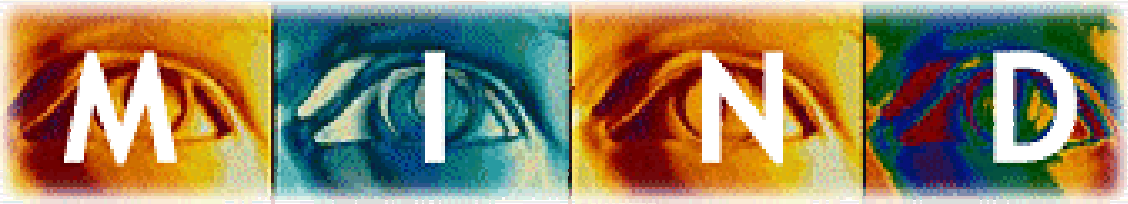

Resource Selection and Data Fusion for Multimedia International Digital Libraries

MIND: An architecture for multimedia information retrieval in federated digital libraries

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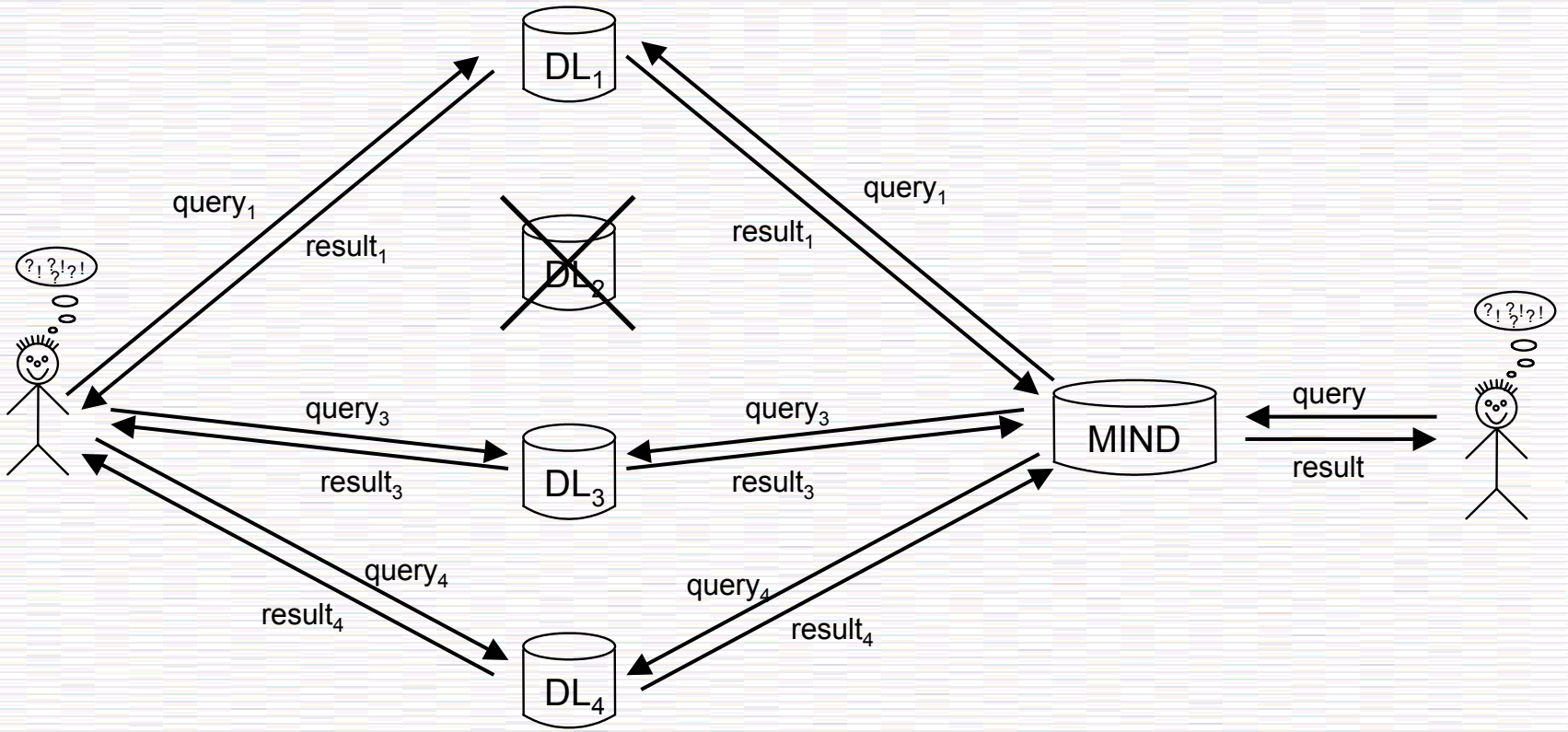
ist information society technologies

