Cancer, apart from being a mortal disease, is also a summary of cell evolution within a short time period. Therefore, at the fundamental level, cancer research is not only helping the patient, but also helping to uncover the laws of evolution, influenced by mutations, selection and other mechanisms. In turn, progress in understanding these laws provides cues for understanding other diseases. Modern biology entered the stage in which we can obtain personalized information about mutations in tumors of a given patient, and this information may help design the right treatment.

In this project, we explore two major topics, related with increased availability of detailed molecular data. One of them is the question how much can be learned about the past (and by extrapolation, of the future) of a tumor, from the pattern of mutations in this tumor genome? Methodologically, this topic belongs to the so-called Genetic Archeology, which has been fruitfully used for example in deciphering early human population growth and migration rates. In case of cancer, the same techniques can help estimating the growth and mutation rate of the tumor, which otherwise are not available. In particular, we are interested in the differences between primary tumors and distant metastases. We will use data from the publicly available Cancer Genome Atlas database as well as from sequencing of head-and-neck and breast cancer specimens.

Another research topic we plan to explore is the connection between immunity and potential of the tumor to form distant metastases. We developed a mathematical model connecting immunity with one of the mechanisms of cancer metastasis, called EMT (epithelial-mesenchymal transition). We will use this model among other to predict how drug-induced stimulation of the immune system can influence (reduce) EMT. We will validate this research by cell line experimentation. Since immunity and EMT-related genes are particularly frequently mutated in breast and head-and-neck cancers, there exists a connection with the previous topic.