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USER MANUAL for CONVAN v2.0

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Latvia, Jelgava, 2011

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INTRODUCTION

This manual is developed by Andrejs Kostromins, author of the ConvAn. In case of any problems feel free to contact author by e-mail: andrejs.kostromins@gmail.com.

ConvAn v2.0 graphic user interface (GUI) consists of 6 separate parts divided by their functionality. All parts are accessible from the *main menu strip* in main window of ConvAn. Each of menu items has name with intuitively understandable functionality.

ConvAn v2.0 has two versions: one is for Microsoft SQL Server users and second is for PostgreSQL users.

In this manual author will show all the possibilities and functionality of ConvAn v2.0 in user friendly way with color pictures. Sample date for exercising can be downloaded from http://www.sysbio.lv/convan/sample_files.

1. MAIN WINDOW

The main window of ConvAn v2.0 consists of 3 parts: *main menu strip*, loaded data *column viewer*, and loaded data *graphical viewer* (see **Figure 1**).

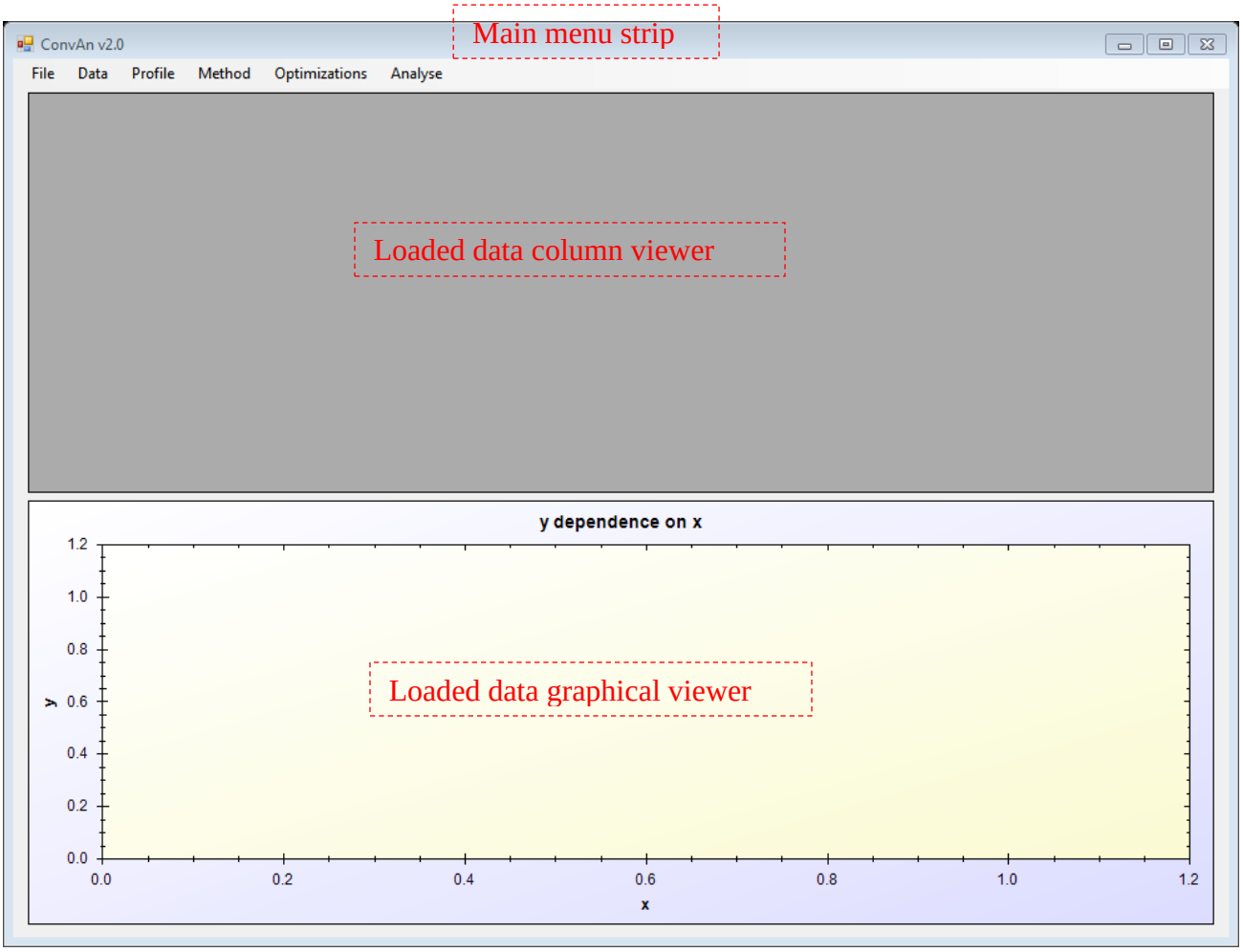

Figure 1. Structure of the main window of ConvAn v2.0.

1.1. Main menu strip

Main menu strip consists of 6 menu items:

- *File*;
- *Data*;
- *Profile*;
- *Method*;
- *Optimizations*;
- *Analyze*.

Each of them has several lower level menu items which lead to new windows for particular tasks.

1.1.1. Main menu item *File*

The main menu item *File* consists of 2 lower level menu items (see **Figure 2**):

- Open text file… (load data into ConvAn);
- Exit (exit the ConvAn).

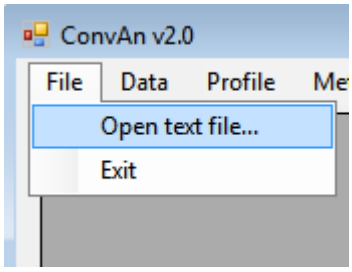

Figure 2. Lower level menu items of main menu item *File* in ConvAn v2.0.

1.1.2. Main menu item *Data*

The main menu item *Data* consists of 5 lower level menu items (see **Figure 3**):

- Associate to X axis (associate data from chosen column to X axis);
- Associate to Y axis (associate data from chosen column to Y axis);
- Add to graph (show associated data on the loaded data graphical viewer);
- Sava to database (save associated data to database);
- Clear all (clear all loaded data).

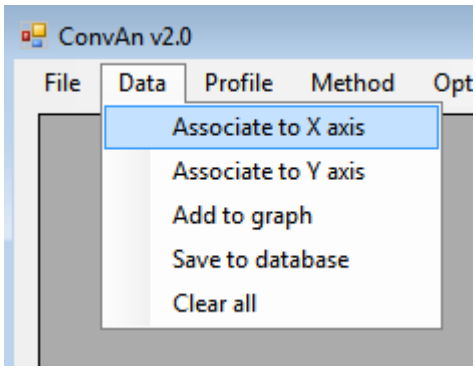

Figure 3. Lower level menu items of main menu item *Data* in ConvAn v2.0.

1.1.3. Main menu item *Profile*

The main menu item *Profile* consists of 2 lower level menu items (see **Figure 4**):

- New… (create new profile);

- Edit… (edit existing profile).

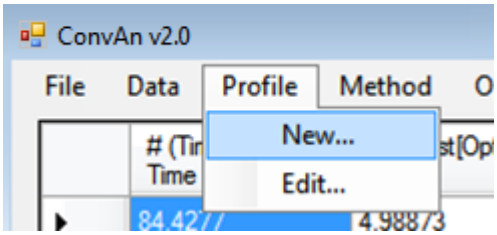

Figure 4. Lower level menu items of main menu item *Profile* in ConvAn v2.0.

1.1.4. Main menu item *Method*

The main menu item *Method* consists of 2 lower level menu items (see **Figure 5**):

- New… (create new method);
- Edit… (edit existing method).

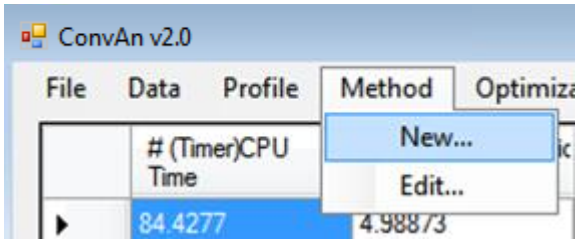

Figure 5. Lower level menu items of main menu item *Method* in ConvAn v2.0.

1.1.5. Main menu item *Optimizations*

The main menu item *Optimizations* consists of 2 lower level menu items (see **Figure 6**):

- View (view optimization data grouped in profile);
- Edit (edit saved optimization data).

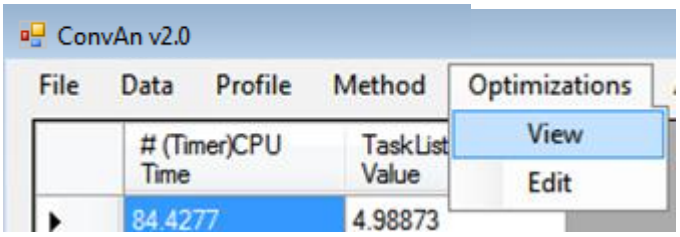

Figure 6. Lower level menu items of main menu item *Optimizations* in ConvAn v2.0.

1.1.6. Main menu item *Analyze*

The main menu item *Analyze* consists of 2 lower level menu items (see **Figure 7**):

- Maximization analyzer (analyze maximization tasks);

- Minimization analyzer (analyze minimization tasks).

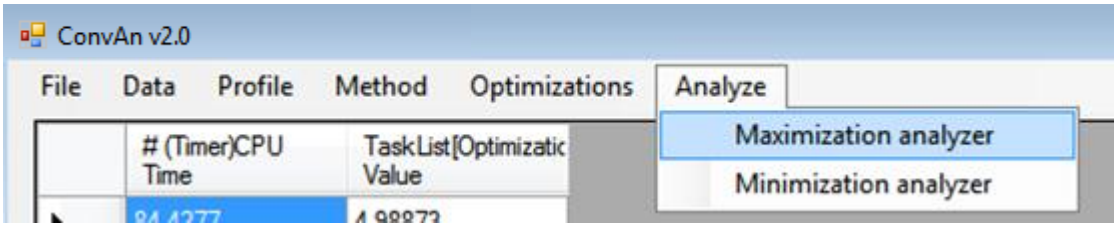

Figure 7. Lower level menu items of main menu item *Analyze* in ConvAn v2.0.

1.2. Loaded data column viewer

In the loaded data *column viewer* are shown all the columns user had loaded before. From these columns user can choose what data series associate to X and Y axes (see **Figure 8**).

