A method of user preference elicitation by pairwise comparisons

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Problem statement

Let the objects set $\Omega \equiv \{\omega_j\}_{j \in J}$ have an order « $\preceq$ » and/or a strict partial order « $\prec$ ».

Absolute preference is characterized by utility function (UF) $u: \Omega \to R$, and relative preference is described by preference function (PF) $p: \Omega \times \Omega \to R$.

The preference function has restrictions based on the properties of the corresponding order relations such as asymmetry in argument, transitivity, etc.

Information about pairwise comparisons can be presented in the form of values of the preference function $p(\omega_j, \omega_i)$ or in the form of a symbolic representation:

$$z_{ij} \equiv z(\omega_j, \omega_i) = \begin{cases} 1, & p(\omega_j, \omega_i) > 0, \\ 0, & p(\omega_j, \omega_i) = 0, \\ -1, & p(\omega_j, \omega_i) < 0. \end{cases}.$$

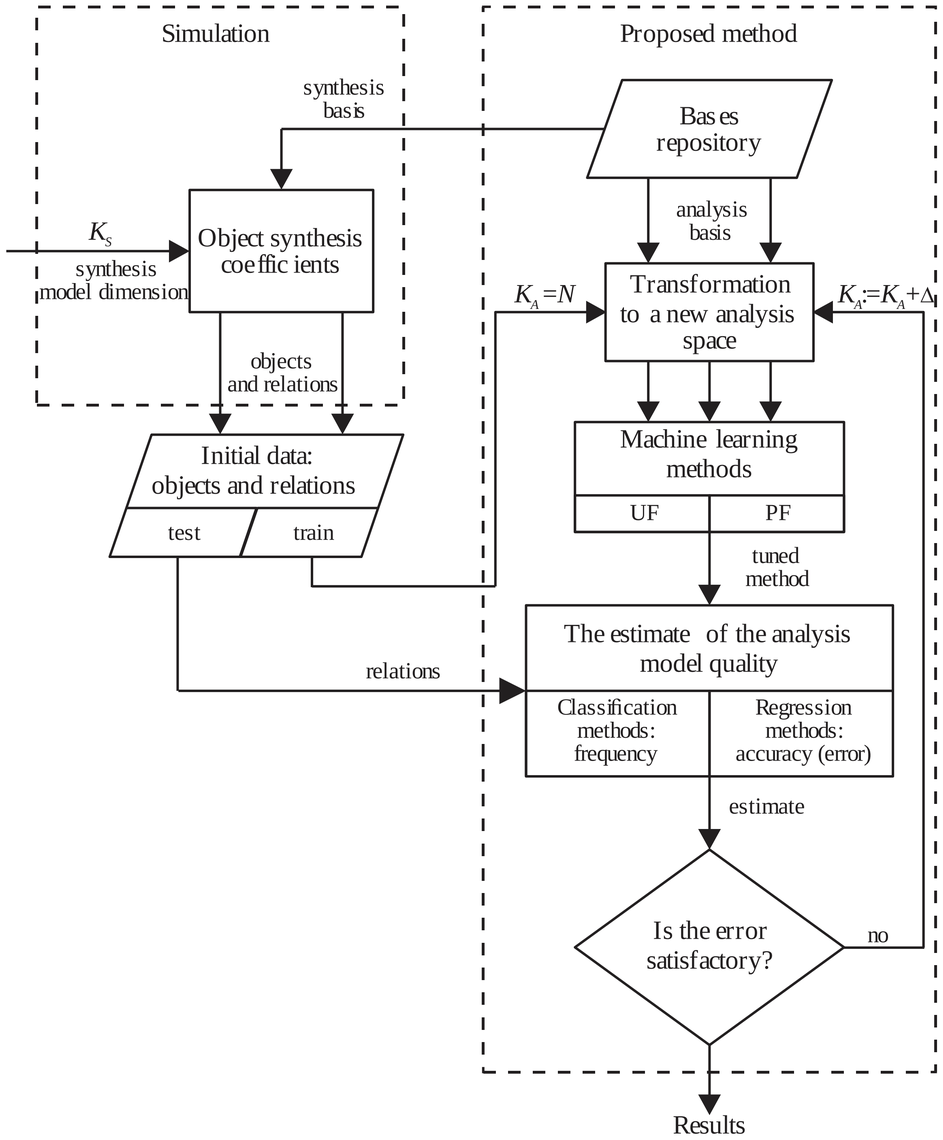
The choice of a specific route from the route list proposed by the system is an example of information on paired comparisons in a transport recommendation system.

The number of incorrectly reconstructed relationships, the Kendall distance for pairwise comparisons, is a criterion for the reconstruction quality of the preference and utility function:

$$d = \left| \left\{ (i,j) : z(\omega_i, \omega_j) \neq z(\mathbf{x}(\omega_i), \mathbf{x}(\omega_j)), \quad (i,j) \in I \right\} \right|,$$

This value in the normalized form is an estimate of the corresponding relation errors probability:

$$\tilde{d} = d \cdot |I|^{-1}.$$



Method

The method of function reconstruction by their symbolic representation contains the following steps:

- feature values normalization in the range [0,1];
- selection of a new feature space (basis) Y;
- transformation of the original feature vector $\mathbf{x}$ into the new feature space Y with a higher dimension K=dim(Y) ≥ N;
- building a linear or nonlinear classifier in the feature space Y;
- quality assessment of the building classifier on the test dataset.

In the case when the evaluation of the preference function is unsatisfactory, go to the selection of a new basis and transformation of the feature space.

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Ks	Ka	InstNum	Error											
			S: Fourier A: Polynomial		S: Fourier A: Haar		S: Polynomial A: Fourier		S: Polynomial A: Haar		S: Haar A: Fourier		S: Haar A: Polynomial	
			LR	RF	LR	RF	LR	RF	LR	RF	LR	RF	LR	RF
15	15	10000	0.2246	0.1129	0.0078	0.0482	0.0092	0.0115	0.0048	0.0101	0.0015	0.0408	0.0068	0.0067
15	15	50000	0.14208	0.06006	0.00172	0.02366	0.01004	0.00952	0.00164	0.0062	0.00222	0.0211	0.00244	0.0048
15	63	10000	0.1986	0.1159	0.0083	0.0509	0.008	0.0139	0.0064	0.0091	0.0067	0.0422	0.0035	0.0051
15	63	50000	0.15958	0.07988	0.00442	0.0319	0.00434	0.00792	0.00144	0.00554	0.00248	0.02138	0.0014	0.00422