

# How To Get Berkeley Madonna Working

For ODE's with Dr. Hoffoss

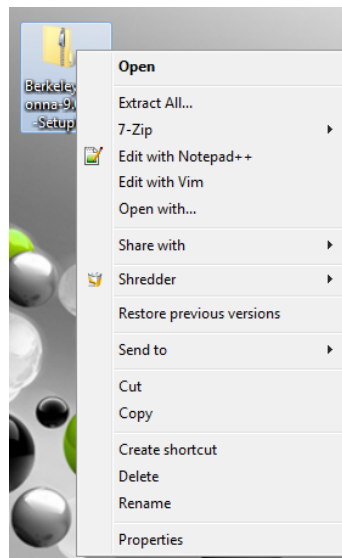
June 9, 2013

## 1 Installation

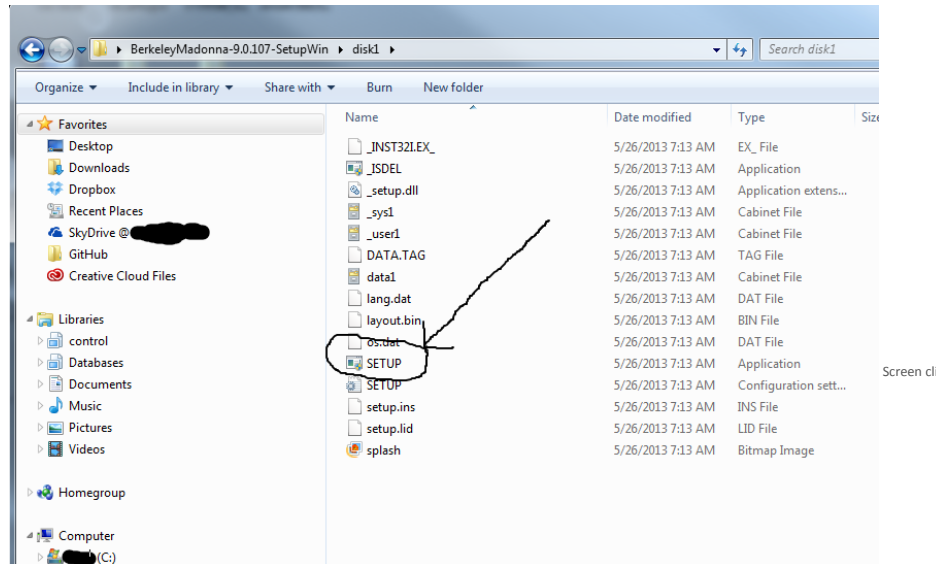
1. Go to [Berkeley Madonna](#) homepage and click on the [Download](#) tab.
2. Scroll to the bottom of the page and pick the [Download](#) the beta version ( <http://www.berkeleymadonna.com/jmadonna/jmadrelease.html> )
3. Now follow the instructions for your operating system. . .

### 1.1 Windows

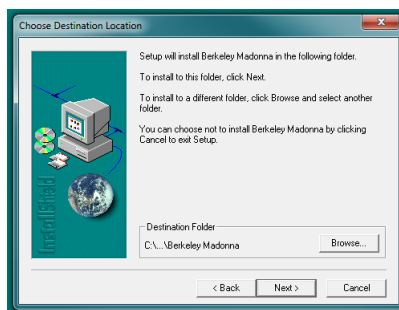
1. At the screen to select your [download](#), choose the “Download Windows” [option](#).
2. Save the file to your Desktop.
3. Right click on the file and choose “Extract All”



4. If the file doesn't automatically open, open the folder that was just created, and enter the "disk1" folder (it's the only one)
5. Double click on "SETUP" (the application, NOT the Configuration settings - don't worry if you do the wrong one, if the program doesn't start loading, exit notepad and choose the other one).



