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A DECISION SYSTEM USING ANP AND FUZZY INPUTS

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Abstract. *We propose a new decision model based on ANP for solving the decision making problem with fuzzy pair-wise comparisons and a feedback between the criteria. The evaluation of the weights of criteria, the variants as well as the feedback between the criteria is based on the data given in pair-wise comparison matrices. Extended arithmetic operations with fuzzy numbers are proposed as well as ordering fuzzy relations to compare fuzzy outcomes. An illustrating numerical example is presented to clarify the methodology.*
Keywords: Multi-criteria decision making, Analytic hierarchy process, AHP, Pair-wise comparisons, Systems with feedback, Fuzzy numbers, Analytic network process, ANP

1. **Introduction.** In this paper we propose a fuzzy extension of the analytic network process (ANP), particularly an analytical hierarchical process (AHP) with feedback between criteria that uses uncertain human preferences as input information in the decision-making process. Instead of the classical Eigenvector prioritization method, employed in the prioritization stage of the ANP, a new fuzzy preference method, based on logarithmic least squares method is applied. The resulting fuzzy ANP enhances the potential of the ANP for dealing with imprecise and uncertain human comparison judgments. It allows for multiple representations of uncertain human preferences, as crisp, interval, and fuzzy judgments and can find a solution from incomplete sets of pair-wise comparisons.

When applying classical AHP in decision making, e.g. when you want to buy a best product for your personal use, say a car or digital camera, one usually meets two difficulties: (1) When evaluating pair-wise comparisons on the nine point scale we do not incorporate uncertainty; (2) The decision criteria are not independent as it is normally required.

We solve these difficulties by proposing a new method which incorporates uncertainty adopting pair-wise comparisons by triangular fuzzy numbers, and take into account interdependences between decision criteria.

The first difficulty is solved by the help of fuzzy evaluations: instead of saying e.g. "with respect to criterion C, element A is 3 times more preferable to element B" we say "element A is possibly 3 times more preferable to element B", where "possibly 3" is expressed by a (triangular) fuzzy number, similarly to the fuzzy number depicted in Figure 2. In some real decision situations, interdependency of the decision criteria occur quite frequently, e.g. in the problem of choosing the best product the criterion "price of