

# Applying Artificial Intelligence Principles to Portal Customization - A Theoretical Approach

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## Abstract

The Portal is one of the hottest topics in the Web environment, and has been for a while due to its multi-disciplinary focus. Their ability to be customized is what differentiates portals from standard websites. Two common and widely-used forms of customization are based on preset user profiles and preferences. This paper takes a look at portals from a different angle - an angle based on Artificial Intelligence, robotics, intelligent agents and adaptive systems. Portals and Artificial Intelligence are much-researched topics in their respective fields. However, less academic research has been conducted in bringing these two disciplines together. This paper defines certain key terms and discusses a third form of Portal customization, one that requires a learning and adaptive back-end system and is based on user habits and usage patterns.

**Keywords:** artificial intelligence, portals, usage patterns, customization, adaptive systems, intelligent agents

## 1 Introduction

Ever since 1920, when Karel Capek created the word "robot" for his play called "R.U.R.: Rossum's Universal Robots" [1], man has associated robots with independent, mechanical, human-like entities able to perform certain tasks and, although the term Artificial Intelligence (AI) was only coined thirty six years later, robotics is defined as an area of AI.

More recently, with the creation of ARPANET (which evolved to become the Internet) by the United States of America's Advanced Research Projects Agency in the 1960's, and the World Wide Web (Web) by Tim Berners-Lee and scientists at CERN, Geneva in the late 1980's, the number of Internet hosts increased from 4 in 1968 to 3.2 million in 1994 and the number of websites increased from 50 in 1992 to an estimated 3,000 in 1994 [2] and [3]. Since then the number of hosts and websites have increased exponentially. The number of hosts, according to Lotter, reached 140 million in 2001 while, according to OCLC Office of Research, the total number of websites reached 8.7 million in the same year [4].

Not long after 1994, when the Web became a commercial playing field with many websites being electronic company brochures and research articles, websites with dynamic content, or otherwise referred to as dynamic websites, started to appear. Combined with the new-found dynamic abilities, a number of websites set out to bring some order to the wealth of diverse information on the Web by undertaking to become single points of entry that allow for user customization [5]. Portals had emerged.

Traditionally, portal customization allowed for two methods namely profile- and preference-based. Profile-based customization refers to users belonging to a predetermined group and thereby inheriting the group's customization settings, for example Faculty of Engineering staff will be presented with all Faculty of Engineering content including news, events, research items, links, etc. Preference-based customization refers to users specifying their unique customization settings based on relevance, for example users select the content that is of particular interest to them and with which they wish to be presented.

However, a third method of customization, based on usage patterns, is identified and discussed in this paper to determine whether it would be possible for a learning and adaptive system to analyze each user's unique usage patterns in real-time and dynamically build a personalized portal, based upon predetermined groups and information resources as well as the user's unique, everyday habits.

### 1.1 Research problem

Can portal customization be enhanced by applying Artificial Intelligence principles?

### 1.2 Research methodology

To answer the question posed by the research problem, the author has undertaken a literature study in which artificial intelligence and robotics, websites and portals, as well as personalization and other related terms are defined.

Furthermore, the author studied a case to identify key customization features of portals and discuss whether such features could be enhanced through the application of Artificial Intelligence principles.

## 2 Definition of terms

### 2.1 Artificial Intelligence

*AI* is a discipline of computer science that focuses on software development and the writing of computer programs that are able to solve problems creatively [6]. According to Alan Turing's theory known as Turing's test, when something is placed behind a curtain and it talks without the audience being able to tell whether or not it is a human being, it is *AI* [7]. John McCarthy defined *AI* in 1956 as "The branch of computer science concerned with making computers behave like humans" [8]. In summary, *AI* is intelligence revealed by anything manufactured [9].

### 2.2 Adaptive systems

An *adaptive system* is a system that is capable of monitoring its own performance and able to adjust or vary its own parameters [10]. An *adaptive system* is an information processing system with insufficient knowledge and resources that has the ability to adapt to its environment [11]. According to Eklund & Sinclair [12], an *adaptive system* reflects some features of the user in the user model and applies that model to adjust a number of visible and functional characteristic of the system. From these and other definitions, it appears as though the term *adaptive system* is used in various contexts. Therefore, and for the purposes of this paper, *adaptive system* is defined as an interactive system that adjusts its actions for each user, based on assumptions from information about the user, as defined by Jameson [13].

### 2.3 Robotics

A robot is a physical, man-made entity with a feedback-driven, intelligent connection between sense and action [14]. *Robotics* is the area of Artificial Intelligence that is concerned with the practical and physical application of computer programs and the use of robots [6]. Therefore *Robotics* is defined as "devices that can move and react to sensory input" [7].

### 2.4 Web bots

Intelligent agents are software entities that, with some degree of autonomy, perform operations on behalf of a user while employing some knowledge of the user's objectives [15]. *Web bots* are intelligent agents that move throughout the Web accessing web pages while gathering information to build, for example, search engine indexes, and are referred to as robots that exist only in code [14].

