

# Chapter 20

## Hybrid Fuzzy Neural Search Retrieval System

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### ABSTRACT

*Search engines are crucial for information gathering systems (IGS). New challenges face search engines concerning automatic learning from user requests. In this paper, a new hybrid intelligent system is proposed to enhance the search process. Based on a Multilayer Fuzzy Inference System (MFIS), the first step is to implement a scalable system to relay logical rules in order to produce three classifications for search behavior, user profiles, and query characteristics from analysis of navigation log files. These three outputs from the MFIS are used as inputs for the second step, an Adaptive Neuro-Fuzzy Inference System (ANFIS). The training process of the ANFIS replaced the rules by adjusting the weights in order to find the most relevant result for the search query. This proposed system, called MFIS-ANFIS, is implemented as an experimental system. The system performance is evaluated using quantitative and comparative analysis. MFIS-ANFIS aimed to be the core of intelligent and reliable search process.*

### 1. INTRODUCTION

The increasing growth of available Internet data, produced by a great number of heterogeneous providers, has great potential in various domains like IGS (Tao, Li, & Zhong, 2011). Centralized traditional search process poses a serious problem in finding the relevant information for a given query. We still need more time examining the retrieved Web sites than the time needed to retrieve the list of the Web sites (Das & Kalita, 2016). Meanwhile recent research in intelligent systems development to improve the search process uses new methods, such as Web Content Mining (Bock & Hettenhausen, 2012), Web Structure Mining (Putra & Akbar, 2013) and Web Usage Mining (Sisodia & Verma, 2012). Search engines should progress from being Web document retrieval tools to become intelligent systems that fully support user's behavior during their interactions with the Web (Klus, Kapahnke, Schulte, Le-

DOI: 10.4018/978-1-5225-1908-9.ch020

cue, & Bernstein, 2015). This creates novel and exciting research challenges ranging from the ability to recognize tasks from the issued queries (Lucchese, Orlando, Perego, Silvestri, & Tolomei, 2013), to the design of new recommendation strategies and user-customized search for showing relevant results (Dao, Hoang, Ta, & Tho, 2013).

While the navigation search behavior can help the Web master to restructure their Web sites, we can also use the history of query text produced by users and also the user profile to predict the most relevant information (Yu, Ma, Hsu, & Han, 2014). Having an adaptive Web search process based on navigation search history, user profile and query text is our motivation for this work.

In this paper, we face the problem of inefficient search engine retrieval by proposing a hybrid intelligent system aimed to enhance the search result based on the user needs. This will save user's time and increase their satisfaction. By using the Web browsing behavior, user profile, and needed query, we implement an intelligent system that can predict the most relevant Web sites regardless of the rank of these Web sites. The proposed system improves the performance of the search engines by providing intelligent recommendations not only matching based on the ranking of the Websites.

The proposed system architecture is divided into two stages. The first stage is composed of three parallel fuzzy subsystems that use navigation search data, profile data, and query data independently to generate three outputs based on fuzzy rule-based inference engines. In the second stage these three outputs are used as inputs for an Adaptive Neuro-Fuzzy Inference system to generate the most relevant search results using back-propagation learning algorithm.

The rest of this paper is structured as follows. Section 2 reviews the recent research in Web mining and intelligent Web search engines. Section 3 describes the proposed system and the rationale behind our design. Section 4 explains the system implantation procedure; some experiments are explained and evaluated. The paper concludes in section 5.

## **2. RELATED WORK**

In Web mining (Jiang, Pei, & Li, 2013) the miner tries to benefit from the data created through the sessions of surfing the Web or behavior of this surfing. Although Web content and structure mining use real and primary data on the Web. Web usage mining extracts also from the secondary data originated as a result of the user interactions during Web sessions. Information in Web usage covers data from server access logs, proxy server logs, browser logs, to user profiles, registration data, user sessions or transactions, cookies, user queries, bookmark data, mouse clicks and scrolls, and any other data as the results of interactions (Umagandhi & Kumar, 2013).

Intelligent Web mining supported by semantic based search leads to a useful pattern for better search process (Bollegala, Matsuo, & Ishizuka, 2011). This area of research addresses the optimization of the structure and the connection of the Web sites (Yang, Sun, Tang, Ma, & Li, 2015).

Soft computing is one of the emerging approaches that has been used in intelligent search engines area because of its parallels reasoning and ability to learn in an environment of uncertainty and imprecision (Szczepaniak, Segovia, & Zadeh, 2012). Neural networks and fuzzy logic are two powerful techniques in soft computing; the hybridization of both techniques would inherit all the advantages of both techniques. Problems that have dynamic nature and uncertain input are a good application for such techniques.

In particular, soft computing techniques have been used to improve Web page ranking and structuring using genetic algorithms (Yan, Gui, Du, & Guo, 2011), artificial neural networks (Mohammad, Thabtah,

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