# Integrated Content Presentation for Multilingual and Multimedia Information Access

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## ABSTRACT

For multilingual and multimedia information retrieval from multiple potentially distributed collections generating the output in the form of standard ranked lists may often mean that a user has to explore the contents of many lists before finding sufficient relevant or linguistically accessible material to satisfy their information need. In some situations delivering an integrated multilingual multimedia presentation could enable the user to explore a topic allowing them to select from among a range of available content based on suitably chosen displayed metadata. A presentation of this type has similarities with the outputs of existing adaptive hypermedia systems. However, such systems are generated based on "closed" content with sophisticated user and domain models. Extending them to "open" domain information retrieval applications would raise many issues. We present an outline exploration of what will form a challenging new direction for research in multilingual information access.

## Categories and Subject Descriptors

H.3 [**Information Storage and Retrieval**]; H.3.3 [ **Information Search and Retrieval**]: Search Process, Selection Process

## General Terms

Human Factors

## Keywords

multilingual retrieval, multimedia retrieval, cross-media retrieval, presentation of retrieval results, extending adaptive hypermedia

## 1. INTRODUCTION

The last 10 years have seen a huge international participation in research into Multilingual Information Access (MLIA). Much of this work has been concerned with Cross-Language (or Bilingual) Information Retrieval (CLIR) where search topics or requests in one language are used to retrieve documents in another language. Research has concentrated on adapting information retrieval (IR) methods for different document languages and developing techniques for translating topics and occasionally documents to cross the language barrier. While early work in MLIA concentrated on text documents from published news sources, more recent work has extended this to explore various multimedia IR data sources including annotated photographic and medical images, spoken data sources, and multilingual web documents.

Engaging though this activity has been, all this research is still essentially concerned with the conventional IR scenario of using a search request to retrieve individual unstructured documents one or more of which it is hoped will individually be relevant to the user's information need. In the case of CLIR there is the inescapable additional issue that while a retrieved document may be relevant to the information need, the user may not have sufficient knowledge of the document language to be able to identify and extract the information they are seeking from it. Machine translation or content gisting in context, based on bilingual machine readable dictionaries, has been investigated as a means of accessing particular information or at least determining whether a document is relevant. In the case of images, and potentially video, the user can often identify desired content even if they cannot read any accompanying textual annotation.

Considerable progress has been made in technologies for, and in the understanding of the issues, in CLIR and related topics for all media. However, it can be argued that restricting research to the retrieval to ranked lists of potentially relevant documents is a rather limited vision of what might be possible with multiple information sources in different languages and media.

Of course, if the user has a simple focussed information need requiring the location of a single known (or even unknown) relevant document (often in a known language) using a standard CLIR approach is the right solution. If their need is even more focussed seeking a single fact answer then a question answering system may be the best strategy. However, if the information need is more exploratory in nature where the user browses among a number of either linked or semantically related documents to learn about a subject, then the standard presentation of disconnected content in separate lists is probably not the ideal way of making potentially interesting content available to them.

At present we typically have separate search systems for different media in multimedia information retrieval (MLIR) providing separate ranked lists of text, images, video and

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audio. In MLIR it is sometimes argued that separate lists should be provided to the user for each document language. However, providing merged language documents lists remains an active unsolved area of research in MLIR. There appears to have been no substantive research in providing merged media lists in multimedia IR. Current work in cross-media IR is seeking to enable integration of multiple sources to improve content indexing, or to allow search queries in one media to look for documents in another. A user with an exploratory information need querying a collection of content in diverse media and languages could thus easily end up needing to explore more than a dozen separate lists.

In this case some form of dynamic integrated presentation might provide a more natural environment for interaction and investigation of the topic of interest. Such presentations might deliver a multimodal set of content identified as potentially relevant to the user's information need. One could see this as a form of dynamic multilingual multimedia multi-document summary generated in response to an information need which the user can then explore interactively.

In another area of research this idea of adaptive integrated presentation has been actively pursed for a number of years. *Adaptive Hypermedia (AH)* is concerned with personalized presentation of hyperlinked content [1]. Although originally focussing primarily on text data, it is now becoming concerned with the composition of multimedia presentations. Research is currently underway in next generation multimedia applications in areas such as e-learning, e-commerce and e-publishing.

The remainder of this paper introduces some of the common features of AH technologies, considers how they relate to IR, and briefly considers some starting points for how they might be integrated[1].

## 2. ADAPTIVE HYPERMEDIA

A "classic" hypermedia application serves the same pages and the same set of links to all users. However, the classic 'one size fits all' content delivery systems are simply not powerful enough in many application areas, e.g. eLearning, eCommerce. Many websites and hypermedia systems now attempt to 'personalize' their contents so that it is relevant to the user or the context of its usage e.g. adapted to the delivery device such as mobile phone or PDA. Adaptive hypermedia (AH) systems make it possible to deliver "personalized" views of a hypermedia document space without requiring programming from the content author by building a model of the goals, preferences and knowledge of the individual user (called the user model). While it is possible to initialise the user model using some form of questionnaire or use stereotypical user models, the adaptation can also be done automatically simply by observing the browsing behaviour of the user. A comprehensive review of AH techniques can be found in [2].

