SAVM 2024/2025 Assignment[1]
Simulation, Analysis and Validation of Computational Models

This is an exercise worth 30% of the course mark. The maximal score you can get for this assignment is 100 points. The assignment is to be completed by yourself individually, and you are asked to submit an individual solution, and not to discuss or share your solution with other students.
The assignment requires you to write programs in Python[2] (you can use Jupyter notebooks), with which you will carry out a number of investigations related to three problems. You will need to submit your program code (zip) and a report (pdf). It can be useful, if you include some comments in your code, but there will be no marks specifically for the code, see the mark breakage below.

Problem 1 (20/100)
a) For the nonlinear system of difference equations

$$x(t) = x(t-1) + 0.1(x(t-1) - x(t-1)\,y(t-1)),$$
$$y(t) = y(t-1) + 0.1(y(t-1) - x(t-1)\,y(t-1)),$$

where $x > 0$, $y > 0$, study asymptotics and describe the qualitative behaviour in the (x,y) plane. Both numerical or analytical solutions are equally acceptable. (10/100)
b) Approximate the behaviour of the above system in the vicinity of the fixed point by a linear continuous system. (10/100)

Problem 2 (30/100): Epidemics modeling
a) Adapt the SIR model to run on a simple graph. (10/100)
b) Compare the behaviour of the model on two different graphs of a suitable size. You can use one regular graph and a random graph or different types of random graphs or graphs from real-world studies (see e.g. https://public.websites.umich.edu/~mejn/netdata/). (20/100)

Problem 3: (50/100): Forest modelling
a) In modern forestry, clearcutting is and other rotational forest management systems are avoided, instead, whenever possible, a continuous cover of the surface by trees is maintained while a certain fraction of the trees is harvested.
Forest management requires a cooperation with various stakeholders including loggers and foresters, land owners, state authorities, transportation companies, fire departments, wood traders, wood processing industry as well as organisations for conservation of wildlife, sports, tourism etc.
Choose and apply a systems engineering approach to gain a rough overview of the structure of the management tasks involved in forest management. (20/50)
b) Use the systems engineering considerations to justify a simplified model to predict the proceeds from the wood harvest. Discuss the technical formulation of the model, and analyse the model in order to give advice that might be useful to some of the stakeholders. (20/50)
c) Describe potential improvements of the model including implications for computing, data acquisition and theory. (10/50)
Note: As this question is aimed as an exercise in systems engineering rather than in forestry, completeness and deeper insights in the specificity of the target domain are not expected.

You may find the following comments useful for your work on the assignment:
For most questions, computer experiments will help to substantiate your answer. If you answer any questions solely based on literature, you may loose marks. Likewise, you will not get full marks, if

1 In comparison to the prelimnary version, only the brackets in Problem 1a) have been corrected.
2 You can use also C/C++, C#, Objective-C, Java, or Matlab. For other options, please contact the course organiser.

you submit numerical results without any explanation.
If you choose details of your approach or values of parameters, explain and justify your choice at least briefly.
If you perform comparisons, make sure that the comparison is reasonable and fair, and discuss your evaluation procedure.
Explain your decisions on the termination criterion, and on the number of repetitions of runs.
Wherever possible, use graphical representations of your numerical results.
If you give any results numerically, make sure to use a reasonable precision for the numbers.
Although the report needs to be concise, try to include justification and explanation of your work, rather than just a list of the steps that you have carry out.

Structure of the report

In the report on your work on this assignment, start a new page for each of the questions. There is no page limit for the report, but please take some effort to keep your answers and the total report short and concise. If you prefer to include material which could be seen as redundant or as not directly related to the tasks, please put it in an appendix.
Feel free to use any existing resources and literature to prepare your work and to support your argument, but make sure to cite all papers and to include links to all online resources that you have used for this assignment. Place this list of references and links at the end of the report.
Submit your report as a PDF file and your code as a separate zipped file via Learn. Deadline for submissions is

12 noon of Thursday, 21. November 2024.

You can submit an interim report by 7/11/24 by e-mail to the course lecturer. The report will not be marked and whether you will receive individual feedback, will depend on your submission date and on the total number of submissions.
After each lecture, at the labs and, after week 6, during the drop-in sessions (same time of day as the lab), and on Piazza will be an opportunities to clarify your questions related to the assignment. For any urgent questions, please contact michael.herrmann@ed.ac.uk.