Modelling Complex Systems
Final Project

The deadline for the final project is **Friday, 1st June**.

It has different requirements with the last two projects. Please read carefully.

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 3 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. Once you have a group send the names to David Sumpter (david.sumpter@math.uu.se). If you have not managed to form a group by the lab on Wednesday the 9th then you have to come to the lab (13:15-16:00) and we will form groups there. If you have managed to form a group then please come to the lab together, having decided which paper to look at. I can then give you tips and advice how to get started.

For the labs on Tuesday 15th and Monday 21st of May I will assign times (15 min each) to each group to have individual project supervision.

The report should not be more than 10 pages including figures (with reasonable layout). Please submit hand-ins on Studentportalen. 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 Studentportalen or uploaded elsewhere.

The following is a list of papers you can choose from:

1. Evolving the selfish herd, Wood and Ackland (2007)
2. A simple rule for the evolution of cooperation on graphs and social networks, Ohtsuki et al.(2006)
3. Insights into resource consumption, cross-feeding, system collapse, stability and biodiversity from an artificial ecosystem, Liu and Sumpter (2017)
4. Self-organized criticality: an explanation of $1/f$ noise. Bak, Tang and Wiesenfeld (1987)

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:

- **(4 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 the similar phenomena as the one in the paper.

- **(8 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. Investigate how systematically changing a parameter leads to changes in the measures you have defined. Show these changes visually, for example with a bifurcation diagram.

- **(10 points) Extension** Extend the model in some way. Use Google Scholar to investigate how the paper you look as 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 a predator, investigating a different network structure, changing the population interaction rules or anything else you think could be an interesting extension of the work. You can also think about possible mean-field models, master equations and how these approximations might be applied here. For "model extension", extend the model in some way. Add a new behaviour or different mechanism, and investigate how this extension works.

- **(6 points) Conclusions** Describe what we can conclude from the model simulations. Use Google scholar to find 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.