XIRQL: Eine Anfragesprache für Information Retrieval in XML-Dokumenten

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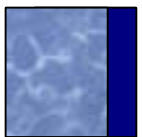
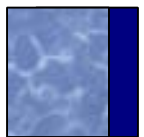
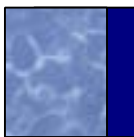
Universität Duisburg

Outline of Talk

I. XML retrieval

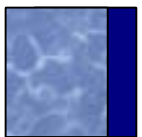
II. XIRQL: XML IR Query Language

III. XIRQL vs. XQuery

IV. User Interface

V. INEX: Initiative for the Evaluation of XML Retrieval

VI. Summary



I. XML documents

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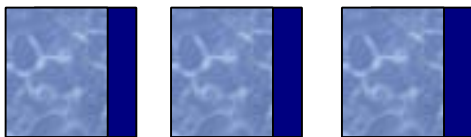
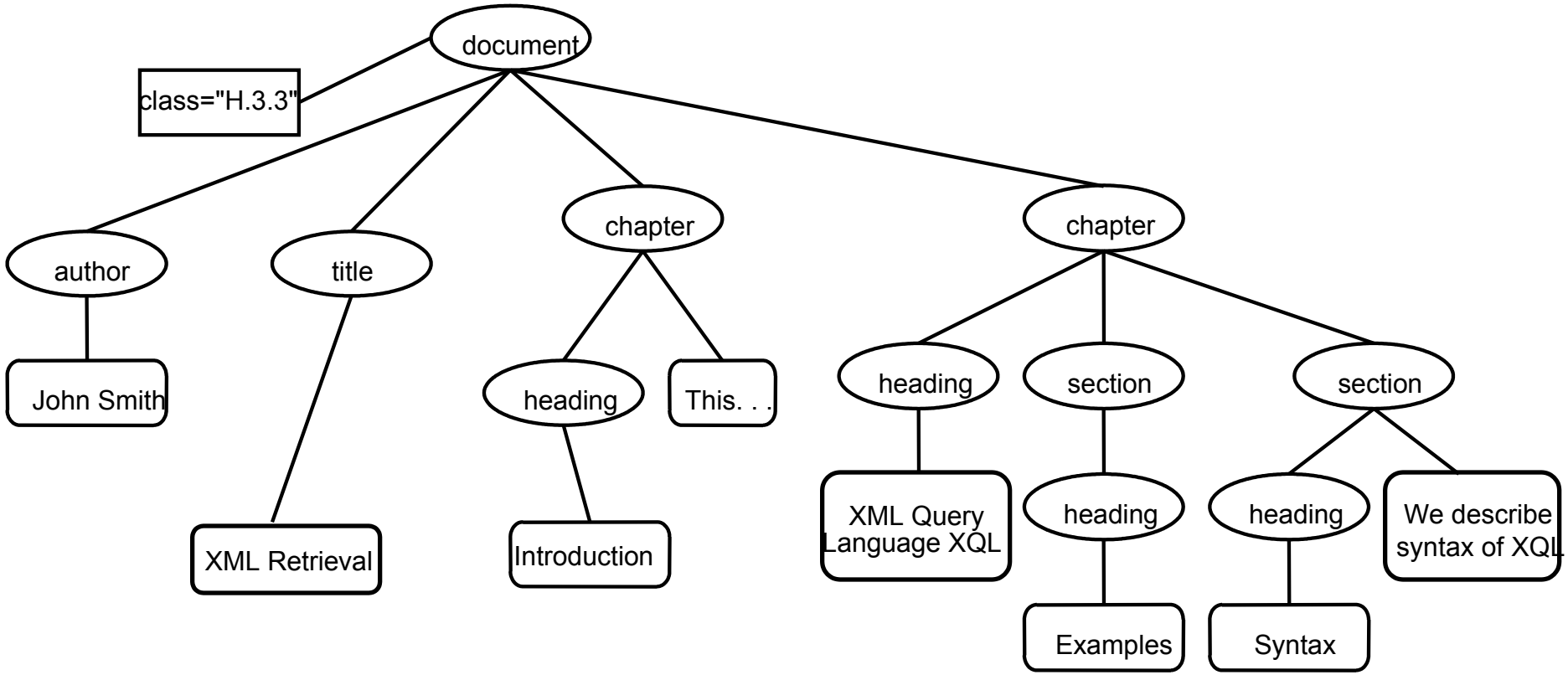
  <author>John Smith</author>
  <title>XML Retrieval</title>
  <chapter> <heading>Introduction</heading>
    This text explains all about XML and IR.
  </chapter>
  <chapter>
    <heading> XML Query Language XQL </heading>
    <section>
      <heading>Examples</heading>
    </section>
    <section>
      <heading>Syntax</heading>
      Now we describe the XQL syntax.
    </section>
  </chapter>
</book>
```

Elements:

- start tag
