The project has as its specific aim the building of group of 4 experienced mathematicians and 1 PhD student to study challenging problems in multi-scale approach with applications to the life and social sciences. The expertizes of the researchers are complementary. It is going to be a continuation of their previous studies but in a unified way. Modeling of many life and social processes leads to the investigation of mathematical structures (models) at various levels of resolution. For instance, a biological population can be described by the state of each individual and by interactions between them (referred to as the individual, or microscopic, level), at the level of statistical description of a sample of the system (the mesoscopic, or kinetic, level), and at the level of interactions between subpopulations of the original system (the macroscopic level). Each level has an associated class of mathematical equations which provide an appropriate model. Usually their structures at various levels are completely different.

A challenging problem of contemporary mathematics, which we are going to pursue in the proposed research, is to develop a reasonably general mathematical background in which the collective behavior of large systems evolving in space and time is described at different spatial and temporal scales in a consistent way based on the information on their individual behavior. Within this problem, it is important to develop new ways of studying such systems that are beyond the existing standard methods, as well as to learn how to transfer mathematical information on the properties of the given system from one scale to another having in mind that such transitions usually lead to a dramatic change of the mathematical structure of the model. Large systems of human related entities have been actively studied. Such entities can be society members, economic agents, pedestrians, vehicles, etc. Their individual behavior is much easier for observation, but again, a challenging problem is to understand and hence predict their collective behavior on the basis of the individual level observations.

We believe that the development of new mathematical techniques suitable to describe the basis of multi-scale approach and nonlocal phenomena will lead to a better understanding of many real life processes and to many fascinating and challenging mathematical problems.

We would like to emphasize that models of apparently distinct phenomena in various areas of science often have a similar mathematical structure. Therefore the importance of the project lies in the analysis of new mathematical structures and in the development of modeling tools which may have genuine impact on our understanding of these phenomena.

The significance of the project is twofold. First, we believe in the importance of the envisaged results from the purely mathematical point of view. Second, the results should pave the way to many applications in life sciences. However, it is to emphasize that this is to a large extent a theoretical project aimed at a better understanding of complex intertwined structures of biological and medical systems. The main impact of the work will concern the qualitative analysis of systems of the PDEs, integro-differential equations, dynamical systems, both finite- and infinite-dimensional. On the other hand, the mathematical results may give new insights into complex processes in life and social sciences. For instance, swarming, opinion formation and traffic flows are closely related to applications; here, indeed, mathematics meets real applications.