DESCRIPTION FOR THE GENERAL PUBLIC

Optimisation is, in economics, one of the basic term and it is a core approach for investments, managing and risk analysis. Within this project we aim to construct a general framework that encompasses various optimisation problems sharing the same methodology. Particularly, we plan to focus on so-called optimal stopping which involves choosing the best time to act based on a sequence of observations. This optimal stopping rule is designed to balance multiple, and often conflicting issues, such as detection delays versus false alarms and outbreak risk versus economic damage. The recent struggles with COVID-19, frequent cyberattacks and appearance of new other American-type options and financial-actuarial products have demonstrated the need for optimal stopping and have provided us with insight and motivation. Moreover, the limitations of the existing theories and methodologies have been exposed. Therefore the development of methodologies for computing optimal stopping rules, via cutting-edge probability theory research, is crucial for decision-making process. We will focus on six main optimisation problems:

1. Choosing optimal allocation of resources in health care;
2. Developing optimal control of spread of viruses;
3. Pricing American options with additional cancelling features;
4. Pricing American options with restricted time execution regions;
5. Pricing American options in a Markov regime-switching market with random discounting;
6. Modeling optimal dividend payments under a Markov regime-switching market uncertainty.

The intended outcomes of the first two problems are a set of new optimisation economical models and efficient algorithms for making fast and informed decisions in an allocation of shared critical resources. We plan to use optimal stopping theory to detect abrupt changes in the statistical behavior of hospitals and, in general, national medical systems.

We are also going to use branching processes theory and sequential testing to control the spread of viruses. We expect that the outcomes of this project can be successfully used by the governments and the industry as well.

The next three problems concern pricing American options with new key features all related to some randomness added to classical payout function like a random cap, random interest rate and considering a Markov regime-switching market. This regime-switching market stems from the need of more realistic models that better reflect random market environment. The need for such a model comes from allowing the key parameters of the asset price to respond to the general market movements. The market regime could reflect the state of the underlying economy, the general mood of investors in the market, and other economic factors.

The last research topic concerns the maximisation of dividend payments. This problem is related to pricing a value of a company using discounted cash flow method. We plan to add a Markov regime-switching market uncertainty to this model as well (as in the case of American options), and show that a barrier strategy at certain positive regime-dependent levels is optimal.

The present research proposal aims also at contributing to the development of the new optimisation statistical tools for the analysis of the above mentioned problems. The proposed research is based on: risk processes techniques, optimisation theory, quantitative finance techniques, statistical data analysis.