Synopsis

1. Retrieval in Digital Libraries
2. Architecture
3. Terminology
4. Query process in detail
   - query transformation
   - resource selection
   - data fusion
5. Resource gathering in detail
6. Project organisation

Retrieval in Digital Libraries

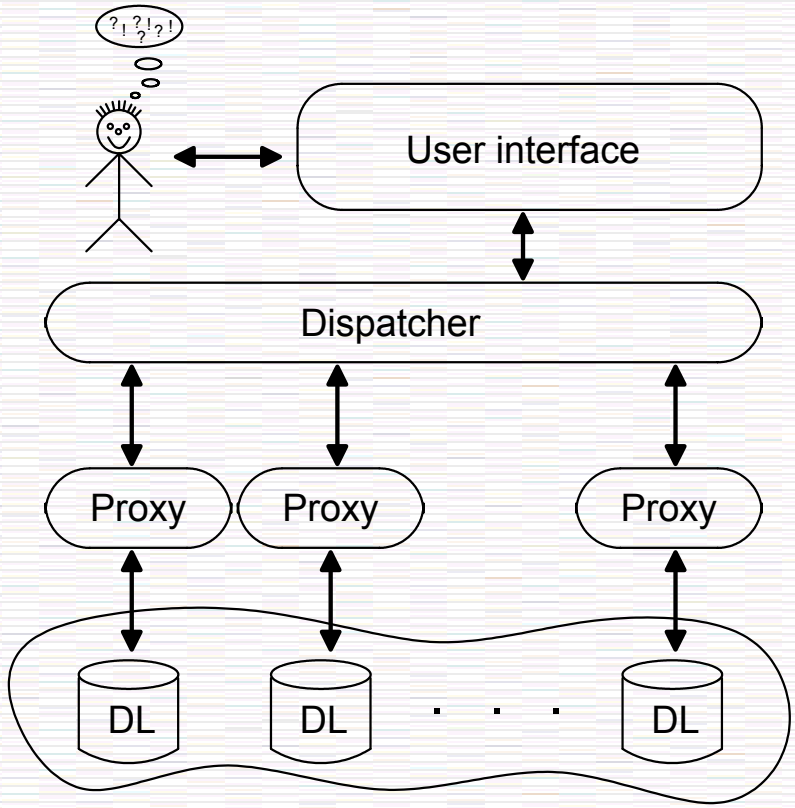


Federated Digital Libraries

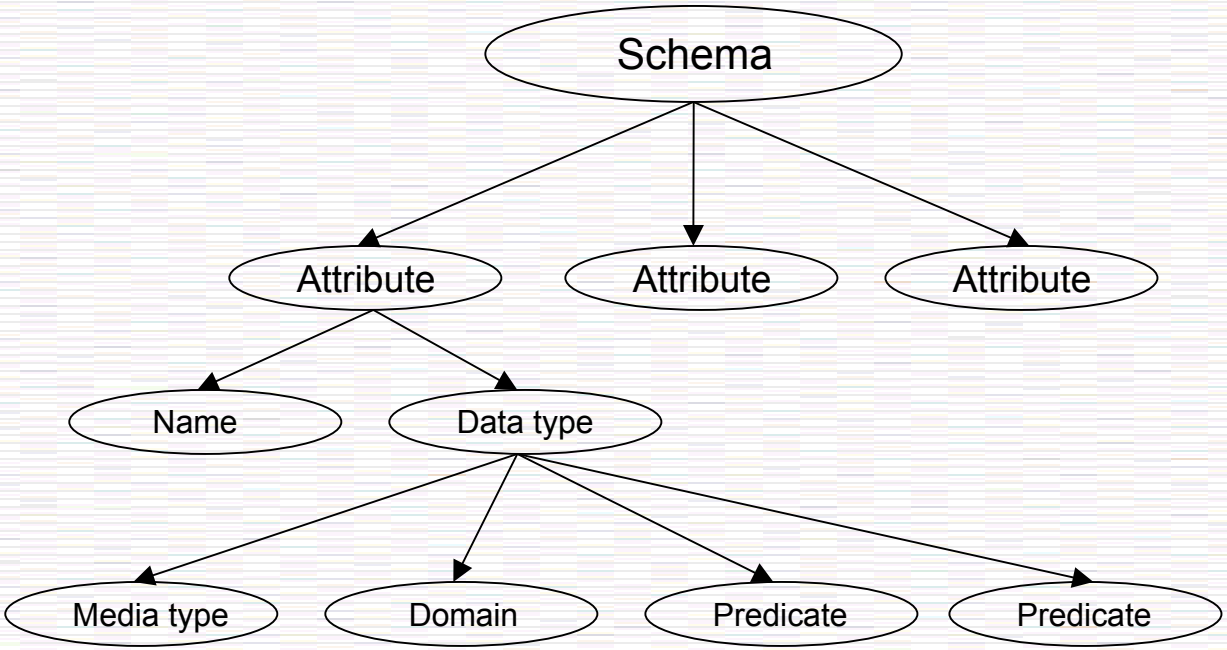
- Database-oriented approaches:
  - heterogeneity
- Information retrieval approaches:
  - vagueness and imprecision
