

Evolutionary genomics: Modeling and prediction of progression of breast and lung cancer

We plan to develop new mathematical and computational methods of estimating the growth and progression of solid tumors based on the distribution of DNA variants at diagnosis. The topic is of current interest, as it is believed that deciphering the past of tumors leads to understanding the causes of their growth and progression. We also hypothesize that understanding the pattern of mutations helps reconstruct the timeline of cancer progression before diagnosis, which is not observed.

The outcome may help answer the question, how to detect cancers early, so they can be treated and cured, which has profound public health importance. In the planned research, we will focus on two of the most common and deadly cancers: lung cancer and breast cancer. To validate mathematical methods, we will use publicly available databases such as The Cancer Genome Atlas but also plan for DNA collection and sequencing.

In the current proposal, we plan to follow-up on both recent work and on experience gained during the 1990-2012 period, in modeling cancer (specifically lung cancer) progression based on demographic and epidemiological evidence. In other words, we plan to link genetic DNA-based evidence with evidence based on who and at which age may get cancer.

There are several specific topics we plan to pursue. One is to look for evidence of major rearrangements in DNA structure of cancer cells, which allow them grow faster and increase their ability to invade surrounding tissue. We will also use mathematics to address theories about how cancer cell compete with each other and with normal cells.

Our investigations until now indicate that the pattern of growth and change in lung cancer cells is very different from that in breast cancer. To understand these differences and translate them into numerical parameters, we need to collect DNA obtained from cancer specimens preserved in paraffin blocks or frozen at very low temperatures. For these reasons, we established collaborations with Maria Skłodowska-Curie National Research Institute of Oncology (Krakow Branch) and Medical University of Gdansk to obtain regular supply of cancer DNA.

We also involved an international team of consultants and collaborators.