Biomodeling - Model Set #1

Due Wednesday 11th

Constructing A New Model From Scratch

I. Setting up to work

A) A new Master Model to work on

Always make a new MasterModel *folder* each time before beginning to work on a new model. To do so

-> select the MasterModel folder (at the desktop level)
-> from Edit, Copy it (CTRL-C)
-> from Edit, Paste it (CTRL-V)
-> rename the new folder ExpPopGrow1.1

You now have a new MasterModel folder copy to work on.

B) Opening a template model

-> Open your new folder and then start the shell model "MasterModel" inside it. [remember, always work with the project file]

C) Saving a Copy To Work On

To save a copy of the 'new' model you are about to work on, do the following:

-> select Save Project As.. from the File menu, backspace (<delete>), type in a new file name (e.g. ExpPopGrow1.1) and Save this as the current working version of this model to your disk.

Remember, it is a wise practice to re-Save to disk frequently to protect yourself against accidental loss of your hard work in the event of a network or machine crash.

D] Grab more screen real estate for your model Code window.

1) Shrink the Project and Properties windows

Move the mouse pointer to the right until it contacts the right- hand windows and turns into a double headed arrow. Push the arrow half way to the right shrinking the right hand windows and expanding space for the model list.

2) Grab the lower right hand window tab (45 degree lines) of the code window and pull it down and to the right to expand it. (this gives you more editing space)

-> Scroll down through it until you reach the portion that reads

```
'**********************Run Model**************************
Do While T < 50
    N = K * T
    T = T + dT
    X1 = T: Y1 = N: StyleType = 0: PlotPoint
Loop
'*********************************************************
```

Look around this section, focusing especially on the model itself . Aways work at getting a feeling for the flow of logic!

This is a simple model that contains the basic (no pun) structure you need to fit your own analytical models into. Sometimes you merely have to replace one or two lines to get a substatially new model. You will be working with this or similar 'starter' models extensively. You essentially construct new models by Editing older previously written ones.

E) Try it out (a review of the previous session)
-> From Run pick Start (F5)
-> Click through Continue, Graph and Run model.

The model runs once through until finished. To avoid labeling and printing, pick Exit.

You are now back in "idle" in BASIC looking at the model List in the Code window.

II. A new population growth model

Recall that the 'final' version of this model of population growth that you arrived at last time was

N = K * T + N0

If necessary re-edit this model as you did last time so that it a) contains the above equation and 2) assigns a value to the initial population of N0 = 10.

Recall that this model was not very realistic.

As you know, population growth is classically exponential rather than straight line in nature. We will now replace the old model with an exponential one.

-> Edit the equation so that it is replaced with the following exponential model:

☞ $N = N_0 e^{Kt}$ Keen eq. 1.6

In BASIC, **e** is handled (and the above relationship is written) as follows:

N = N0 * **EXP**(K * T) (be careful of letter case and zero/letter 'O' errors!)

Notice that the "*" is used for multiplication and EXP( ) means "e to the K times T power". You now have a new model of population growth, an exponential one. As an aside, powers of a function, say X^2, are handled by the ^ symbol. Thus, $Y = X^2$, in BASIC, is Y = X^2.

We now have to assign appropriate initial values for the terms in the equation. Find the "Assign Constants" section and

☞ Assign constants as follows:

```
N0 = 2          'initial bacteria/ml
K = 0.1         'per hour
T = 0           'hours
```

(note: any item followed by an apostrophe (e.g. ') is taken by BASIC as a comment (REM) rather than an instruction to execute. Thus, we can leave an explanatory comment note next to our N0=2 assignment by typing <tab>, then ', then whatever we wish to say (e.g.initial bacteria/ml))

☞ Check graph labels ['Label graph..] to make sure they read:

```
Xlabel = "Time (hrs)"
Ylabel = "Bacteria/ml"
```

Edit the labels if necessary.

☞ Check graph maxima and minima and change them to:

```
xMax = 50       'Show 50 hours
xMin = 0        'low end of x axis on graph
yMax = 50       'set Y top at 50 bacteria/ml
yMin = 0
```

This sequence of four steps indicated by the hand (☞) is one you will always perform when constructing a graphic output model in BASIC.

-> Run the model; viola, exponential growth (don't label or print yet).