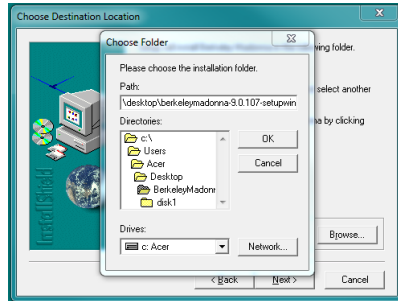
6. DO NOT just accept all of the default options. When you get to



do the following

- (a) Choose "Browse..."

- (b) Navigate back to the Desktop. Each system might be a little different, but you will probably have to double click on the “C:” to get all of the available paths to show. This step is very important (if you accept the default option you will have issues running the program)!
- (c) Choose the “BerkeleyMadonna-9.0.107-setupwin” folder (the one we made by extracting the zip file).



- (d) Select “Okay”
  - (e) Now accept the remaining defaults.
7. Check your installation by opening the BerkeleyMadonna-9.0.107 folder on your Desktop.
  8. Double click on the BerkeleyMaddona application (blue circle with integration symbol) and make sure it opens.

## 1.2 Mac

Please see Dr. Hoffoss if you need help with installation on a Mac.

## 1.3 Linux

The free beta version link has been disconnected. Sorry.

# 2 Berkeley Madonna Basics

Berkeley Madonna is simply a tool to evaluate mathematical expressions, particularly differential equations. Before we get into how to use the Berkeley Madonna tool, a quick definition:

*Model.* A Model in Berkeley Madonna is a collection of differential equations, along with the necessary information to solve the equations. At a minimum, that necessary information is:

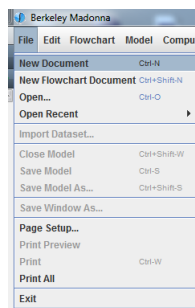
1. An initial condition (the value of the variable at time 0).
2. The equation itself.

3. Values for all non-variable parameters.

To use Berkeley Madonna, we define “models.” So, let’s get started!

## 2.1 First Script

When you run Berkeley Madonna, you should see a welcome screen that tells you your beta version will expire the end of the summer. Click “OK” to dismiss this notification. Go to “File→New Document.”



In the far left of the screen, we see an area with information already filled in. We’ll cover what they mean in just a minute. For now we see a line “{Type Equations Here.}” As you might expect, this is where we define our model.

For our model, suppose we are interested in the function  $P(t)$  where  $t$  represents time. The equation we are solving is:

$$\frac{dP}{dt} = rP,$$

where  $P(0) = 5.3$  and  $r = 0.4$ . Notice we have the 3 necessary things:

1. Initial condition:  $P(0) = 5.3$ .
2. The equation:  $\frac{dP}{dt} = rP$ .
3. The parameter values:  $r = 0.4$ .

We enter these into Berkeley Madonna below the line “{Type Equations Here.}” in the following way:

```
init p = 5.3
d/dt(p) = r * p
r = 0.4
```

`init` defines the initial,  $P(0)$ , condition.  $d/dt(p)$  looks weird, but is equivalent to:  $\frac{d}{dt}(P) = \frac{dP}{dt}$ .  $r$  is simply a constant. One important note: **capitalization does not matter** in Berkeley Madonna. We could have just as easily wrote  $d/dt(p) = r*P$  and  $R = 0.4$  and still be expressing the same thing.

Run the model by clicking the “Run” button. Did it work? Congratulations! Otherwise, make sure you followed the directions precisely.

