UPPSALA UNIVERSITY
DEPARTMENT OF MATHEMATICS
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Final Project
Spring 2022

Modelling Complex Systems
Final Project.

The deadline for the final project is midnight Friday 3rd June.

In this project you are asked to implement and investigate a model described in a scientific paper. You should complete this project in groups of 1 to 5 people. Each group member will be given the same mark for your joint work and you should write just one report per group. You are free to form your own groups.

The report should not be more than 10 pages including figures (with reasonable layout). Please submit hand-ins on Studium. Ask only one person from your group to submit your group work. All names of contributing authors should be clearly stated. All code should be submitted as an appendix and not as part of the answer to the hand-ins, i.e., the report and codes are combined as a zip file. Please feel free to submit videos illustrating your results where appropriate, via Studium or uploaded elsewhere.

You may choose your own paper. It need not be published but it should be available online, e.g. on arxiv. The paper should include simulations and a clear description of a model. Possible topics include self-proplled particle models perhaps with multiple types of particles, genetic algorithms or testing properties of networks. If you are in doubt of the paper being suitable I will be available at various times in the later labs to discuss this with you.

How to write the report

In this final project you should implement and investigate a model similar to (but not necessarily identical to) the one described in the paper you choose. The report should be broken into the following sections:

- **(6 points) Model description.** Write a full description of your model. Describe it in detail so it can be reproduced by others. It need not to be exactly the same model as in the paper since you may want to simplify or improve it a bit. But it should capture a similar phenomena as the one in the paper.
- **(6 points) Simulation results.** Provide sample runs for different parameter values to give an overall understanding of the behaviour of the model. Describe what you see in the model outcomes in words. Use these simulations to motivate one or two measures that could be used to characterise your model for different parameter values. You are welcome to include videos of your simulation outcomes.
- **(9 points) Modifying a parameter.** Investigate how systematically changing a parameter leads to changes in the measures you have defined (you may use the same measures as the paper or different ones). Show these changes visually, for example with a bifurcation diagram or heat maps.
- **(15 points) Extension.** Extend the model in some way. Use google scholar to investigate how the paper you looked at has been cited by others and the other papers that are cited by the paper. Look at ways these other researchers have extended this work, and think of a project to do of your own. This could be changing the rules for the self-propelled particles, investigating a different network structure, seeing if you can find other ways for self-reporduction or anything else you think could be an interesting extension of the work.
- **(4 points) Conclusions.** Describe what we can conclude from the model simulations. Find, e.g. using google schoolar, other papers which have cited or been cited by the paper you choose, and discuss your results with references to these other works. Explain the results' relevance to the application area.