### 2.5 Internet

The *Internet* is defined as a network of networks, linking computers to computers by means of the TCP/IP protocol [16]. Khan [17] states that the *Internet* is a logical, global interconnection of many, otherwise independent, computers, communication entities and information systems using a set of common communication standards, procedures and formats. Thus, the *Internet* is a worldwide collection of computer networks, using a common software standard to cooperate with each other to exchange data in a client/server or peer-to-peer architecture [18].

### 2.6 World Wide Web

For half a century, a universal database of knowledge has been envisaged, and finally, similar to the W3C's [19] definition of the *World Wide Web* (Web) as being the "universe of network-accessible information, the embodiment of human knowledge", Hughes defines the *Web* as a "wide-area hypermedia information retrieval initiative aiming to give universal access to a large universe of documents" [20]. Therefore, the *Web* is defined as the Internet-based facility that allows users to access information that is stored on various computers throughout the world by means of the hypertext transfer protocol (HTTP).

### 2.7 Website

A *website* is a space on the Web consisting of one or more digital pages that contain text and multi-media content (e.g. graphics, audio, etc.) that are written in an Internet standard code such as HyperText Markup Language (HTML), and are linked together by means of hyperlinks [21] and [22].

### 2.8 Portals

A *Portal* is seen to be a Website that is or sets out to be a major starting point consisting of services and resources for users who connect to the Web [23]. Similarly, a *portal* is defined as a "supersite" that provides an all-inclusive entry point for a vast array of resources and services [24]. Going a step further, a *portal* is a Web system capable of authenticating and identifying users in order to provide them with a personalized and insightful interface that facilitates access to content that is relevant and of primary interest to the users [25].

### 2.9 Personalization

*Personalization* is the ability for a Web user to customize the content and layout of a Portal page [26]. Furthermore, *personalization* is a powerful tool that allows one to select the content, presentation, and functionality of the portal according to one's unique preferences and needs [27].

### 3 University of Johannesburg

#### 3.1 Background

Two higher education institutions in Johannesburg, South Africa, namely the Rand Afrikaans University and the Technikon Witwatersrand, will merge to form the University of Johannesburg (UJHB) in January 2005. These institutions have embarked on conceptualizing and designing the new UJHB Web presence. This Web presence is multi-faceted, with various online systems targeting different groups, including staff, current students and prospective students. Currently, each of these online systems is to a great extent unrelated and independent of the others. The objective is therefore to combine these online systems into one system, the UJHB Portal. The challenge is to continue providing each target group with relevant content.

It is proposed that the academic programmes and marketing-related content, targeted mainly at prospective students, be presented to all users the first time they access the portal. Thereafter content can be personalized by means of portal customization.

#### 3.2 Profile-based customization

After accessing the portal for the first time, staff would be able to sign on and, in the traditional sense of customization based on their sign-on credentials, be recognized as being members of staff who belong to, for example the Department of Computer Science in the Faculty of Science. The profile-based method of customization would adjust the portal settings in that only content relevant to the Department of Computer Science and the Faculty of Science would be presented to the staff member.

Although already filtered, this may still result in information overload, and would need to be refined further. Besides, a lecturer may have different requirements regarding content than what a secretary may have.

#### 3.3 Preference-based customization

Preference-based customization would allow a staff member to select relevant items that are of interest to him/her within his/her predetermined profile, for example content relating to Genetic Algorithm and Intelligent Control, and not Computer Graphics and Compiler Construction.

One limitation is that other relevant content may be obscure or hidden from the user, for example lecturers may be guest lecturers in other faculties, or may be assistant coaches of sport teams.

This limitation could be overcome by applying Artificial Intelligence principles and techniques during the registration and authentication process.

#### 3.4 AI-based customization

Anything manufactured that exhibits intelligence is considered to be AI [9]. Problems, search and knowledge representation form the basis for many AI systems. Facts and the representation of facts are two entities when knowledge is represented. Facts are regarded as the knowledge level and the representation of the facts, the symbol level [28].

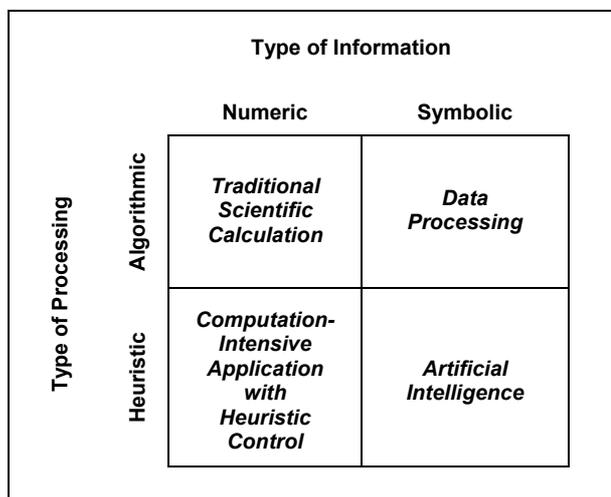


Figure 1: Four areas of computing [29]

To generate intelligent solutions to problems, AI systems use complex interrelations of variables and symbolic computation, as depicted in figure 1 [29]. Such solutions are considered to be intelligent because unpredictable situations are accommodated. However, problems cannot be stated in the way required by deterministic and sequential algorithms because they are often unstructured.