- end tag
- content
- attribute



Tree view


document
class="H.3.3"
author
title
chapter
chapter
John Smith
XML Retrieval
heading
This. . .
Introduction
heading
section
section
XML Query Language XQL
heading
heading
We describe syntax of XQL
Examples
Syntax

XML query languages

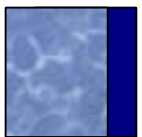
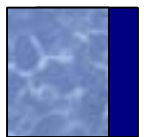
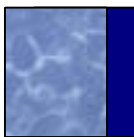
- **Data-centric view:** XML as exchange format for structured data
- **Document-centric view:** XML as format for representing the logical structure of documents

W3C WG proposal for XML query language: **XQuery**

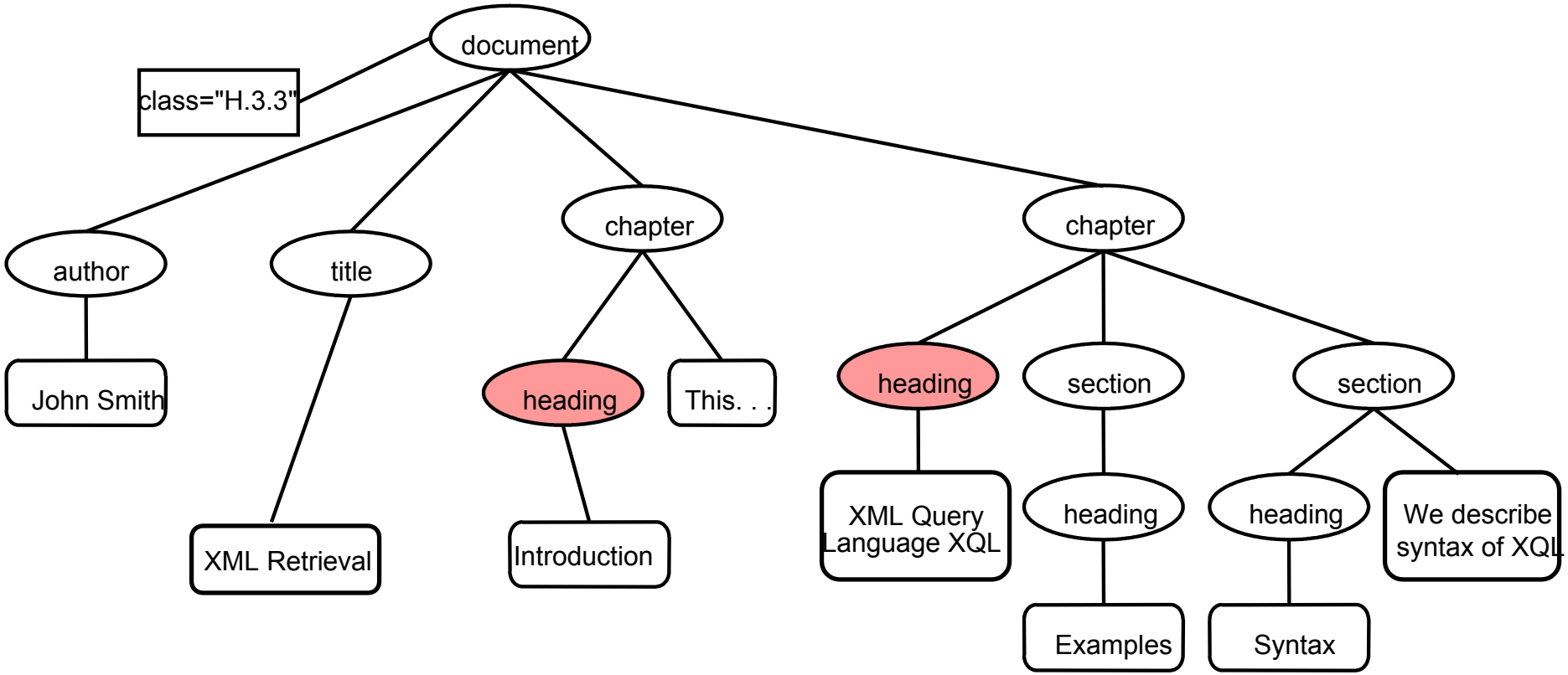
Focuses on data-centric view

here:

- Information Retrieval for document-centric view
- Starting point: XPath (XQL)

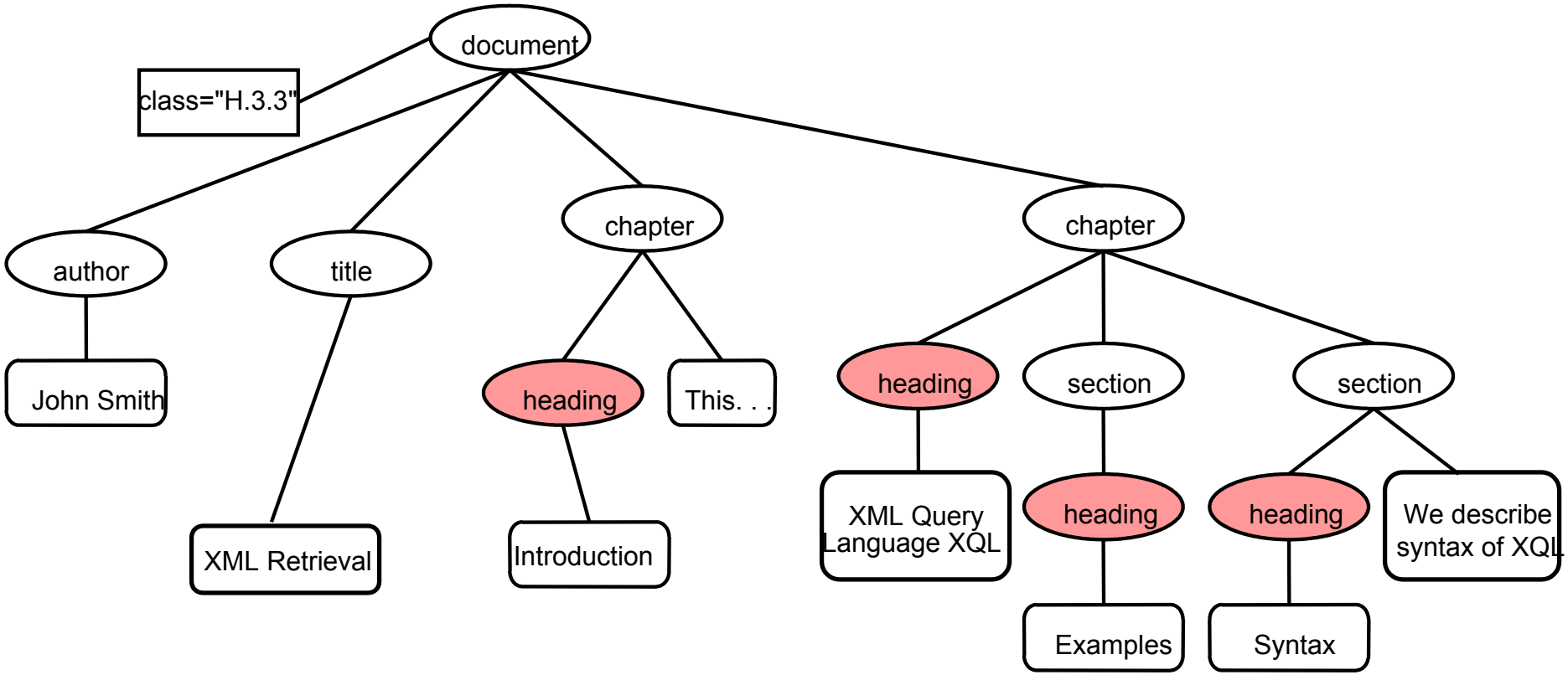




XPath



Path condition: parent/child node chapter/heading

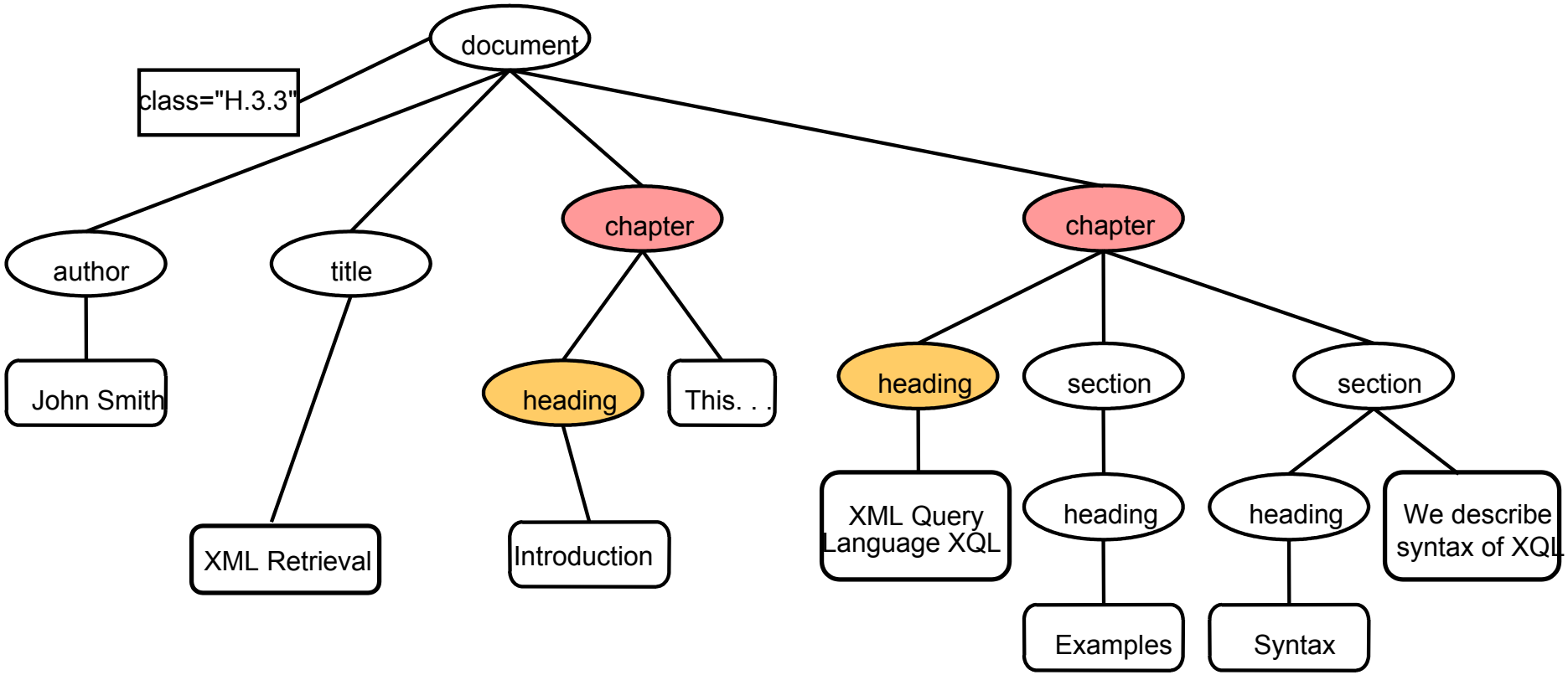
XPath



Path condition: ancestor-descendant

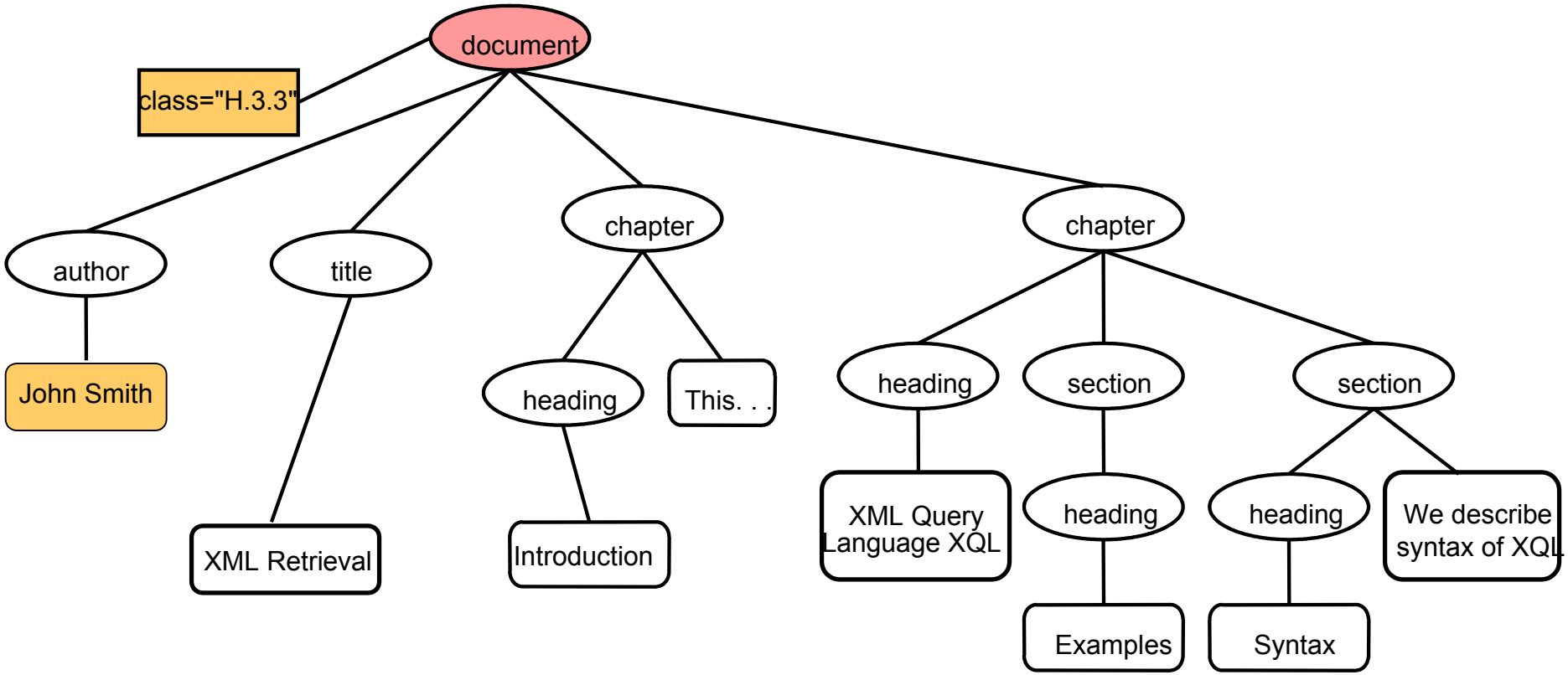
chapter//heading

XPath



Filter wrt. structure:
