

December 1998

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## Recommended Citation

Gregg, Dawn, "DSS Access on the WWW: An Intelligent Agent Prototype" (1998). *AMCIS 1998 Proceedings*. 55.  
<http://aisel.aisnet.org/amcis1998/55>

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# DSS Access on the WWW: An Intelligent Agent Prototype

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## Abstract

*This paper describes a prototype DSS Discovery Agent, an intelligent agent designed to facilitate access to DSS deployed using an Open DSS protocol. The agent utilizes a set of specialized HTML metainformation headers to determine whether a given Web site contains a Decision Support System (DSS) and whether that DSS meets user defined requirements.*

## Introduction and Background

Today, technologies like the World Wide Web WWW and corporate Intranets have made it possible for people to share vast and varied information with other individuals both within their organization and in the world at large. At present the Internet provides access to thousands of gigabytes each of software, books and papers, raw scientific data, menus, meeting minutes, advertisements, video and audio recordings, and more. Increasingly, competitive firms are tapping this information source to meet their decision support needs. However, coordinating and effectively using all of this information is a monumental task, that can take time, cost money and lead to information overload.

Intelligent search engines currently are being used to automatically classify and index the collections of data. But, these search engines cannot classify resources on the Internet that are not text based. This leaves decision-makers without adequate mechanisms for discovering a wide range of resources that are potentially useful to business people. These resources include graphical information, software, intelligent agents, and decision support systems.

One method that has been proposed for improving discovery of non-text resources is Web page labeling. This technique uses labels or metainformation to identify the content and quality of non-text information. These labels must be developed to provide the information necessary for specific domains. One such specialized labeling scheme has been developed for decision support systems (DSS). In 1995, Goul et al. proposed a protocol suite that utilizes a set of specialized headers to provide basic information about a DSS to automated intelligent search agents. The metainformation headers are used to specify any information necessary to evaluate a DSS.

The purpose of this paper is to present a prototype intelligent agent that allows automated discovery of DSS that are distributed using the Open DSS protocol. The *DSS Discovery Agent* is an artificial intelligence based expert system. It traverses links to a specifiable depth beginning at a URL passed as an argument. The intelligent agent identifies DSS and performs keyword filtering to determine if the DSS meets a set of end-user criteria.

## The Open DSS Protocol

The Open DSS Protocol approach for DSS deployment allows DSS to be distributed on individual web pages, consistent with the way other types of data are currently being offered. It is a general protocol that provides facilitated access to DSS using existing Internet application layer protocols. It consists of two layers, the Metainformation Layer and the Transaction Layer. The advantage of an open protocol is that the automated intelligent search agents, like the *DSS Discovery Agent*, have the capability of finding any DSS compliant with the protocol.

The *DSS Discovery Agent* retrieves the information contained in the Metainformation Layer of the protocol to determine if the DSS meets the user-specified requirements. This layer utilizes a set of specialized headers to provide basic information about the DSS to the automated intelligent search agents. The header information is in a consistent format so that the automated *DSS Discovery Agents* can filter the Web pages correctly.

The basic information necessary for DSS metainformation includes the content type (DSS), a list of keywords, and a description of the DSS. The metainformation layer also contains parameters related to DSS functionality. These parameters were selected based model management research. The goal of much of this research has been to develop techniques to select or construct appropriate models to be run so as to provide the appropriate answer. To date there has been no universally agreed upon method for representing and specifying DSS models. However, at a minimum, a DSS representation scheme should include descriptions of the stimuli (inputs) and responses (outputs), state (data structures), and procedures (control structures). The Open-DSS protocol metainformation currently includes functional parameters related to the problem domain of the DSS, the solution options, the inputs, the outputs and assumptions made.

The Open-DSS protocol also includes metainformation information on the resources required to execute the DSS. These include information on the hardware requirements (e.g., computing platform), software requirements (e.g., operating system or

application needs), and any specific user skills required to use the DSS. Finally, the metainformation contains all other information necessary to purchase and download the DSS. This includes information on the DSS cost, its references, related DSS, and vendor information [14].

The Open-DSS protocol discussed in this section provides one mechanism for deploying DSS on the WWW. However, the protocols and standards discussed here will be required to evolve to respond to the ever-changing WWW environment and to meet the changing needs of its users. Additional information on the Open DSS Protocol is available at: [http://www.public.asu.edu/~dgregg/dss\\_protocol](http://www.public.asu.edu/~dgregg/dss_protocol).

### How the System Works

The *DSS Discovery Agent* application provides the basic functionality necessary to locate pages created in compliance with the Open DSS protocol. The *DSS Discovery Agent* can connect to a specific web site and evaluate the site metainformation to determine if it contains a protocol compliant DSS. The goal of this application is to help the user find DSS that meet their individual needs, needs of their team and/or the needs of their organization either on the WWW or company Intranet.

An initial prototype of the *DSS Discovery Agent* has been completed and is currently being validated. It is available for testing at [http://www.public.asu.edu/~dgregg/dss\\_protocol](http://www.public.asu.edu/~dgregg/dss_protocol). The agent is written in Java. It accessed via three main GUI controls. A **List** of Web site URLs to be searched, a **List** of DSS sites found, and a **TextArea** that displays connection and error messages. Users are allowed to select specific Web sites to be searched or may choose to conduct a search of sites indexed by the **Metacrawler** search agent. Once the starting location for the search has been selected, the user specifies the depth (number of links to be traversed) of the search and a "Searcher Agent" thread is begun.

The searcher agent evaluates the header information for each site it visits and determines if the site contains a protocol compliant DSS. If it does, the metainformation is downloaded and a DSS Specification object is created. This specification information is used to automatically evaluate the DSS based on a set of user defined keywords. Currently, the evaluation consists of counting the occurrence of each keyword in the specification, and then computing the sum. This sum is the overall score for the DSS and is displayed in the list of DSS sites found along with the DSS title. Users can select individual DSS from the list of DSS sites found and view the DSS specification or the individual counts for each of the keywords.

The searcher agent then parses the body of the html Web page to find links to other web pages. These links are used to develop a graph of additional web sites to be searched. The *DSS Discovery Agent* utilizes an iterative deepening search strategy. In this approach, links that are found are added to the front of the queue of nodes to be searched. To minimize loops and dead ends nodes are only added to the queue if they are different from the parent web page, the grandparent page and the other child pages already discovered. The maximum depth chosen by the user is used to limit the search to a maximum depth of the tree and this depth can be increased once the initial search is completed.

### Conclusions and Directions for Future Research

This article discussed the design of a prototype intelligent agent that facilitates discovery of DSS that are distributed using the Open DSS protocol. It provides a first step in the development of systems to automatically process Web based information. Future versions of this system may have the intelligence necessary to select candidate DSS based on the metainformation and then rank the DSS based on how well they meet the users needs. In addition, future intelligent agents should be able to select a set of DSS that could be integrated to solve a larger problem. These intelligent search agents can be considered DSS themselves, because they will aid end-users in the overall decision making process.

This system provides a mechanism to improve information discovery on the Web. However, for the Internet to become an effective information resource for business, more methods for "automatically understanding" all types of Web information must be created. With modest effort, the *DSS Discovery Agent* discussed in this paper could be tailored to digest information in many different formats, and offer custom knowledge discovery services on the Internet. We intend to continue development of this agent and other agents like it. We would appreciate any comments or insights you have: please forward them to dawn.gregg@asu.edu. Your comments and insights will be used to guide us as we work to refine implementation details for both the *Open-DSS Protocol* and the *DSS Discovery Agent*.

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