B5.1 (Stochastic modelling of Biological Processes) special topics: some things to think about

Area of application. Is there an area of application that particularly interests you? This could be an area of biological science, e.g., *biochemistry*, *physiology*, *ecology*, *epidemiology*, and so forth. It could also be a broad theme such as *extinction*, *switching*, *oscillation*, *pattern formation*, *collective behaviour*, etc., which arises in many different settings. When considering an area of application you might think about:

1. **Key questions.** What are the key questions in this area? E.g., in epidemiology, key questions revolve around what factors influence the size and duration of *outbreaks*; in ecology and resource management, we often ask about *biodiversity* and vulnerability to *extinction*; in medical contexts, we ask how *diseases progress*, and what effect *medical interventions* could have; and so on. Doing a quick literature review is a good idea.

2. **Analysis.** Are there simple models which can be treated analytically? For "M" projects, this question is especially important. But, it is a good idea to find such models even if your project is a "C" project. At least, you can confirm your code is working by comparing computed and exact results for simple models.

3. **Computational work.** What computational methodologies are most relevant? There are many possibilities in this course, including *Gillespie simulation*, τ*-leaping*, *multiscale approaches*, *Euler-Maruyama simulation of SDEs*, numerical *integration of ODEs or PDEs*, etc. Make sure you understand the theoretical basis of any algorithms you use, and any assumptions and limitations. If you are doing a "C" topic, you may consider comparing efficiency and accuracy of different approaches to the same question.

4. **Stochastic vs. deterministic.** Since the theme of this course is stochastic modelling you may consider exploring models in which determinstic and stochastic approaches give very different results. For this you will need to understand both stochastic and deterministic modelling. Also, you could explore whether there is some limit in which stochastic modelling gives similar results to deterministic modelling.

Modelling and computation. The emphasis may vary, but for both "M" and "C" topics, there is likely to be: some modelling, i.e., setting up and doing basic analysis of biological models; and some computation/simulation. Think about what balance will work best for you.

General points. Make sure your work is

- Clear and mathematically **correct**.
- Within the **page limit**.
- Mathematically and computationally **nontrivial**, and goes beyond lecture notes.
- **Readable and nicely presented.** It is worth thinking early about what the final product will look like, including pictures, graphs, and so forth.