

CPiME Support Documentation

Luke Paul Buttigieg

August 2017

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1 Introduction

Welcome to the Continuous Pi-Calculus [1] MATLAB [2] Extension [3] (henceforth CPiME) Support Documentation. This document primarily describes how to use the functionality found in the Command Line Interface (CLI) and Graphical User Interface (henceforth GUI).

2 Background Reading

We have included a list of Continuous Pi-Calculus papers which you can consult if you need to understand the syntax and semantics of Continuous Pi-Calculus, or need further information about CPiME [1][4][5][6][3].

3 Downloading CPiME

You can download the CPiME Source Code directly from GitHub [7] from <https://github.com/continuouspi/cpiwb>. The extension source code is found in the `matlab_extension` directory. You need to be in this directory in MATLAB to use any of the CPiME functionality.

4 Command Line Interface

The CLI offers quick, direct access to the CPiME functionality. You can load an interactive interface by typing `cpime` in the MATLAB Command Window, as seen in Figure 1. Additional CLI-specific help can be accessed by typing `help`, including a list of available functions.

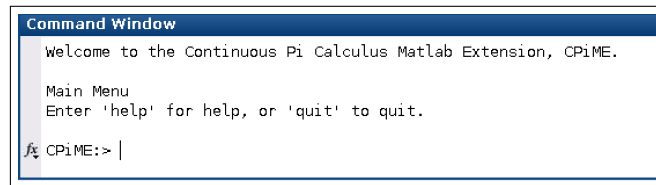
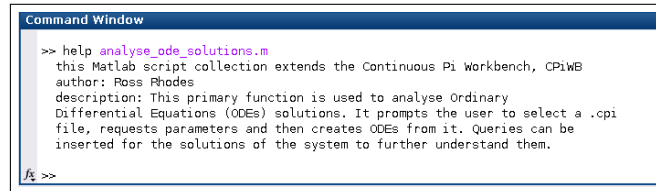


Figure 1: The CPiME [3] interactive CLI.

You can also call nine function files directly, bypassing the interactive CLI and integrating them in data processing pipelines. For example, to call the `analyse_ode_solutions` function, type `analyse_ode_solutions` in the MATLAB Command Window. All the callable files are found in the `matlab_extension` directory and end with a `.m` file extension. There is one exception: the `gui.m` file should **not** be used for direct access, as this file is used by the GUI. Files inside the `private` directory are **not** intended for direct calling.

You can access specific CPiME function file support documentation using the standard MATLAB CLI support documentation function, `help` [8]. An example is shown in Figure 2.



```

Command Window

>> help analyse_ode_solutions.m
this Matlab script collection extends the Continuous Pi Workbench, CPiWB
author: Ross Rhodes
description: This primary function is used to analyse Ordinary
Differential Equations (ODEs) solutions. It prompts the user to select a .cpi
file, requests parameters and then creates ODEs from it. Queries can be
inserted for the solutions of the system to further understand them.

fx >>

```

Figure 2: Using the inbuilt MATLAB `help` [8] functionality to return information about the `analyse_ode_solutions` function.

5 Graphical User Interface

The GUI offers a visual way of using the CPiME functionality and could help newer or less technical users. Nearly all the CLI functionality is available through the GUI.

Contextual Help Information [9] is available for all GUI elements. Simply hover over a GUI element to see the associated tool-tip, as in Figure 6.

5.1 Opening the Application

You can launch the GUI by typing `gui` in the MATLAB Command Window. The default landing page is the "Edit Model" screen, as seen in Figure 2.

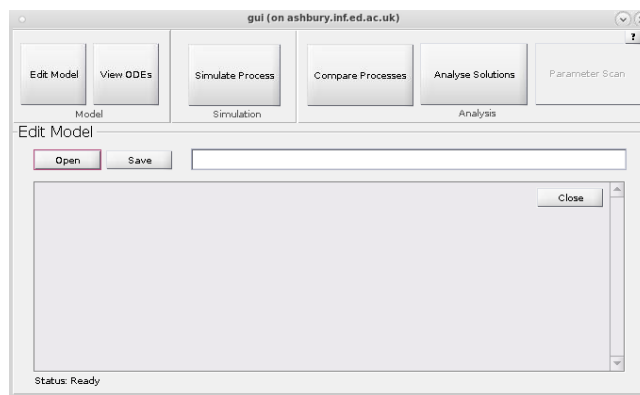


Figure 3: The default landing page is the "Edit Model" screen.