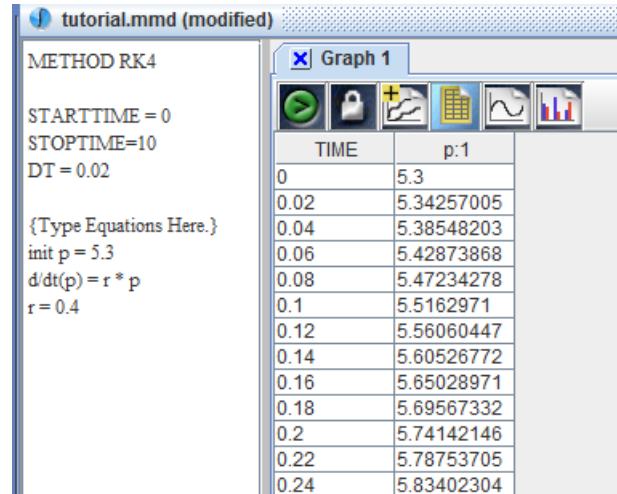
## 3 Using Berkeley Madonna

### 3.1 Save Your Model

To save your work, just go to “File→Save Model.” If this is your first time saving, it will prompt you for where to save to. Note the location in case you need to find it again to pick up where you left off. Berkeley Madonna is pretty clever, though, so if you forget and “File→Open...” doesn’t automatically show you your file, you can instead do “Open Recent” and most likely find your file there.

### 3.2 Tabular Output

You noticed from earlier that the default output is graphical. If you want to see a table of values, just click on the table looking icon in the graph window. Click it again to go back to graphical output.



Notice that the time interval changes by 0.02. This is because we defined 0.02 to be the smallest interval Berkeley Madonna needs to worry about when we set  $DT = 0.02$ . Well, we didn’t write that - it was the default, but you see it above the “{Type Equations Here.}” line. If we want a different time interval, we just need to change that  $DT$  value. You may find as you progress in the course that the default 0.02 value will not be appropriate. Generally, smaller values will give you more accurate results at the cost of possible taking

longer to compute. Keep in mind that Berkeley Madonna does not solve differential equations for you, it is instead computing numerical approximations of the solutions.

