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Optimal protocols for chemo- and immunotherapy in a mathematical model of tumor-immune interactions

In this talk, a classical model for the interactions between tumor and the immune system under treatment is considered as an optimal control problem with multiple controls representing actions of cytotoxic drugs as well as of agents that give a boost to the immune system. In the objective, a weighted average of several quantities that describe the effectiveness of treatment is minimized. These terms include (i) the number of cancer cells at the terminal time, (ii) a measure for the immunocompetent cell densities at the terminal point (included as a negative term), (iii) a measure for the side effects and cost of treatment in form of the overall amount of agents given and (iv) a small penalty on the terminal time that limits the overall therapy horizon which is assumed to be free. This last term is essential in obtaining a well-posed problem formulation. The form of the objective is motivated by the dynamics of the system without treatment and models the goal to move the state of the system from a region of malignant cancer growth into a benign region. Employing a Gompertzian growth model for the cancer cells, for various scenarios optimal controls and their corresponding system responses are calculated. Both the cases of mono- and combination therapies will be considered.