>IS DEDICATED TO THE MEMORY OF</ab>
 <ab>SARAH BARNARD</ab>
 <ab>THE BELOVED DAUGHTER OF</ab>
 <ab>WILLIAM HENRY BARNARD</ab>
 <ab>CLERK, LL B OF THE UNIVERSITY OF OXFORD</ab>
 <- some text omitted ->
 <ab>SHE WAS BORN AT THE</ab>
 <ab>ISLAND OF MADEIRA</ab>
 <ab>JANUARY 4<hi rend="sup">TH</hi> 1800.</ab>
 <ab>AND DIED AT ROME</ab>
 <ab>AUGUST 24 1817.</ab>
 <ab>IN THE 18.  YEAR OF HER AGE.</ab>

</div>
```

eXist: Looking for words

We are going to be using the eXist native XML Database for our XPath and XQuery exercises. It has some useful text searching capabilities. For example:

```
//tei:div[. &= 'loving wife']
```

will find paragraphs containing both the words `loving` and `wife` (in either order anywhere in the `<div>`), and is rather easier to type than the equivalent xpath:

```
//tei:div[contains(.,'loving') and contains(.,'wife')]
```

In eXist you can also do a proximity search:

```
//tei:div[near(.,'loving wife',20)]
```

as well as stem matching:

```
//tei:div[. &= 'lov* wife']
```

eXist Operator Extensions

- &= searches as a boolean AND – all keywords must exist
- |= searches as a boolean OR – either keyword must exist

Using the eXist Basic XQuery Interface

- eXist is running in memory off the TEI Knoppix CD
- From the initial web page click on ' eXist XQuery Interface' link
- http://localhost:8080/cocoon/exist/xquery/xquery.xq
- From this web-form you can submit XPath and XQuery searches to the database and see the XML results
- In submitting a query, using your browser 'back' button allows you to re-edit, while 'New Query' link saves search to the 'Query History'

Example XPath Query


```
(: Find Beloved Sons :)
declare namespace tei="http://www.tei-c.org/ns/1.0";
collection('/db/pc')//tei:body[near(.,'beloved son', 15)]
```

Another XPath Query


```
(: Beloved and Son Profiles :)
declare namespace tei="http://www.tei-c.org/ns/1.0";
collection('/db/pc')//tei:TEI[.//tei:body &= 'beloved son']
  //tei:profileDesc
```

And on to the XPath Exercises

- You have been provided with some XPath exercises to try out some of these concepts for yourself
- Raise your hand if you need some help
- You don't have to finish all of them
- If you do, experiment with other XPath queries