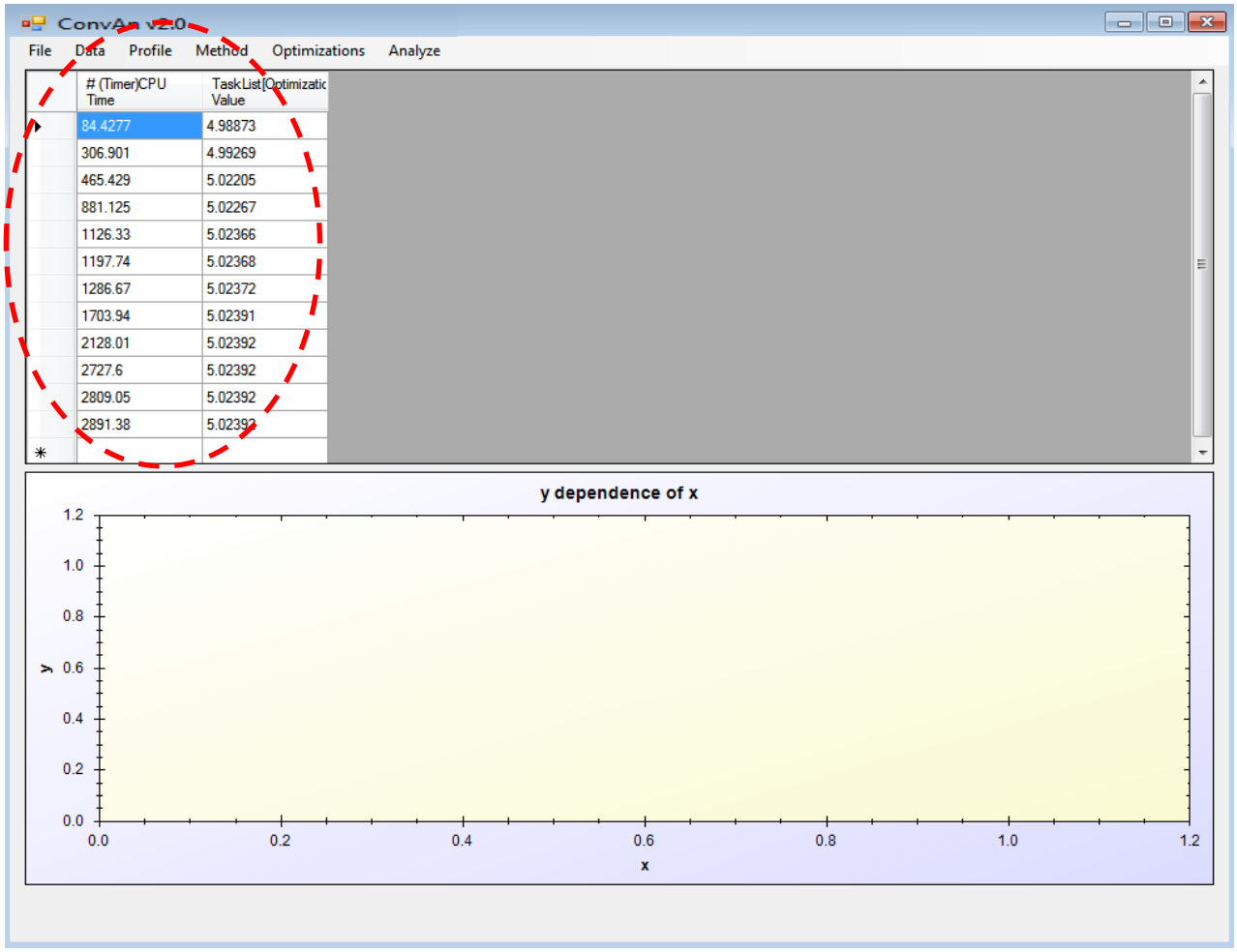

Figure 8. Sample data loaded into data *column viewer* in ConvAn v2.0.

1.3. Loaded data graphical viewer

When loaded date columns are associated to X and Y axis, user can draw results on the plot. Plot functions in ConvAn v2.0 performs loaded data *graphical viewer*. The names of columns are associated to corresponding plot axes and plot title is generating according to chosen columns as well (see **Figure 9**).

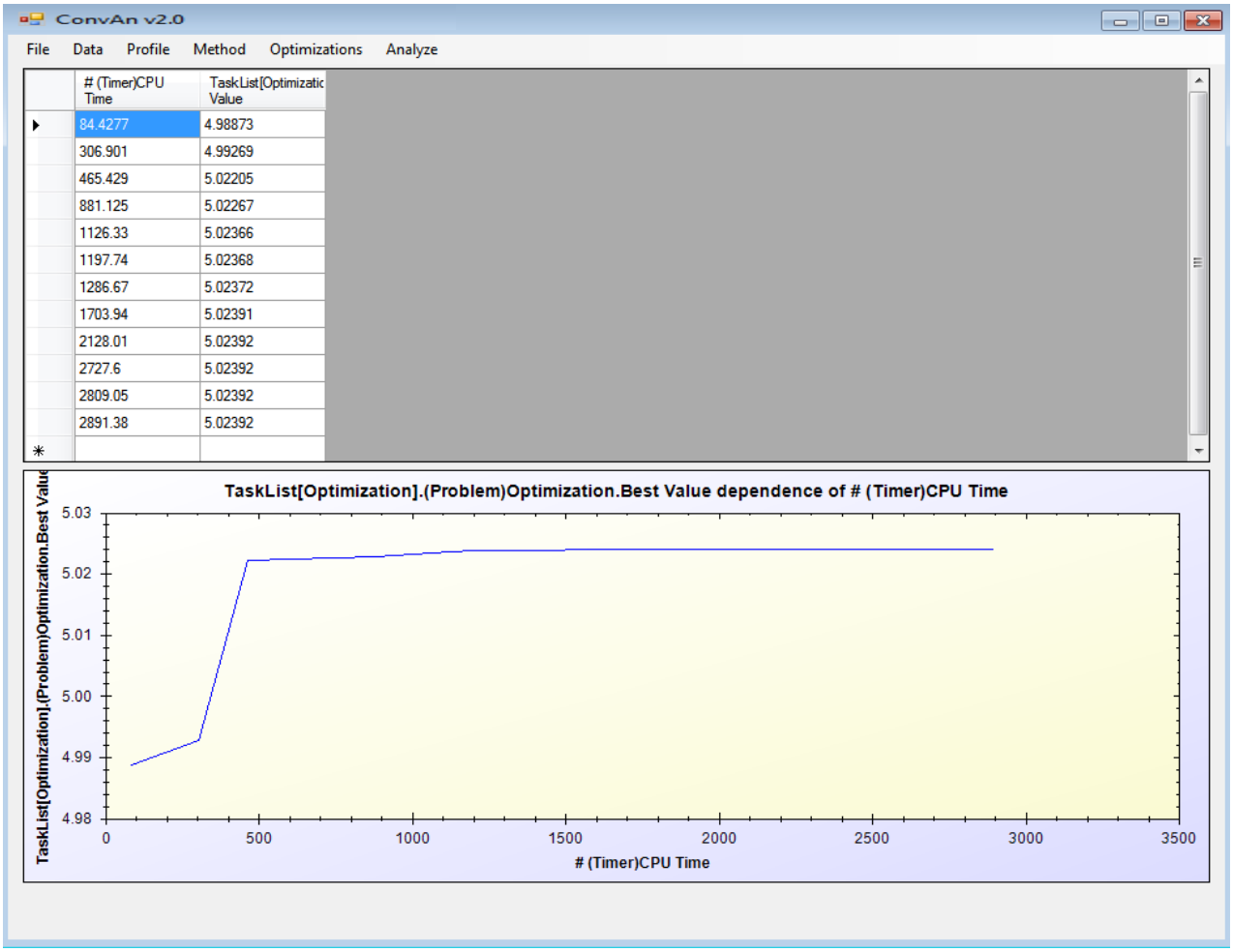

Figure 9. Sample data loaded into data graphical viewer in ConvAn v2.0.

2. LOAD DATA INTO CONVAN V2.0

ConvAn v2.0 operates with *.txt* extension files, where optimization results are stored as time series in columns separated by *TAB* separator (see **Figure 10**).

```
# (Timer) CPU Time Values [A] → Values [B] → Values [KR] → ¶
0.234001 → 0.966743 → 4.02198 → 1.77114 → ¶
445.398 → 0.96643 → 4.02767 → 1.77196 → ¶
992.198 → 0.965208 → 4.0498 → 1.77517 → ¶
1696.21 → 0.964844 → 4.05637 → 1.77612 → ¶
3651.22 → 0.964829 → 4.05664 → 1.77616 → ¶
3913.82 → 0.964746 → 4.05813 → 1.77637 → ¶
4198.97 → 0.964736 → 4.05831 → 1.7764 → ¶
4691.48 → 0.964709 → 4.0588 → 1.77647 → ¶
4974.93 → 0.964703 → 4.05891 → 1.77649 → ¶
5150.25 → 0.9647 → 4.05896 → 1.77649 → ¶
5367.5 → 0.964698 → 4.05899 → 1.7765 → ¶
5989.58 → 0.964697 → 4.05901 → 1.7765 → ¶
6287.98 → 0.964697 → 4.05902 → 1.7765 → ¶
6804.72 → 0.964687 → 4.05919 → 1.77653 → ¶
7189.42 → 0.964685 → 4.05923 → 1.77653 → ¶
10947.7 → 0.964685 → 4.05924 → 1.77653 → ¶
11604.3 → 0.964685 → 4.05924 → 1.77653 → ¶
11900.1 → 0.964685 → 4.05924 → 1.77653 → ¶
12685.9 → 0.964685 → 4.05924 → 1.77653 → ¶
14214→0.964685 → 4.05924 → 1.77653 → ¶
17294.7 → 0.964685 → 4.05924 → 1.77653 → ¶
19364.1 → 0.964685 → 4.05924 → 1.77653 → ¶
25763.5 → 0.964685 → 4.05924 → 1.77653 → ¶
27510.1 → 0.964685 → 4.05924 → 1.77653 → ¶
```

Figure 10. Text file example with 4 data columns, where arrows represent *TAB* separators.

