1. The objective of the project

The goal of this research project is to implement new interactive algorithms for optimization. The task of these algorithms will be to solve problems which consist of many conflicted criteria. The evolutionary algorithms – that mimic the real-world evolution when solving problems of optimization – will constitute the basis of implemented methods. It is noticeable that for multiple objective problems there does not exist a single optimal solution that could be the best with respect to all criteria. The conflict between objectives means that to gain on one criterion the other has to be deteriorated. As a consequence, in such problems there exists a set of incomparable candidate solutions. Each of them is a prospective final solution of a problem. Hence, the task of the Decision Maker (DM) is to choose only one solution that is the most relevant to him or her. To help the DM to make a choice as well as to improve the process of optimization, the DM and the algorithm may work together to achieve better results. In such interactive process the method may obtain examples of preferences of the DM and use this knowledge to find the most relevant solution to him or her. What is more, the DM may observe the effects of his or her actions. It not only consolidates the knowledge about his or her preferences but also gives a possibility to reconsider his or her objectives.

2. Research to be carried out

This research project concerns 4 research directions to be carried out. The realization of these tasks will enhance the knowledge about the interactive evolutionary algorithms for multiple objective optimization. Each of these research directions constitutes a new and meaningful contribution to this scientific area.

   a) There exist many models of preferences as well as forms of preference examples. Some of them have interesting properties that could be utilized within the interactive algorithm. However, they have not received due attention yet. This project concerns the development of scientific knowledge about the utilization of different ways of discovering the DM's true preferences and their impact on the process of interactive optimization.
   b) Cooperative evolutionary approaches constitute an interesting branch of evolutionary theory. However, considering the domain of this research, it is a new but promising research direction. This task concerns the implementation of methods which use cooperative evolution as a basis of interactive multiple objective optimization.
   c) The process of discovering the true preferences of the DM is a major part of interactive optimization. This task utilizes an assumed preference model which is used to reconstruct the way the DM makes his or her decisions and to estimate his or her preference function. The improper choice of the model may yield a deterioration of efficiency of the method. The goal of this task is a simultaneous utilization of multiple models to reduce this bias and speed up a process of discovering the DM's true preferences.
   d) The task of Group Decision Making is to elaborate a compromise solution. However, one cannot simply define a compromise. The goal of this research direction is to develop new methods which could seek for many, instead of only one, compromise solutions at a single run of the algorithm. What is more, by keeping many compromise solutions the algorithm may provide a basis for the negotiations between the DMs.

3. Reasons for choosing the research topic

Interactive evolutionary methods for multiple objective optimization constitute a new and rapidly developing research area which combines three distinct scientific fields: Decision Support, Multiple Objective Optimization, and Evolutionary Algorithms. Even though this research considers only theoretical analysis in the spirit of basic research, the results of experiments that are to be conducted are of a great significance for the humankind in the nearest future. The decisions that are to be done by the governments, word-wide companies, and many others are significant for the development of the world. The implementation of poor solution may yield a negative impact on all of us. Hence, it is important to develop efficient methods. The approaches that aim at learning the DM's preferences will allow discovering relevant solution faster and more accurate. It is also meaningful that this area of research is relatively new but the results obtained so far impose a great significance of this project.