- MIND bases on information retrieval approaches, extensions:
  - heterogeneity (e.g. query language, schema)
  - multimedia (text, facts, images, speech)
  - non-co-operative libraries (query interface only)

MIND Architecture

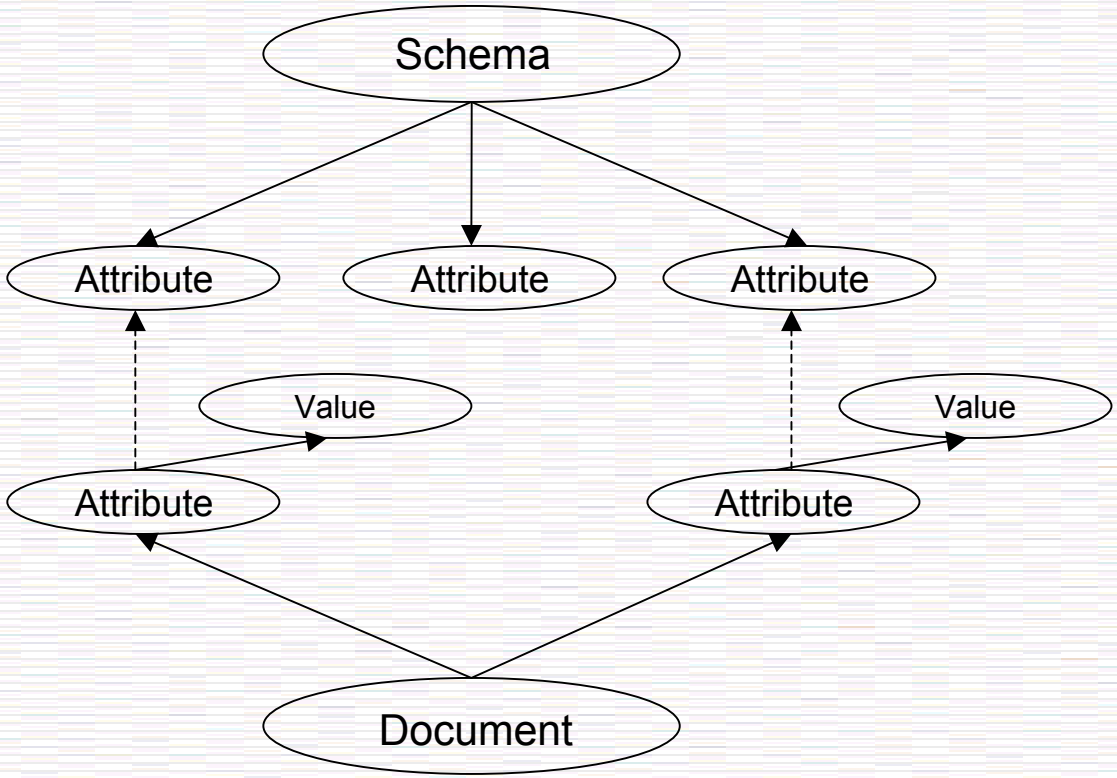
- Dispatcher:
  - library-independet work
- Co-operating proxies:
  - extend functionality of non-co-operating library
  - provide all information required by the dispatcher
  - standard implementation with textual resource descriptions (XML)



