# Growth Curve Analysis Tool

GCAT version 6.1

1. **Introduction**

GCAT is a web based tool for summarizing microbial growth curves using mathematical modeling. The user interface requires no programming and calls on an R package of the same name which processes input data files, models the curves, calculates important growth parameters from the fits, and returns both graphical and tabular output.

1. **Testing Scope**
   1. **The Entire Work Flow**

* Check single plate and multi-plate datasets from default\_examples
* Check two sets of Settings
  + Default settings with user-entered Media background = 0.04
  + Legacy settings: Media background = first OD reading; OD transform log(x+) with  = 1; Inoculation time point = 2.
* Check two types of Growth Curve model
  + Sigmoid curve
  + Loess (smoothing parameter = 0.1 for single plate; 0.5 for multi-plate)
  1. **Efficacy of model formulas**
* Verify that fitting is successful in all wells that have growth
  + Single plate default example: all non-empty wells should be successfully fit. F06 and F11 also have growth and should be successfully fit, even though they were supposed to be empty.
  + Multiple plate default example: all wells should be successfully fit
* Cursory inspection of plots to see that “reasonable” sigmoid curves are fit by the model. *Please direct questionable fit failures to Yury.* (Note that, in the single plate dataset with default settings, the loess curve will plunge at the lower end. This is expected behavior, as time point 1 is much lower than the rest).
* When a model fits the data successfully, the model should be “reasonably” close to the numbered data points on the plots*. Use your best judgment here. The model should have a similar shape as well. Direct questionable fits to Yury.*
* Legacy settings should produce output files that have the same values as GCAT 4.
  1. **Browser and Operating System Compatibility**
* The client side common browsers such as Firefox, Chrome, Safari and IE
* The results can be download and the files can be unzipped on all applicable OS
* The output zip file should contain 3 heat map PDF files for each plate.
* And make sure the heatmap color ranges correspond to the output spreadsheet values for each well.
  1. **Data Validation**
* Any invalid data input should be rejected
* These error messages should look nice, e.g. no rails code error messages.
  1. **The User Interface**
* Layout
* Tooltip Text

1. **Testing Details & Tasks**
   1. For both Single Plate and Multi Plate Workflows
2. Upload Input Data File (CSV format)

* If an Excel file is uploaded, a “nice” error should be displayed to user.
* List of invalid test files:
  + 133 Well H1-H3 M200.csv: Unrecognized encoding.
  + 133 Well H1-H3 M200 UTF-8 fixed.csv: Fixed encoding but the number of columns is not correct. (Have temperature column)
  + 133 Well H1-H3 M200 UTF-8 fixed noT.csv: Fixed encoding and wrong number of columns, but have missing data point at well A6 time point 14.
* All valid .csv should be able to be created.

1. Set up analysis parameters
2. OD Transform

* Test log(x+)
* Using the Single-Plate Example File
* For OD transform set the radio button to log(x+).
* Enter the number 0.1 in the text box below.
* Create Assay.
* Diff the output\_gcat.fit output file generated by the test against default output file.
* Should diff clean (if you cannot diff the files just visually inspect outputs)

1. Inoculation time point

* Test inoculation parameter
* Using the Single-Plate Example File
* Enter the number 3 in the inoculation timepoint text box
* Create Assay

1. Growth threshold

* **Bad parameter test**
* Using the Single-Plate Example File
* Set the growth rate to the value of 1.37 (for example)
* Create Assay
* The effect of this should be to exclude all well-fits except well #63 (G8)
* Verify that the desired result occurs, or at least that wells with Max. Values < 1.37 get skipped
  1. Points to ignore
* Validate that numbers entered into the **Points to ignore** textbox appear greyed out rather than black.
* Ensure that invalid input is rejected gracefully. This includes:
* Negative values
* Non numeric strings
* Values > total number of points analyzed
  1. Heat map ranges
     + The values in this field should be positive real numbers, and the right number should be higher than the left.
     + Verify that setting a range affects colors on the corresponding heat map. For example:
       1. Run GCAT with the example single plate dataset with default options and Media background = 0.04. Heat map ranges are fields are left empty by default. Download results, unzip and look at the heat map in “single - YPDAFEXglucoseTests\_2-25-10\_max\_spec.growth.rate.pdf” The max specific growth rate heat map is all red with one bright yellow square at B3.
       2. Run GCAT again with the same options but set the max specific growth rate range from 0 to 0.3. The heat map is mostly yellow now.
     + Try the same for another heat map. You can use the Min, Med and Max values displayed in the header of a heat map to see what ranges would make a difference. E.g., if you set the range to start close to the median value, most of the heat map should be red; if you set it to end close to the median, most of the map should be yellow.
  2. Area Under the Curve (AUC)
     + The values in this field should be positive real numbers, and the end time should be higher than the start time.
     + In the example single plate dataset, AUC and AUC.OD should go up monotonously for consecutive wells in the same column, e.g. from B02 to G02, from B03 to G03 etc.
     + The time course in the example dataset is 0-24 hrs. If you enter a more narrow range for the AUC, e.g. 5-15, you should get smaller AUC values for all wells.
  3. Timestamp format
* Timestamp field should not appear as an option when single-plate option is selected
* When multi-plate option is selected, verify that that the list of timestamp format options includes the format for all test files used.
  1. Output table
* Should contain all column that Results Data Table in Results Page
* Retest Trac ticket #1200
  1. Browser and Operating System Compatibility
* Firefox 32.0.1 on Windows 7
* Google Chrome Version 37.0.2062.120 m on Windows 7
* IE 10 on Windows 7
* Firefox 32.0.1 on OS X 10.9.4
* Google Chrome Version 37.0.2062.122 on OS X 10.9.4
* Safari 7.0.6 on OS X 10.9.4
  1. User Form
* Check layout
* Check Tooltip Text
* Check Mouse Click
* Check Email sending
* Send an email to the link provide at the bottom of the main page.
  + Ask Nate (or current GCAT project member) if he/she received the email
* Check Links(user manual etc)
* Download all example files and the instruction guide. Verify that they can be accessed.
* Retest Trac ticket #1364
  1. Results Page (When Loess not selected)
* Clicking plate in results page downloads zip file
* Numeric values in table are should either be two significant digits or in scientific notation (e.g. nothing like 9.0000000000000000000000000087 or 8.333333)
* Results Data Table shouldn’t overflow black border on page (see gcat3 for example)
* If Model is listed as “Richards”, there should be a numeric value in the shape.par and shape.par.SE columns.
* lag time, spec growth, lower asymptote, upper asymptote, and shape (if Richards) values should all have a corresponding SE (standard error) value in the table
* Clicking numbered links in the row column should open the corresponding plot in a tab in your browser
* RSS column should exist and have a numeric value for all fitted well rows
  1. Using Loess
* Loess uses a different R function/ algorithm to model the data. It has an optional smoothing parameter that can be used. Some distinctions:
  + No parameter estimates are returned internally, therefore there will be no SE values in the table.
  + The plots should only list the smoothing parameter rather than lag time, spec growth,etc.
* Test several smoothing parameter values between 0 and 1. Smaller values should result in a more “jagged” model (play around with it to get a feel for what I mean). Conversely larger values will result in smoother curves at the expense of greater residuals. Test that changing the smoothing parameter has this effect

1. **Testing Schedule**

Time period: 3-4 days

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| --- | --- | --- |
| **Starting Date** | **Complete Date** | **Objectives** |
|  |  |  |

# Deliverables

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| --- | --- | --- |
| **Deliverable** | **Responsibility** | **Completion Date** |
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