DESCRPTION FOR THE GENERAL PUBLIC

New challenges for IBC

Information-based complexity (IBC) is a branch of computational mathematics that deals with problems for which available information is partial, noisy, and priced. Such problems arise in various disciplines, such as physics, economics, mathematical finance, computer vision, control theory, uncertainty quantification, medical imaging, weather forecasting, climate prediction, and statistics. Their mathematical formulations lead to problems defined on function spaces and include: function approximation or integration, solving ordinary, partial or stochastic differential equations, or various optimization problems. An ε-complexity of a problem is the minimal cost of solving it with error at most ε. The aim of this project is to further develop the theory of complexity of continuous problems and to construct new adaptive algorithms for solving them. The research is conducted by using tools of linear algebra, functional analysis, probability and measure theory, as well as those independently worked out in IBC. We put special emphasis on the notion of *information*. Particular issues are as follows:

A. *Noisy information and tractability of multivariate problems.*

Tractability is a part of IBC which studies complexity of multivariate problems, which are described using a large number of variables. Such problems often suffer from the *curse of dimensionality*, which means that the complexity increases exponentially fast as the number of variables increases. How to vanquish the curse is one of the main problems of contemporary computational mathematics. Up to now, tractability of multivariate problems has been studied for exact information. We extend this study to information contaminated by deterministic or random noise. Noisy information is usually present in computational practice.

B. *Adaption in efficient solutions of continuous problems.*

Succesive computational steps of adaptive algorithms depend on the results of previous computations. Adaptive information and algorithms are important tools in numerical analysis; however, sufficient theoretical justification of their good performance if sometimes missing. In this project, we study in a quantitative way the efectiveness of adaptive algorithms in comparison to nonadaptive algorithms for solving deterministic and stochastic differential equations. Knowing the essense of adaptive algorithms will help constructing new, more effective, algorithms for those problems.

C. *Unsigned information and its potential use for IBC problems.*

Unsigned information is used, e.g., in signal reconstruction and audio processing. We this new type of information from the point of view of its effectiveness in solving IBC problems.