5.2 GUI Layout

You can access different screens by clicking on the different menu buttons along the top, such as "Edit Model" and "View ODEs". The current screen title can be seen in the upper left corner, such as "Edit Model" in Figure 3. Some screens have an "Open" button which is used to open files and a "Refresh" button which is used to refresh the currently loaded file. The "Edit Model" screen has a "Close" button, which is used to close the currently open file.

There is a status string in the bottom left which updates depending on how CPiME is being used.

5.3 Editing CPi Model Definition Files

CPiME offers a text editor which can be used to edit CPi Model Definition files. Currently, new model definition files cannot be created using CPiME.

1. Ensure you are on the "Edit Model" screen by clicking on the "Edit Model" menu button. The GUI should look like Figure 3.
2. Click on the "Open" button to display the "File Selector" Dialog Box, as seen in Figure 4. The dialog only shows files with the `.cpi` file extension by default.
3. Click on the file you want to open to select it, and then click "Open".
4. The file contents will be displayed in the "Edit Model" window, as seen in Figure 5. The file path will be displayed in the file path bar.
5. You can write the changes to disk by clicking the "Save" button. The status string will update to "Ready" when the files contents have been written to disk, as in Figure 6.
6. Click on the "Close" button to close the open file. You will see a dialog box to confirm whether you want to close the file, as in Figure 7. The screen will look like Figure 3 again if you click "Yes" on the dialog box.

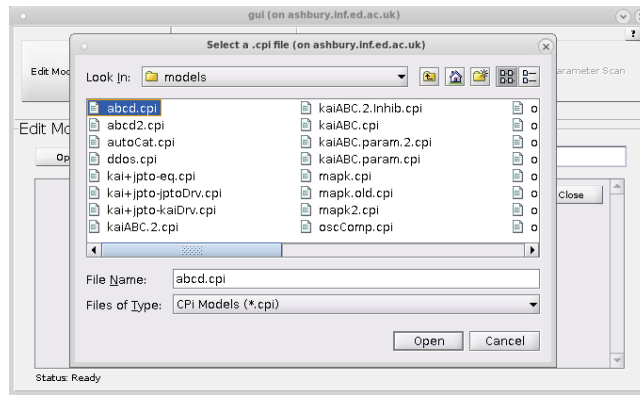


Figure 4: After clicking "Open", select a file to open in "Edit Model" screen.

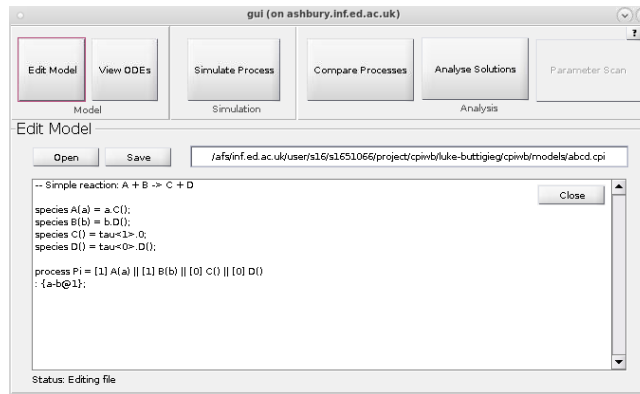


Figure 5: Editing a model definition file's contents in the "Edit Model" screen.

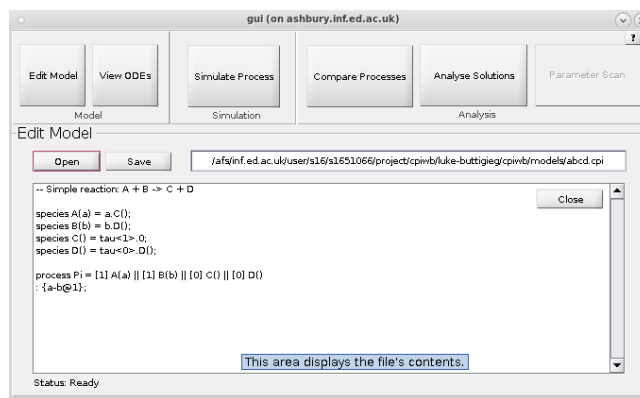


Figure 6: Click on the "Save" button to write any changes to disk. The status string will revert back to "Ready" on the "Edit Model" screen.

