

Course Project
Parameter identification in a mathematical model
describing tumour-macrophages interactions

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PARAMETER IDENTIFICATION IN A MATHEMATICAL MODEL DESCRIBING TUMOUR-MACROPHAGES INTERACTIONS

BACKGROUND

In this project will be studied Parameter Identification Problem (PIP) for determination of parameters in a system of ODE describing tumour-macrophages interactions. We will study simplified mathematical model which was introduced in [1] at the first time and which describes the anti-tumour/pro-tumour immune responses generated by M1 and M2 macrophages.

It is well-known importance of the anti-tumour and pro-tumour Th1/Th2 immune cells and M1/M2 macrophages. However, it is still unknown how different parameters in the mathematical model can be determined by measured values of main functions of the model ODE on some time interval.

DESCRIPTION OF THE PROJECT

The main goal of the project is develop algorithms for parameter identification problem in the simplified mathematical model presented in [1] which describes tumour-macrophages interactions. The values of parameters can result in prediction of tumour growth and the final tumour size for concrete patient.

More precisely, main tasks in the project will be:

- Study mathematical model introduced in [1] which describes the anti-tumour/pro-tumour immune responses generated by M1 and M2 macrophages. Study biological processes which correspond to this system of ODE, see [1, 2] and references therein.
- Study Lagrangian approach for solution of PIP, see [4]. See, for example, the recent work [3] where the Lagrangian approach was used for solution of different PIP (determination of drug efficacy in the model of HIV Infection).
- Study Lagrangian approach for solution of simplified problem proposed in [1], see my notes. Remark: I will give you material of this notes: it is still unpublished and should not spread.
- Study MATLAB solver available at the link [5] used in [3] for time-adaptive determination of drug efficacy in the model of HIV infection.
- Develop new MATLAB solver for solution of forward problem proposed in my note (optional: proposed in [1]). Study developed programs on the solution of forward and adjoint problems of the model problem described in my note (optional:proposed in [1]) using different values of parameters of this system.
- Optional: using solutions of forward and adjoint problems, develop reconstruction algorithms in MATLAB for parameters of the simplified problem.
- Optional: develop adaptive reconstruction algorithms.

REFERENCES

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- [2] Raluca Eftimie, Jonathan L Bramson, David J D Earn, Modeling anti-tumor Th1 and Th2 immunity in the rejection of melanoma, *J Theor Biol*, 2010. doi: 10.1016/j.jtbi.2010.04.030
- [3] L. Beilina, M. Eriksson, I. Gainova, Time-Adaptive Determination of Drug Efficacy in Mathematical Model of HIV Infection, *Differential Equations and Dynamical Systems*, 844, 2021.
- [4] L. Beilina and I. Gainova, Time-adaptive FEM for distributed parameter identification in biological models, *Applied Inverse Problems*, Springer Proceedings in Mathematics Statistics, Vol. 48, pp. 37-50, DOI 10.1007/978-1-4614-7816-4, 2013.
- [5] MATLAB source code for determination of drug efficacy in the model of HIV infection, https://github.com/larisa70/AFEM_HIV