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Software for intercriteria analysis: implementation of the algorithm of intercriteria analysis with weight coefficients of the objects or the criteria

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Abstract: In the current research work an implementation of intercriteria analysis with weight coefficients of objects or criteria is presented. The program workflow is explained. The software can be used for datasets investigation using standard intercriteria analysis approach and the intercriteria analysis with weight coefficients of objects or criteria. Additional options are discussed.
Keywords: InterCriteria Analysis, Weight coefficients, Criteria, Objects, Software, C++.

1. Introduction

In the current research work a software implementation of InterCriteria Analaysis (ICA) with weight coefficients of objects or criteria is discussed. ICA is a decision making approach proposed in 2014 by Krassimir Atanassov, Deyan Mavrov and Vassia Atanassova [5, 8]. InterCriteria Analaysis is defined on the base of index matrix theory [2] and intuitionistic fuzzy sets [3]. The main algorithm is used to investigate real numbers in two-dimensional case [5]. Thereafter, several extensions and modifications of ICA are introduced [14, 18]: Three Dimensional Intercriteria Analysis over Intuitionistic Fuzzy Data [29], Intercriteria Analysis over Intuitionistic Fuzzy Data [13], Intercriteria analysis using special type of intuitionistic fuzzy implications [7], Intercriteria analysis: From pairs to triples [9], An auxiliary technique for InterCriteria Analysis via a three dimensional index matrix [30]. ICA application over normalized data is published [4]. The investigation according to different

number of objects is made [30]. Different algorithm for relation calculation are discussed [25]. Several variations of ICA software are developed: VisicrA and InterCriteria Analysis Data (ICrAData) by Nikolay Ikonomov [16, 17], InterCriteria Decision Making (ICDM) with author Deyan Mavrov [21-23], ICRA scripts for Python by Evgeniy Marinov and ICrA for MATLAB with authors Peter Vassilev and Olympia Roeva [19]. The software presented in current research work is an extension of the InterCriteria Decision Making (ICDM) program with author Deyan Mavrov. A huge amount of investigations applying ICA by presented software are published. The ICA is successfully applied in the fields of medicine and healthcare [1, 10, 11, 26], university rankings [12, 24, 27], ecology [15, 28], economics and finance [20] and etc.

2. Software for Intercriteria Analysis: Implementation of the Algorithm of Intercriteria Analysis with Weight Coefficients of the Objects or the Criteria

The presented software is an extension of the InterCriteria Decision Making (ICDM) program with author Deyan Mavrov. The ICA implementation is written in C++. The program is made using Qt framework. The ICA software is designed to allow the quick application of ICA on a table of input data, which can come either from a Microsoft Excel workbook or a text file with tab-separated values. The last version of the program is upgraded to support the latest extension of ICA, namely, Intercriteria Analysis with Weight Coefficients of the Objects or the Criteria [6]. The functionalities allow to the user to select an option to perform ICA with priorities on the criteria or objects.

The input data for ICA with Weight Coefficients of Objects or Criteria has to include dataset with criteria and objects located in Sheet 1 of the Excel workbook and the weight coefficients assigned to the place for criteria or object names in Sheet 2 (Fig.1).

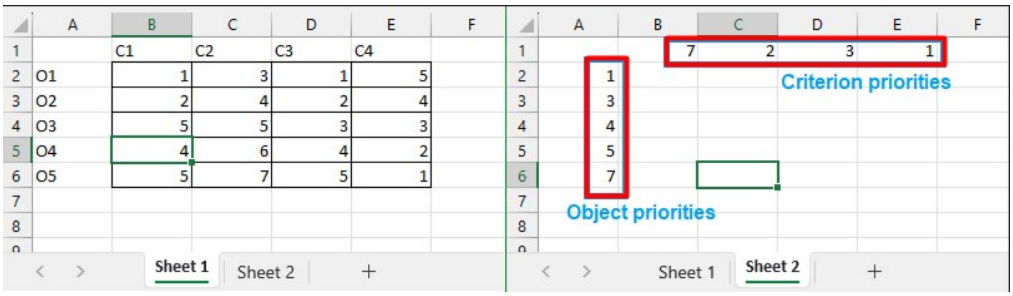

Figure 1. Input format of the data for applying ICA with Weight Coefficients of Objects or Criteria

The first step when the user starts the application is to select the input file to open it in the ICA software (Fig.2). There are four options in *File* menu. Using the first option *Open workbook* the user can load data into the software for analyzing. Selecting the option *Open without performing the analysis* the user will open directly the data from the input file. The third option *Load a precalculated result* loads the resulting data into the program. The *Exit* option close the software.