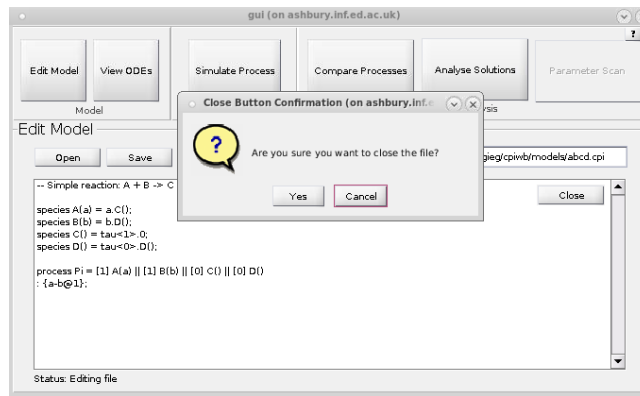


Figure 7: Close a file by clicking on the "Close" button. A confirmation dialog box will be displayed.

5.4 Viewing ODEs

You can view the first-order ordinary differential equations (henceforth ODE(s)) which CPiME is using in the "View ODEs" screen.

1. Navigate to the "View ODEs" screen by clicking on the "View ODEs" button in the menu bar, as seen in Figure 8. Any file selection made in a previous window will carry over to this screen.
2. Click on the "Open" button to display the "File Selector" Dialog Box, similar to that seen in Figure 4. The dialog only shows files with the `.cpi` file extension by default.
3. Click on the file you want to open to select it, and then click "Open".
4. The file contents will be displayed in the "View ODEs" window, as seen in Figure 9. The file path will be displayed in the file path bar.
5. You can click on the "Edit" Button if you need to modify the CPi Model Definition file. This will take you to the "Edit Model" screen.
6. Select the process you are interested in using the drop-down list. In Figure 9, this drop-down list contains a process called "Pi".
7. Click on the "Generate" button to convert the CPi Model definition in ODEs. The status string will change to "Generating ODEs". This process could take a while, depending on the complexity of the model.
8. The ODEs are displayed in the "Generated ODEs" text box, as in Figure 10.
9. You can save the generated ODEs by clicking on the "Save" button. This will display the standard MATLAB "Save File" dialog box, which will allow you to insert a file name and choose a disk location for the file.

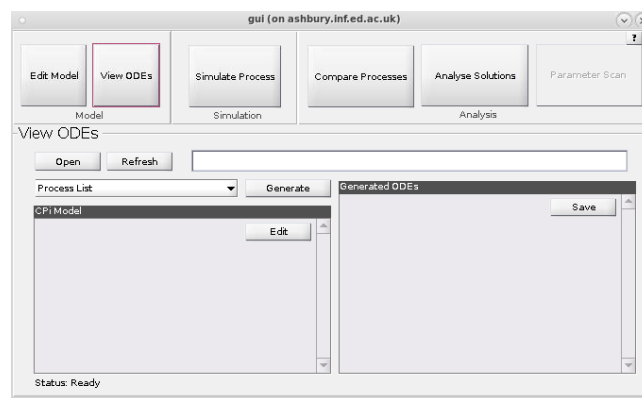


Figure 8: This is the "View ODEs" screen before a file is loaded in it.

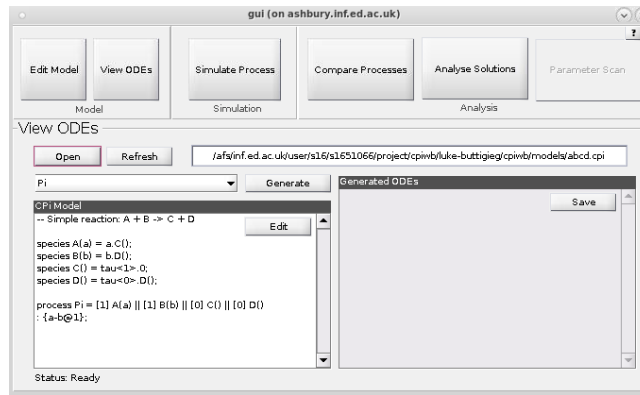


Figure 9: This is the "View ODEs" screen displaying a model definition file's contents.

