Exploring Different Optimization Techniques for an External Multimedia Meta-Search Engine

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ABSTRACT

Along with the tremendous growth of Social Media, the variety of multimedia sharing platforms on the Web is ever growing, whereas unified retrieval issues remain unsolved. Beside unified retrieval languages and metadata interoperability issues, a crucial task in such a retrieval environment is query optimization in federated and distributed retrieval scenarios. This work introduces three different dimensions of query optimization that have been integrated in an external multimedia meta-search engine. The main innovations are query execution planning, various query processing strategies as well as a multimedia perceptual caching system.

Keywords: External Meta-Search, Federated Multimedia Retrieval, Multimedia Cache, Query Execution Models, Query Optimization

INTRODUCTION

The explosive spread of Social Media in the Web resulted in a vast amount of blogs (152M.) and social networks with millions of user profiles, approximately 175M. accounts on Twitter and 600M. on Facebook. Following this trend, several billions of user-generated multimedia resources are publicly available on Social Media sharing platforms such as Flickr, Picasa or YouTube. The volume of digital information, especially image data, on the Internet has constantly increased in recent years. Unfortunately, the media resources are locked within these silos prevented from an unified access. This results in several hetero-
geneity issues, such as different retrieval languages or individual sets of metadata formats for describing content (Smith, 2008). Current research proposals use mediator or middleware based frameworks to improve this situation by utilizing several abstraction layers (e.g., an pivot query language) among participating peers. The basic components of such a meta-search engine are a query dispatcher, which manages enrolled local multimedia repositories, a query translator, which processes incoming queries and a query merger, which merges the results of each engine.

Following those research directions, the Architecture for Interoperable Retrieval (AIR - https://www.dimis.fim.uni-passau.de/iris/index.php?view=air) has been developed. Its implementation follows a broker architecture and the concepts proposed in (Stegmaier, Döller, Kosch, Hutter, & Riegel, 2010). AIR improves the aforementioned interoperability issues by utilizing international standards: unified retrieval is achieved by the MPEG Query Format (MPQF) (Döller et al., 2008), whereas metadata interoperability is enabled by two different, standardized approaches, namely W3C Ontology for Media Resource (Lee et al., 2012) and JPSearch Transformation Rules (Döller, Stegmaier, Kosch, Tous, & Delgado, 2010).

Beside interoperability issues, such a mediator system has to ensure an automatic and efficient retrieval. In detail, at the level of the query dispatcher, a query execution-planning phase identifies possible multimedia repositories as well as an appropriate execution strategy for a specific query request. The query translator has to be aware of a correct and efficient processing of the incoming query and its distribution to the enrolled databases compose the core functionalities. Finally, at the level of the query merger, the individual result sets of the underlying engines have to be preprocessed and a final ranked list of result items created.

Related to the introduced components, this work proposes three global optimization techniques for multimedia meta-search engines, which have been evaluated in AIR. In detail, the work will encompass query execution planning on the basis of real-time statistics, intra-query optimization by means of an ONC/Volcano model as well as a modified pipelined model for query execution and finally an inter-query optimization of query streams by means of a perceptual multimedia caching system.

Constitutively on our paper (Stegmaier, Schlegel, Bayerl, Doeller, & Kosch, 2012), this work deepens these findings and is organized as follows: a section on Interoperable Image Search - QUASI:A and a section on Federated Retrieval Scenario – THESEUS Medico highlights two real world projects, in which AIR has been prototypically integrated. An architectural overview in the section on Architectural Overview serves as a basement for the proposed optimization techniques, which are presented in the section on Optimizing Multimedia Queries. Evaluation section gives insights of the performed evaluation and related work is summarized in the Related Work section. The work is concluded in the conclusion.

Interoperable Image Search – QUASI:A

QUASI:A (query and search for images application) represents a proof-of-concept implementation for a distributed heterogeneous image retrieval scenario. Together with AIR, it implements the JPSearch Standard ISO/IEC 2480025, which standardizes interfaces for an abstract image retrieval system. Within this standard, a specific query language JPEG Query Format (JPQF) was utilized. JPQF has been defined using a subset (tailored to image retrieval) of the MPEG Query Format. Main features of this proof-of-concept are user-friendly generation of multimedia queries, cross metadata as well as cross query language retrieval. A user is able to specify example images and define semantic or syntactic properties of the result images. In addition the user has the possibility to select a subset of the result list (positive as well as negative examples) for relevance feedback. By the use of AIR, heterogeneous and autonomous image
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