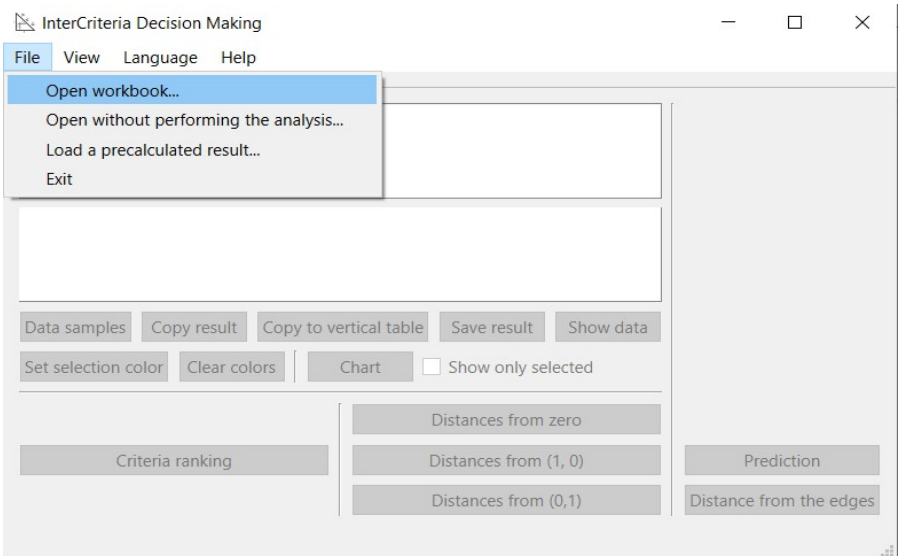

Figure 2. Starting ICA software and select a file

The input file must represent a series of numerical evaluations of a set of objects according to a set of criteria. The program will then execute ICA to generate intuitionistic fuzzy pairs that represent the calculated degree of correlation between every pair of criteria. After selecting the input file, the settings window opens, where the user is given several options to configure the parameters of ICA (Fig.3). The user can select whether the criteria in the input file are given in columns or in rows in section *Input data layout*. The ICA algorithm can be configured to treat two equal pairs of values according to two criteria as increasing either the degree of membership, the degree of non-membership, or both (also called a bias). These options have to be selected from section *When two number pair each give an equality*. If the user checks the *Use object priorities* box, the object priority values are taken into account in the calculation process. The ability to use criterion or object weights is described in [6].

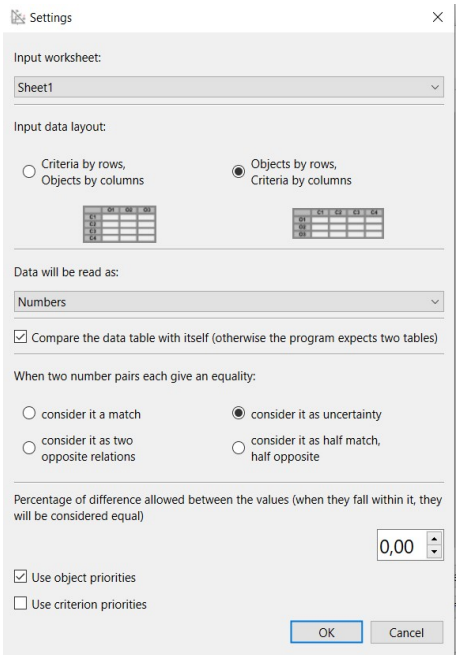

Figure 3. ICA setting window

Finally, the results are displayed in two tables in the program's main window: one for the degree of membership and one for the degree of non-membership (Fig.4). The main window displaying the results has several options for working with data and results.