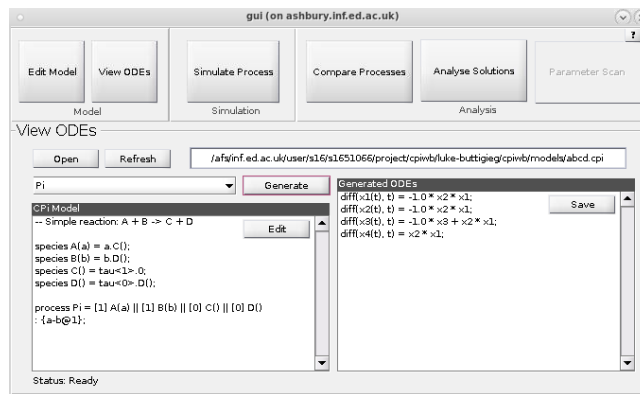


Figure 10: This is the "View ODEs" screen displaying the generated ODEs. You can save the ODEs by clicking on the "Save" button.

5.5 Simulating a Process

You can use CPiME to plot a graph of the ODEs generated from the model definition files. Numerical solutions are also displayed.

1. Navigate to the "Simulate Process" screen by clicking on the "Simulate Process" button in the menu bar, as seen in Figure 11. Any file selection made in a previous window will carry over to this screen.
2. Click on the "Open" button to display the "File Selector" Dialog Box, similar to that seen in Figure 4. The dialog only shows files with the .cpi file extension by default.
3. Click on the file you want to open to select it, and then click "Open".

4. The file contents will be displayed in the "CPi Model" text area. The file path will be displayed in the file path bar.
5. You can click on the "Edit" Button if you need to modify the CPi Model Definition file. This will take you to the "Edit Model" screen.
6. Select the process you are interested in using the drop-down list. This is similar to what is seen in Figure 9: this drop-down list contains a process called "Pi".
7. You can change the settings found in the "Simulation Settings" as required. You can select a different MATLAB ODE solver [10] and the start and end time.
8. Click on the "Simulate" button to convert the CPi Model definition in ODEs, plot a graph of them and display numerical solutions. The status string will change to "Simulating Process". This process could take a while, depending on the complexity of the model.
9. The graph plot and numerical solutions are displayed in separate windows, as in Figure 12.
10. You can reset the "Simulation Settings" to their default values by clicking on the "Reset" Button.

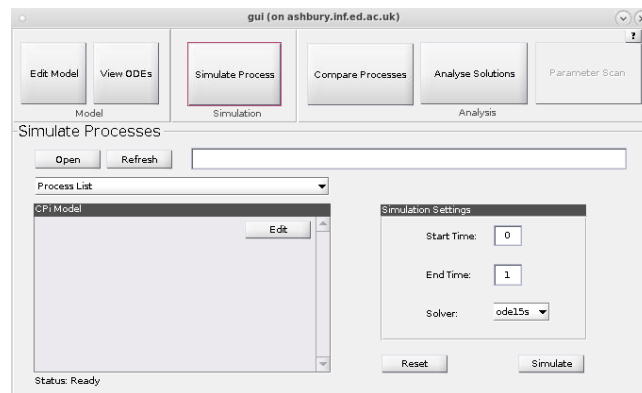


Figure 11: This is the "Simulate Process" screen before a file is loaded in it.

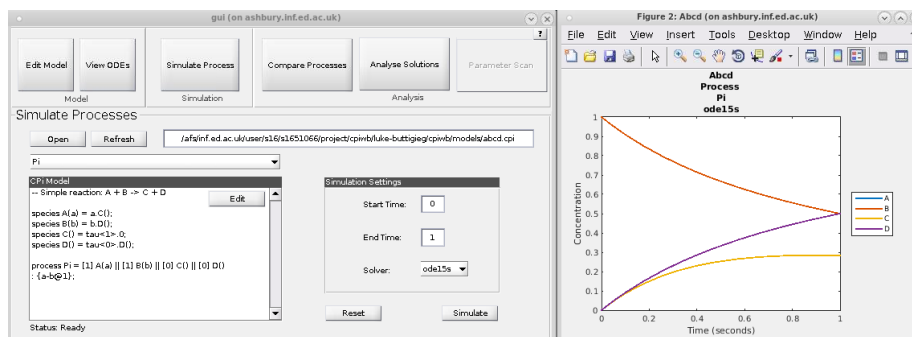


Figure 12: This is the "Simulate Process" screen displaying a model definition file's contents and a graph plot of its ODEs. The numerical solutions will be shown on a separate window.

5.6 Comparing Processes

You can use CPiME to compare up to four processes with each other by plotting graphs of the ODEs generated from the model definition files. Graphs can be plotted on the same graph figure, or on separate ones. Numerical solutions are not displayed in this case.

