For the last several decades computers have been offering us an extraordinary aid in solving many important mathematical problems. Very often, the latter have a very strong and essential association with reality. Most probably there is no such field of technology that does not utilize computers in solving its mathematically stated problems (the very core of computer architecture is mathematical!). In many of those fields, the mathematical statement is formulated in the language of differential equations which describe the evolution of considered systems (both in space and time). As a leading example we can mention the numerical weather prediction without which no one can imagine life as it is now (regardless whether he/she is aware of it!). Other examples include simulations of industrial (from metallurgy through construction to aerodynamics), medical (from tomography through oncology to optometry) and environmental processes (from hydrology through extra-planetary meteorology to plate tectonics).

The aforementioned examples can, of course, be multiplied indefinitely, however it is important to notice one very crucial issue. How do we know that all of the results, which are given by computer simulations, are reliable and true? Can we trust them knowing that many times their outcome affects directly the safety of human life? The answer to above questions lies in the correct and appropriate formulation of algorithms which govern the computer work. The aim of our project is to construct and analyse numerical algorithms used in solving a certain class of equations. Those, in turn, are the *nonlocal* so-called partial differential equations which arise in many applied fields of science such as plasma physics, solid state physics, combustion theory, biology, hydrology, and even financial markets.

The crucial term, that is the main subject of our investigations, is nonlocality. It means that the present state of the process depends on its history (temporal nonlocality) and/or its values at faraway points in space (spatial nonlocality). The correct mathematical treatment of the nonlocal terms in the equation is difficult since it introduces additional complexity that has to be dealt with nonstandard tools. When nonlocality is coupled with nonlinearity, as in our case, the computational cost of the algorithms and their analysis becomes much more complex, demanding, and difficult.

Our aim is to devise numerical methods which implemented on the computer, will allow us to solve our equations in an effective and arbitrarily accurate way. The most important aim we want to achieve is to pursue efficacy, speed, and analyse the convergence of those methods. Speaking very loosely, convergence means reliability. Numerical methods which are *not* convergent are useless since they do not give us true results. We have to keep in mind that only thanks to the mathematical analysis it is possible to ascertain whether a given method is convergent or not. Practical use of algorithms which are not known to be convergent is very dangerous since in that case we are ignorant of the conditions of their applicability. Our aim is to provide a set of safe, convergent numerical methods that can then be readily used by practitioners in solving their important problems.