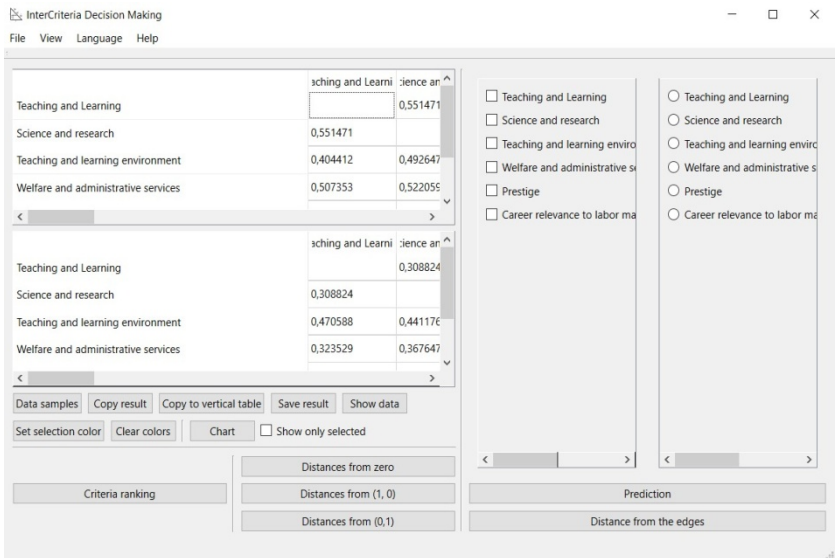

Figure 4. Result after ICA application

Thereafter, after results calculation, the program provides several options for their further analysis, including:

- an option to use the ICA results to make value predictions;
- an option to display the IF pairs as points in the IF triangle, with the ability to show only a selection of points and to color-code the points corresponding to specific criteria pairs;
- an option to explore the points' position in the IF triangle;
- criteria ranking based on the triangle method.

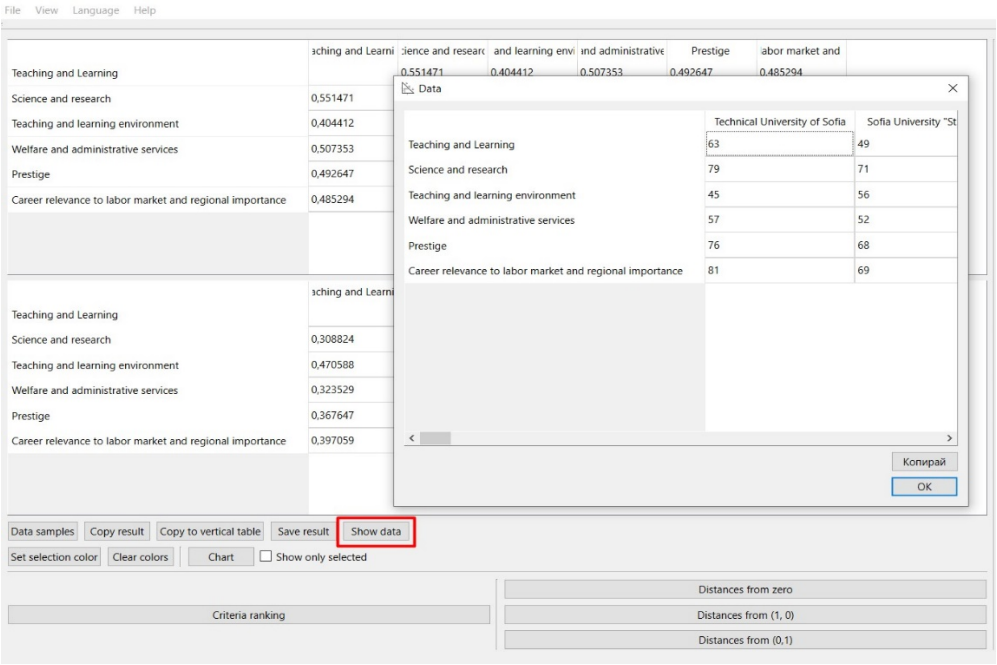

Figure 5. Show data after ICA application

The program can also load data from a previously performed analysis. It also includes an experimental mode for the comparison of logical axiom systems. After ICA application the user can see the input data again using the *Show data button* (Fig.5).