Text files can be loaded by selecting following menu items: *File* → *Open text file…* (see **Figure 2**). In the next step user must choose text file in the window "*Open*" (see **Figure 11**).

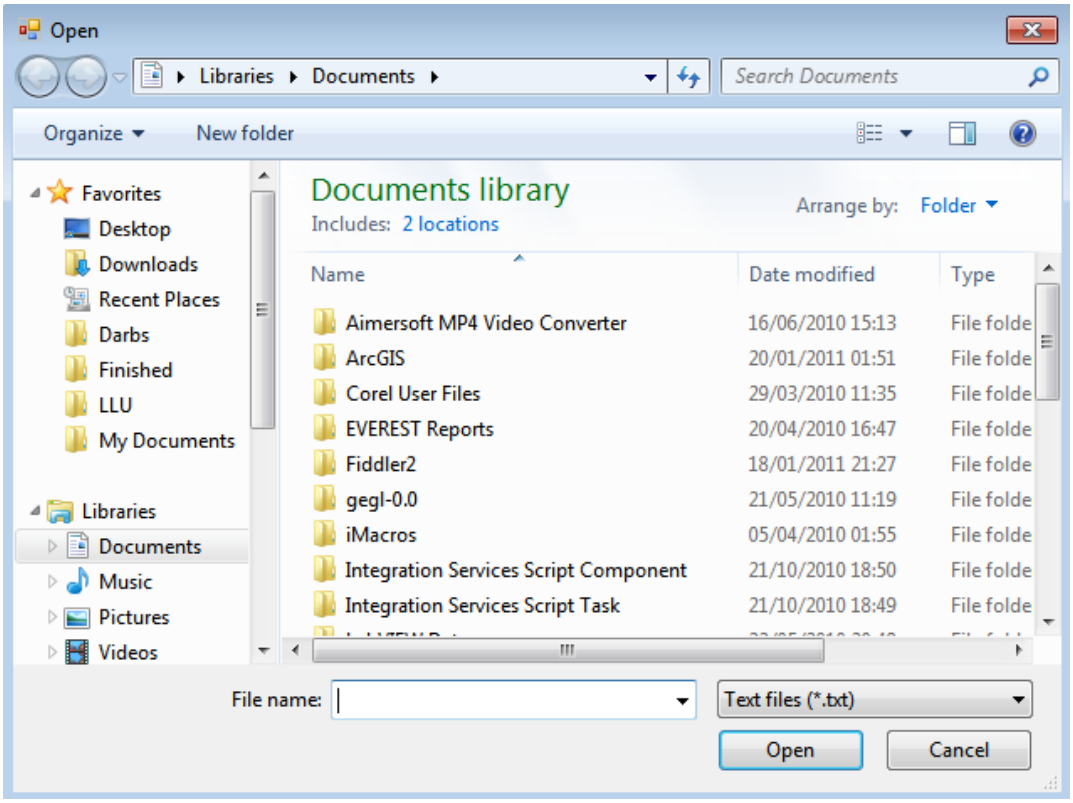

Figure 11. The window *"Open"* for browsing for text file in ConvAn v2.0.

When data file is chosen, click the button *"Open"* and the window for column selection will appear (see **Figure 12**), where user can tick mark on necessary data column by double click on corresponding column title.

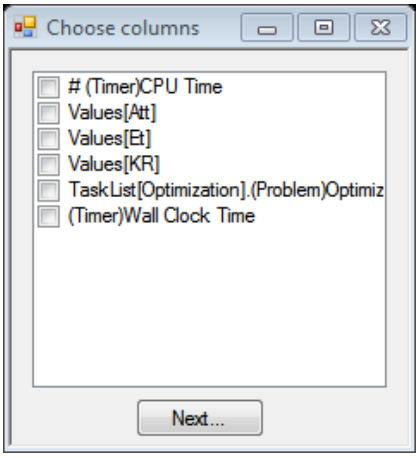

Figure 12. The window *"Choose column"* in ConvAn v2.0.

After actual column selection click the button "*Next…*" in order to load selected data into ConvAn v2.0. Data will appear in loaded data column viewer (see **Figure 8**).

3. SAVE LOADED DATE IN DATABASE

The data represented in loaded data viewer (see **Figure 8**) can be stored in database. Firstly, it is necessary to associate one column for each graph axis by clicking on column header and then executing *Data* → *Associate to X axis* or *Data* → *Associate to Y axis* (see **Figure 3**).

Secondly, user must check if associations were done correctly by drawing data on plot by executing *Data* → *Add to graph*. That leads to pictorial representation of associated columns in loaded data *graphical viewer* (see **Figure 9**).

Thirdly, it is necessary to connect chosen optimization data to particular profile. By execute *Data* → *Save to database* (see **Figure 3**) ConvAn v2.0 will open the new window – *"Save optimization data"* (see **Figure 13**), where user has to give the name to optimization and choose profile from already registered or have to create new one.

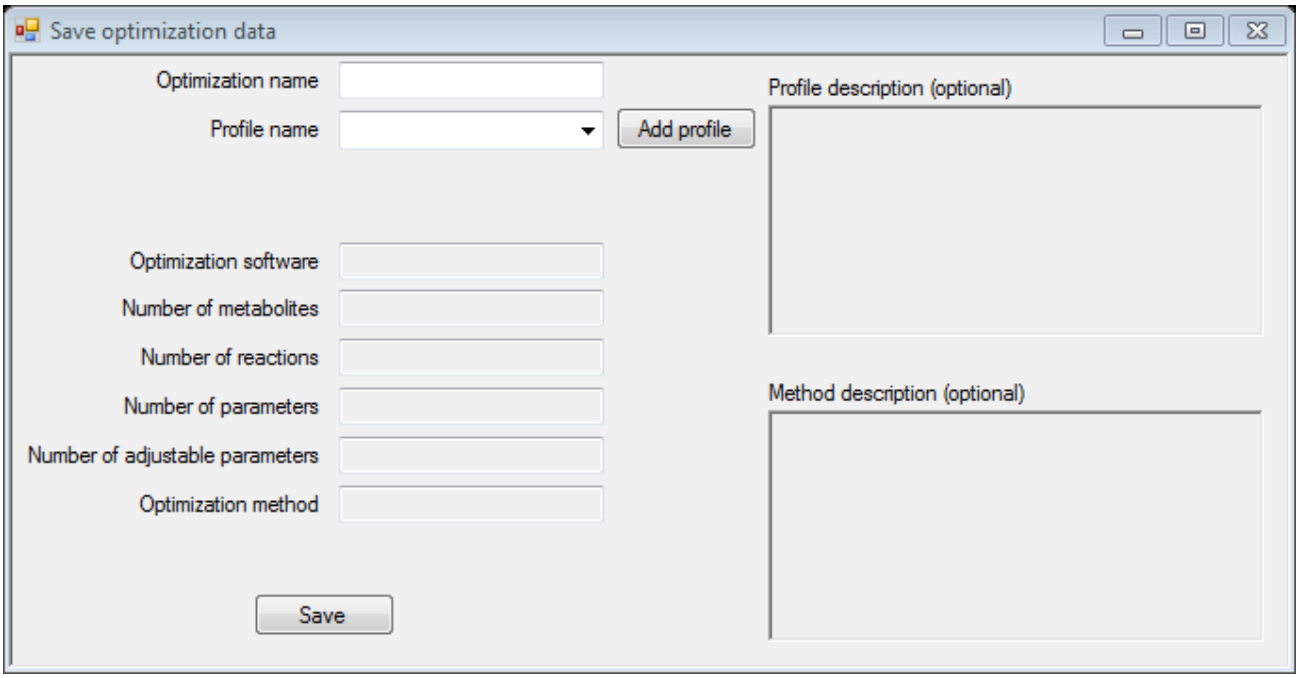

Figure 13. The window *"Save optimization data"* in ConvAn v2.0.

Registered profiles are accessible from drop down menu *"Profile name"*. When particular profile is chosen, the profile information is shown in the other fields in the window (see **Figure 14**).

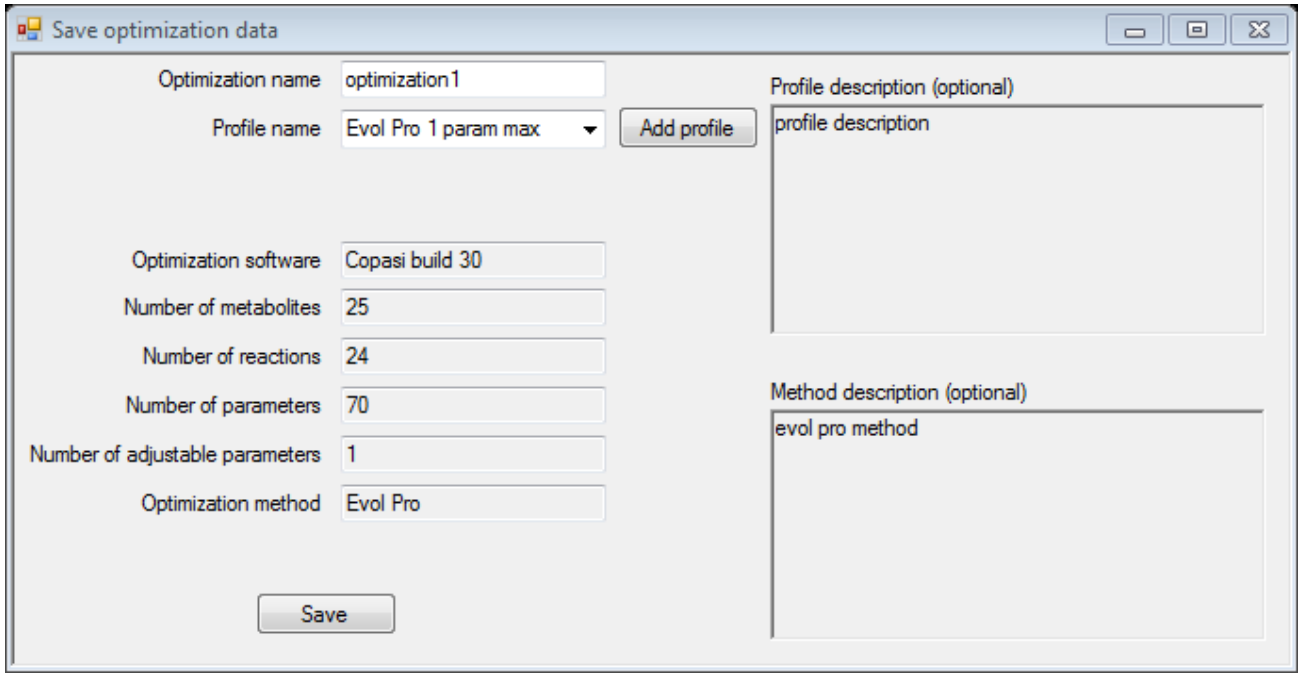

Figure 14. The window *"Save optimization data"* with filled fields in ConvAn v2.0.