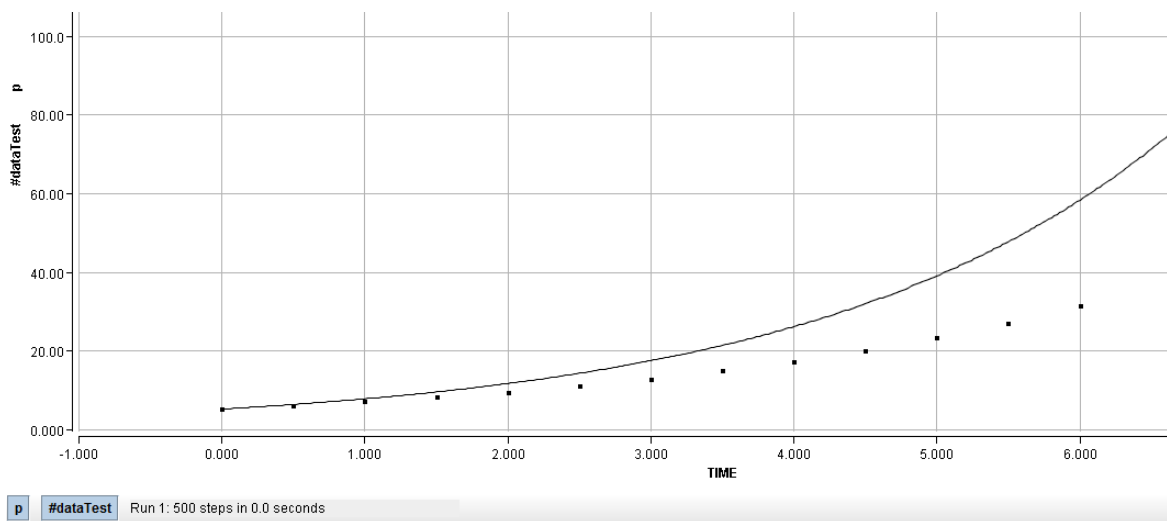
### 3.3 Import a Data Set

A data set is simply a collection of points specified by the  $x$ ,  $y$  axis. Before we can import a data set, we first need to create one! I prefer to keep everything together, so go back to the folder where Berkeley Madonna is installed and create a new folder inside there called “dataSets.” Inside “dataSets” make a new text file (.txt) and call it “dataTest.” Open this file in a text editor, NOT a document editor (so something like notepad and not Word). Enter the following data and save it:

```
0.0 5.300
0.5 6.148
1.0 7.133
1.5 8.275
2.0 9.599
2.5 11.136
3.0 12.919
3.5 14.987
4.0 17.387
4.5 20.170
5.0 23.399
5.5 27.145
6.0 31.491
```

To import this dataSet into Berkeley Madonna, click on “File→Import Dataset...”, find the document you just made (“dataTest.txt”) and open it. Berkeley Madonna assumes that the first column is  $x$  and the second column is  $y$ . Click “OK” and notice the points show up in the graph.

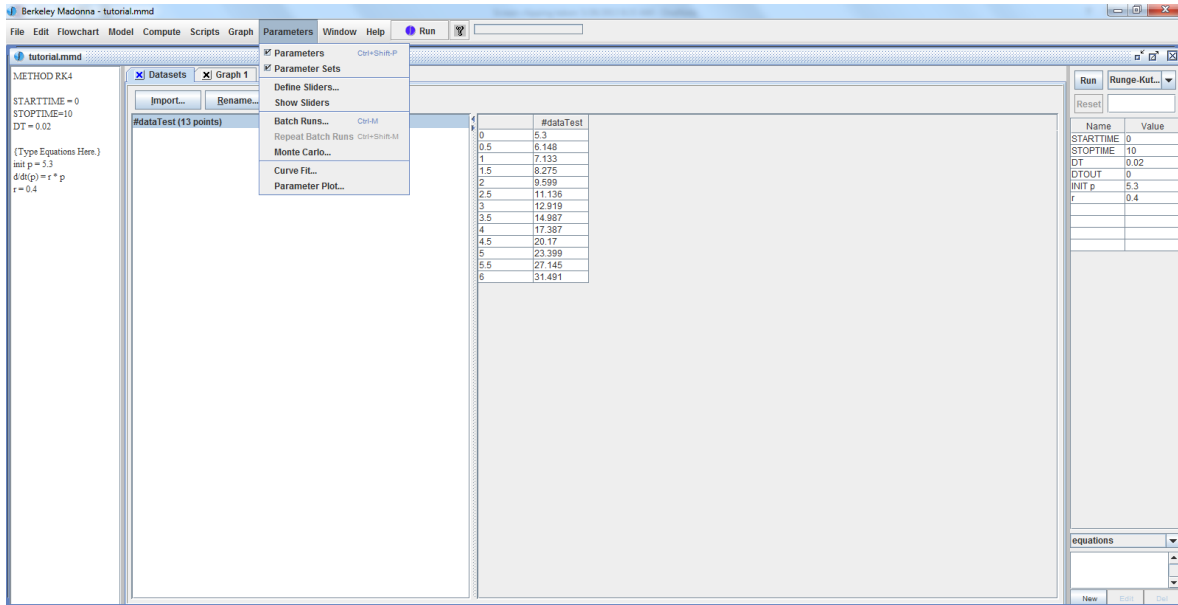
Notice that these points don’t quite match the line! Let’s fix that right now.



(You can zoom in by clicking inside the graph and dragging a “magnification box” around the area you want to magnify. Undo by clicking on the magnifying glass with the “-” or double clicking on the axis and selecting “auto” for all of the options.)

### 3.4 Change Parameter Values in a Model

Changing parameter values, in this case the  $r$  or  $P(0)$  can be done by looking in the “Parameters” menu item, and ensuring the “Parameters” is checked. The menu should come up on the right side of the screen. Change a parameter value by clicking on it, and changing the number in the box above the parameter list. Click “Run” to re-run the model with the new value.