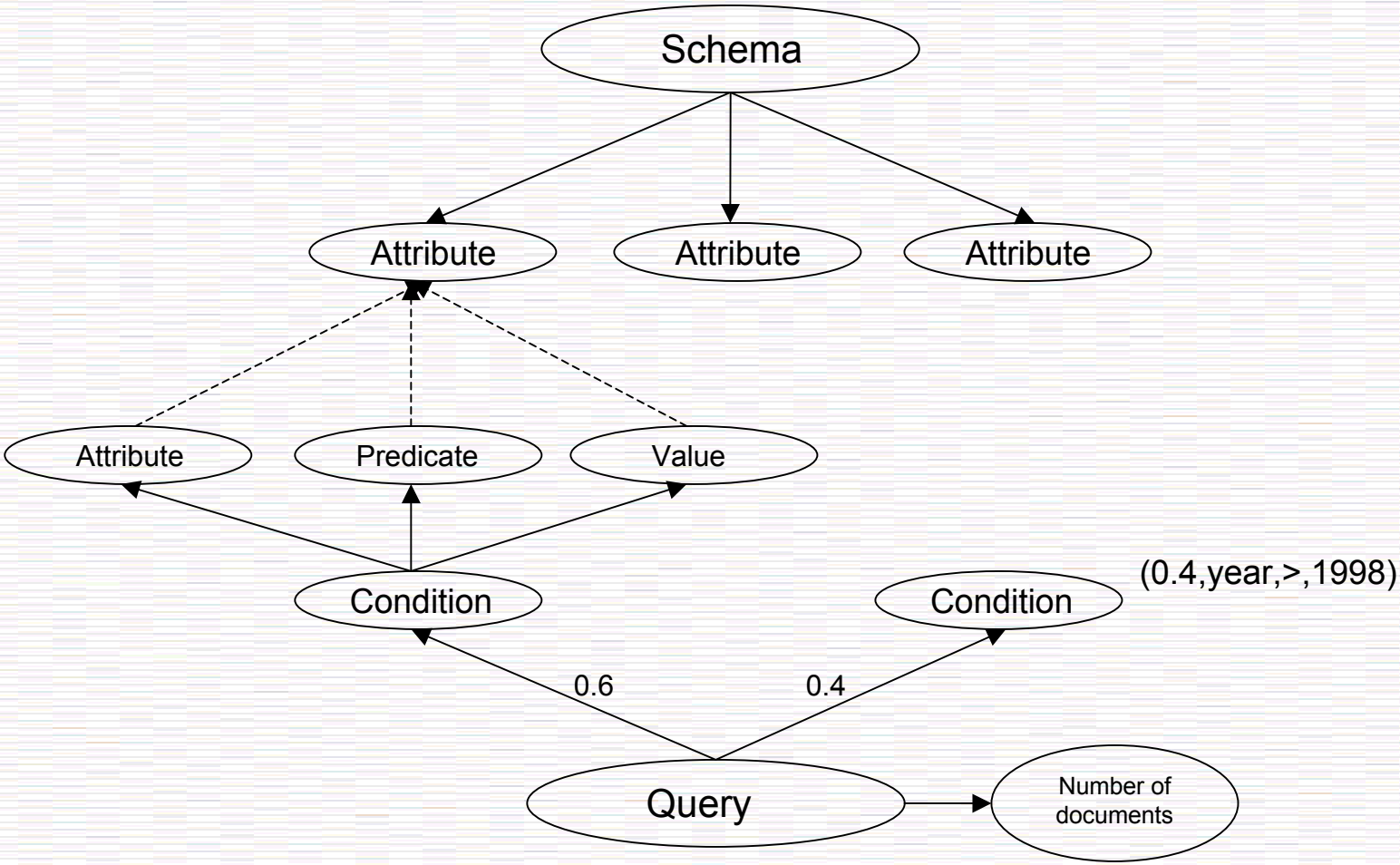
Terminology



Terminology

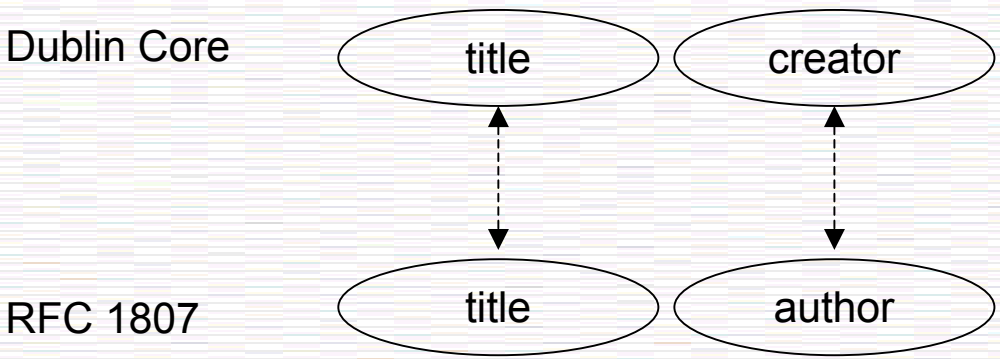


Terminology



Query Transformation

- Heterogenous schemas
- Required: uncertain mapping between schemas, used to transform user query to proprietary query