If there is no appropriate profile to choose, user can create the new one by clicking on the button *"Add profile"* (how to create new profile is described in the chapter 4 *"CREATE NEW PROFILE"*). After these steps user has to click the button *"Save"* and ConvAn v2.0 will notify if operation was success (see **Figure 15**).

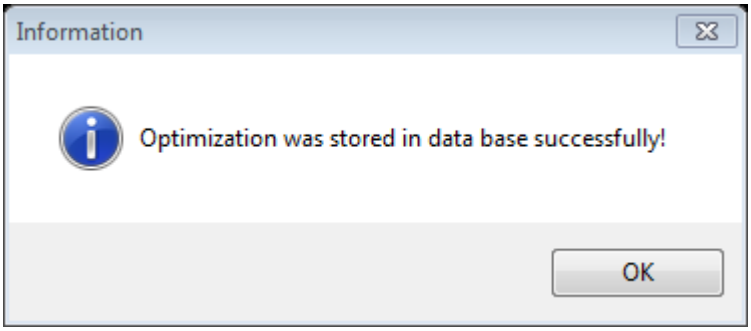

Figure 15. The window *"Information"* about successfully stored optimization data in ConvAn v2.0.

4. CREATE NEW PROFILE

There are two ways how to open the window for profile creation:

- by executing *Profile* → *New…* (see **Figure 4**),
- from the window *"Save optimization data"* (see **Figure 13**).

In both cases the window *"New Profile"* will appear (see **Figure 16**).

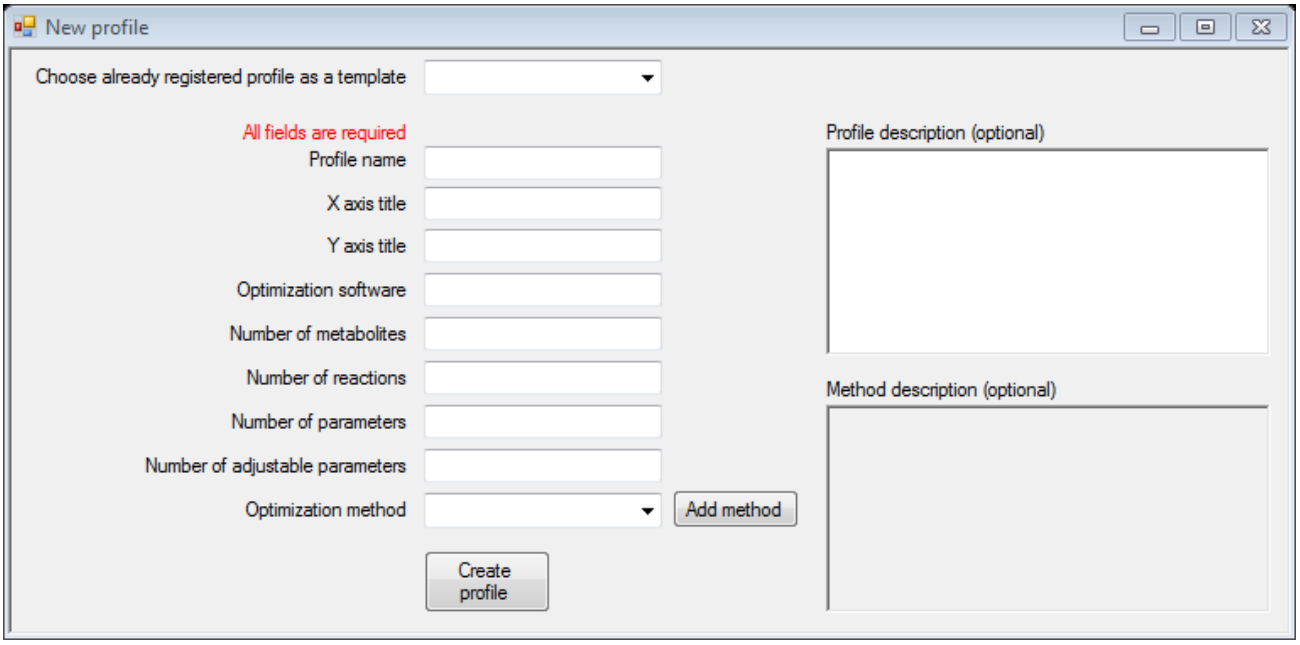

Figure 16. The window *"New Profile"* in ConvAn v2.0.

From the *"Choose already registered profile as a template"* drop down menu user can choose the most appropriate already registered profile as template for the new one. When particular profile is selected, the other fields are automatically filled with information about chosen profile (see **Figure 17**).

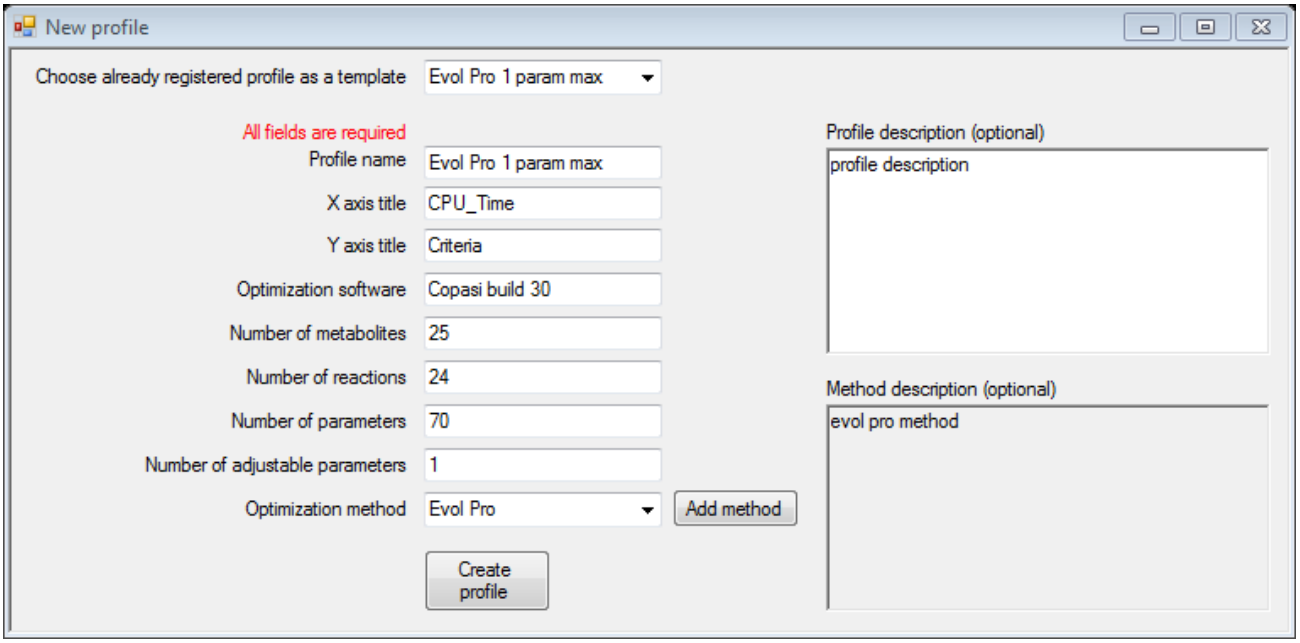

Figure 17. The window *"New Profile"* with chosen profile as a template in ConvAn v2.0.

The name of profile must be unique. Whether profile is being made from template or not, it is possible to freely write date in the fields for user needs. The drop down menu *"Optimization method"* holds in all the previously declared optimization methods. If in the list there is no appropriate optimization method, user can declare the new one by clicking on the button *"Add method"* (how to declare new method is described in the chapter 6 *"DECLARE NEW METHOD"*).

When all required fields are filled with data user can create the profile by clicking on the button *"Create profile"* and ConvAn v2.0 will notify if operation was success (see **Figure 18**).

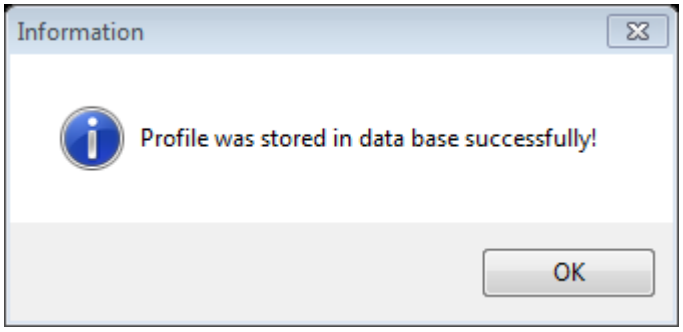

Figure 18. The window *"Information"* about successfully stored profile in ConvAn v2.0.

