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Stochastic estimation of Nash equilibrium in geographic and other spatial data

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The content of this work is the application of linear games in normal form for evaluation of spatial data. The concept of linear games is often used in many applications in economics, ecology, system management, etc., when the interacting subjects have the choice of strategies leading to the result defined in the payoff table. The result of the game is most often evaluated in the sense of Nash equilibrium - NE. Spatial data, however, usually does not contain information about any strategies of interacting entities that would determine their appearance. However, in this type of data one can define individual situations representing, for example, a different degree of occurrence of selected characteristics. The essence of proposed approach is that these data pertaining to individual situations are considered as a payoff value for two, three or more interacting entities, and can form a symmetrical linear game matrix in normal form. For this game, NE can be found representing a specific distribution of strategies of interacting entities. This distribution assigns NE to individual situations depending on their location in the matrix of symmetric game. However, spatial data - such as the land-use does not provide any information for a particular form of this deployment, no structural relationship can be identified between the individual situations for their distribution in the individual rows and columns of the game matrix. The proposed solution is therefore stochastic - all effective permutation of the game matrix, meaning a different result for NE, are evaluated. The result is the NE probability values in each evaluated situation. The proposed approach is to a certain extent similar to the solution given in the Pareto optimality scheme, however, using the Nash equilibrium concept in linear games. The highest equilibrium is in the situation that provides the best possible compromise of the payoff values (in the sense of NE) of the interacting entities. This method could be used, for example, in assessing the degree of stability in the landscape etc. The possibilities of use of the method are shown on the example of the land-use of the selected area, where interacting entities of the type of farmland, meadows, forest and water surface are considered.