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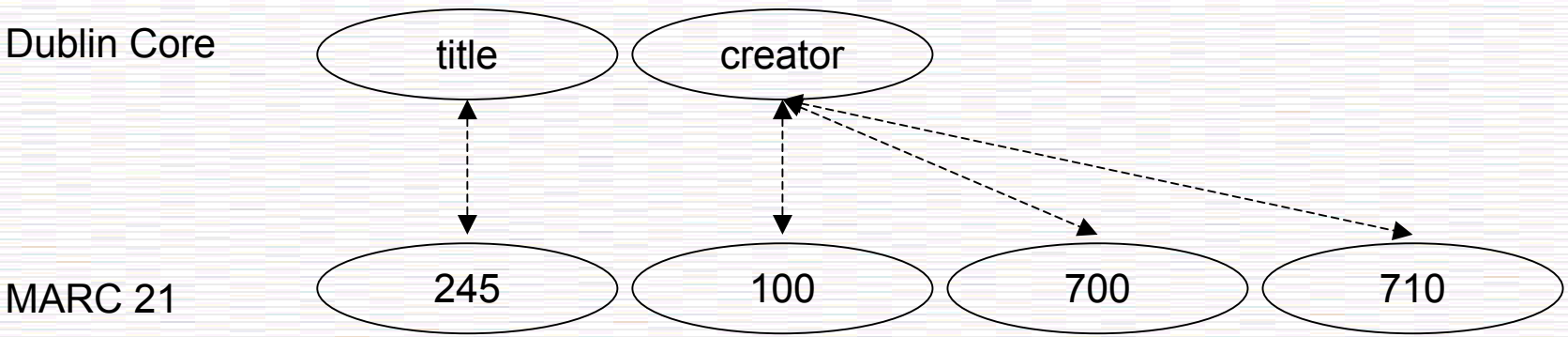
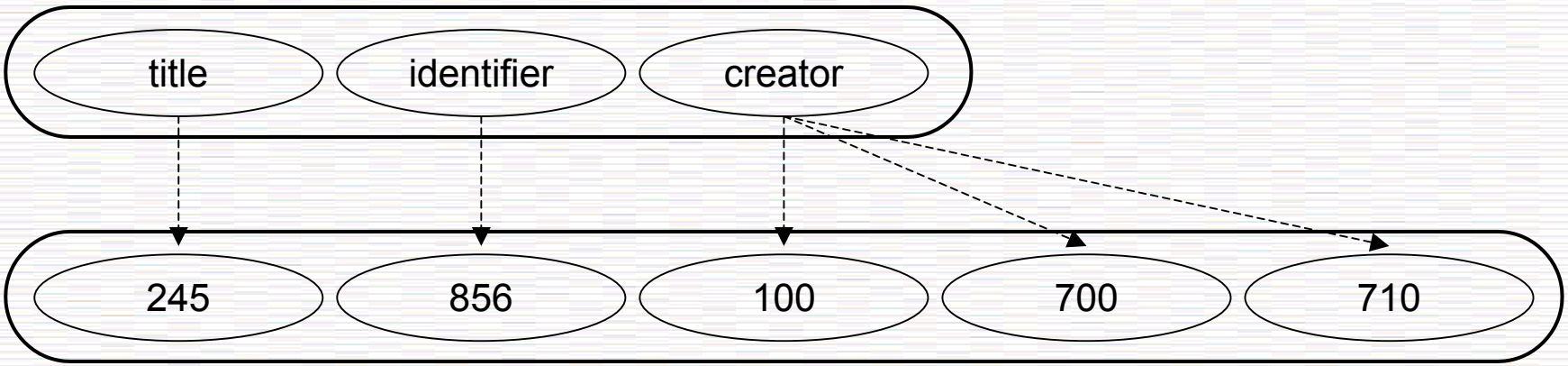


Query Transformation

- Task:
  - transform user query to proprietary query
- Proxy:
  - transforms query condition by condition



Query Transformation

- Attribute/Predicate:
  - mapping modeled in probabilistic Datalog
    - probabilistic extension to Horn predicate logic
    - weights for facts and rules
  - certain mapping rules

```
dc_creator_equals(D,V) ← marc_100_equals(D,V)
dc_creator_equals(D,V) ← marc_700_equals(D,V)
dc_creator_equals(D,V) ← marc_710_equals(D,V)
```

  - uncertain mapping rules

