PROJECTS IN
FRTF01 – PHYSIOLOGICAL MODELS AND COMPUTATION

Instructions

Choose a model of a physiological system from the project list below or from literature, according to your interest. Perform mathematical analysis of the model and evaluate its properties with a comparison of published experimental data, if possible. Otherwise you should make a qualitative assessment of the properties of your model. Draw conclusions on the relationships among structure and function. Perform a critical analysis of the model quality and the accuracy.

The articles given in the project list below are only startup material for your projects. You are expected to perform a literature survey on your own as well.

The report should be structured as follows:

- Abstract: summary of the the report with purpose, results and conclusions
- Introduction: short background and purpose
- Methods: model, assumptions, analysis method
- Results: simulation results/plots and description of these
- Discussion: discuss the results and relate to the purpose and analysis of quantitative and qualitative behavior
- Conclusions: concluding remarks
- References

Additionally,

- Written using a word processor (Microsoft Word, Open Office, LaTeX, etc), save and send in as a .pdf-file according to the deadlines by e-mail to `FRTF01@control.lth.se.`
- If you include figures, make sure they are of good quality. If you take pictures from a book or the internet, make sure they are of good quality as well and that you state the source.

The FRTF01 course project can be done individually or in groups of two students. To make sure that two groups are not doing identical projects, you will have to register your project by filling in a form linked from the course webpage. Also check on the course webpage that your intended project is not already registered by another group and contact the TAs if you are unsure about if your project is unique enough. Make a short project proposal with a work plan and send it to `FRTF01@control.lth.se` for approval by **November 23**. You will be assigned a supervisor. Make sure you set an appointment with him/her to initiate your project. A brief project report on scientific format should be written and sent to `FRTF01@control.lth.se` no later than **December 14**. A short presentation (5 min) should be given on the project seminar on **December 8** at 13-15 in M:E. We expect the project to take less than one week of work.

Project Ideas

- **Immunology and infections**
  See e.g., Baris Hancioglu, David Swigon, and Gilles Clermont. A dynamical model of human immune response to influenza a virus infection. *Journal of theoretical biology*, 246(1):70–86, 2007 or .

- **Modeling HIV and immune system dynamics**
  See e.g., Alan S Perelson. Modelling viral and immune system dynamics. *Nature Reviews Immunology*, 2(1):28–36, 2002.

- **Alternation of the Hodgkin and Huxley model to model disease or toxin impact**
  See e.g., Clay M Armstrong, Francisco Bezanilla, and Eduardo Rojas. Destruction of sodium conductance inactivation in squid axons perfused with pronase. *The Journal of General Physiology*, 62(4):375–391, 1973 for how pronase detroys natrium channel inactivation.

- **Pharmacodynamics and cancer therapy**
  See e.g., Ardith W El-Kareh and Timothy W Secomb. A mathematical model for cisplatin cellular pharmacodynamics. *Neoplasia*, 5(2):161–169, 2003.

- **Optimizing cancer chemotherapy**
  See e.g., Athanassios Iliadis and Dominique Barbolosi. Optimizing drug regimens in cancer chemotherapy by an efficacy–toxicity mathematical model. *Computers and Biomedical Research*, 33(3):211–226, 2000.

- **Modeling of the human sleep/wake cycle**
  See e.g., Lisa Rogers and Mark Holmes. Model of the human sleep wake system. *arXiv preprint arXiv:1208.3228*, 2012.

- **Modeling immune response to tumor growth**
  See e.g., Lisette G de Pillis, Ami E Radunskaya, and Charles L Wiseman. A validated mathematical model of cell-mediated immune response to tumor growth. *Cancer research*, 65(17):7950–7958, 2005.

- **Modeling circadian oscillations**
  See e.g., Quentin Thommen, Benjamin Pfeuty, Florence Corellou, François-Yves Bouget, and Marc Lefranc. Robust and flexible response of the ostreococcus tauri circadian clock to light/dark cycles of varying photoperiod. *FEBS Journal*, 279(18):3432–3448, 2012.

- **Diabetes modeling**
  See e.g., Brian Topp, Keith Promislow, Gerda Devries, Robert M Miura, and DIANE T FINEGOOD. A model of β-cell mass, insulin, and glucose kinetics: Pathways to diabetes. *Journal of theoretical biology*, 206(4):605–619, 2000.

- **Model of treatment strategy for AIDS**
  See e.g., Denise Kirschner and Glenn F Webb. A model for treatment strategy in the chemotherapy of aids. *Bulletin of mathematical biology*, 58(2):367–390, 1996.

- **Epidemiological models**
  See e.g., N Hohmann and A Voss-Böhme. The epidemiological consequences of leprosy-tuberculosis co-infection. *Mathematical biosciences*, 241(2):225–237, 2013 for epidemiological model of leprosy-turbeculosis co-infection. Extensions of the SIR-model are suitable, for instance in comparison with data from SARS, H1N1 or Ebola epidemics.

- **Tracer dynamics**
  See e.g., Sara Garbarino, Giacomo Caviglia, Massimo Brignone, Michela Massollo, Gianmario Sambuceti, and Michele Piana. Compartmental analysis of renal physiology using nuclear medicine data and statistical optimization. *arXiv preprint arXiv:1212.3967*, 2012.

- **Body mass regulation**
  See e.g., Joshua Tam, Dai Fukumura, and Rakesh K Jain. A mathematical model of murine metabolic regulation by leptin: energy balance and defense of a stable body weight. *Cell metabolism*, 9(1):52–63, 2009.

- **Bone remodeling**
  See e.g., Peter Pivonka, Jan Zimak, David W Smith, Bruce S Gardiner, Colin R Dunstan, Natalie A Sims, T John Martin, and Gregory R Mundy. Model structure and control of bone remodeling: a theoretical study. *Bone*, 43(2):249–263, 2008.

- **Predator-prey dynamics**
  See e.g., P Kindlmann and AFG Dixon. Insect predator–prey dynamics and the biological control of aphids by ladybirds. In *First international symposium on biological control of arthropods. USDA Forest Service, USA*, pages 118–124, 2003.

- **Your own project idea**
  You are welcome to propose your own idea after discussing it with the TA's.