Hypermedia systems are generally restricted to "closed" content sets. It is assumed that the content is 'chunked' in some fashion based on subject area(s) upon which it focuses. The content (chunks) are typically annotated with highly structured metadata describing various features of the content e.g. using Dublin Core, LOM. The metadata describing the content, and its schema, is called the 'content model'. The cost of manually producing and annotating content is often very high. More recent systems focus on autogeneration of this metadata as part of the authoring of the original chunk. Others focus on generating the metadata based on the context within which the content was originally developed. A third approach focuses on inspection of the content chunk to facilitate the generation of the metadata [5]. However, manual markup (metdata tagging) is usually still quite common due to metadata quality issues.

Because of the expense of authoring such content chunks, one of the goals of AH systems is to maximise the exploitation and user take up of content in order to recoup the return on investment. The value of content in an area such as e-learning is greatly increased if content can be selectively delivered to the learner so as to optimise their learning and improve their perception of the learning experience.

In addition to the user and content models, most AH systems also use a 'domain model'. Such a model contains a description of the subject area(s) of the domain of interest and the specification of the relationships between these concepts in that domain. The vocabulary used for the domain model should be mappable to the schema of the content model and user model. By dynamically combining the domain model, user model and content model, AH systems can generate personal navigations of adaptively selected relevant content. More recent AH systems have also begun to use other models e.g. models describing the context within which the user is seeking information, or a model of the device upon which the retrieved information is to be viewed [4].

Having a detailed knowledge of the content when the system is designed is obviously rather different to the situation for the designer of an IR system where they often have very little knowledge of the features of the content which is to be indexed or searched. Setting this point aside for the present, this section briefly reviews some of the approaches taken in AH systems. A good introductory summary of AH technologies is contained in [1].

An AH system can be thought of as supporting three functions:

- While the user is interacting with the system the user actions are registered. Based on this, and perhaps context or other user supplied information, the system builds a model of the user's knowledge about each domain model concept. The system seeks to model how much knowledge the user has about the concept and what information they have read about it.
- The adaptive system reconciles the user model to classify all available nodes (chunks) into one of several group's depending on the user's current knowledge interests and goals. The system manipulates links within nodes (and link destinations) to guide users towards interesting relevant information. This is called *adaptive navigation* in [2].
- In order to deliver the content of a page at an appropriate level of difficulty or detail the system can conditionally show, hide, highlight or dim page fragments. This process is referred to in [2] as *adaptive presentation*.

**Adaptive Presentation** Adapting a presentation is typically carried out by manipulation of the closed set of avail-

[1]Note we are concerned here only with integration of IR and AH with regard to information presentation, rather than possible use of AH in the retrieval process itself

able chunks. The aim of these manipulations can be for such purposes as:

- Providing fundamental, additional or comparative explanations. Two approaches to this are:
  - Conditional inclusion of fragments: The user model and the concept relationships can be used to determine which fragments should be displayed [3].
  - Stretchtext: For each fragment a short visible placeholder is selected. The system determines which fragments should be "stretched" (shown) and which should be "shrunk" (displaying only the place holder) in the initial display. The user can then interact with the presentation to stretch or shrink fragments as they explore the topic. The system monitors this interaction and takes account of the user's actions to better predict which fragments to stretch or shrink in subsequent outputs.
- Providing explanation variants: Depending on the user model the level of difficulty, the links to related concepts, the length of the presentation, the media type (text, images, audio, video) can be varied. This can be done within a page or through guidance towards different pages in a process referred to as adaptive navigation support.
- Recording information: The user model can be used to vary the order in which information is presented to the user, similar to IR.

AH systems are not just dependent on the existing hyperlinks within a document (or chunk). Dynamic (adaptive) link insertion allows for new dynamically generated paths amongst the content space to be generated. This provides the appearance of new aggregrations of hyperlinked documents which are formed just-in-time for a particular user.

Some work has explored the incorporation of natural language processing in AH systems. Relatively little research exists in this area so far, but it appears to offer significant potential for discovery and adaptive retrieval of content chunks so as to improve the quality of the retrieved content within AH systems [6].

# 3. INFORMATION RETRIEVAL AND HYPERMEDIA

Based on the features of AH systems reviewed in the previous section we believe that adaptive and dynamic hypermedia technologies potentially offer exciting possibilities for integrated presentation of IR results. However, the traditional restriction of AH systems to "closed" applications presents a significant limitation. With this restriction in place mechanisms for link and content manipulation, selection, presentation and creation can be carefully hand crafted taking account of the domain and to a considerable extent the actual content and its structure and media.