Objects, events, performance, and meta-knowledge are types of knowledge that may need to be represented in AI systems. Such knowledge is used when learning and interacting with existing facts, retrieving, and reasoning [30].

Reasoning is the ability to derive at something that is unknown from something that is known [31], for example drawing the conclusion that Professor Scott is interested in research, from:

- Professor Scott is a lecturer
- Lecturers are interested in research.

Therefore, problems can be solved by considering the appropriate form of knowledge representation and using algorithms to solve parts of the problem.

Because AI regularly supports human decision-making and involves search and inference, it is not uncommon to view AI system as finding solutions to problems in a similar way as humans [32].

To illustrate portal customization and whether Artificial Intelligence principles could enhance personalization, a scenario based on the UJHB web

initiative is created using an academic process as an example.

### 3.4.1 Facts

For the purpose of the scenario, the following facts are taken into consideration:

- Dr Simpson *belongs to* Department of Computer Science
- Dr Simpson *is a* head of department
- Dr Simpson *is a* lecturer
- Dr Simpson *does research in* Intelligent Control
- Prof Scott *belongs to* the Department of Computer Science
- Prof Scott *is a* lecturer
- Prof Scott *does research in* Genetic Algorithm
- Ms Smith *belongs to* the Department of Computer Science
- Ms Smith *is a* secretary.

### 3.4.2 Assumptions

Furthermore, a number of assumptions are made and include:

- Department of Computer Science *is part of* the Faculty of Science
- Heads of departments *are interested in* staff administration
- Heads of departments *are interested in* student administration
- Lecturers *are interested in* research
- Lecturers *are interested in* class schedules
- Secretaries *are interested in* student administration
- Secretaries *are interested in* class schedules
- Secretaries *are interested in* travel
- Academic conference *is part of* research
- Academic journal *is part of* research
- Academic database *is part of* research.

### 3.4.3 Reasoning

The AI system could customize the portal settings for each user [13], and provide Dr Simpson, Prof Scott and Ms Smith with relevant content, for example:

- Dr Simpson, Prof Scott and Ms Smith would have access to faculty and department notices.
- Dr Simpson would have access to the staff administration system.
- Dr Simpson and Ms Smith would have access to the student administration system.
- Dr Simpson and Prof Scott would have access to various conference, journal and database resources.
- Prof Scott and Ms Smith would have access to the class schedules.

- Ms Smith would have access to travel information.

### 3.4.4 Autonomy

The AI system would furthermore deploy intelligent agents or Web bots [14] to refine the content, for example:

- Dr Simpson and Prof Scott would have access to various conference, journal and database resources *relating to their respective fields of research.*

With such relevant information readily available, lecturers would easily be able to identify conferences to which they may submit papers in response to the call for papers.

### 3.4.5 Influencing factors

To demonstrate the effect of an ever-changing environment, the following facts are taken into account:

- A paper of Dr Simpson is accepted at the University of Cape Town
- A paper of Prof Scott is accepted at the University of Manchester

The AI system would have learnt of these papers' acceptance and may have deployed Web bots [14] to locate the most relevant travel and accommodation resources relating to Cape Town and Manchester which could then automatically feature prominently in Ms Smith's portal pages.

The information retrieved by the Web bots could typically consist of the lowest fare air travel and accommodation and could be used almost effortlessly to make the necessary bookings and travel arrangements for Dr Simpson and Prof Scott.

### 3.4.6 Adaptive system

This example briefly illustrates the AI system's ability to adapt to the influence of external variables. Over time, the AI system could learn from each user's unique interests and habits, and adapt the portal and Web bots' settings accordingly [12], thereby providing only relevant content with the most accurate and current being presented prominently.

This could be demonstrated by analyzing Dr Simpson's unique usage patterns (i.e. tracking webpage metadata, keywords and click stream) and establishing that he browses only local conference resources. The assumption could be made that international conferences are not of particular interest to him. The AI system could then alter the portal settings and present Dr Simpson with content relating to only local conferences.

In much the same way, the AI system could learn from Prof Scott's personal preference that he only

travels by air and rental car and stays only at hotels. The Web bots that would be deployed to retrieve travel information would automatically limit their search to only the applicable criteria and return only the most relevant content.

## 4 Conclusion

This paper set out to determine whether portal customization could be enhanced by applying Artificial Intelligence principles.

To bring the two disciplines together and set the scene, Artificial Intelligence, adaptive systems, robotics, intelligent agents, the Internet, the World Wide Web, websites, portals and personalization were defined.

Furthermore, the paper focussed on a Web initiative and discussed academic processes as examples to identify key portal customization features. Although the examples focussed on staff utilization of the portal, another scenario could be created to illustrate the students' portal utilization.

From the discussion and examples, it was established that the application of Artificial Intelligence principles would indeed enhance portal customization beyond the traditional profile- and preference-based customization. Enhanced portal customization will in turn result in increased productivity.

Further research may be undertaken to identify obstacles in the practical implementation and integration of AI in portals as this fell outside the scope of this paper.

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