//chapter[heading]

XPath

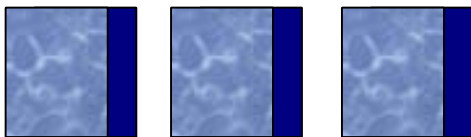


Filter wrt. content:

/document[@class="H.3.3" ∧ author="John Smith"]

XPath properties

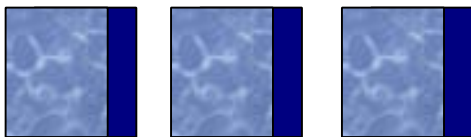
- ✓ Conditions wrt. logical structure
- ✓ Conditions wrt. content
- ✓ Results are arbitrary (complete) elements of the original documents
- - Boolean Retrieval (poor retrieval quality)
- - Relevance-oriented search (irrespective of structure) not supported
- - Few data types only



II. XIRQL: XML IR Query Language

Extend XPath by:

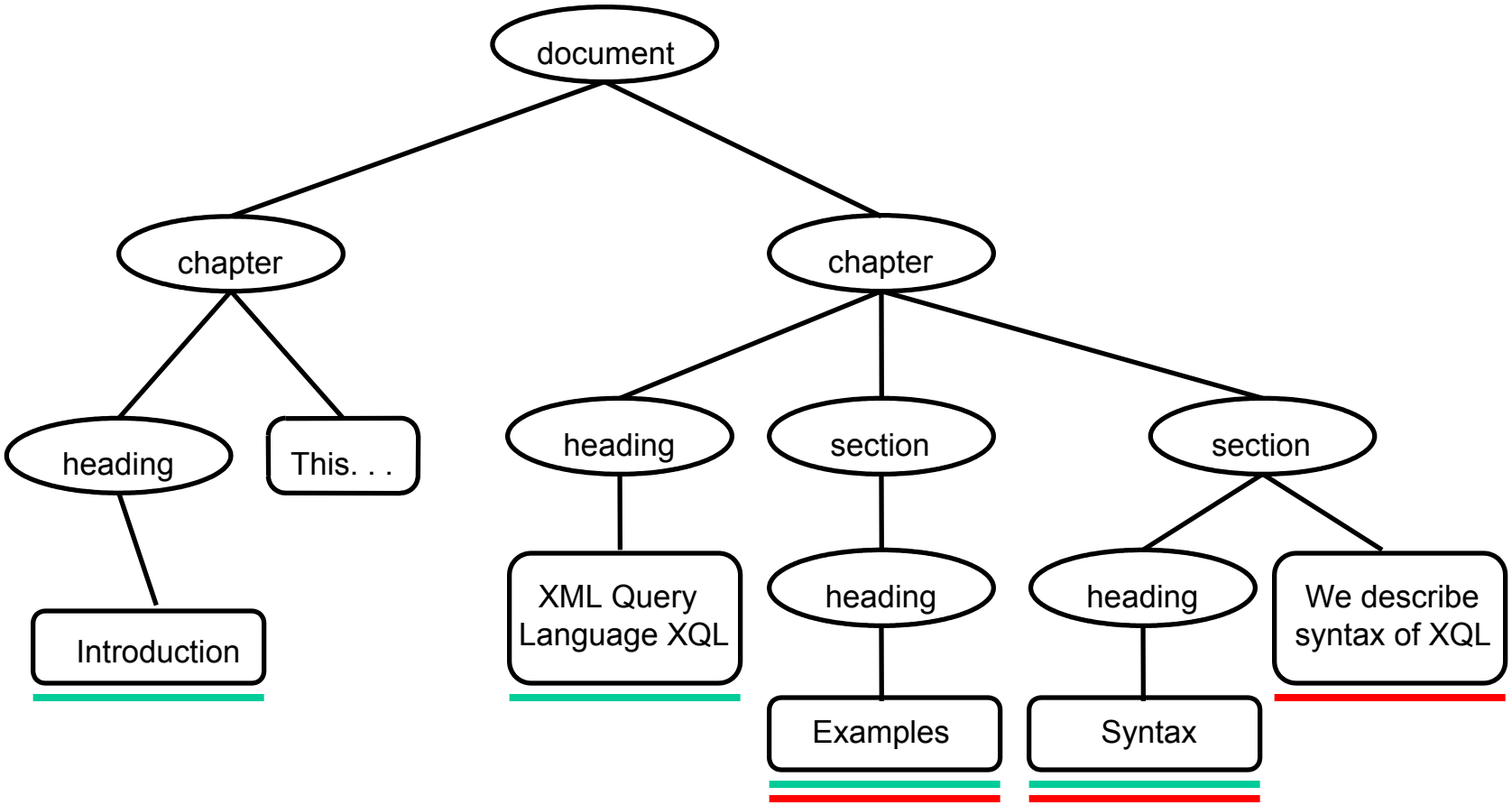
- Probabilistic retrieval with weighted document indexing
- Relevance-oriented search (irrespective of structure)
- (Extensible) data types with vague predicates
- Structural relativism



II.1 Probabilistic Retrieval with XIRQL

Problem: weighting of different forms of occurrence of terms

/document[.//heading ə "XML" ∨ .//section//* ə "XML"]



Weighting of term occurrences in documents

a) Weighting wrt. single query conditions

P(.//heading э "XML“,d) = 0.5

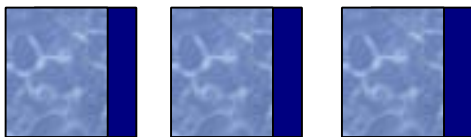