```
0.4 marc_100_equals(D,V) ← dc_creator_equals(D,V)
```

  - rules and probabilities will be learned

Query Transformation

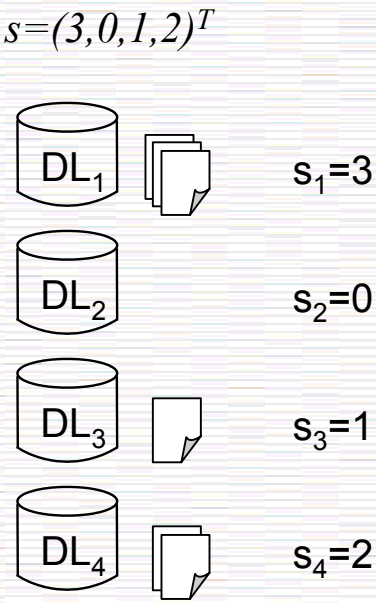
- Comparison value:
  - necessary, when domains do not match
    - dates: “2001-09-09” versus “September 9, 2001”
    - authors: “Fuhr, N.” versus “Norbert Fuhr”
    - classification schemas: DDC versus ACM
    - languages: German versus English
    - image colour histogram: different dimensions
  - transformation:
    - goal: automatic transformation
    - several methods possible, unclear which will be used
    - possibly: simple hardcoding in proxy

