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Identification of sport talents using a web-oriented expert system with a fuzzy module

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ABSTRACT

This paper presents a fuzzy expert system for scouting and evaluation of young sport talents. Based on the knowledge of several human sport experts, various motoric skills tests, morphologic characteristics measurements and functional tests are quantized according to their importance for a chosen set of sports. Obtained values are entered into the knowledge database along with the grades of the measured results for each test. Fuzzy logic is implemented in order to make the system more flexible and robust. The whole system is web-oriented, i.e. developed ASP.NET application is available to the internet users with a proper login and password. The developed expert system gives acceptability prediction and proposal of the most suitable sports for the person being tested. The output results of the system were evaluated by 4 experts, using real data collected during several years.

Comparison is done between the sport proposed by our expert system and the actual outcome of the person's sports career. Also, the comparison of the expert system output and the human expert suggestions were done. All tests showed high reliability and accuracy of the developed system. Strengths, possibilities and future plans of the Sport Talent expert system are also discussed.

1. Introduction

Numerous sport clubs, parents and sportsmen are permanently seeking the answer to the question: how to recognize a talented child and which sport is the most appropriate for him or her? The correct answer is not trivial at all because it demands adequate input information about the observed person, as well as the knowledge of what this information should include. In other words, expert knowledge is needed in order to predict the sport with the highest expectation rate for the observed individual, based on available data.

Similar methodology and knowledge can be implemented and used in order to predict future results of adult sportsmen, but a distinction should be made because a reliable prediction for children is much more difficult. Changes during puberty can significantly influence the prospects of a future sportsman. However, extensive research that has been done in order to test, analyze and compare athletes of various sports (MacDougall, Wenger, & Green, 1991; Stergiou, 2004) brings precious information and knowledge that can be used for the sport talents identification, also.

Comparison of children aged 8–16 can be done on the basis of normative test values (Findak, Metikoš, Mraković, & Neljak, 1996). As one would expect, importance contribution of each test is not the same. Also, importance of each test varies according to the sport chosen. Implicitly, this statement is confirmed by Norton and Olds (2001) in their study of morphological evolution of athletes of various sports during the last century. Additionally, the study conducted by Norton and Olds brings important data regarding morphological trends that can be used for updating some normative values presented by Findak et al. (1996). Based on the set of tests that are already present in elementary and secondary schools, previous research by the authors suggested that the problem's solution should be based on expert and scientific knowledge of relevant motoric skills tests, morphologic characteristics measurements and functional tests (Rogulj, Papić, & Pleština, 2006).

During our search for the right or satisfying solution of sports talent recognition, we should overcome two main problems. The first one is a very difficult task of finding an expert in this field, since the domain of specific knowledge is separated into various sports and, generally, experts have in-depth knowledge of the relevant factors for a specific sport and more superficial for other sports. The second problem is that the knowledge and the results obtained by the system's output should be widely available, independent of the time of day and the conditions (outdoor, indoor). All these facts lead to the decision of developing a computer based

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expert system (Hopgood, 2003; Rajeev, 1996). The attempt to bring expert knowledge closer to the users in the field requires use of new technology and possibilities that it brings. As a natural solution, the development of such a system should include accessibility through Internet.

Expert systems methodologies may be classified into eleven categories: rule-based systems, knowledge-based systems, neural networks, fuzzy expert systems, object-oriented methodology, case-based reasoning (CBR), system architecture development, intelligent agent (IA) systems, modeling, ontology, and database methodology together with their applications for different research and problem domains (Liao, 2005). Knowledge acquisition from the experts can be done using several approaches with different levels of automatization (Tecuci, 1991) and determination procedures of the factors weights (Hessami & Hunter, 2002). Generally, knowledge acquisition techniques that are most frequently used today require an enormous amount of time and effort on the part of both the knowledge engineer and the domain expert. They also require the knowledge engineer to have an unusually wide variety of interviewing and knowledge representation skills in order to be successful (Wagner, Chung, & Najdawi, 2003). As a result, inclusion of the experts with the knowledge from both worlds, in the development of the expert system is a pre-request that should be satisfied if possible.