P(.//section//* э "XML“,d) = 0.7

→ Possible overlapping of query conditions

→ Dependent probabilistic events

→ Only probability intervals for answers

→ No linear ranking of documents



Weighting of term occurrences in documents

b) Weighting wrt. document parts

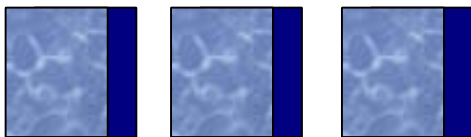
→ Term weighting depends on context of term occurrence

→ All occurrences within same context refer to same probabilistic event

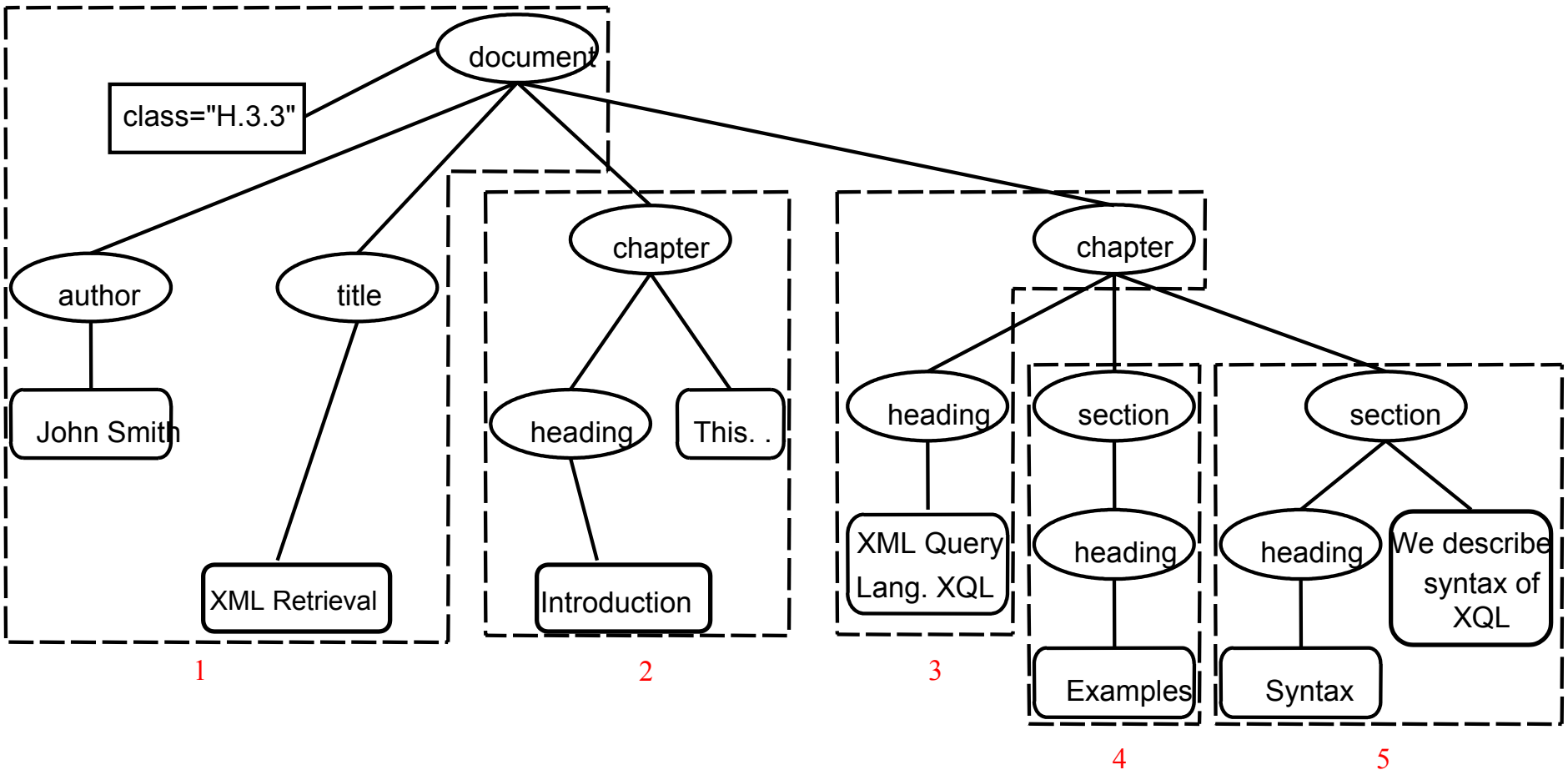
→ Only identical and independent events

→ Point probabilities for answers

→ Linear ranking of documents



Index nodes as units for term weighting

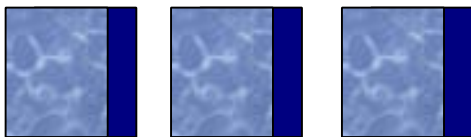


Application of known indexing functions (e.g. tf*idf)

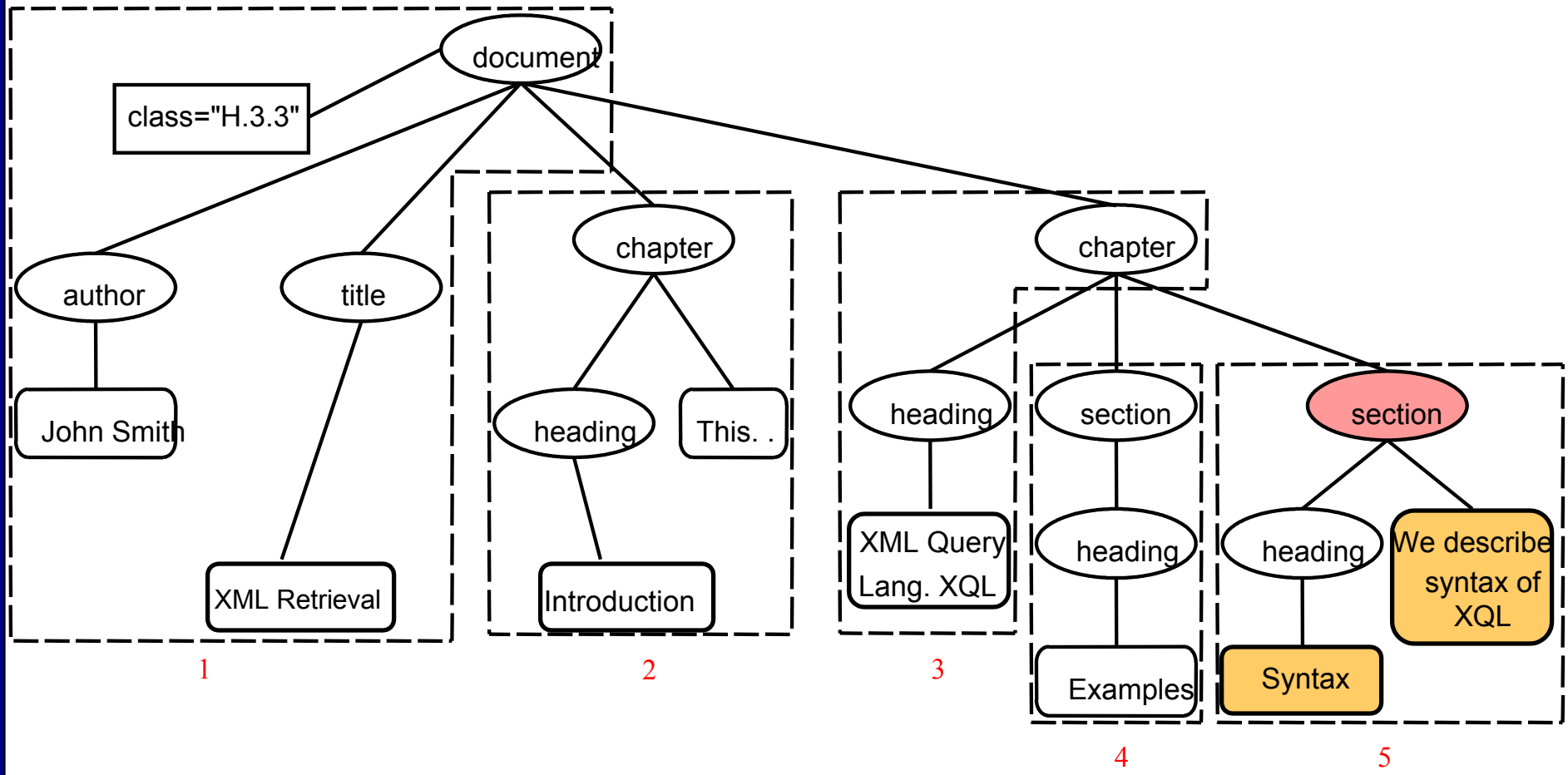
Probabilistic events and event expressions

Problem: combination of term weights consistent with probability theory

- *Basic event:* term occurrence in an index node
- Basic events are independent (different terms, same term in different index nodes)
- *Event expressions* describe combination of basic events in a document wrt. a query