5. EDIT/DELETE EXISTING PROFILE

Profile editing contains profile update operation and profile deletion operation. In both cases first of all user has to choose which profile to modify from *"Profile name"* drop down menu (see **Figure 19**)

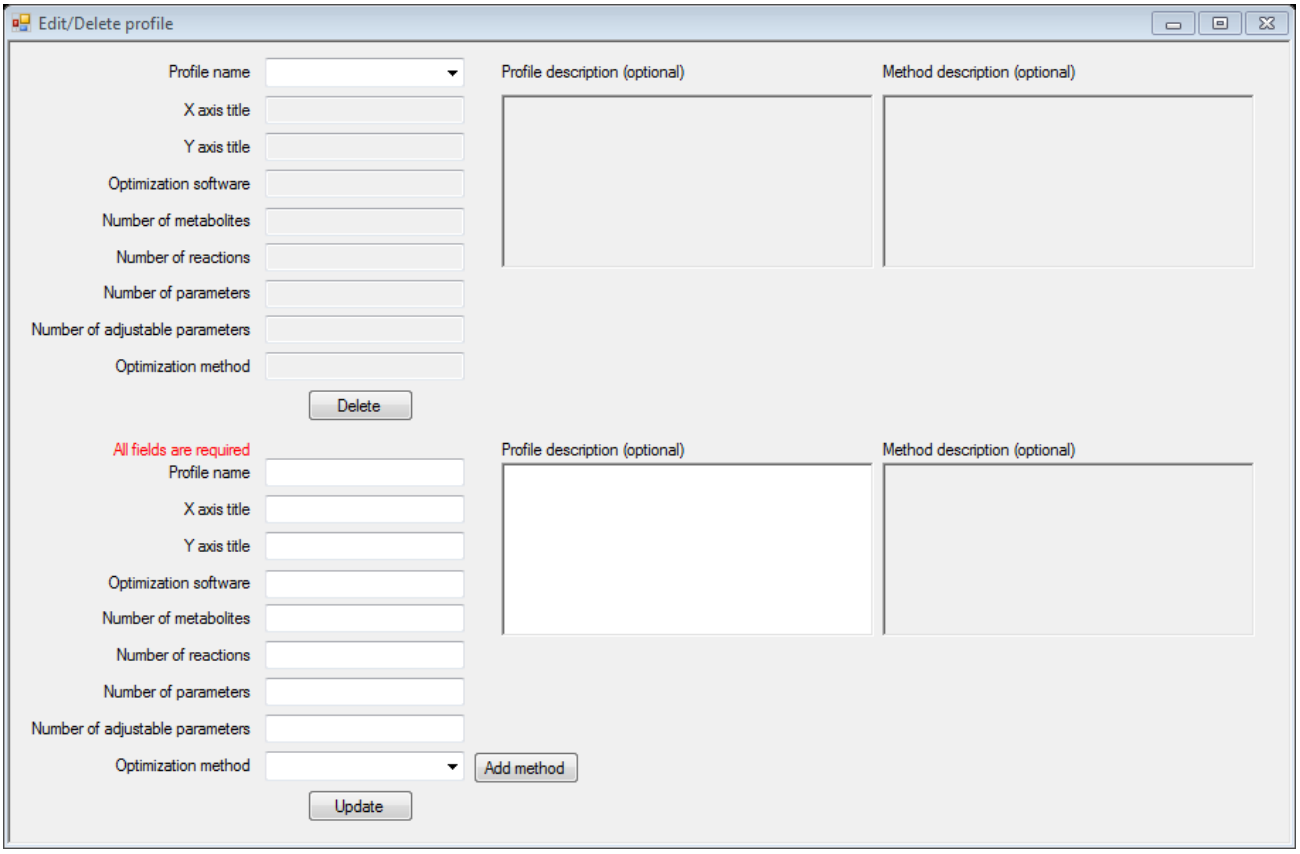

Figure 19. The window *"Edit/Delete profile"* for profiles modification in ConvAn v2.0.

When particular profile is selected, the other fields are automatically filled with information about chosen profile (see **Figure 20**).

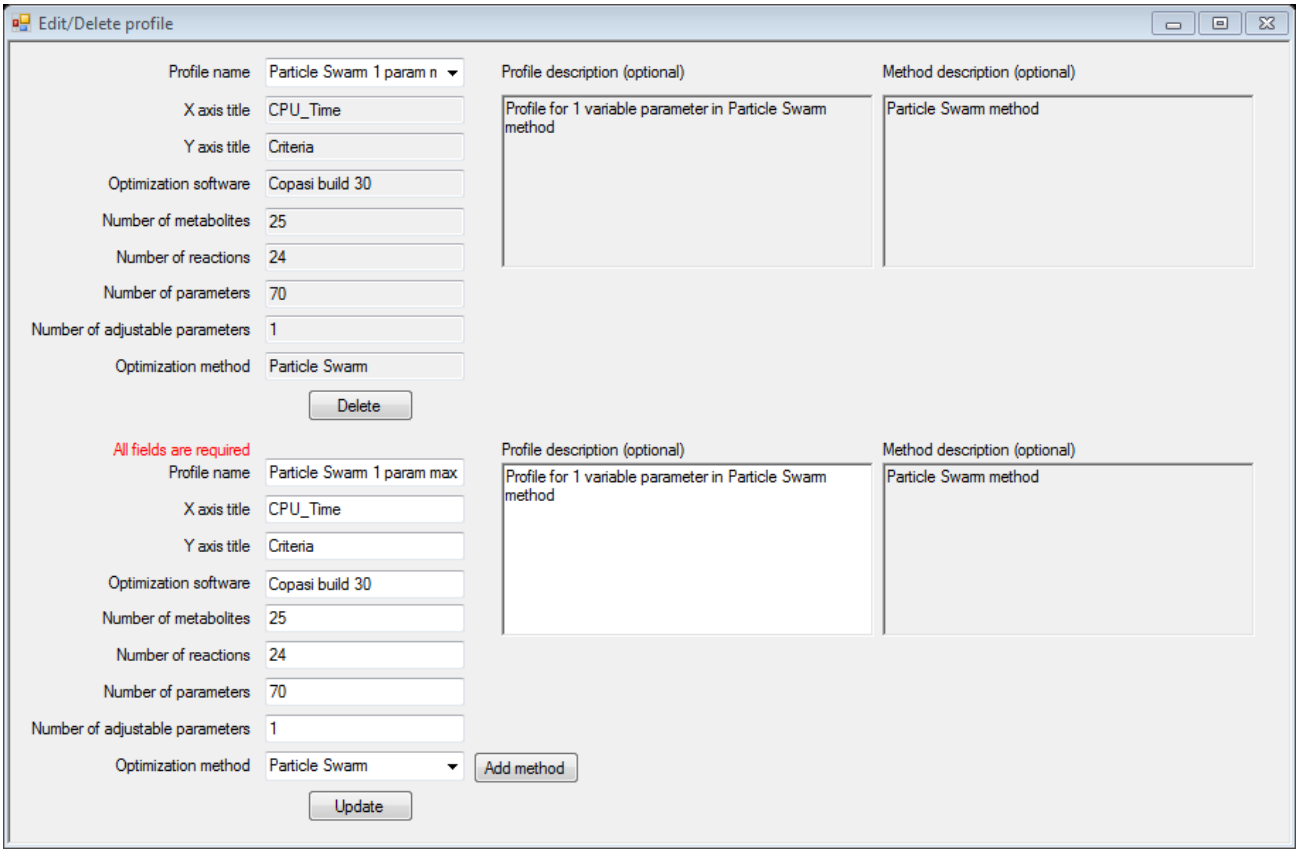

Figure 20. The window *"Edit/Delete profile"* with chosen profile in ConvAn v2.0.

Deletion operation can be performed by clicking on the button *"Delete"*. After successful deletion the window *"Information"* will appear (see **Figure 21**). As a result not only particular profile will be deleted but all connected optimization data will be deleted too.

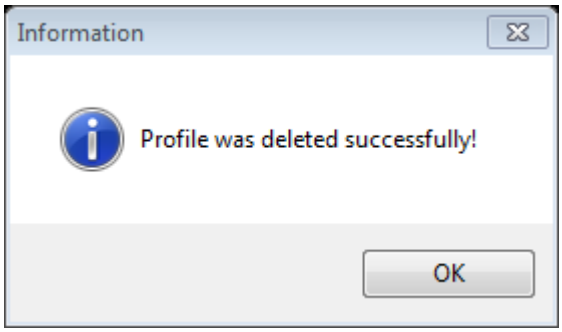

Figure 21. The window *"Information"* about successfully deleted profile in ConvAn v2.0.

If user is not interested in profile deletion but just wants to modify some profile parameters, user can make changes in the fields and save changes by clicking on the button *"Update"*. After successful update operation the window *"Information"* will appear (see **Figure 22**).

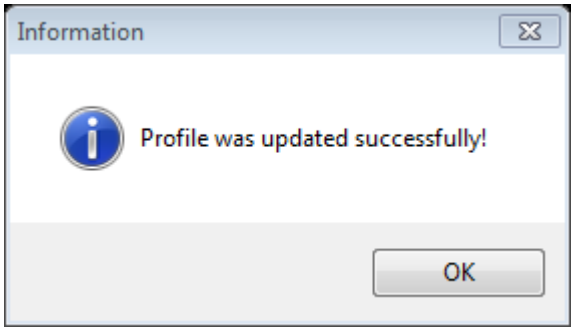

Figure 22. The window *"Information"* about successfully updated profile in ConvAn v2.0.

The drop down menu *"Optimization method"* holds in all the previously declared optimization methods. If in the list there is no appropriate optimization method, user can declare the new one by clicking on the button *"Add method"* (how to declare new method is described in the chapter 6 *"DECLARE NEW METHOD"*).

6. DECLARE NEW METHOD

There are three ways how to open the window for method declaration:

- by executing *Method* → *New…* (see **Figure 5**),
- from the window *"New Profile"* (see **Figure 16**),
- from the window *"Edit/Delete profile"* (see **Figure 19**).

In all cases the window *"New Method"* will appear (see **Figure 23**).

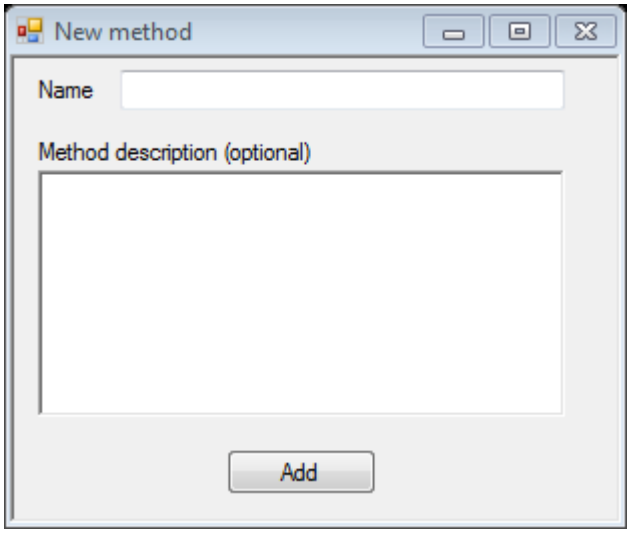

Figure 23. The window *"New Method"* in ConvAn v2.0.

