Task 4.5a

Visualization in Digital Libraries (Relevance Feedback)

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Problem Specification

- “semantic gap” between machine computed similarity of multimedia objects and human perception
- similarity between objects can be easily expressed using a weighted sum of metric distances but users identify similar objects on a semantically higher level
- relevance feedback mechanisms can bridge this semantic gap but we need rich visual and interactive paradigms

Major Research Activities in T4.5a

1. Visualization of Multimedia Objects for Relevance Feedback

2. Visual Relevance Feedback Mechanisms for Content-Based Multimedia Retrieval

3. Mathematical Foundations to Incorporate Relevance Feedback

4. Extensibility to Distributed Environments

1 - Visualization of Multimedia Objects for Relevance Feedback

- Major challenges:
  - multimedia objects are represented by *several dimensions* (high dimensional feature vectors)
  - human perception is restricted to *few dimensions*
  - dimensional reduction is required
- Existing systems offer either a one or two-dimensional visualization
- We compared: FastMap, IsoMap, and LPP in terms of usefulness (IsoMap wins)

Information Visualization Support

- Applying existing visualization techniques to relevance feedback (drawing from a large literature)
- Enhancing interaction. The existing interaction methods are quite limited, basically implemented as simple selections other methods (e.g., dynamic filtering) may be used
- Exploring new ways for obtaining overviews for browsing and exploration tasks
- Representing interaction data, represent history data along with manipulated objects
- Apply sampling-based techniques for providing accurate visualization

2 - Visual Relevance Feedback Mechanisms for Content-Based Multimedia Retrieval

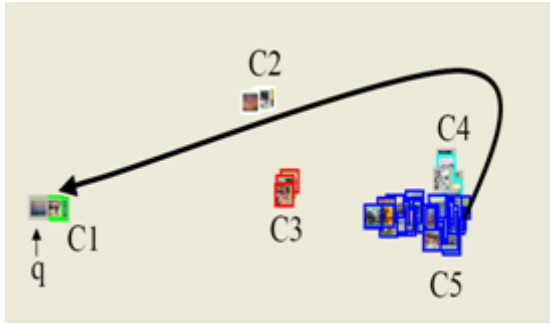
- Selecting good initial representatives
  - Due to lack of screen space it is of high importance to display “good” representatives
  - We investigate how data mining techniques and visualization can be used to give the user an overview on the database content and facilitate the choice of the starting image
  - Mainly using clustering techniques an good representatives within clusters

- Providing relevance feedback
  - Relevance feedback can be given by marking objects as positive or positive and negative examples
  - We want to go beyond this binary classification of objects in relevant or irrelevant ones and allow *continuous degree of relevance*

Visual Relevance Feedback Mechanisms for Content-Based Multimedia Retrieval (2)

- Giving relevance feedback by moving objects and interactive clustering in a 2D user-interface

- Procedure
  1. The result set is clustered giving the user an impression of the current similarity measure.
  2. We indicate cluster membership by differently colored frames.
  3. The user changes the cluster structure of the displayed objects by moving objects.
  4. The system adapts the similarity measure to the users needs.



