Stochastic control is an important area of research. Modeling real world phenomena is a nontrivial problem. We are using mathematical tools: equations, formulae, relations to describe evolution or behavior of real objects. These objects are frequently subject to random disturbances sometimes because of their dynamics or measuring errors. We model them using stochastic processes. Together with modeling we frequently would like to have an influence (control) on the object we describe. Then we have stochastic control problems. Our control strongly depends on the cost (reward) functional we want to minimize or maximize. Another problem is a time horizon. Very often it is non specified, we know that it is finite and sufficiently large. Since the form of control may strongly depend on the time horizon it is convenient to consider long time horizon equal to infinity, thinking that control determined by such functional will be good for finite, sufficiently long time horizon. In the project we are interested in two kinds of stochastic control problems: *asymptotics (limit behavior) of long run functionals* and in *non convex stochastic control problems*. Long run functionals appear in a form of discounted functionals, average cost per unit time functionals and risk sensitive functionals. The last class of functionals is very important since because of its form they measure not only expected value of an average cost but also other moments, in particular variance which is frequently considered as a measure of risk. The state process is modeled using controlled Markov processes in discrete or continuous time, that is processes for which future behavior depends on the actual state but do not depend on the former states. In the case of continuous time we prefer impulse control, which practically is an important class of feasible controls. It consists of a sequence of random times and controls chosen at these random times. In the project we are studying approximations of average cost per unit time functionals using discounted functionals, discrete time approximations of continuous time functionals, approximations of average cost per unit time functionals using risk sensitive long run functionals. We would like not only to approximate functionals but also to do the same with value functions i.e. optimal values of the cost functionals. Such approximations are important to form optimal or nearly optimal controls. Namely, frequently optimal control of the limit problem is nearly optimal for an approximation. The state process maybe fully observed or we have only partial observation of the state process, basing on which we have to determine control. Since we are studying long time horizons, the problems with partial observations (degenerated or non degenerated) are hard to investigate. We are also interested in stochastic games with average cost per unit time or long run risk sensitive functionals.

Non convex problems appear in many situations in stochastic control. In the project we shall concentrate on a family of problems coming from mathematics of finance, in particular markets with concave transaction costs. It is quite usual that when we buy or sell larger number of assets or currency or more expensive commodity then we pay transaction fee, which depends on the transaction volume and is proportionally smaller when the transaction is big. When we consider so called solvency set i.e. the set of all nonnegative positions of our portfolio then it appears to be non convex set. We are interested in characterization of absence of arbitrage, which is an absence of possibility of obtaining nonnegative gain and positive with positive probability, without risk. Then we would like also to characterize optimal portfolio maximizing expected utility from terminal wealth. Solving such problem, although we utility function is concave, the value function appears to be non concave.