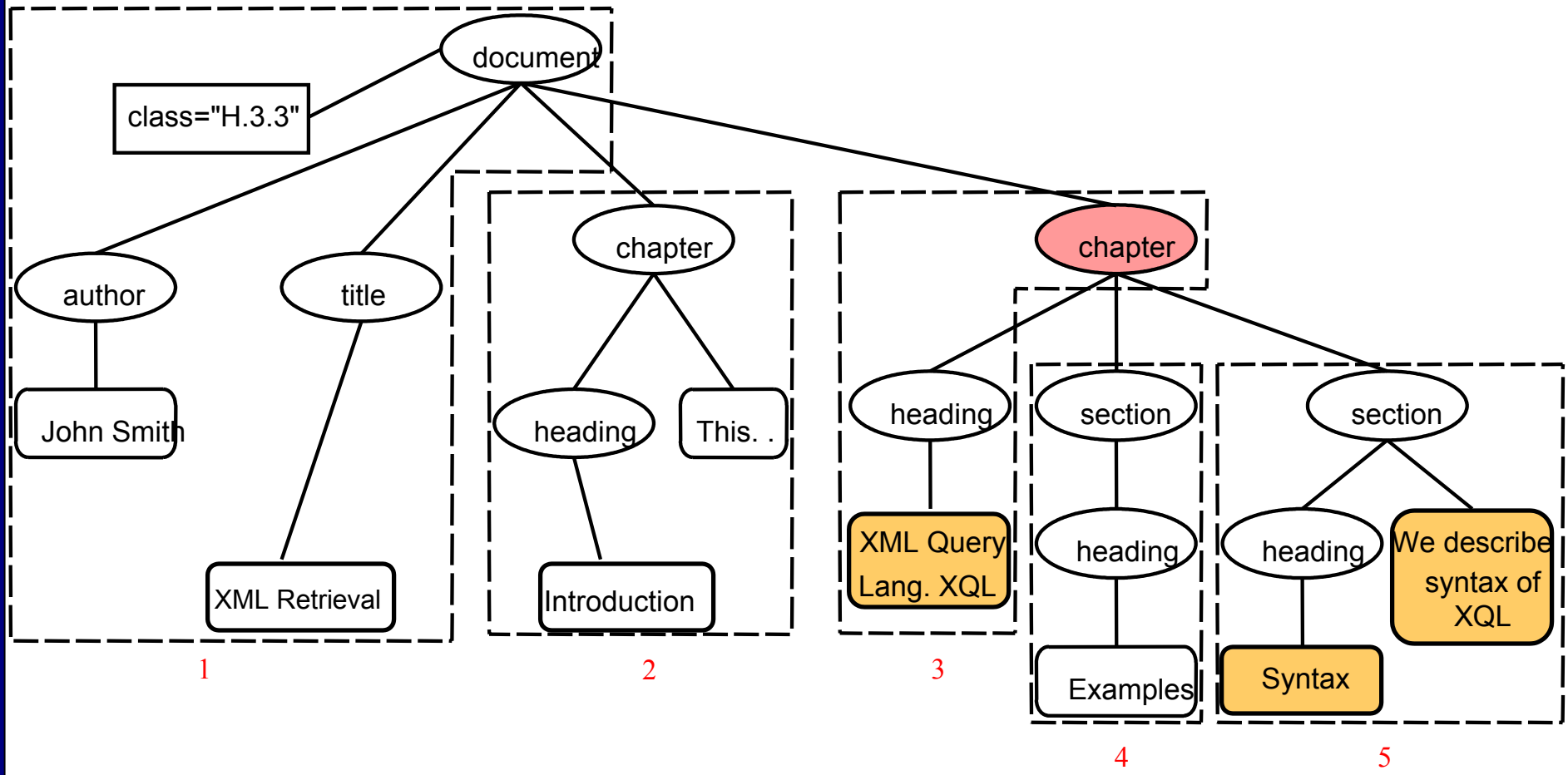
Event expressions



//section[.//* ∋ "XQL" ∧ .//* ∋ "syntax"]

[5,XQL] ∧ [5,syntax]

Event expressions



/document/chapter [.//* ∋ "XQL" ∧ .//* ∋ "syntax"]

([3,XQL] ∨ [5,XQL]) ∧[5,syntax]

Evaluation of event expressions

(as in probabilistic Datalog)

1. Transform event expression into disjunctive normal form

   $e = C_1 \vee \ldots \vee C_n$

   C_i: Conjunction of event atoms

   Event atom: positive or negated basic event

2. Application of inclusion/exclusion formula:

$$P(e) = P(C_1 \vee \ldots \vee C_n)$$

$$P(e) = \sum_{i=1}^{n} (-1)^{i-1} \left(\sum_{1 \le j_1 < \ldots < j_i \le n} P(C_{j1} \wedge \ldots \wedge C_{ji}) \right)$$

II.2 Relevance-oriented search

(Queries irrespective of document structure)

1) Restrict possible answers

   (not all elements suitable)

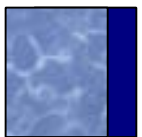
2) Retrieval strategy: return most specific element satisfying the query

but: combination with weighted indexing?

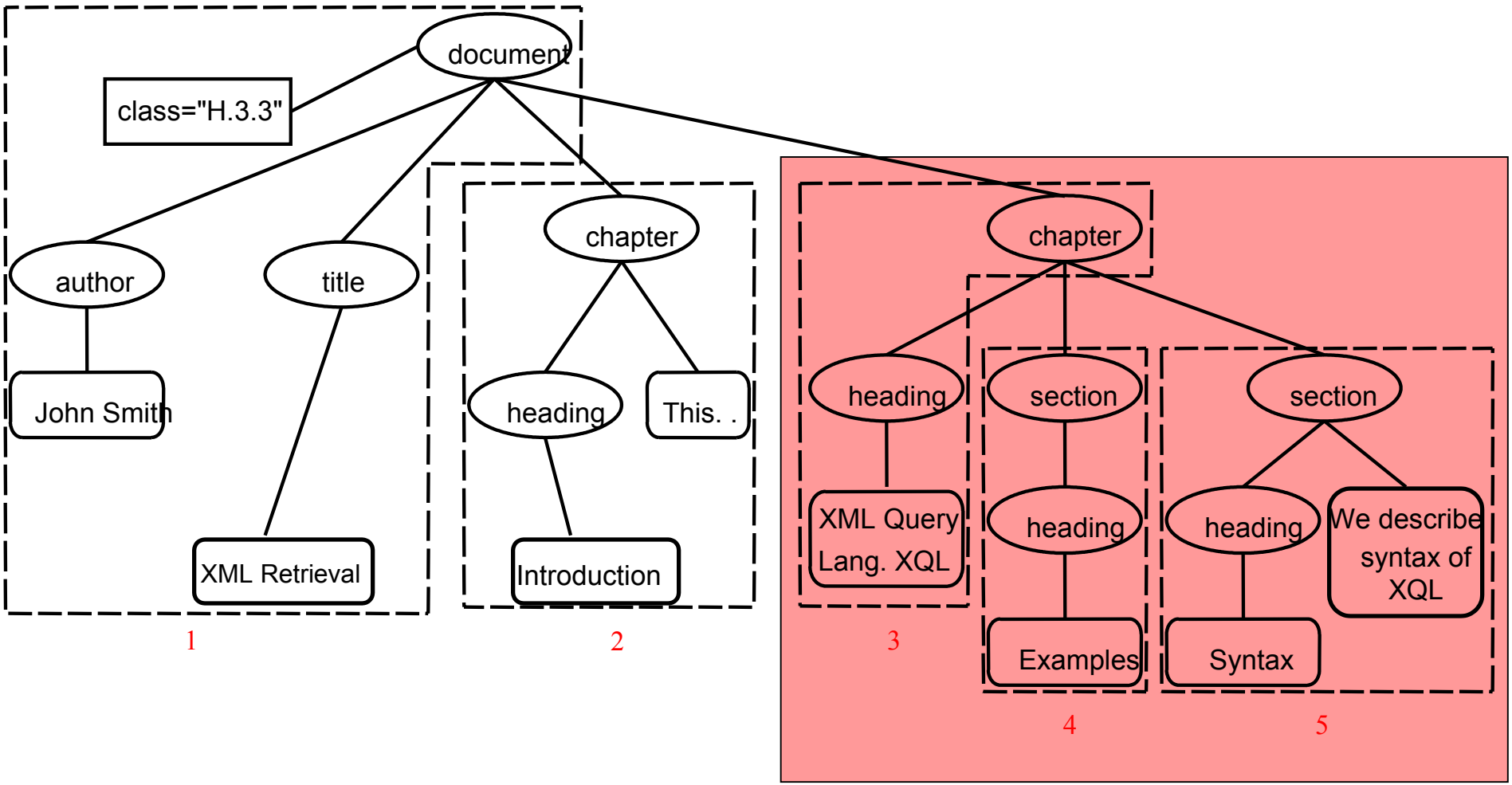
Solution:

1) Index nodes as roots of possible answers

2) Augmentation as concept for computing tradeoff between indexing weights and specifity of answers

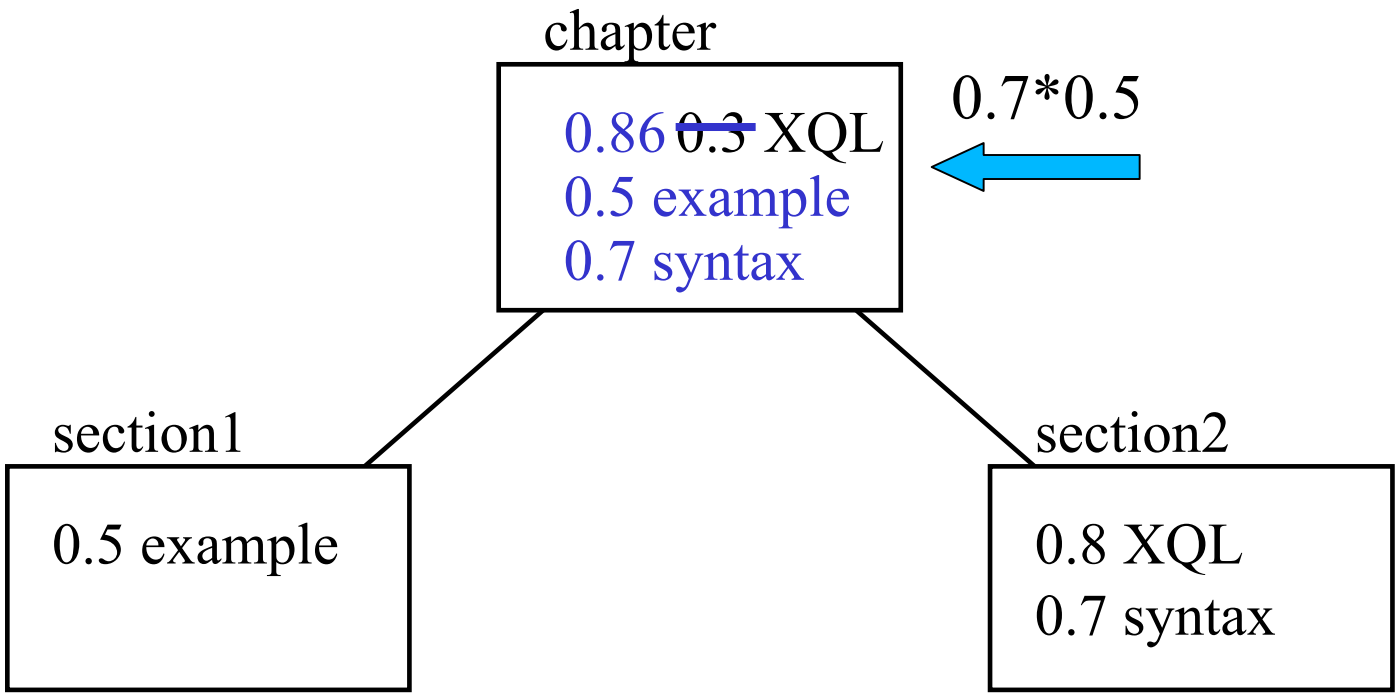


Index nodes for relevance-oriented search



Augmentation

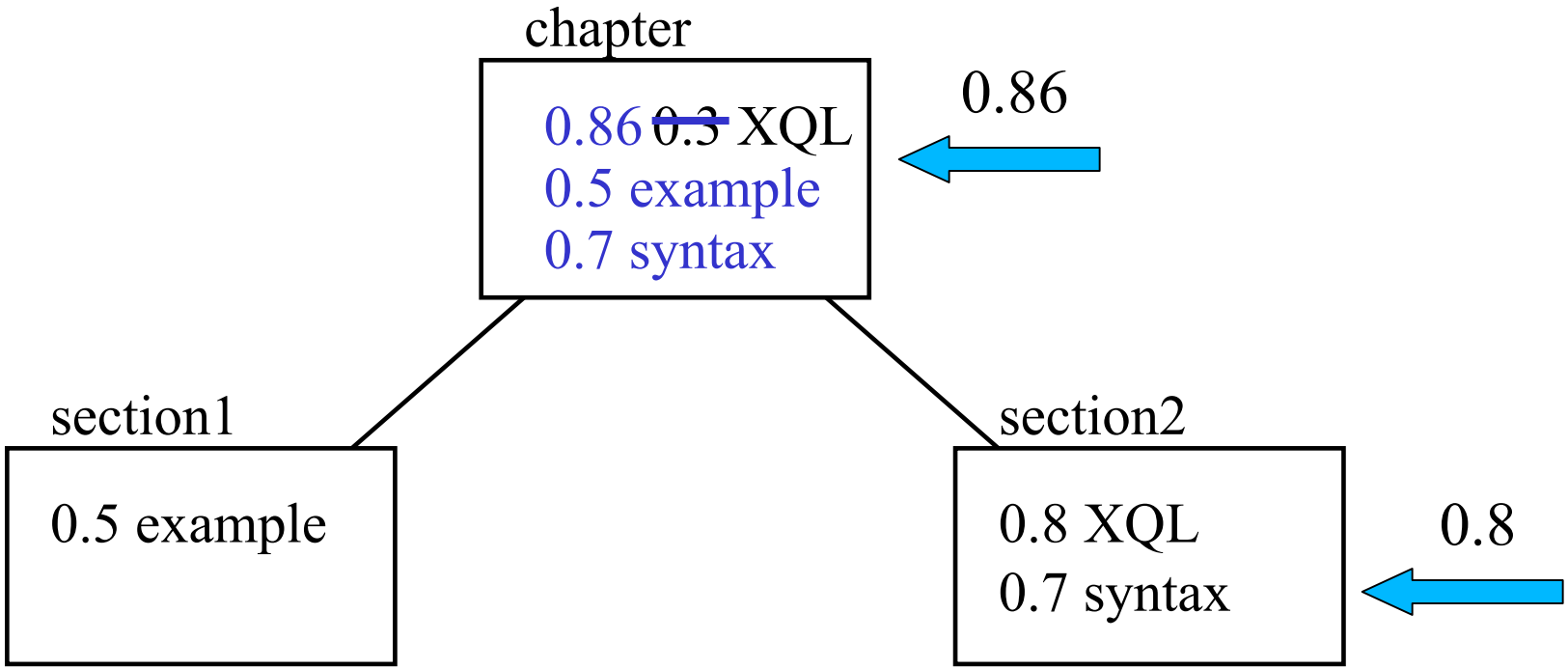
…by disjunction



Example query: syntax ∧ example

Augmentation

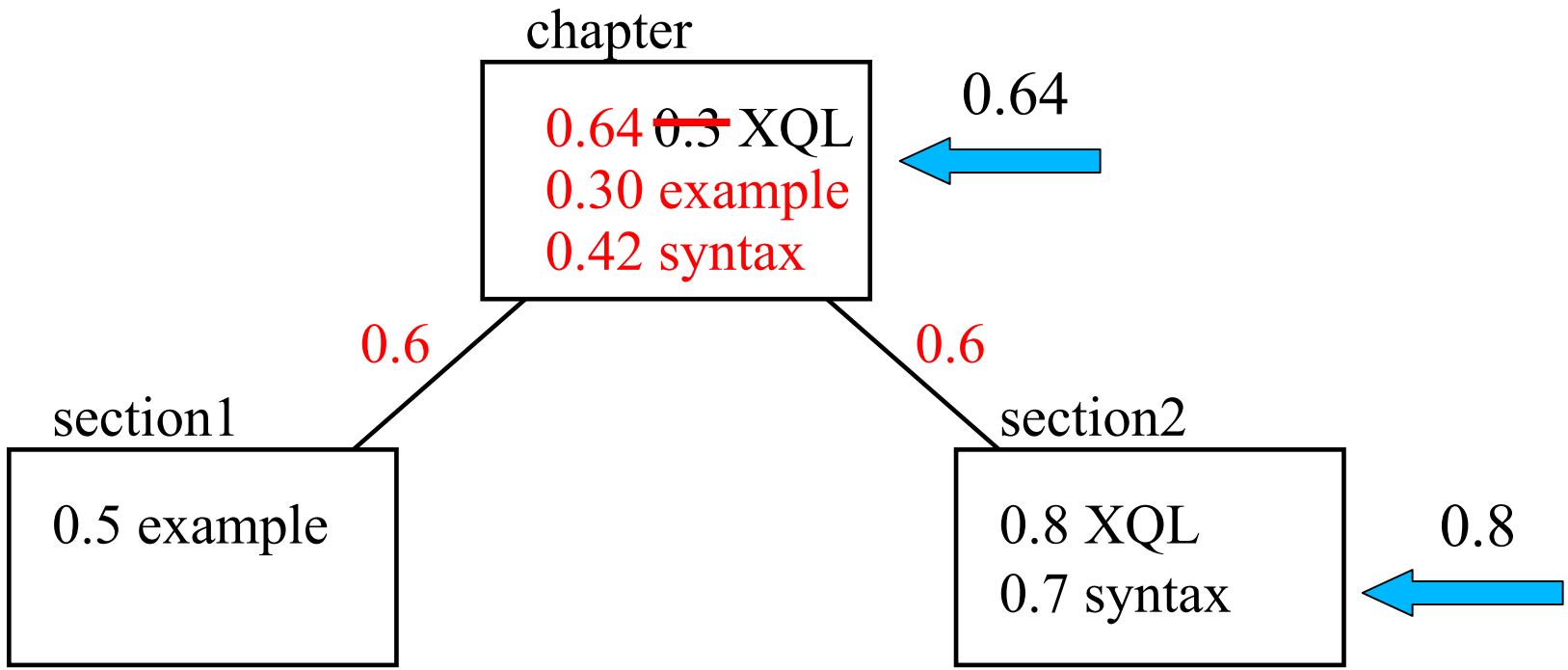
…by disjunction



Example query: XQL

Augmentation

…with augmentation weight



Example query: XQL

II.3 XIRQL: Data types with vague predicates

XML markup allows for detailed markup of text elements

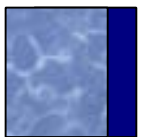
- Exploit markup for more precise searches
- Consider also vagueness and imprecision of IR
- Data types with vague queries

  ``Search for an artist named Ulbrich, living in the Rhine-Main area of Germany about 100 years ago”

  Ernst Olbrich, Darmstadt, 1899

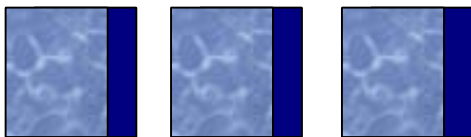
- (Extensible) data types for document-centric view

  (person names, dates, geographic locations, classifications/ images, audio,...)