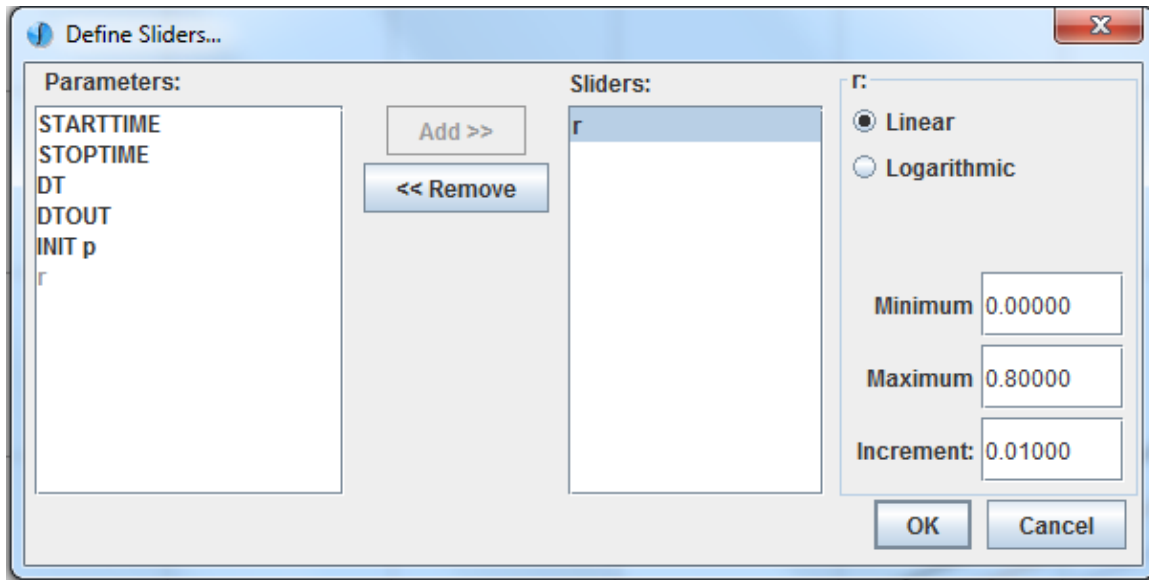


Changing a parameter like that is great and all, but awfully tedious. We have two other, more powerful options, sliders and batch runs.

### 3.4.1 Sliders

Sliders are great because they can help you gain an intuition about how the model behaves as a parameter's value changes. Let's define a slider and see how  $r$  effects our model. Again, from the menu, go to "Parameters→Define Sliders." Highlight  $r$  and click "Add." You can play around with the boundaries, but the default is fine for now.