The name of method must be unique meanwhile *"Method description"* field is optional and can be left empty. When data is filled in, user can declare the method by clicking on the button *"Add"* and ConvAn v2.0 will notify if operation was success (see **Figure 24**).

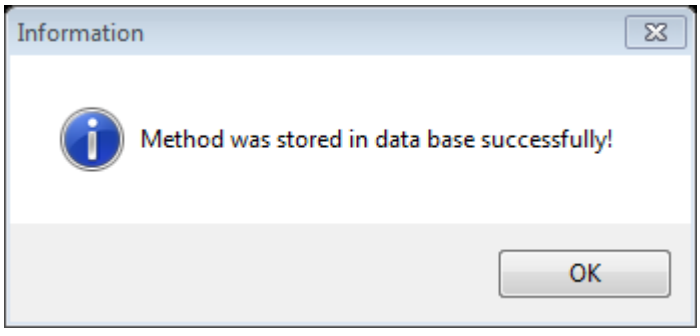

Figure 24. The window *"Information"* about successfully stored method in ConvAn v2.0.

7. EDIT/DELETE EXISTING METHOD

Method editing contains method update operation and method deletion operation. In both cases first of all user has to choose which method to modify from *"Choose method"* drop down menu (see **Figure 25**)

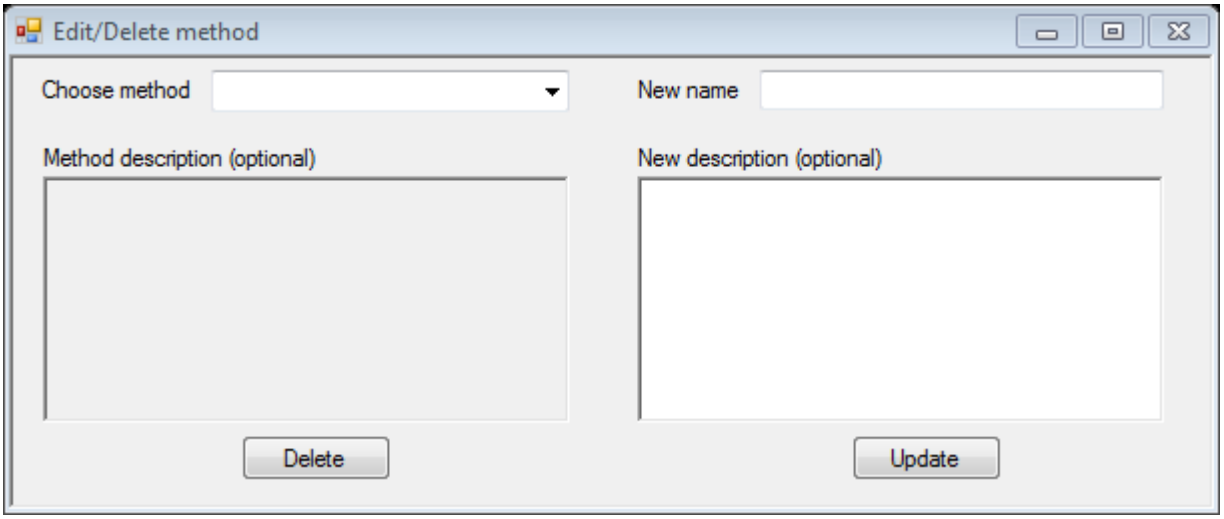

Figure 25. The window *"Edit/Delete method"* for methods modification in ConvAn v2.0.

When particular method is selected, the other fields are automatically filled with information about chosen method (see **Figure 26**).

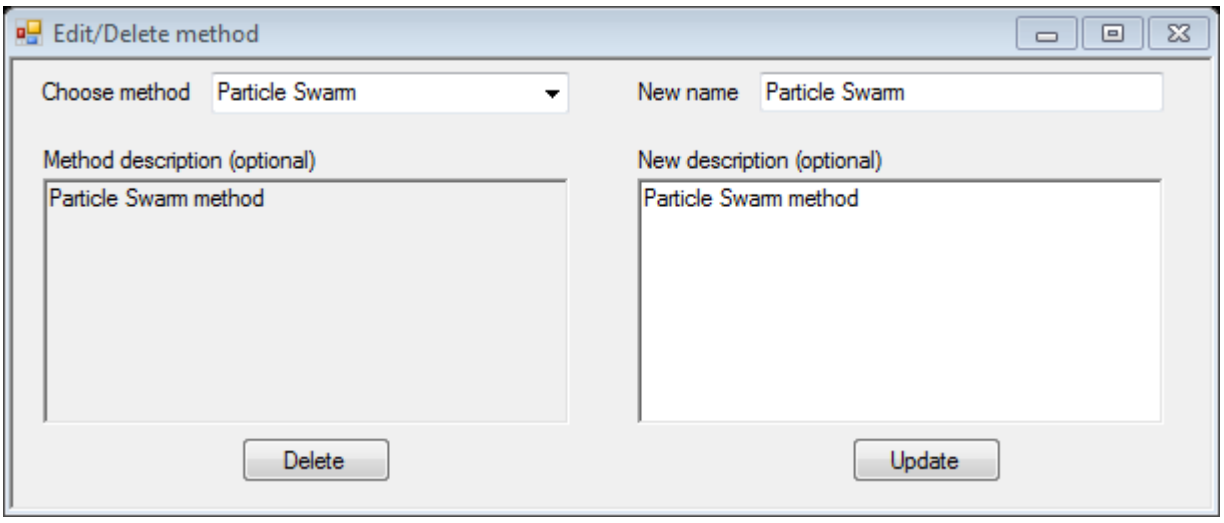

Figure 26. The window *"Edit/Delete method"* with chosen method in ConvAn v2.0.

Deletion operation can be performed by clicking on the button *"Delete"*. After successful deletion the window *"Information"* will appear (see **Figure 27**). As a result not only particular method will be deleted but all connected profiles and optimization data will be deleted as well.

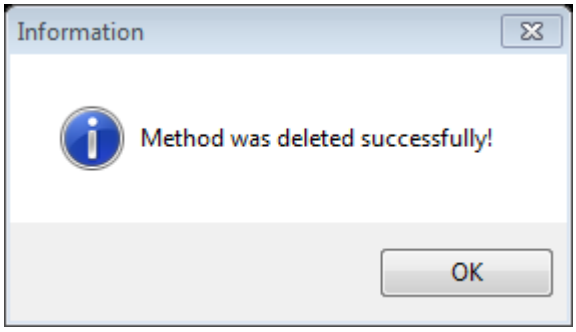

Figure 27. The window *"Information"* about successfully deleted profile in ConvAn v2.0.

If user is not interested in method deletion but just wants to modify methods parameters, user can make changes in the fields and save changes by clicking on the button *"Update"*. After successful update operation the window *"Information"* will appear (see **Figure 28**).

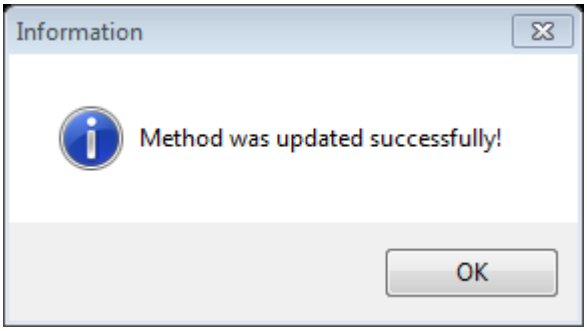

Figure 28. The window *"Information"* about successfully updated method in ConvAn v2.0.

8. ANALYZE PROFILE OPTIMIZATION DATA

In ConvAn v2.0 it is possible to analyze every profile as a data set in order to see tendencies and stability of particular optimization run depending on optimization parameters. The window *"Profile analyzer"* (see **Figure 29**) can be accessed by executing *Optimizations* → *View* (see **Figure 6**).

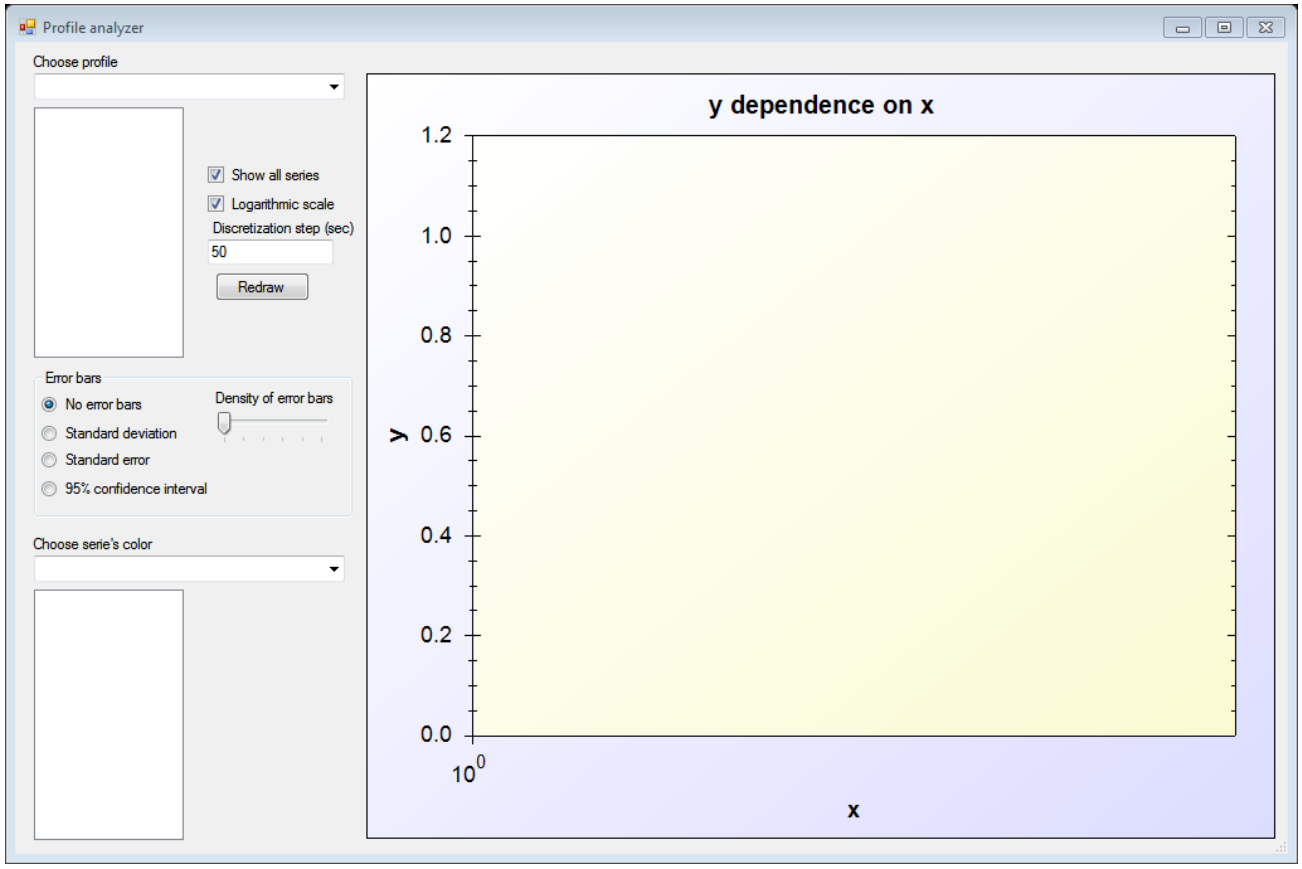

Figure 29. The window *"Profile analyzer"* for profile analysis in ConvAn v2.0.