Extensible type hierarchy

- Extensible type hierarchy with vague predicates for each data type
  1) **text**: substring-match
  2) **Western language**: single word search, truncation, word distance
  3) **English text:** stemming, noun phrases
- Data types of XML documents defined in extended DTD (XML schema)



II.4 Structural Relativism

- Drop distinction attribute/element:

  ~author searches for attribute or element

- Generalize to data types:

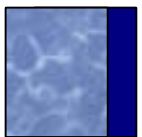
  #personname searches for attributes/elements of specific data type

- Exploit ontology over element names:

  region – country – continent

- Edit distance on paths:

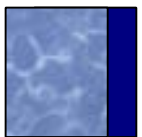
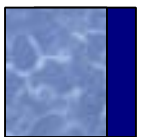
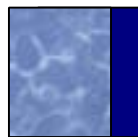
  author="Smith" vs. author/name vs. author/name/lastname



III. XIRQL vs. XQuery

XQuery (proposed as standard XML query language by W3C WG):

- No IR support (weighting, vague predicates, relevance-oriented search, structural relativism)
- Aggregation operators (sum, count, min, max, avg)
- Restructuring of results

XIRQL as IR extension of XQuery subset

- XQuery structure:

  FOR PathExpression

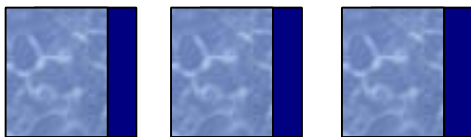
  WHERE AdditionalSelectionCriteria

  RETURN ResultConstruction

- XIRQL subset:

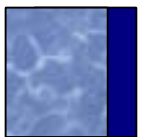
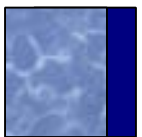
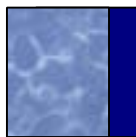
  FOR $X IN PathExpression

  RETURN $X

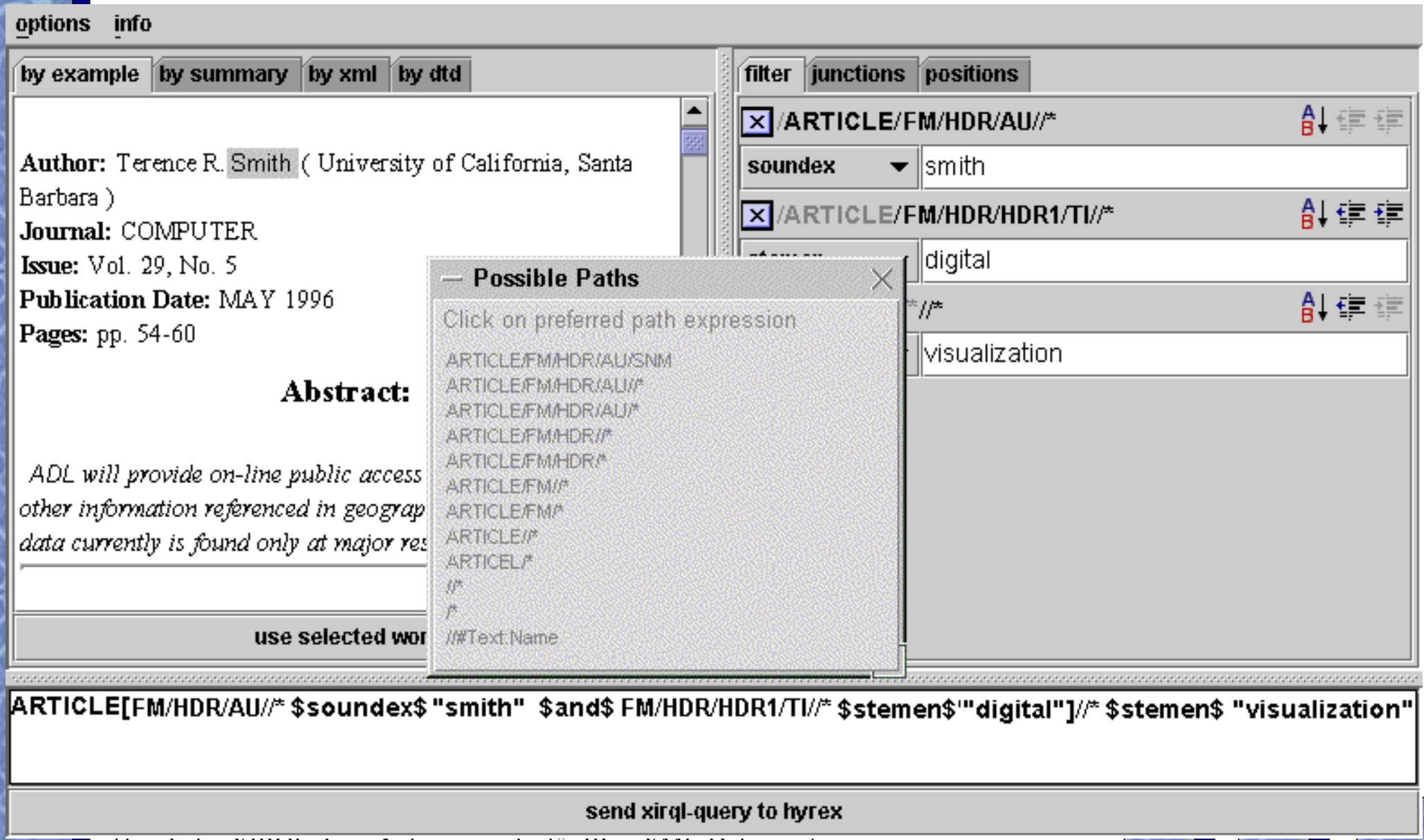


IV. User Interface

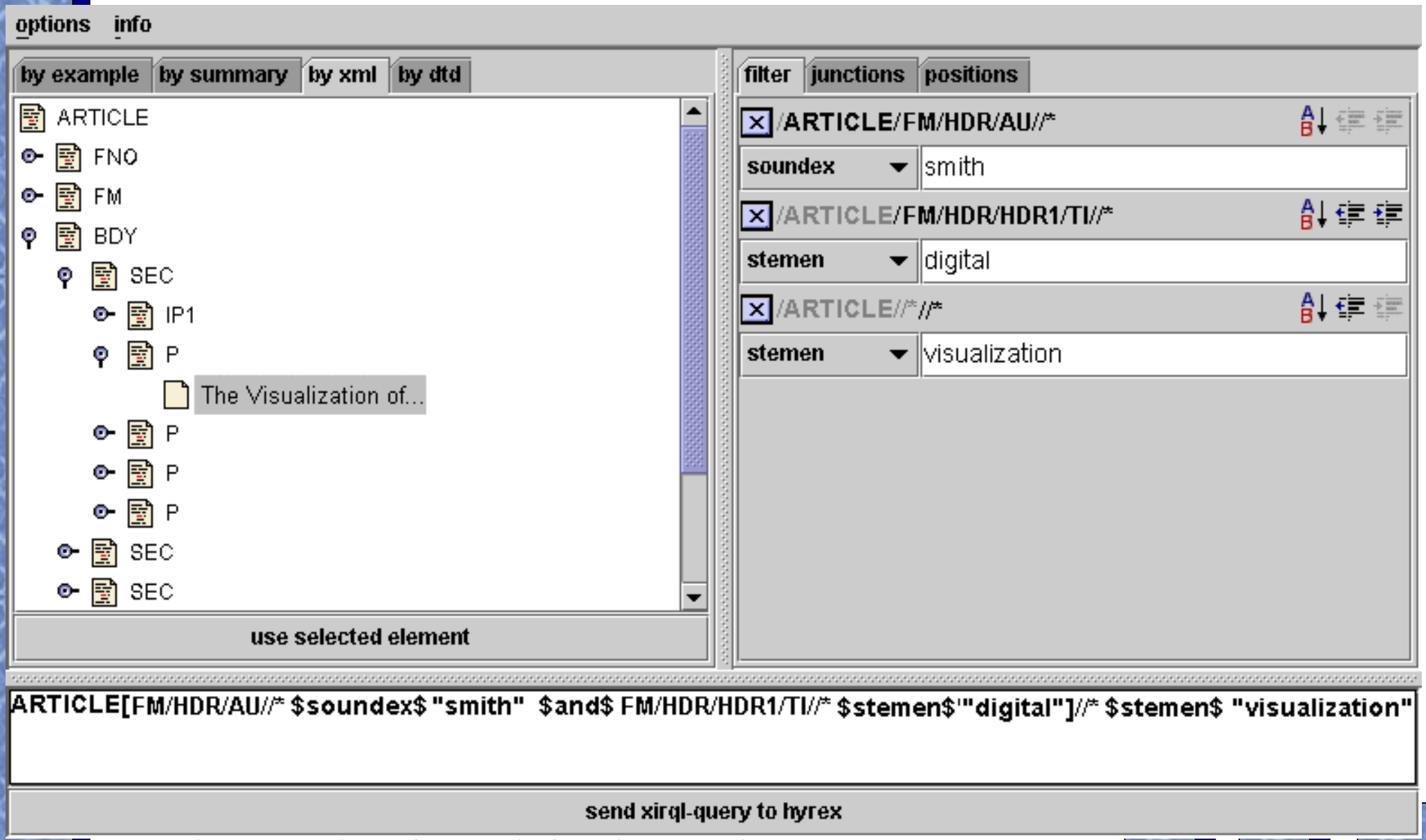
