Lesson 3: Matlab instructions to buid and run disease models

Learning objective: The learning goal of this lesson is to learn how to build and run disease models with ordinary differencial equation systems (ODEs) using MATLAB.

Self-learning steps: The student will learn to use the four necessary scripts for formulating and running disease models. First, in section "MATLAB code for models" the student will learn to use the scripts for executing the simulation, describing the equation system, plotting, parameter setting, and understand the outputs of each script. In this section, he student will use the adequate folder and script extensions. Second, the student will lern about the commands for running simulations and the editor window in section " MATLAB commnd to run a model". The student will need to spend 3 hours for learning the basics of the strucure of disease models in Matlab. This knowledge is critical for constructing disease models in Matlab in the excersice lessons.

Additional resources for the lecture: Additional learning resources about MATLAB instructions for building and running a model or the alternative open source software GNU Octave can be found on links 5 and 6 in section "Readings and other resources".

3.1. MATLAB code for the models

Each of the models described or developed by the student is or will be programmed in four matlab scripts. Matlab scripts are required to end with .m. The user of this

type of models should run first script $RUN\_MODEL.m$ to run a simulation and the fourth script $PLOT\_MODEL.m$ (see below) to obtain plots of the simulated model solution.

(1) RUN_MODEL.m

The main (driver) script with the name RUN, followed by the name of the model (e.g. $RUN\_SI.m$), defines variable names, sets up the model, initial conditions and run length (time span). This main script also renames the solution to have more convenient names (e.g. S, I, D, P). Running this script model solutions for the specified time are obtained.

(2) PAR_MODEL.m

The parameter script with the name PAR, followed by the name of the model (e.g. $PAR\_SI.m$) defines parameter names and set their values for the equation system.

(3) RHS_MODEL.m

The structure of the model is specified in the script starting with RHS, followed with the name of the model (e.g. $RHS\_SI.m$) , which defines the right-hand-side of the time dependent ODEs defining the model. These control the interaction of the various parts of the model.

(4) PLOT_MODEL.m

The plot script with the name $PLOT$, followed by the name of the model (e.g. $PLOT\_SI.m$) makes plots of the model solution. These are mainly the number of animals or particles in various model categories over time. Some graphs show the

rate of some model processes. It should be easy for the student to add other figures at the end of the modelling lessons.

Runing this script model plots of the model solutions are obtained.

3.2. MATLAB commands to run a model

MATLAB needs to be installed on the computer you are using. The four model scripts need to be in the same folder on your computer. Start MATLAB. The large window in the middle of the page that opened is (most likely) the command window. MATLAB acts on commands typed into this window. The MATLAB prompts are "» ".

Make sure that the current active directory or CURRENT FOLDER window (left side of the MATLAB window) is the folder in which you put the two matlab scripts; RUN_MODEL.m, PAR_MODEL.m, PLOT_model.m and RHS_model.m. The line just above the command window tells you what folder is the current folder MATLAB is working in.

At the MATLAB prompt in the command window, type RUN_MODEL and click $ENTER$ to run the the model. This will set the parameters and run the model. There is another option to run the script: click on the name of the script on the current folder window (left side of the MATLAB window) and it will be opened on the central $EDITOR$ window. Then, click on the RUN button on the top menu bar.

Once the simulation is run, typing PLOT_MODEL in command window the plots of model solutions will appear on the screen. As for the main script, the plot script also can be run by opening it on the editor and clicking on the RUN button on the

top menu bar.

The editor is available with the "open" button on the upper left of the MATLAB page. Use this editor to change parameter values, graphics or model interactions.

Any editor can be used to change the MATLAB scripts, the built-in one has convenient features. The only requirement is that the files must be plain text (no word processors).