The relationship between IR and hypermedia received some research attention in the mid-1990's, see for example [7]. However, whilst both IR and hypermedia technologies have advanced considerably in the last ten years they have very much developed independently, and little consideration has been given to their interaction in recent years.

Of course, the combination of content and document link structure searching has become the focus of much research interest in IR since the advent of PageRank [8] and similar algorithms which use exploit inter-document link structure to improve retrieval effectiveness. There is also currently interest in dynamic creation of inter-document links based on content for the purpose of improving document ranking [9]. While this work takes account of inter-document link structure within IR, it is being used to enhance document ranking, which is not at all the purpose for it is used in systems described as *hypermedia* applications.

While hypermedia systems are generally closed with respect to content there is some interest in exploring the need to include content from outside the application. However, this is generally restricted to considering content fragments or material extracted from a database that is not under the direct control of the hypermedia application [11]. One example of this system type is web information systems which access certain classes of content for presentation without the application author knowing the exact content that will be displayed. Typically such systems deliver retrieved data to the users in a hypermedia presentation generated dynamically using the adaptive handcrafted rules. Thus the outside content is usually known at a schema level, meaning that run time retrieval and rendering is relatively predictable and easy to control. This is still a considerably more restricted scenario than the accepted understanding of searching in IR.

The topic of extending AH to embed more open ended IR techniques has received very little attention. However, one interesting examination of this issue is reported in [10]. This begins to explore the significant issues that open searching for external content would raise for an AH system, including:

- Document metadata would no longer be under the control of the application author. Metadata fields in retrieved contents will often be inconsistent, unreliable or missing completely. Since AH systems make extensive use of highly structured metadata, this will be a very significant issue.
- AH systems have an extensive and dynamically updated user model. IR systems often have no user model for their search. Relevance feedback mechanisms offer some means of learning about what the user has seen during an individual search session and what is deemed relevant to the information need. However, this mechanism is much simpler than that employed in AH, and there is little work on topics such as tracking developing user knowledge and consequent development of the information need in IR.
- Selection of content for presentation to the user. IR systems have mechanisms for ranking potentially relevant documents, but this is rather different to the focus of AH systems which often aim to give users a diverse range of document fragments which form a dynamic document composition which to address their current state of believed knowledge and need (based on the user model).

# 4. INTEGRATED MULTILINGUAL MULTIMEDIA PRESENTATIONS

So what might AH technologies have to offer to systems for multilingual information access systems? We offer here

two brief sketches as possible starting points for considering this topic further.

## 4.1 Cross-Language Multimedia Re-Annotation

One of the most popular areas of cross-language information access research which has emerged is recent years relates to image retrieval. Users enter a search query in one language to search for an image annotated in a different language. Images may be described individually or the textual annotation can be assigned based on an image's proximity to it within a document. The argument for the usefulness of this task is that images are essentially language independent, thus if the system retrieves the correct image, it does not matter to the user that they cannot understand the textual annotation which accompanies it. A richer response to the user might be use the original query and the textual annotation to find related textual material in the query language and use this to re-annotate the image. Of course, such a process will always be prone to errors, so the selection of the material and appropriate presentation to the user will need careful exploration.

A similar approach could be adopted in the case of cross-language speech and video retrieval. In the case of spoken documents, even if the user can read the document language often they will not be able to clearly understand the natural spoken form, and the textual output of a speech recogniser may be too noisy for them to interpret properly. In this case supporting the user by automatically locating related material in the query language may be effective in facilitating access to the information in the document. A similar approach could be taken in the case of video retrieval, where supportive materials are sought to accompany a soundtrack that the user cannot easily understand.

Note in all these cases the potentially relevant documents are themselves used as part of an integrated "query" to find useful material in the document language. It is not merely a case of taking the initial user query to try to find relevant documents in the query language. The actual relevant material is assumed here not to be available in the query language, or not to be available using the entered query. The documents subsequently retrieved using the integrated query may thus not themselves actually be relevant to the information need, but are selected to facilitate the user making best use of the retrieved relevant documents.

## 4.2 Multilingual Topic Exploration

Considering now a standard multilingual text search scenario. Rather than providing separate ranked lists for each language collection or a merged interleaved list in different languages, one could think of providing a more integrated experience. Related documents from different languages might be linked together with documents represented by translated snippets. Users could then stretch or shrink documents in the manner of an AH presentation with translation as needed. Segments of documents might also point to related content in the topic language to assist the user in understanding the content of the potentially relevant document. Again here the content linked to may itself not be relevant, but may offer an explanation of some part of the relevant document in the language of the query.

# 5. CONCLUSIONS

Retrieving multiple ranked lists of multilingual content for presentation to the user can place a significant burden on the user to find relevant material, sometimes involving considerable translation effort. We propose that integration of content across languages and media for presentation of retrieved results offers possibilities for more efficient, effective and richer user experiences when using multilingual information access systems.

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