- Query formulation
- Result visualization

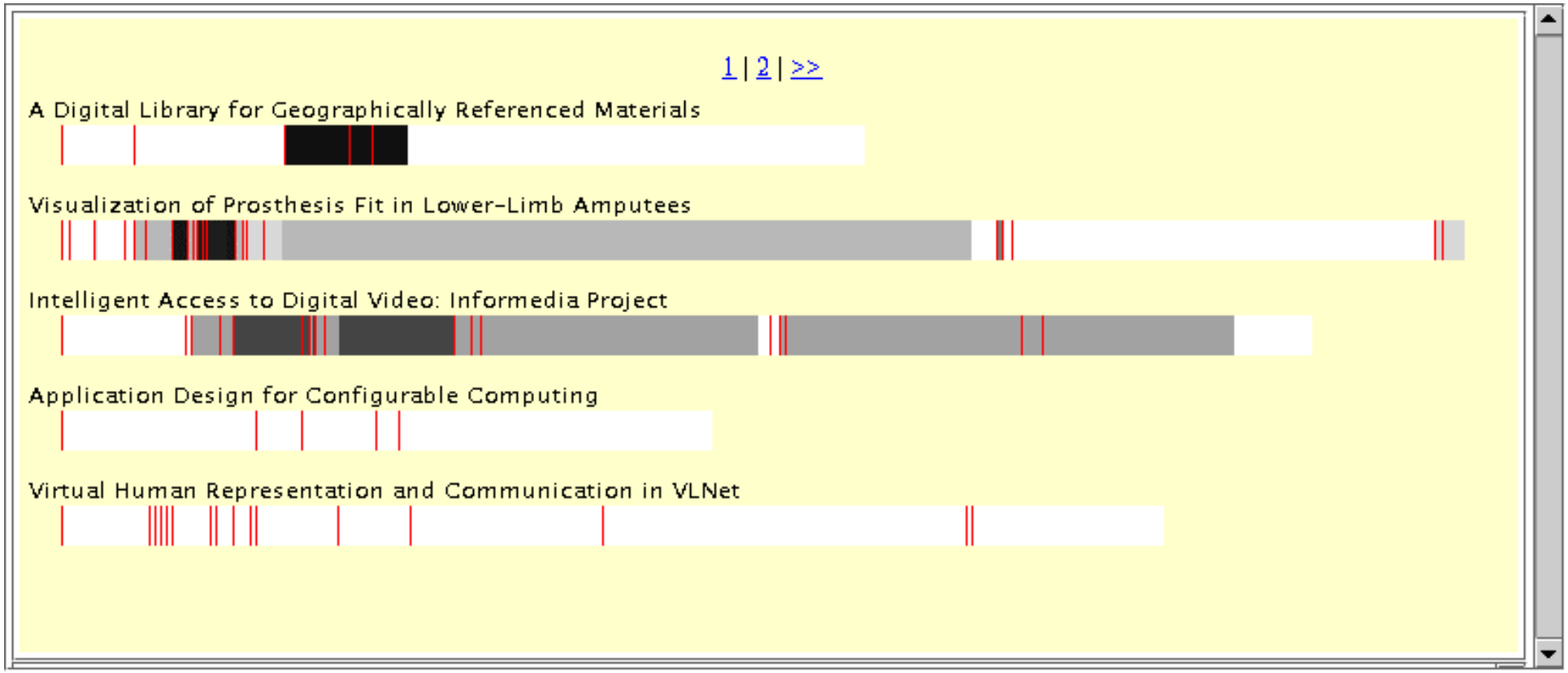
Query Formulation: Layout-oriented



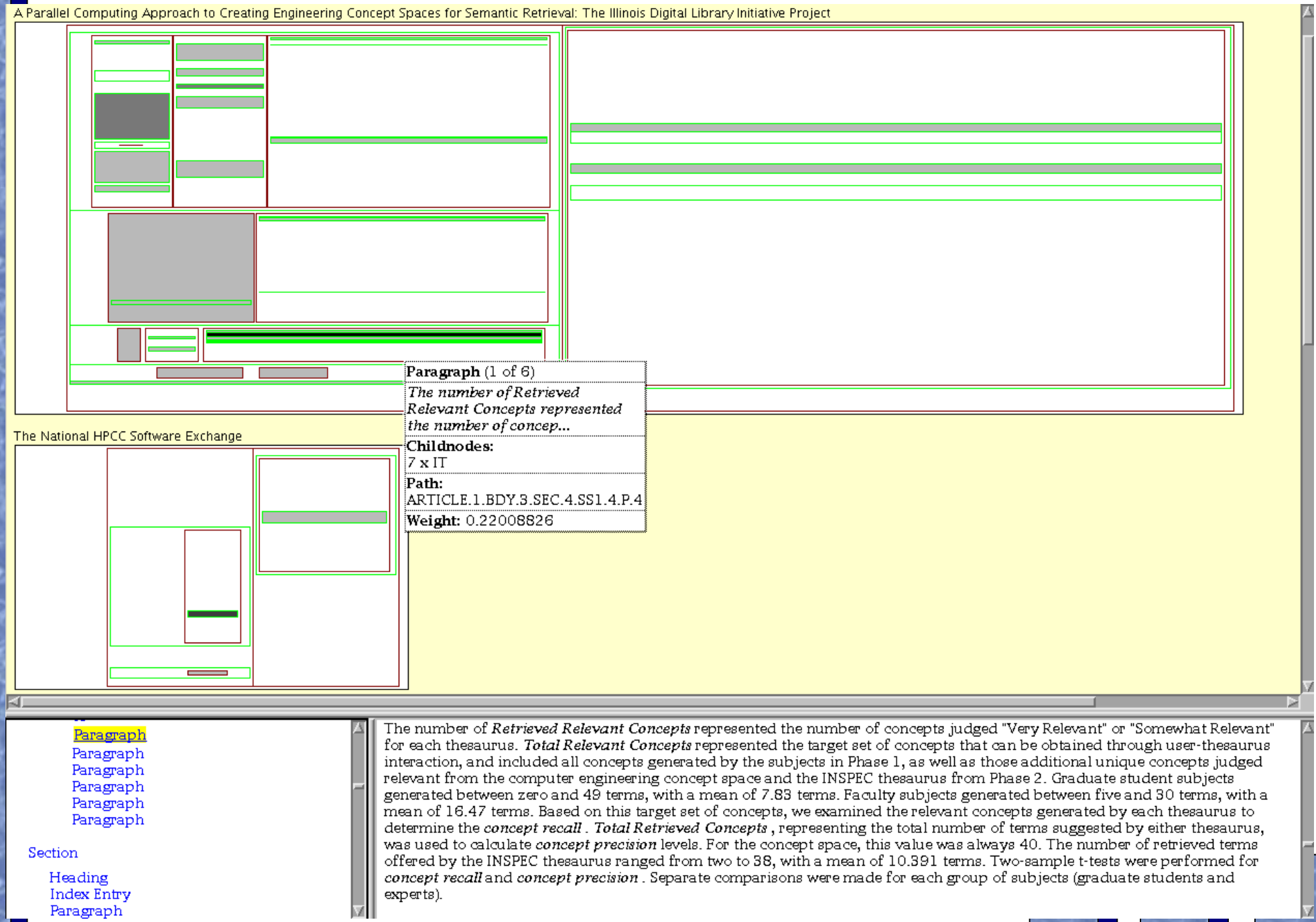
Query Formulation: Structure-oriented



Visualization of Results: Textbars



Visualization of Results : Treemaps

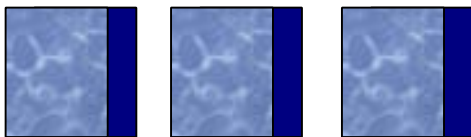


V. INEX: Initiative for the Evaluation of XML Retrieval

- Initially 50 groups from 20 countries (finally 27 active)
- Documents:

  7 years of IEEE-CS journals (12107 articles, 494 MB)
- Queries:

  30 content-only, 30 content+structural conditions
- Results due: September 15, 2002
- Relevance judgements due: November 20
- Final Workshop: December 9-11, 2002



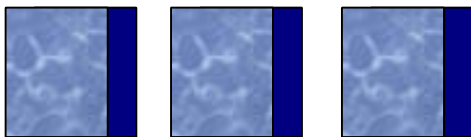
Example query

- Title: Nonmonotonic Reasoning
- Description:

Retrieve all articles from the years 1999-2000 that deal with nonmonotonic reasoning. Do not retrieve articles that are calendar/calls for papers.

- Condition:

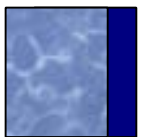
/article[./bdy/sec ∋ “nonmonotonic reasoning” ∧
./hdr/yr[.= 2000 ∨ . = 1999] ∧ .//. ∋ “belief revision” ∧
¬ .//tig/atl ∋ “calendar”]



VI. Summary

- Data-centric vs. document-centric view on XML

  (database vs. IR view)
- IR methods for XML must support uncertainty and vagueness…



XIRQL: XML query language implementing

- Combination of structural conditions with probabilistic weighting
- Relevance-oriented search by augmentation
- Extensible data types with vague predicates
- Structural relativism

HyREX: Open source XML retrieval engine:

http://ls6-www.cs.uni-dortmund.de/ir/projects/hyrex