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Theory and Practice of Pairwise Comparisons

Preface

Weights or weighted attributes are a part of most measurement, indexing and classification techniques. However, when judgments are subjective; weight assignment, and especially weight consistency, is almost always problematic. A ranking or preference is usually defined as a weakly ordered relationship between a set of items such that, for any two items, the first is either "less preferred", "more preferred" or "indifferent" to the second one. While most existing methods involve numbers, in many cases using only qualitative assessments might be more trustworthy. Formulas and rules involving numbers are considered more scientific and credible than those that involve qualitative values only. This is obviously true when the notions of interest can be measured directly or indirectly, as for instance velocity, height, voltage, pressure etc. However, when it comes to subjective notions as love, importance, taste, beauty, etc., we have to be very careful when numbers are used. One of the ways to deal with such intangible concepts is the pairwise comparisons method. This method is based on the observation that it is much easier to judge the mutual relationship (preference, importance, intensity, etc.) of two objects than to do this for several objects at once.

This special issue of *Fundamenta Informaticae* is devoted to different aspects of the pairwise comparisons method. It is comprised of fourteen excellent articles that present the phenomenon of pairwise comparisons from various perspectives.

The work, *"Continuous Pairwise Comparisons"* written by *Thomas Saaty* definitely goes far beyond currently ongoing discussions and opens up new horizons for researchers. In the article he proposes changing perspective from a discrete to a continuous one. The suggested solution is to determine the rankings for continuous pairwise comparisons based on solving *Fredholm's* integral equation of the second kind.

In *"Complex Ranking Procedures"* the authors *Barbara Sandrasagra* and *Michael Soltys* investigate pairwise ranking problems where relatively few items are to be ranked with a complex procedure and according to a large number of criteria. They discuss their solutions in the context of tender procedures.

Andrew Schumann and *Jan Woleński* enrich the discussion on pairwise comparisons methods by presenting their logical approach enclosed in the article *"Two Squares of Oppositions and Their Applications in Pairwise Comparisons Analysis"*.

The most known and used example of using the pairwise comparisons method is *AHP (Analytical Hierarchy Process)*. It also raises the most discussion and polemics. For this reason, a substantial portion of the submitted articles relate directly to this method. The article *"Eigenvector priority function causes Strong Rank Reversal in group decision making"* written by *Joaquin Perez* fits in the current debate on *AHP* properties. In his work, the author contributes to the extensive discussion on the rank reversal phenomenon and provides the new arguments in favor of the geometric mean method.

Eng U. Choo, et al. in the article *"Mathematical Support for the Geometric Mean when Deriving a Consistent Matrix from a Pairwise Ratio Matrix"* focus on different priority deriving methods. They also investigate the problem of effectiveness of those methods.

In the work *"Efficiency analysis of simple perturbed pairwise comparison matrices" Kristóf Ábele-Nagy* and *Sándor Bozóki* take on the important topic of efficiency analysis. In particular they show that the eigenvalue method applied to a simple perturbed pairwise comparison matrix is efficient.

In *"Important Facts and Observations about Pairwise Comparisons" Waldemar Koczkodaj et al.* deals with several important problems relating to pairwise comparisons. In particular the authors raise the issue of the relationship between Saaty's *AHP* and the pairwise comparisons as such. They also discuss the matters of a scale selection, judgment consistency and the eigenvalue method.

László Csató and *Lajos Rónyai* in their paper *"Incomplete pairwise comparison matrices and weighting methods"* analyze the eigenvector method and the logarithmic least squares method with respect to the linear order preservation. The pairwise comparisons matrices considered in the article are incomplete.

An essential issue concerning the pairwise comparisons method is the inconsistency of assessments. An interesting voice in the ongoing discussion is the article *"Recent advances on inconsistency indices for pairwise comparisons — a commentary"* written by *Matteo Brunelli*. The article is a polemic along with another article recently published in *Fundamenta Informaticae*.

Despite its long existence the *AHP* method still prompts researchers for further explorations. This results in the creation of new methods and the improvement of already existing ones. An example of such work is *"A Hierarchical Decision Model Based on Pairwise Comparisons"* written by *Fujun Hou*. In his paper the author presents the Multiplicative Pairwise Comparison based Hierarchical Decision Model *(MPCbHDM)* and discusses its strengths and potential benefits arising from the use of this model in practice.

The next two papers concern the problem of uncertainty representation. *Han-Chen Huang* and *Xiaojun Yang* in the work *"Representation of The Pairwise Comparisons in AHP Using Hesitant Cloud Linguistic Term Sets"* propose using hesitant cloud linguistic term sets *(HCLTSs)* to represent uncertainty connected with expert assessments in the *AHP* method.

In the article *"Intuitionistic fuzzy optimized weighted geometric Bonferroni means and their applications in group decision making" Jin Han Park, et al.* define and analyze four variants of the optimized weighted geometric Bonferroni means applied to group decision making. Two of presented are based on the fuzzy set theory.

The problem of group decision making is also considered in the article *"Deriving weights of the decision makers using AHP group consistency measures"* by *Bosko Blagojevic et. al.* In their work, the authors propose a new local group priority deriving method that meets three selected consistency conditions.

Finally, *András Farkas* in *"Balancing Pairwise Comparison Matrices by Transitive Matrices"* provides an algorithm for finding the best transitive approximation of pairwise comparisons matrices.

Editing this special issue would not be possible without the hard work of reviewers. We would like to thank to all of you whose detailed and constructive feedbacks to authors have contributed to substantial improvement in the quality of reviewed manuscripts. We would like to express our sincere gratitude to the editor-in-chief of *Fundamenta Informaticae Prof. Damian Niwiński*. Without his constant help and kindness all this would not be possible.

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