-> Finally, personalize the List by editing the line near the top that reads:
'version 9/3/02
to list your name, the subject of the model and the date. For example:
' Rmeyers-NewExpPop Growth with K = 0.1 -9/03/02

-> Now document your model. To do you will need to do the following:
a) Save a working copy on your data disk (if you have already Saved and renamed it just pick Save Project)

b) Print an output - Run & label the graph (model name/your name/date) and then select PRINT.

c) Print a model List - select the model and the assignment, graph label and graph max/min sections above it and Print selection.

III. Changing the model

a) Prepare a fresh MasterModel folder to work on. Name it ExpPopGro1.2 .
b) double and halve the value of K.
- RUN each time to check your results against expectations.
c) increase by a factor of two and then five your initial population.
- RUN to check each out against expectations.
- See section IV. immediately below for how to document multiple changes of this type on one graph. (You do NOT yet need to Save & Document these section III models).

IV. Multiple Outputs

Suppose we wish to show the results of various models with differing values for K on the same graph. Study the following code and edit your new ExpPopGro1.2 population model to match it. Then, try it out. Remember, you do not have to type in anything that starts with a ' (single quote mark) such as the line below that reads
'Define Graph Maxima and Minima
Such lines are merely comments (i.e. notes to yourself, REMarks) and are ignored by BASIC.

```
'Define Graph Maxima and Minima
xMin = 0
xMax = 25   '<- - - notice change
:
:
'assign constants...
    N0 =
    T = 0                                   'start time at zero days
    dt = 1                                  'time is advanced by 1 day/cycle
    DO WHILE T < 25                         'keep going until time reaches day=26
      '---solve & plot 1rst value---
      K = 0.1
      N = N0 * EXP(K*T)
      X1 = T: Y1 = N: StyleType = 0 : PlotPoint
```

```
'--- solve & plot second value---
K = 0.2
N = N0 * EXP(K*T)
N = N0 * EXP(K*T)
X1 = T: Y1 = N: StyleType = 1: PlotPoint

T = T + dt                          ' advance the time by dT(1 hour here)
LOOP 'loop back to WHILE
```

Note above that 1) time (& graph) maximum has been lowered to 25 and that the change in plotting symbols has been achieved by changing the StyleType.

Be certain you understand that this plots 2 separate curves because each time (T) through the loop the equation is solved and plotted twice, once for each value of K.

Also trace through in your mind the WHILE....LOOP control loop and the advancing of time by increments of dT each time through.

Save this project with its changes.

As practice in multiple output graphing (see assignment summary below)
-> Set up a new MasterModel folder (ExpPopGrow1.3)
-> Type in and run a model in which three values for K are shown on a single graph plot.
K = 0.1, 0.2, 0.075
-> Document (i.e. model on disk, printed list and printed output) your results.
-> Save & Exit BASIC to the desktop.

V. Read this

As this is your first modeling assignment to be handed in, now is an excellent time to review what is required for a submission. At the beginning of the specified assignment due deadline, you should hand me full 4 piece documentation (a model LIST, a printed labelled output graph, a working project file Saved on your disk & a brief statement of biological significance, often written on right on the graph) for each of the following models .....

1.1) new (exponential) population model w/ K=0.1 (section II. above) (1 point)

1.2) new population model w/ 2 values for N0 (section IIIb above) (1 point)

1.3) new population model w/ 3 values for K (section IV above) (1 point)

1.4ec) Keen example 1.3 - see below - for extra credit (1 point)

Also note:
a) Since you will be giving me your disk & will not have it back for a week, you must also make a second copy of your disk (just drag the entire folder) which you will then work on the second week. We then swap disks at the end of each week.

b) All work is to be completed BEFORE the hand-in class. You come in, drop your disk, Lists, graphs & reasoning into the collection box and then sit down to work on the new material. No old Lists should be printed out during the new work period.

Assignment 1 - model #1.4ec - extra credit

In Wednesday's lecture, we will be discussing in some detail how to set up and write models given our "intuitive" understanding of how a particular system behaves. To get an early start, we will try Keen exercise 1.3 (ex 1.3, page 21).

First read his introductory material taking a particularly careful look at equation 1.8. Notice that it is the negative of the exponential growth process we modeled this time and that as such, with very little modification of your last model, should also be solvable by the methods you have already learned.

1.4ec - Model and document Keen ex 1.3. (extra credit models are not required & can be done only once. If they are 'correct' they receive full credit; if not, there is no redo)

From now on, and for the rest of the course, please always bring in your copy of Keen as we will almost always be working from it.

See you Wednesday at 12:20 - Dana 181 for lecture. When you come in, please hand in your assignment #1 material to me.