Novel methods to support decision making processes

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Mathematical analysis based on numbers and numerical estimates is widely used in decision making everywhere from public administration and business to environmental conservation. Methods for decision analysis evaluate different alternatives with regard to several criteria. The more attributes and possible options, from which to make decisions there are, and the larger the amount of available data, the more complex the analysis gets – and it begins to escape the grasp of decision makers.

Aalto University researcher Antti Punkka has studied in his doctoral dissertation for the Department of Mathematics and Systems Analysis how to improve multi-criteria decision and efficiency analysis by asking decision makers relevant and easy questions and producing decision recommendations that are transparent and straightforward to understand.

In multi-attribute decision making situations there are rarely univocally optimal solutions, and this requires including the decision maker's preferences and values in the analysis models.

The new model finds the right alternatives

Punkka has studied so-called additive value functions, which are in their simplest form familiar from product comparisons where a range of products are reviewed against each other according to certain criteria. Traditionally these methods require exact numerical values as quality measures.

Punkka, on the other hand, has come up with models that are based on rank-based information about the alternatives. These models promote the consideration of the decision maker's preferences and values.

The models Punkka has created give recommendations for decision making also when the properties of the alternatives and the preferences of the decision make are expressed in the form of incomplete ordinal information – not as exact numerical values. The decision maker can for instance recognise two best alternatives according to certain criteria, not having to consider, which of them is better.

The model lists the preferences of multiple decision makers

The models developed in the dissertation have proven to be useful in situations where the same model is used to depict the preferences of several decision makers. The methods have been used for instance to support traffic infrastructure maintenance planning.

"A decision maker can compare, say, the value of the effects of reducing road salting as relative to the value of increasing accidents. The models we have created do not necessitate numerical statements in comparing these values."

"In organisations in which decision processes need to be transparent – for example in ventures within public administration – preferences are not defined and decisions made by a single decision maker but groups," Punkka points out.

"My research and the algorithms I have developed could raise the bar in the quality of the recommendations models give to decision makers. The mathematical analysis should be in line with the preferences and values

of the decision makers. We strive to make the use of the models increasingly transparent, all the way from defining preferences and modelling them mathematically to presenting results."

A model to measure the efficiency of decision making units

Punkka and his colleagues also combine in an unprecedented way the properties of rank-based computation to efficiency analysis. In it the efficiencies of decision-making units are compared based on the ratio of their multi-criteria output and input values.

The developed methods enable for example analyses of how sensitive the decision-making units' efficiencies are to the relative values of different output and input criteria

"Our methods will surely receive a lot of attention: they provide a variety of completely new approaches to efficiency analyses," trusts Punkka.

Antti Punkka's dissertation "Rank-based information in multi-attribute decision and efficiency analysis" available online (pdf).

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