Creation and Enhancement of Fuzzy Ontology Structures for Query Answering from Text Documents – A Text Mining Paradigm

by

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to the

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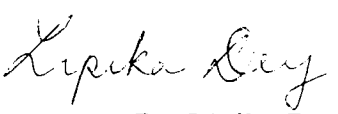
To my parents, who taught me how to tackle life's many impediments.

To my wife, sons – Yusuf and Haris, and daughter – Aisha who make the journey worthwhile.

Certificate

This is to certify that the thesis entitled **"Creation and Enhancement of Fuzzy Ontology Structures for Query Answering from Text Documents – a Text Mining Paradigm"** submitted by Mr. Muhammad Abulaish to the Indian Institute of Technology Delhi, for the award of the degree of Doctor of Philosophy, is a record of the original bona fide research work carried out by him under my supervision and guidance. The thesis has reached the standards fulfilling the requirements of the regulations relating to the degree.

The results contained in this thesis have not been submitted in part or full to any other university or institute for the award of any degree or diploma.



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Supervisor

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Abstract

Over the last decade the World Wide Web (WWW) has virtually become the main repository for data sharing and information gathering. Most of the data on the Web are embedded within text documents which are either unstructured or semi-structured in nature. Thus even though there is no scarcity of information on the Web, locating, extracting and analyzing required information from this vast unstructured collection is a complex and challenging task. Most of the problems are obviously due to the incapability of the computer in comprehending natural language texts with all its nuances.

Word based searches for relevant information from texts retrieve a huge collection and burden the user with information overload. Ontology based text information retrieval can perform concept-based search and extract only relevant portions of text containing concepts that are present in the query or those that are semantically linked to query concepts. While these systems have better precision of retrieval than general-purpose search engines, there are some crucial problems which have to be tackled while designing such systems. Considering that ontologies are created and maintained by domain experts, creation and maintenance of ontologies are expensive tasks. Though ontology provides a structured framework to store domain knowledge, all ontological concepts cannot be unambiguously described using crisp property descriptors. Besides, the ontological descriptors may not exactly match text descriptions or the user given descriptors in query. Appropriate reasoning mechanisms have to be designed in order to apply ontologies for text information processing.

In this thesis we have proposed the use of a text mining framework which can integrate the problems of ontology enhancement with text information retrieval. Thus the system provides

dual advantage of content-based retrieval and ontology learning from text documents. In order to achieve flexibility in concept definition we propose to enhance the traditional ontology structures into fuzzy ontology structures. These structures can accommodate imprecise concept descriptors that are prevalent in text documents. The ontology-based text mining framework mines precise and imprecise concept descriptions from text documents and enhances the fuzzy ontology structure with them. The mined knowledge is stored in a structured knowledge base which design is derived from the underlying fuzzy ontology structure representing the domain. We have shown that the fuzzy ontology structure can provide a viable solution to resolve inconsistencies over concept descriptions encountered in multiple overlapping ontologies. The proposed framework is also enriched with a fuzzy reasoning mechanism that is used to process user queries over a curated knowledge base.

The text-mining framework is enhanced to mine inter-concept relations besides structural semantic relations from text. The query processing principle is then appropriately extended to answer relation-based complex user queries over a curated database. This has been tested over biomedical document repositories, in which relations play an important role in focused information retrieval. Since mining can yield a wide array of relations, these relations are subjected to a significance analysis to identify the key relations of a domain. The significant relations are used for enhancing the underlying concept ontology into a relational ontology.

Table of Contents