1. Navigate to the "Compare Processes" screen by clicking on the "Compare Processes" button in the menu bar, as seen in Figure 13. Any file selection made in a previous window will carry over to this screen and populate the first process settings.
2. Click on the "Open" button to display the "File Selector" Dialog Box, similar to that seen in Figure 4. The dialog only shows files with the `.cpi` file extension by default.
3. Click on the file you want to open to select it, and then click "Open".
4. The file contents will be displayed in the "CPi Model" text area. The file path will be displayed in the miniaturised file path bar.
5. You can click on the "Edit" Button if you need to modify the CPi Model Definition file. This will take you to the "Edit Model" screen.
6. Select the process you are interested in using the drop-down list. This is similar to what is seen in Figure 9: this drop-down list contains a process called "Pi".
7. Click on the "2" "Process" radio button to select the file and process for the second process you would like to compare.
8. If you want to compare more than 2 files, change the "Processes" drop-down list value in the "Comparison Settings" area to a higher number.

9. Continue selecting files until all processes are selected.
10. You can now modify the "Comparison Settings" as required. You can select a different MATLAB ODE solver [10] and the start and end time. You can also change whether to display the plotted graphs on the same Figure by selecting the "Together" option in the "Plot" drop-down list. Otherwise, display them separately by selecting the "Separately" option.
11. Click on the "Compare" button to convert the CPi Model definitions in ODEs, and plot graphs of them. The status string will change to "Comparing Processes". This process could take a while, depending on the complexity of the models.
12. The graph plots will be displayed once the process has finished executing.
13. You can clear the file selection and reset the "Comparison Settings" to their default values by clicking on the "Reset" Button.

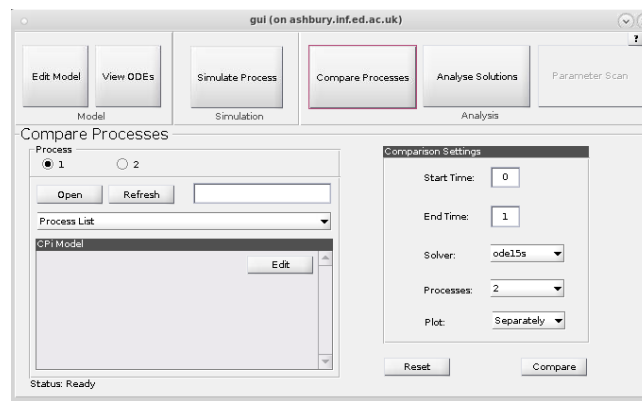


Figure 13: This is the "Compare Processes" screen before a file is loaded in it.

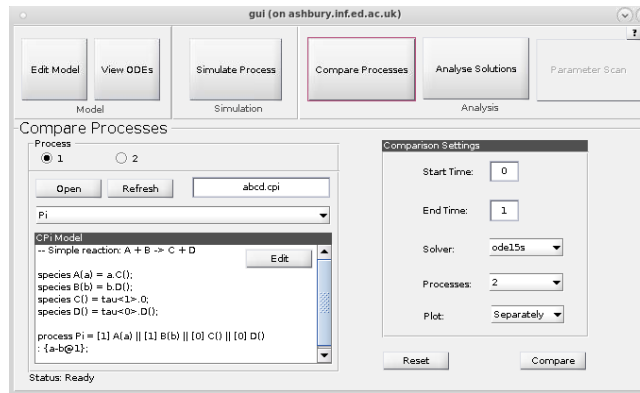


Figure 14: This is the "Compare Process" screen displaying the model definition file's contents for the first selected file. You can select a another file by using the "Process" radio buttons.

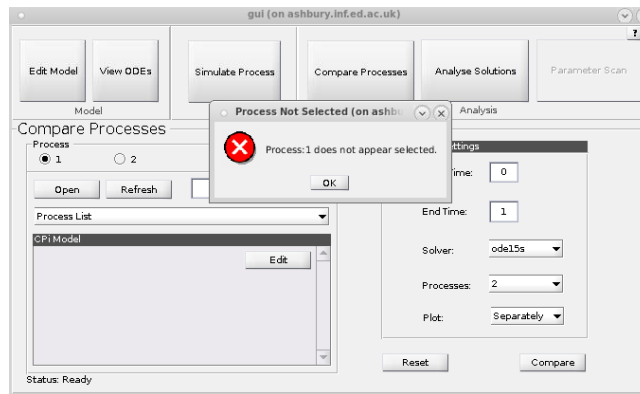


Figure 15: You will see this error if you do not select a file for all the processes you want to compare.