First of all user has to set analysis settings. In *"Profile analyzer"* window there are two checkboxes (*"Show all series"*, *"Logarithmic scale"*), input field for discretization step (*"Discretization step (sec)"*), four radio buttons (*"No error bars", "Standard deviation", "Standart error", "95% confidence interval"*) and slide bar (*"Density of error bars"*). By default both checkboxes are marked, radio button *"No error bars"* is chosen, slide bar is set to left side (max density of error bars), and discretization step is set to 50 seconds. The functionality of *"Show all series"* checkbox will be discussed later. The mentioned radio buttons enables corresponding statistical functions or disables visualization of error bars for average curve of all optimization runs for chosen profile. *"Logarithmic scale"* checkbox switches X axis between linear or logarithmic

scales. *"Density of error bars"* slide bar regulates how often error bars are visualized on the average curve. Discretization step is very important parameter, because profile analysis and all calculation steps depend on value of discretization. Discretization step in seconds indicates how often ConvAn v2.0 performs better value check in all data series of optimization runs and calculates average values after each iteration which is equal to set discretization step. If discretization step is chosen too big, no curves will be drawn because of shorter optimization runs, but very small discretization step will lead to time consuming analysis in case of long optimization runs.

When analysis settings are set, user can choose the profile from *"Choose profile"* drop down menu. ConvAn v2.0 will prompt for confirmation of discretization step (see **Figure 30**).

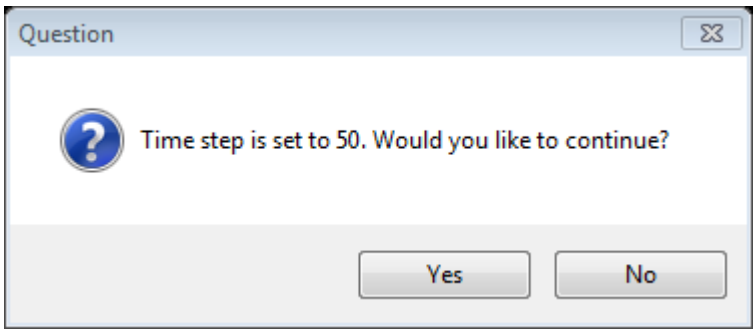

Figure 30. The window *"Question"* for confirmation of discretization step in ConvAn v2.0.

If user clicks on the button "No", it is possible to change settings, but in case of approval (the button "Yes") ConvAn v2.0 returns a list of optimizations which are connected to that profile and graphical representation on the plot (see **Figure 31**).

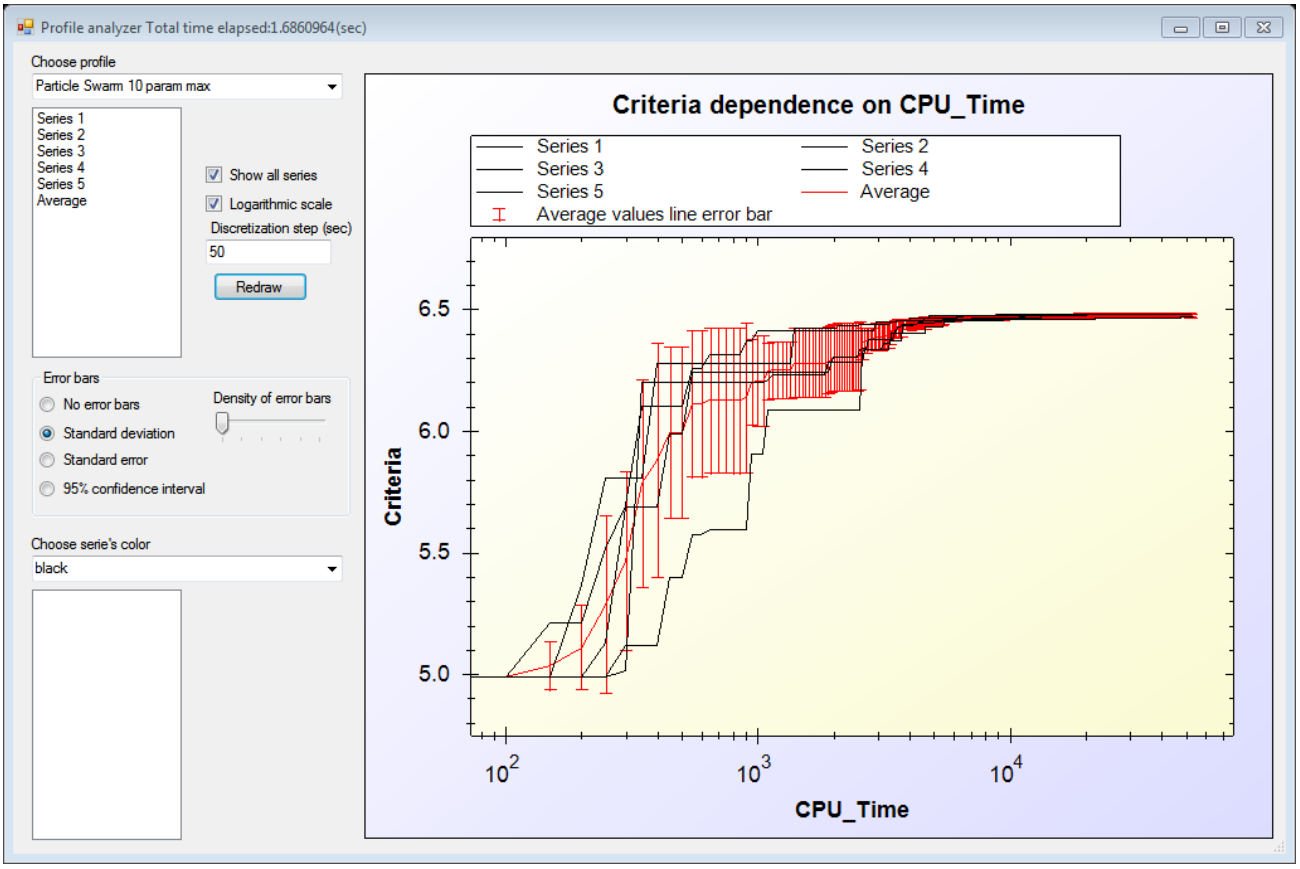

Figure 31. The window *"Profile analyzer"* for profile analysis with chosen profile in ConvAn v2.0.

Graph can be zoomed in and zoomed out, it can be saved as picture for further analysis. These options are accessible from the context menu dialog box, when the right button of mouse is clicked on the plot (see **Figure 32**).

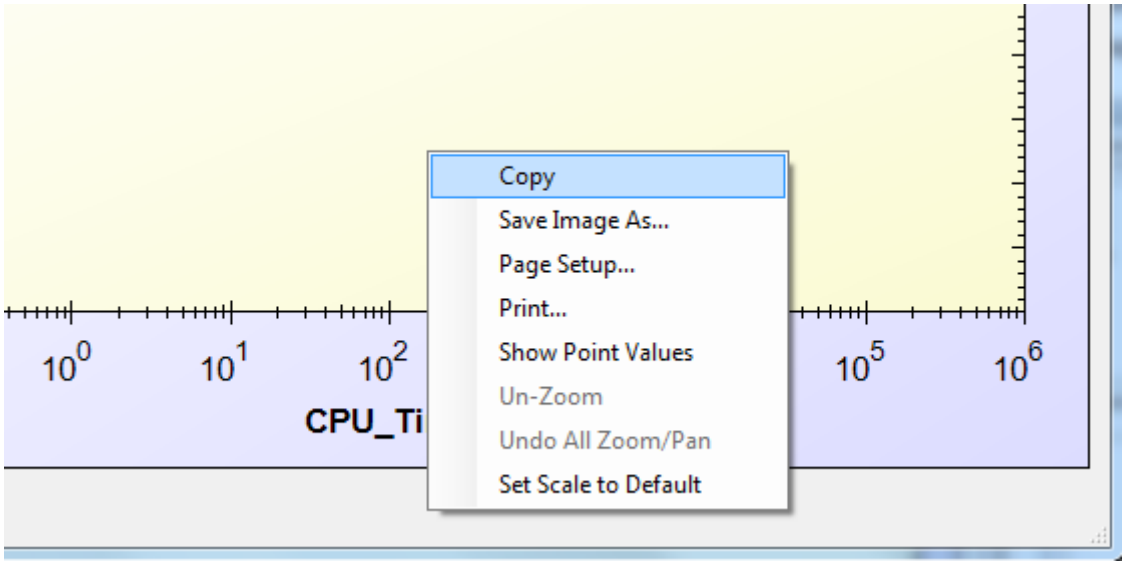

Figure 32. Context menu dialog box for plot functions in ConvAn v2.0.

All series on the plot are shown in black color by default but user can choose which series to show and can change the color for each series as well. In order to choose which series to show user has to click on series name in the list of series under *"Choose profile"* drop down menu. In order to hide series user has to do the same operations as mentioned above.

When series is selected it appears on the plot and it's name in the selected series list. Then user can change color by clicking on series in selected series list (left bottom corner) and choosing the color from *"Choosing series color"* drop down menu (see **Figure 33**).