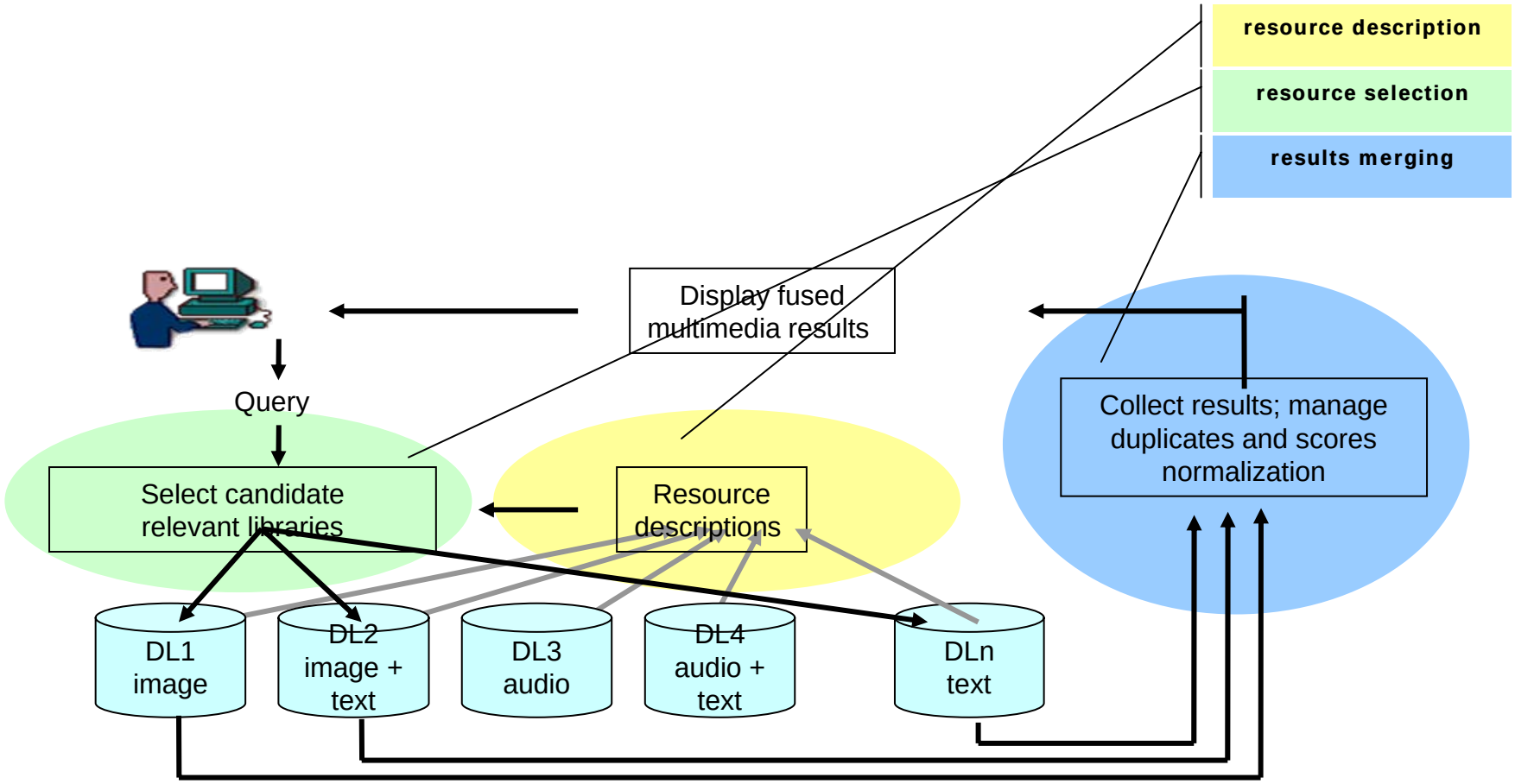
Mathematical Foundations to Incorporate Relevance Feedback

- Assigning new weights when objects are moved and/or marked as relevant
- Going back from 2D space to nD space
- We explore different ways to internally react to the given relevance feedback
  - e.g., linear discriminant analysis and density-based clustering (already running in our prototype), semi-supervised categorization and classification methods.

Extensibility to Distributed Environments

- Relevance feedback has been studied in centralized scenarios, a distributed environment poses additional issues
- Three major issues:
  - the content and availability of each DL must be known at query time (resource description)
  - On this basis relevant libraries have to be selected (resource selection)
  - The results have to be merged
- Relevance feedback can be used to
  - adaptively change the selection process
  - to modify the fusion process according to different relevance to repositories

Extensibility to Distributed Environments



Future Research

- Exploring new ways of giving relevance feedback using InfoVis techniques
- Long-term adaptation and personalization
- Incorporate relevance feedback information into dimensionality reduction and clustering
- Explore and extend the mathematical foundations to incorporate relevance feedback (using classifiers, (subspace-) clustering methods
- Content-based multimedia query execution in a distributed setting