2023 Harvard/University of Global Health Equity
Mathematical Modeling for Infectious Disease Planning

Berkeley Madonna Tutorial

Time: 1 hour

This material is an adaptation of the "5-Minute Tutorial" on Berkely Madonna (BM) (Marcoline et al., 2022) accessible via Help > Examples > 5 Minute Tutorial.mmd.

For ease of reference, the tutorial has been pasted below with some additional notes for clarification.

Before working on the following steps, please ensure the following.

a) BM is registered (see email from Sylvia about licenses)
b) The latest version is installed.

1. **Enter model**. Click File > New Document. Enter the following equations into the Equation Window, typically on the left side of the application (or under the Model menu, or Ctrl-E). Do not duplicate lines.

```
METHOD RK4
STARTTIME = 0
STOPTIME = 10
DT = 0.02
d/dt (A) = - ka*A
d/dt (B) =ka*A - kb*B
d/dt (C)  = kb*B
init A =100
init B = 0
init C = 0
ka =1
kb =1
```

The above is a set of ordinary differential equations (ODE) (lines 5-7) with initial conditions (lines 8-10), parameter values (lines 11-12), time step specifications (lines 2-4) and the ODE solver method (line 1).

2. **Save and run model**. Save the model as "BM_Tutorial.mmd" with File > Save Model As. Then, click the Run button on the right side, or type Ctrl+R (Windows) or Cmd+R (MacOS). Madonna automatically plots the first two variables in the Equation window. The first is scaled on the left, the second on the right. The next six variables are easily addressed by buttons on the left bottom margin.

3. **Graph view**. Use the buttons on the left bottom margin of the display to toggle the graphs of A, B, and C. Toggle C on. Use shift+click B to change the scaling axis for B from right to left axis. General control of plotting variables (e.g., adding other variables) is handled by a dialog initiated after double clicking anywhere in the x-y plane.

4. **Table and legend view**. The Graphic tool bar is located at the top of the graph window.

Toggle the "table" button to see the graph change into a table of numerical values. Toggle the "legend" button for a legend. See Part 9 of the in-app tutorial at Help > Examples > 5 Minute Tutorial.mmd for a general description of all buttons in the Graphic tool bar.

5. **Modifying parameter values**. Open the Parameter Window using the Parameters menu or Ctrl+Shift+P (Windows) or Cmd+Shift+P (macOS).

Change the value of ka by double-clicking it and entering the changed value into the edit box next to the Reset button. Parameters that have been changed are indicated with an asterisk - they can be reset to default values by the Reset button.

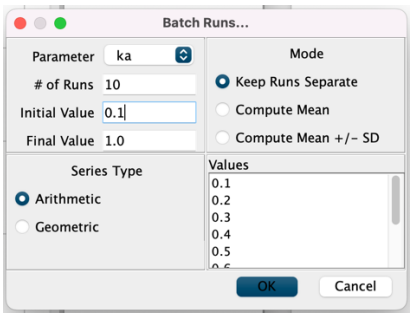
6. **Sliders**. Open the Define Sliders dialog in the Parameters menu.

Double click on ka and on kb to add them to the Slider list. Click OK.
Move the sliders (found below the graph) back and forth: when you release the mouse, Madonna automatically runs the program with the current parameter values.

Each slider has a check box labeled "10x" which reduces the range of the slider by a factor of ten around its current value. This feature makes it easier to zero in on a desired value.

Double click within the text area of the sliders to open the Sliders dialog where you can add sliders, adjust the current slider limits etc.

7. **Batch Runs**. Plot a family of curves. Click on Batch Runs in the Parameters menu and set it up as shown below. In this case we want to make several automatic runs for different values of ka, so we select ka in the Parameter popup. We will display 10 runs with values ranging from ka = 0.1 to 1.0.



Click OK. The concentration profiles are calculated and displayed. Toggle the “legend” button to display, in brackets, the ka corresponding to each profile in the legend. Toggle “A” and “C” off the graph (by clicking on the buttons “A” and “C” below the graph) so that you can see the unencumbered behavior of B. The same can be done for A and C.

Reference

1. Frank Marcoline, Michael Grabe, Smita Nayak, Tim Zahnley, George Oster, Robert Macey (2022). Berkeley Madonna User’s Guide. Version 10.4. https://www.berkeleymadonna.com/downloads/BM_Users_Guide_10.4.pdf