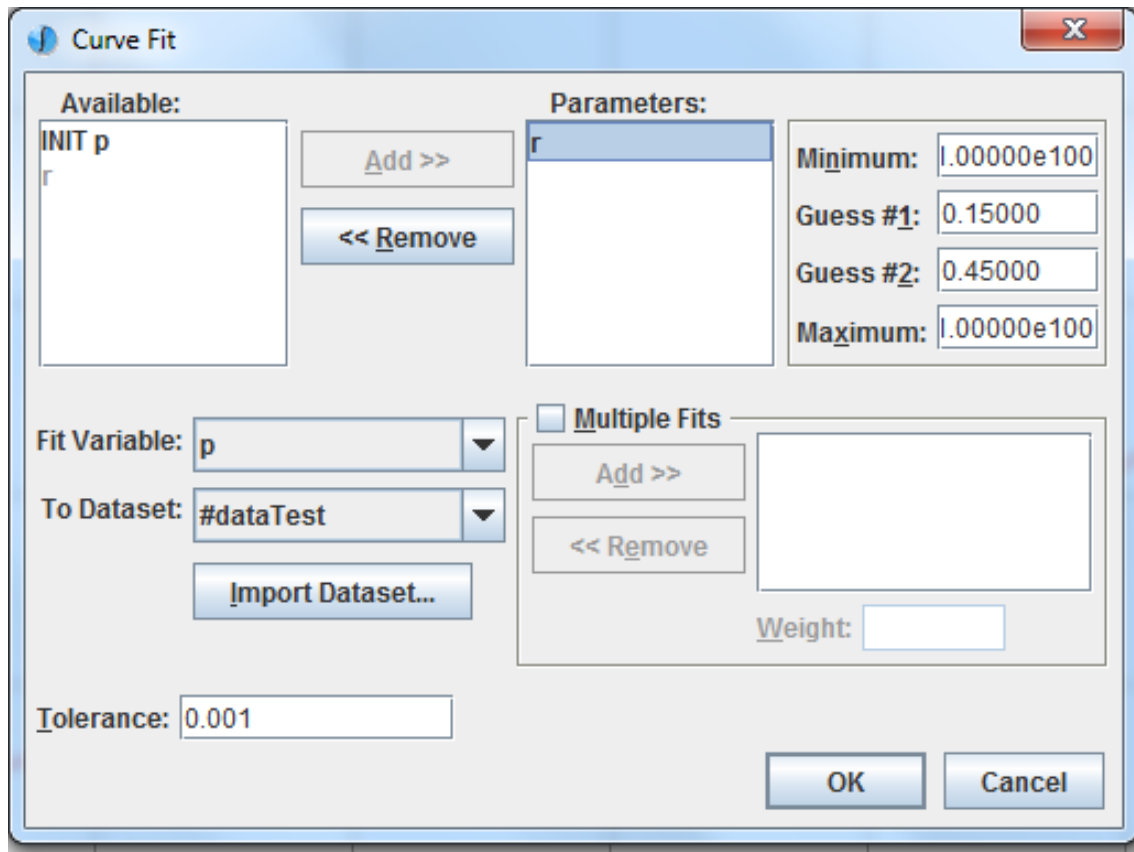
A slider bar now appears in the lower portion of the screen. Move it left and right and try to match the line with the points from our dataset!

### 3.4.2 Batch Runs

While a slider allows us to see the effect a single parameter on our model by moving the plot around the graph, batch runs will plot multiple solutions to the model on the same graph. We can start batch runs from “Parameters→Batch Runs.” Play around with the different options and see what each one does!

## 3.5 Curve Fitting

By now you probably have a pretty good idea what  $r$  should be to fit the model to the dataset. Let’s see what Berkeley Madonna thinks it is. We can try to fit the curve to the points by, again, going to “Parameters→Curve Fit.” Choose  $r$  from the available parameters, and click “Add” Let’s go ahead and put in some reasonable bounds for the minimum and maximum, based on what you observed from the slider and batch runs. Also, make two guesses as to what the value should be. For the best possible result, you should also decrease the “tolerance.”



The value Berkeley Madonna found that fits the data best, given the boundaries, shows up in the “Parameters” window on the right. The plot should match the data exactly, does yours? If not, try another curve fit and see if you can change some options to get it perfect.

### 3.6 Phase Portraits

If we have two dependent variables in our system, say  $P$  and  $Q$ , a phase portrait can be created by just changing what is plotted on the x axis. To do this, double click anywhere in the graph. Notice the “X Axis” drop-down selector. Change that to be one of the dependent variables, say  $P$ , and remove  $P$  from the “Y Axes.”

If you would like several solution curves, each corresponding to a different initial condition, click the Initial Conditions button, as in the picture below. Then, wherever you click on the phase plane, a solution curve will be drawn with that initial condition.



For some experience working with phase plots, you can go to “Help→How Do I→Make A Phase Plane

Plot.mmd” for an example. Run the model, double-click on the graph. Remove “Z” from the Y axis, and make Z the variable in the X axis. Now you have a Phase Plot!