The World Wide Web is emerging as an increasingly important platform that can reduce technological barriers and make it easier for users in different geographical locations to access the decision support models and tools (Bhargava, Power, & Sun, 2007; Shim et al., 2002). Existing stand-alone applications can be converted to the java-based web applications (Alpert, Singley, & Fairweather, 1999), but there are also other web-based ITS architectures that can be used. Internet based expert systems can have different architectures, such as centralized, replicated or distributed (Bardina & Thirumalainambi, 2005). This categorization is done according to the place where the code is executed (Šimić & Devedžić, 2003). Another, similar categorization (Kim, Song, & Hong, 2005) of the existing methodologies is into two categories, the server-side and the client-side, depending on the location of the inference engine of a Web-enabled, rule-based system. The server-side category can be further divided into three more detailed categories, the CGI program, the server-side script, and the Web server embedded module, depending on the types of inference engine implemented. The client-side category may be classified into two sub-categories, the external viewer and the Java applet.

Applications of the Web-enabled expert systems based upon client–server architecture for planning (Li, 2005) and decision-making using a multi-agent approach (Li, 2007; Shaalan, El-Badry, & Rafea, 2004) are becoming more and more popular. Although most of the Web-enabled, rule-based systems have been developed using CGI technology, less burden to Web servers is present when the ASP as the server-side script approach (Wang, 2005) is used.

Expert system applications development is a problem-oriented domain. Very generally speaking, our interest can be described as the evaluation of a particular subject according to some demands or rules (Drigas, Kouremenos, Vrettos, Vrettaros, & Kouremenos, 2004; Hinkemeyer, Januszewski, & Julstrom, 2006). Vagueness of expert knowledge, grades and some other data needed for the solution of our problem resulted in the necessity of fuzzy logic implementation (Siler & Buckley, 2005; Zadeh, 1965) and the approach that can, in some aspects of fuzzy logic implementation, be compared to the solution proposed by Weon and Kim (2001) or the system developed by Bai and Chen (2008) for the evaluation of students' learning achievement.

The use of the expert systems for the assessment of sports talent in children have been reported in the past (Leskošek, Bohanec, Rajkovič, & Šturm, 1992). Some results obtained by this research were used for the development of a more specific expert system for the basketball performance prediction and assessment (Dežman, Trninić, & Dizdar, 2001a,b). Neither of these systems has used web technologies and, as a consequence, has some limitations that can now be overridden. An expert system should be adaptive to constant changes of new standard values and measures as well as open to insertion of new knowledge. Bases of the approach proposed by the authors are described and presented in (Rogulj et al., 2006) but further development and evaluation of the system showed that there are many questions left unanswered. Also, lots of possible improvements regarding methodology, technology and a scope of a possible application can be done. One of the most important improvements concerning reliability of acquired expert knowledge and the desired system flexibility is the introduction of fuzzy logic. More on fuzzy logic and fuzzy sets will be explained in the following section. System adjustments are done after an evaluation of the expert system that was made possible after extensive field research that resulted in collecting a large set of reliable test data.

Our software based solution has the following characteristics: ability of forming a referent measurement database with the records of all potential and active sportsmen, diagnostics of their anthropological characteristics, sports talent recognition, advising and guiding amateurs into the sports activities suitable for their potential. Also, a comparison of the test results for the same person and for overall achievement monitoring through a longer time period is possible.

The rest of this paper is organized as follows. In Section 2, the elements and basic methodologies of our expert system are reviewed. In Section 3, the system architecture is described and explained. Section 4 deals with the system's implementation and evaluation issues and, finally, Section 5 concludes the paper.

2. System elements and methodology

2.1. Knowledge acquisition and input data

The problem with knowledge acquisition is, simply stated, how to efficiently acquire the specific knowledge for a well-defined problem domain from one or more experts, and represent it in the appropriate computer format.

Knowing the purpose of this expert system and having the intention to apply the system in outdoor and indoor situations, an already existing set of eleven tests for children's evaluation has been chosen. These tests can be divided into three groups: motorical, functional and morphological tests. Conduction of the tests is mandatory for all children age 6–18 during every school year. Thus, having the scope of possible inputs well-defined, a questionnaire was prepared. Two main, yet correlated, questions were the basis of the questionnaire. The first one is how do the particular expert estimates importance for each of the three main test groups, in order to determine the subject's potential in a particular sport. The second question is similar, but focused on each individual test and its importance to the subject's potential in a particular sport.

The questionnaire was handed out to 97 kinesiology experts. There were two groups of experts: general knowledge experts (kinesiology teachers in high and elementary schools) and experts in a particular sport (trainers and university professors). Because of different scopes and depths of their knowledge, extensive data processing and adaptation of acquired knowledge was done after the answers to the questionnaire were given. An expert in the particular sport had to rate the importance of each test evaluating only the sport of his/her expertise while general knowledge experts evalu-