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A Recommender System for Medical Imaging Diagnostic

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Abstract. The large volume of data captured daily in healthcare institutions is opening new and great perspectives about the best ways to use it towards improving clinical practice. In this paper we present a context-based recommender system to support medical imaging diagnostic. The system relies on data mining and context-based retrieval techniques to automatically lookup for relevant information that may help physicians in the diagnostic decision.

Keywords. PACS, HIS, CBIR, Recommender systems

1. Introduction

Healthcare professionals have early recognized the benefits brought by the application of information technologies (IT) in the daily clinical practice [1]. However, the amount of clinical data available in the Web is vast and, while many repositories with clinical information, assessment and guidelines are available, information is very dispersed. For instance, platforms such as Radiopaedia [2], GoldMiner [3] and AuntMinnie [4] provide rich collaborative repositories of radiology cases and articles, but to access these resources the radiologists have to move from their clinical review context to the online platforms. The inexistence of knowledge tools and proficient information retrieval systems for clinical data is a limitation that hampers the full exploration of available healthcare information. In this paper we present a recommender system to support medical imaging diagnostic, which is able to provide enhanced information to the physician during a clinical case analysis.

2. Methods and Materials

The integration of a recommender system [5] (RS) in a medical image viewer (clinical workstation) has the potential to provide valuable knowledge to physicians. However, the diversity and amount of information available nowadays is immense, which means that the identification of useful information is a difficult task. To overcome this problem we use context-based information to extract features aiming to improve the precision while searching for relevant documents and studies. The context is defined by the current study modality, image data, patient's age and sex or other personal information.

The proposed architecture for the clinical recommender system is depicted in Fig. 1.

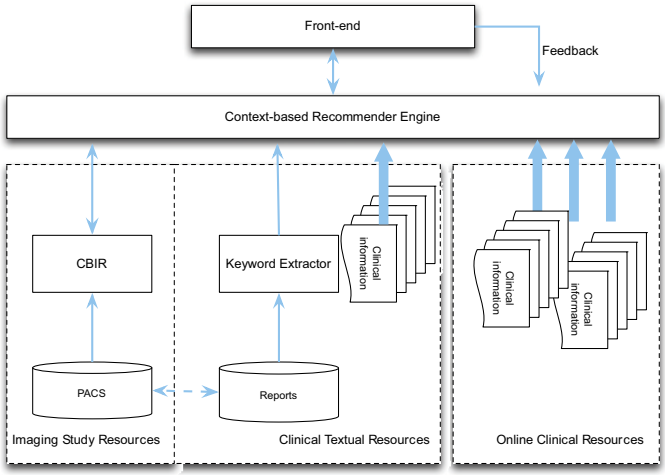

Fig. 1 – Clinical Recommender System architecture

In the back-end, we use the Dicoogle PACS [6] that provides a Content-Based Image Retrieval (CBIR) component to extract and index image-based features. The CBIR implemented a modality-depend algorithm for breast cancer exams, which allow analyzing tissue anomalies and identifying similar studies.

The front-end was developed using 100% Web technologies [7]. A new tool that provides a list of recommended items and links to clinical resources available online was added to the DICOM Web viewer.

The architecture delegates the imaging analysis and similarity search to the CBIR plugin [8]. Feature representation and similarity measures are handled internally, and then exposed via a REST interface.

The CBIR plays an important role while finding useful studies that are relevant to the current review context. Moreover, the texts extracted from similar studies' reports are then used to define the feature vector that is sent to the recommender system engine for retrieving relevant suggestions. The Keyword Extractor uses the CTAKES framework [9] to annotate and extract clinical knowledge from these reports. From the annotations we get important keywords that describe reports main topics. So, the system uses this information to query the recommender system for relevant information considering the knowledge extracted from those reports.

Heterogeneous knowledge sources are integrated in the RS by using connectors that have the role to extract information from these data source and to index the data obtained.

The information is indexed using Apache Lucene [10]. The annotations are indexed as keywords aiming to improve the recall and precision while searching. Studies similarity score is based on document cosine similarity. Lucene also provides some other features for compute the similarity. The engine allows us to boost the terms of the query and also the terms of the documents. We take advantage of this feature to improve the performance by giving a boost for the annotated keyword. Moreover, the system makes query refinement using the feedback obtained from the users. The refinement pushes toward a vector of relevant documents and subtracts the non-relevant ones. The query refinement is based on Rocchio's query expansion with pseudo-feedback [11]. Biomedical literature present in PubMed that is related to the

MeSH term “radiology” was indexed using Neji [12]. The indexed dataset contains near 650,000 documents.

3. Discussion

Physicians usually review many cases a day, and even being expert in reviewing these exams, they may face some rare cases that raise doubts in the decision-making process. Our system gets information about the reviewing context and sends this information to the context-based recommender engine, which uses the CBIR component to find studies that have similar image-based features. Thus, the system streamlines access to similar studies and the physicians do not have to waste time to remember and find these studies. On the other hand, the physician may find second opinion within the documents that are also suggested by the RS. For instance, from the indexed PubMed documents the system may suggest some articles to the physician.

In this paper, we present a solution to deliver relevant clinical information to practitioners when performing a clinical analysis. The architecture combines features extracted from images and reports along with a context-based recommender system.

We believe that recommender systems will be a key component and will have wider application in the near future of biomedical informatics.

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