A neuro-fuzzy approach for adaptable user interface implemented in the information system of Bulgarian parliament

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1. Introduction
When users confront systems with large amount of information often they get lost by it and are unable to find the information items they are interested in. It is also necessary to provide an interaction structure of the information system adapted to the user. For this purpose an approach for adaptation of user interface is presented. Based on this approach a software tool is developed. The feasibility of adaptable user interface was demonstrated by help of the menu-based information system of Bulgarian parliament.

2. Description of the neuro-fuzzy-based approach
In order to adapt the user interface of an information system we propose to use the stored protocols of user dialogue. This information should be retrieved during the user’s work with the system. We suggest to move up the interaction points in the interaction structure of the information system according to their frequency of use. So often used interaction points can be reached by shorter selection pathway in the new interaction structure. Further without loss of generality will be considered hierarchical menu-based interaction structures. The networked interaction structures have no empirically provable performance advantages versus hierarchical interaction structures (Rauterberg, 1995).

For realising the idea to move the interaction points we propose a Neuro-fuzzy approach for adaptation of user interface (NADIA). It is based on the fuzzy backpropagation (FBP) algorithm (Stoeva) and the Huffman’s algorithm (Huffman, 1952). The FBP algorithm combines fuzzy sets and neural networks. The steps of NADIA approach are given on figure 1.

The initial interaction structure in form of a tree is constructed by expert(s) in step 1. The tree nodes represent its interaction points and the leaves - its terminal interaction points (TIP). Using the recorded protocols of the user’s dialogue with the information system the matrix of transitions between all pairs of TIP is determined (step 2), e.g. in case of menu structure they can represent menu action options. The weights of TIP are learned by the FBP algorithm (step 3). Based on requirements of the ergonomic standard ISO 9241-14 the maximal number $m$ of arcs starting from a tree node is determined, i.e. maximal $m$ options in a menu. According to ergonomic requirements (constraints) the vector of the weights of TIP is divided to subvectors (step 4). Using the Huffman’s algorithm for each subvector an interaction substructure with optimal weighted path length tree is generated (step 5). The sum of the weighted path lengths of a subtree with given maximal number $m$ of arcs starting from a tree node is minimal. Then the other interaction substructures are constructed bottom up to form the overall interaction structure with optimal path lengths (step 6), where ergonomic constraints are satisfied.
Determining of initial interaction structure as tree hierarchy

Based on dialogue protocols determining of matrix of transitions between each pair of terminal interaction points (TIP)

TIP weights learning

Partition of TIP weights vector to subvectors according to ergonomic constraints

Construction of minimum weighted path length subtree hierarchy

Are there other TIP weight subvectors

Yes

No

Construction of optimal tree hierarchy

Figure 1. NADIA approach sequence of steps

3. Experimental implementation
The NADIA approach was implemented in a software tool programmed in VISUAL BASIC and running under WINDOWS. It can work as independent system on PC and interact via inter-process communication with specific application systems like DBMS ACCESS. In order to demonstrate the feasibility of a user interface adaptation with NADIA approach the software tool was tested with the information system of Bulgarian parliament. Its data base uses the DBMS ACCESS. Based on records of dialogue protocols of users performing a number of representative tasks with the information system its user interface was adapted. On figures 2 and 3 are shown parts of the interaction structure before and after adaptation.

4. Conclusions
The user interface created by NADIA approach supports the user’s flow of work and facilitates the user’s ability to find and select interaction points relevant for the task. Often used interaction points can be reached by shorter selection path.

Advantages of the approach proposed are: 1) supporting the acquisition of implicit user’s knowledge without representation of knowledge in explicit form, i.e. implicit user modelling which is advantage in comparison to other user modelling approaches, for example (Kobsa, 1994); 2) rapid search/access time; 3) reduction of training needs.

By NADIA approach can be created: 1) system defaults for specific task; 2) system defaults for different user groups (e.g. engineers, economists, etc.; 3) system defaults for different level of user experience; 4) individual defaults.

Further developments are: 1) fast access to specific interaction points through extending the
hierarchical interaction structure to networked interaction structure; 2) adding additional ergonomic constraints according to ISO 9241-14; 3) providing navigational cues by 3D spiral tree visualising the interaction structure (Okuma, 1996).

References
ISO/DIS 9241-14, 1995, Ergonomic requirements for office work with visual display terminals (VDTs). Menu dialogues.