Interesting option in ICA software is the *Criteria ranking* button. It visualizes the ordered list containing the resulting intuitionistic fuzzy pairs representing the criteria relationships (Fig.6).

The options of displaying the IF pairs as points in the IF triangle, with the ability to show only a selection of points and to color-code the points corresponding to specific criteria pairs are presented in Fig.7 and Fig.8.

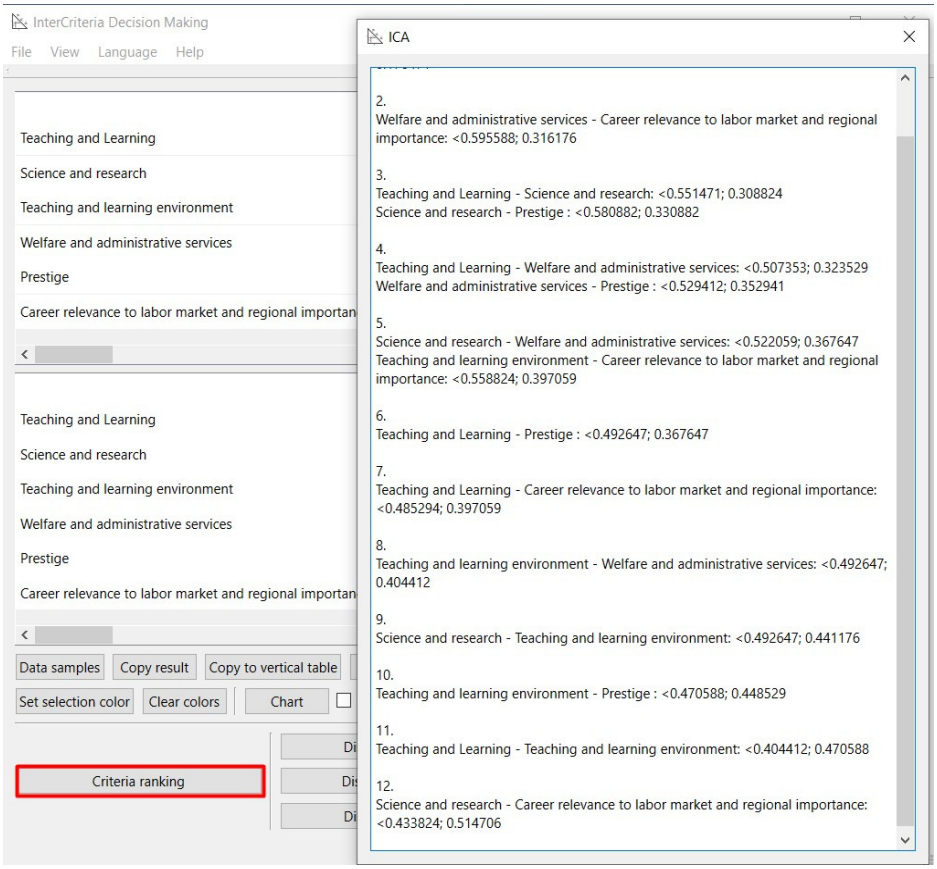

Figure 6. Criteria ranking

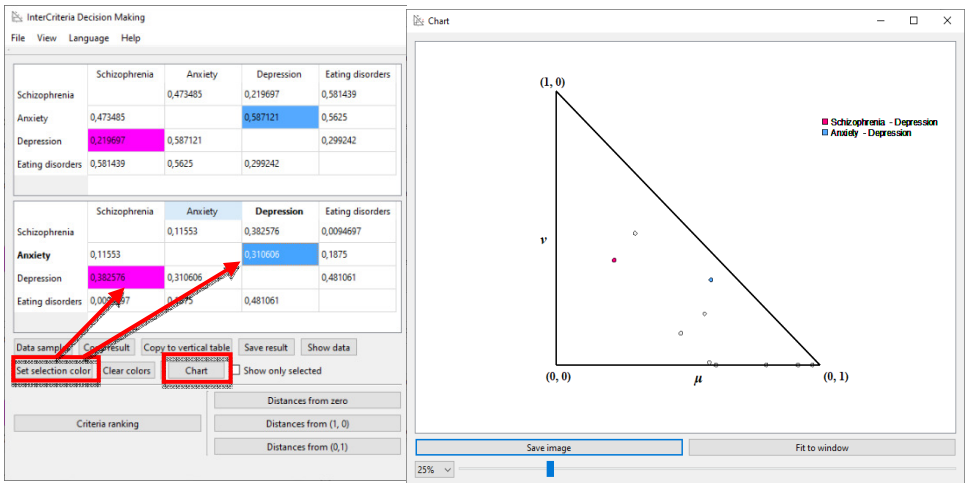

Figure 7. ICA results presented in the IF triangle with color-coded criteria pairs

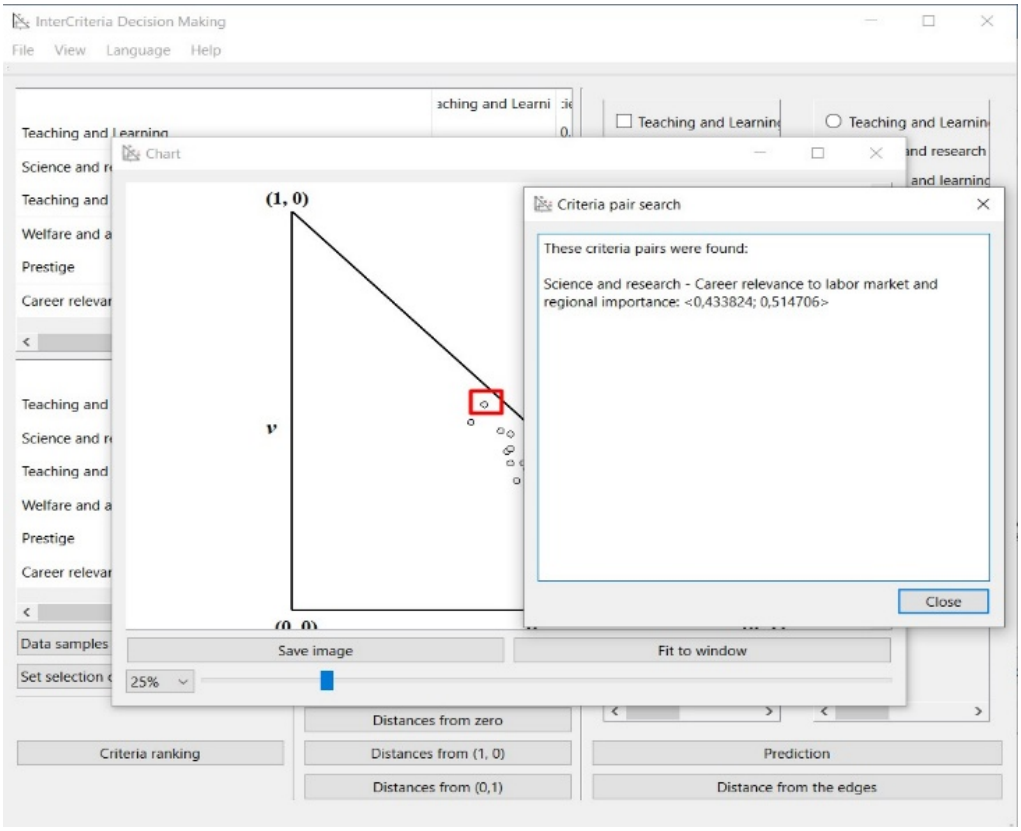

Figure 8. Describing a selected point of IF triangle

The proposed software can be used for analyzing different objects and criteria having weight coefficients. It will provide more accurate results according to the similarities, opposite properties or neutral behavior of the investigated objects.

3. Conclusion

In the current research work a software for intercriteria analysis with weight coefficients of objects or criteria is presented. The implementation allows the user to apply ICA with weight coefficients of the objects or weight coefficients of the criteria in addition to the input dataset. The steps of performing ICA using the proposed software are explained. The workflow is visualized.

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