Resource Selection

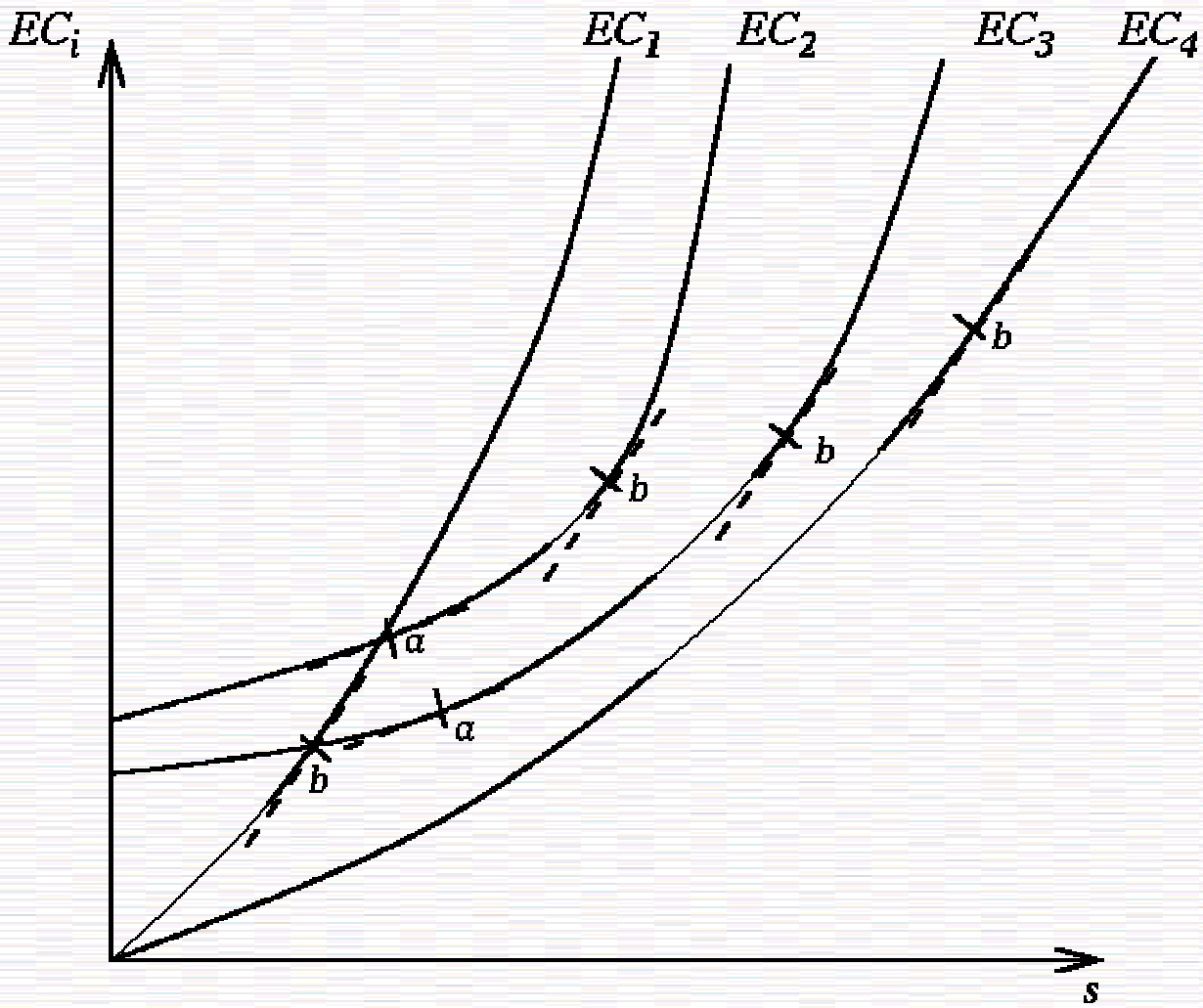
- Task:
  - find relevant libraries w.r.t. the query
- Method:
  - decision-theoretic model
  - cost factors
    - computation and communication time
    - charges for delivery
    - retrieval quality
  - goal: retrieve many relevant documents at low expected costs