5.7 Analysing Solutions

You can use CPiME to check whether LBC [4] queries are true or false for the ODEs generated from the model definition files.

1. Navigate to the "Analyse Solutions" screen by clicking on the "Analyse Solutions" button in the menu bar, as seen in Figure 16. Any file selection made in a previous window will carry over to this screen and populate the first process settings.
2. Click on the "Open" button to display the "File Selector" Dialog Box, similar to that seen in Figure 4. The dialog only shows files with the .cpi file extension by default.
3. Click on the file you want to open to select it, and then click "Open".

4. The file contents will be displayed in the "CPi Model" text area. The file path will be displayed in the file path bar.
5. You can click on the "Edit" Button if you need to modify the CPi Model Definition file. This will take you to the "Edit Model" screen.
6. Select the process you are interested in using the drop-down list. This is similar to what is seen in Figure 9: this drop-down list contains a process called "Pi".
7. You can change the "End Time" to a value other than the default value of 1.
8. Type in the LBC query you would like to test, or type in `example` for a list of examples, as seen in Figure 17.
9. Click "Test" to check whether the query is true or false for the selected CPi Model Process, as seen in Figure 18.
10. You can clear the file selection and reset the "Comparison Settings" to their default values by clicking on the "Reset" Button.

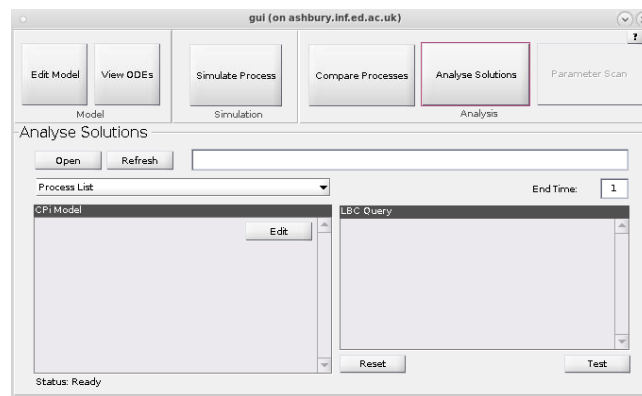


Figure 16: This is the "Analyse Solutions" screen before a file is loaded in it.

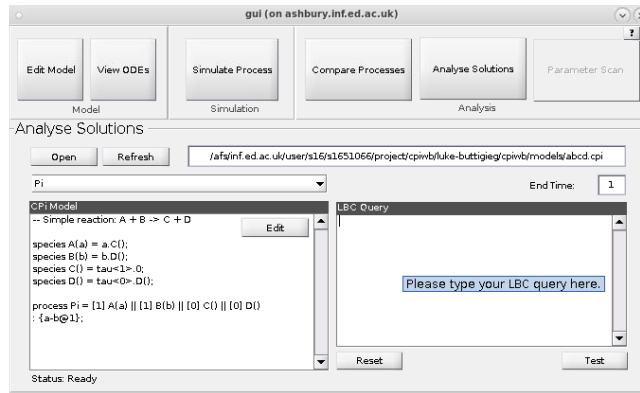


Figure 17: This is the "Analyse Solutions" screen displaying the model definition file's contents for the first selected file.

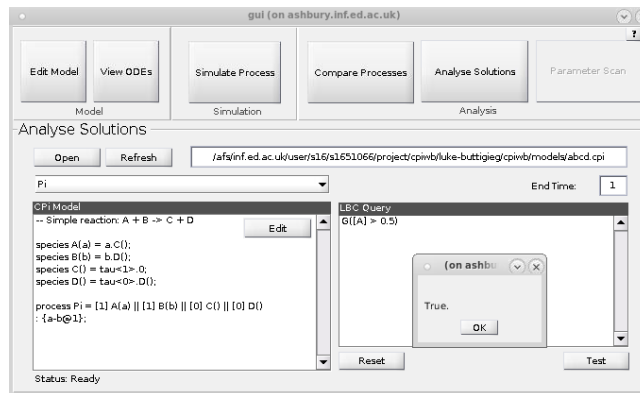


Figure 18: After typing in the LBC query, click the "Test" button to check whether the query is true or false for the selected CPi Model Process.

6 Bibliography

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