Resource Selection

- Task:
  - calculate optimum selection
    - vector $s=(s_1,\ldots,s_l)^T$
    - expected retrieval costs $EC_i(s_i)$
    - minimal overal (summed up) expected costs
- Proxies:
  - calculate $EC_i(j),\ 1 \le j \le n$
- Dispatcher:
  - calculates optimum selection $s=(s_1,\ldots,s_l)^T$



Resource Selection



Resource Selection

- expected number of relevant documents in library

$$E(rel \mid q, DL) = \sum_{d \in DL} P(rel \mid q, d)$$

$$P(rel \mid q, d) = P(d \rightarrow q) \cdot P(rel \mid d \rightarrow q), P(rel \mid \neg d \rightarrow q) \approx 0$$

$$P(d \rightarrow q) = \sum_{c_i \in q} P(d \rightarrow c_i) \cdot P(c_i \rightarrow q)$$

indexing weight; condition weight

$$E(rel \mid q, DL) = P(rel \mid d \rightarrow q) \sum_{c_i \in q} P(c_i \rightarrow q) \sum_{d \in DL} P(d \rightarrow c_i)$$

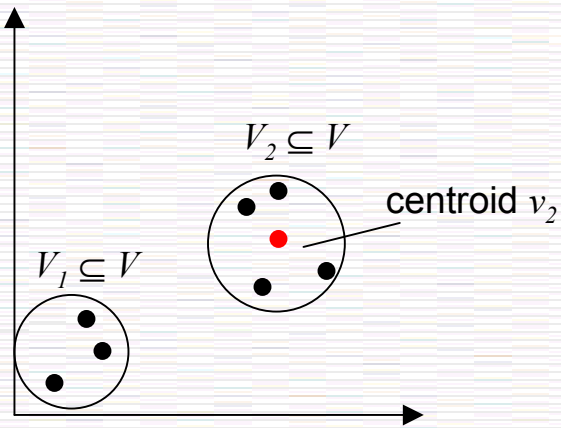
estimate (relevance feedback if available); from resouce description

  - required: last sum of indexing weights

Resource Selection

- sum of indexing weights:
  - text, speech:
    - e.g. normalised tf idf values as indexing weight
  - facts, images:
    - feature vectors over continuous domain V
    - clusters $V_j \subseteq V$, centroid v_i
    - f: V × V → [0,1] retrieval metric
    - approximation for indexing weight sum:

$$\sum_j |V_j| \, f(v_j, value(c_i))$$



Data Fusion

- Task:
  - optimise overall retrieval quality
- Proxies:
  - modify weights of their documents (normalisation) based on global idf values
  - provide local df values
  - create summaries
- Dispatcher:
  - merges results w.r.t. normalised document weights
  - computes global idf values

Resource Description

- Schema
- Uncertain schema mapping
- Statistical description of collection:
  - text, speech: terms
    - document frequencies (df)
    - sum of indexing weights
  - facts, images: clusters of feature vectors
    - centroid vector, cluster radius (number of clusters determines granularity of metadata)
    - number of vectors in cluster

Resource Gathering

- Task:
  - create and update resource description
- Proxy:
  - uses query-based sampling for statistical descriptions
    - iterative retrieval of documents
    - assumption: union of results is representative for whole collection
    - extract resource description w.r.t. document sample
  - learns uncertain schema mapping rules
  - goal: learns library schema

Project Organisation

- Funded by the EU commision (FP 5)
- Duration:
  - January 2001 - June 2003
- Project participants:
  - University of Strathclyde (UK) (Coordinator)
  - University of Dortmund (Germany)
  - University of Florence (Italy)
  - University of Sheffield (UK)
  - Carnegie Mellon University (USA)

Conclusion

MIND deals with

- vagueness and imprecision
- heterogeneity
- multimedia
- resource selection
- data fusion
- non-co-operation (resource descriptions)

in federated digital libraries