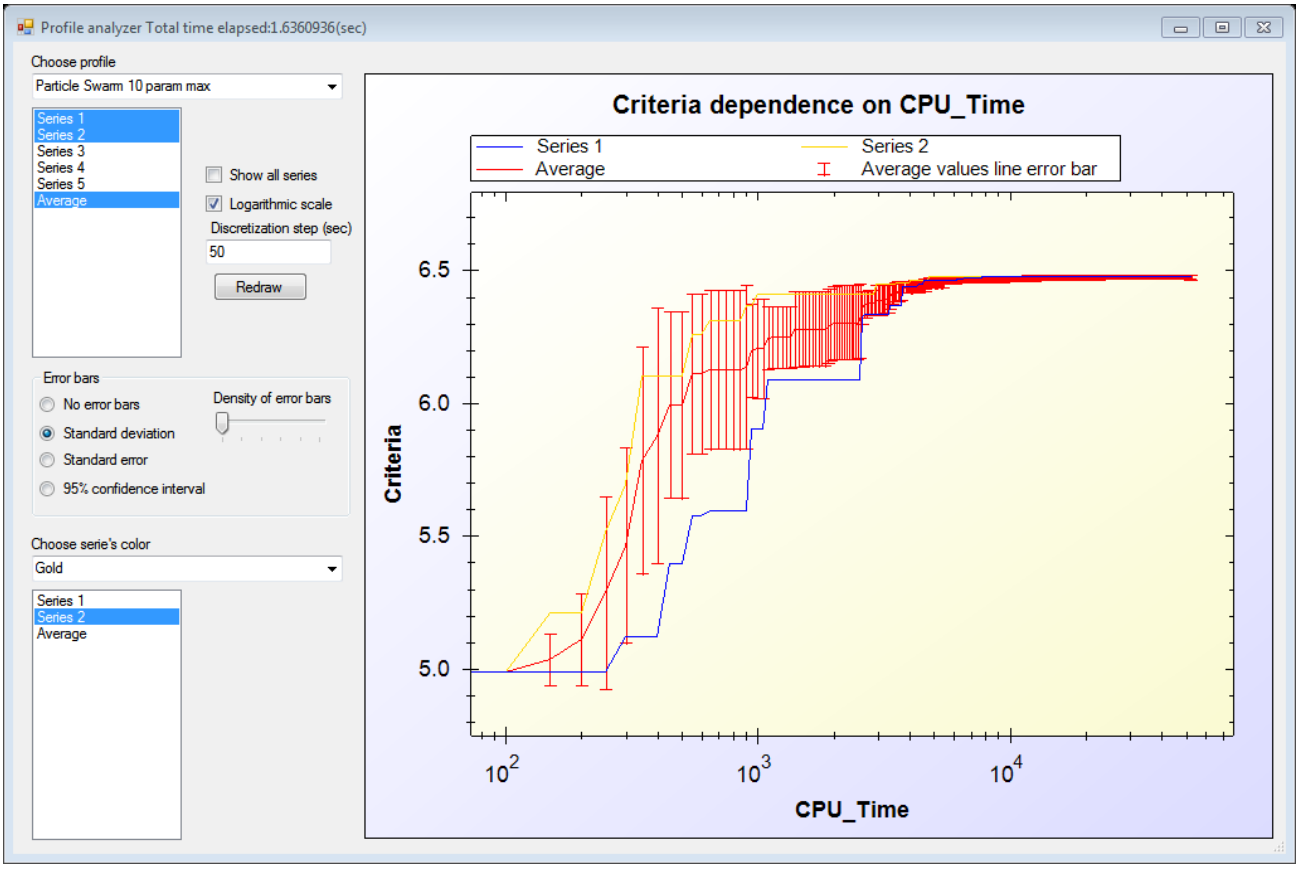

Figure 33. The window *"Profile analyzer"* for profile analysis with chosen profile and some series in ConvAn v2.0.

If it is necessary to reanalyze profile with different discretization step, it is possible to change discretization step in the field and click on the button *"Redraw"*.

9. EDIT/DELETE OPTIMIZATION DATA

In ConvAn v2.0 it is possible to look at every optimization run one by one as data series columns and graphical representation. These functions are available in the window *"View optimization"* (see **Figure 34**). It can be accessed by executing *Optimizations* → *Edit* (see **Figure 6**).

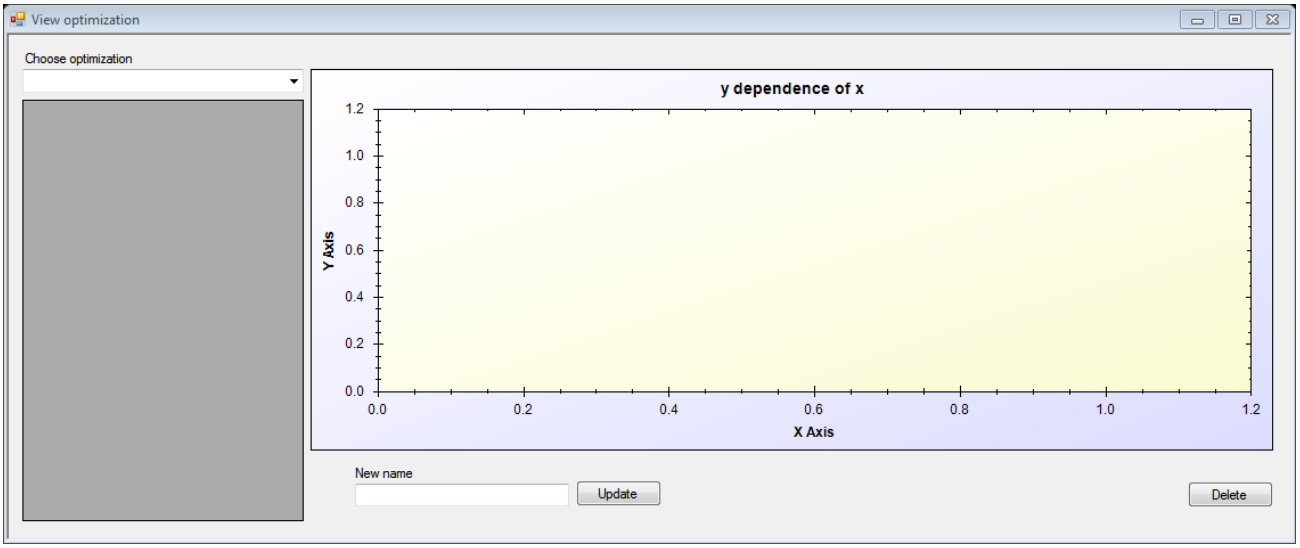

Figure 34. The window *"View optimization"* for optimizations data modification in ConvAn v2.0.

From *"Choose optimization"* drop down menu user can choose optimization run and corresponding data series appears in the left side of the window and graphical representation appears on the plot (see **Figure 35**).

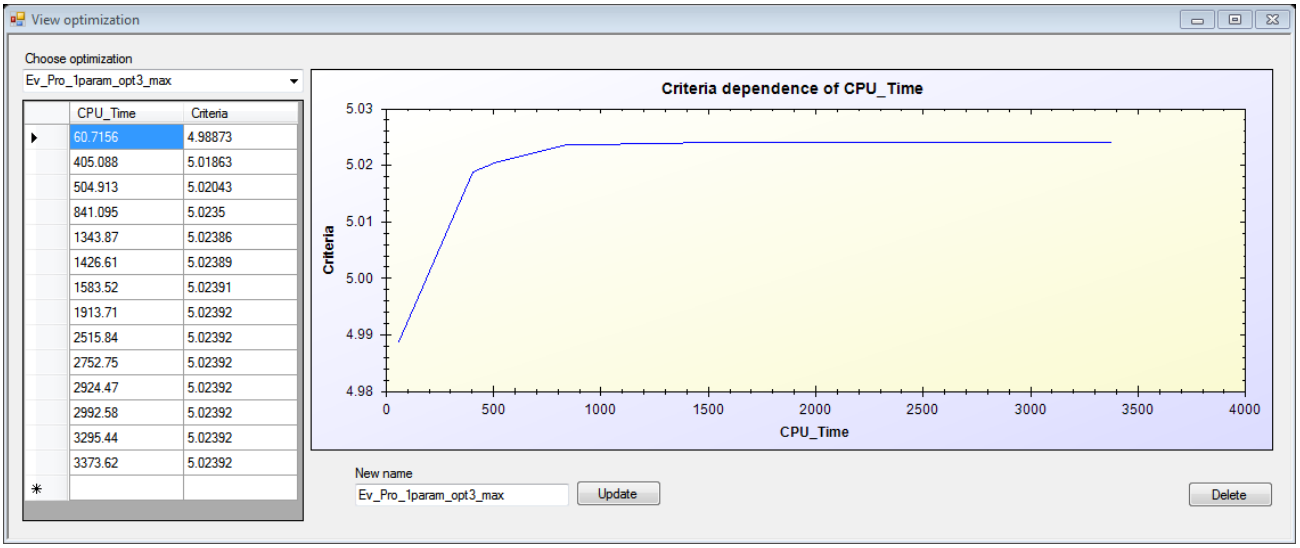

Figure 35. The window *"View optimization"* with selected optimization run in ConvAn v2.0.

User can change the name of optimization run in *"New name"* input field and save it by clicking on the button *"Update"* or delete chosen optimization run by clicking on the *"Delete"* button. For both actions in case of success ConvAn v2.0 shows windows *"Information"* (see **Figure 36** and **Figure 37**).

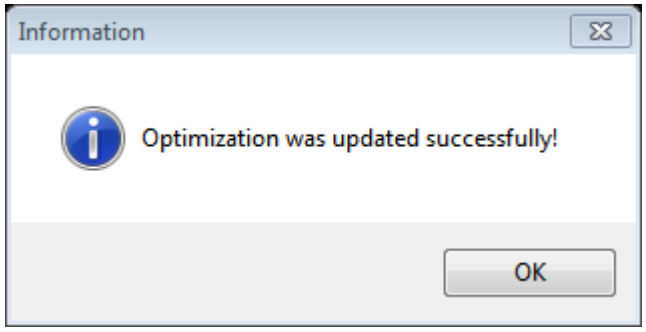

Figure 36. The window *"Information"* about successfully updated optimization in ConvAn v2.0.

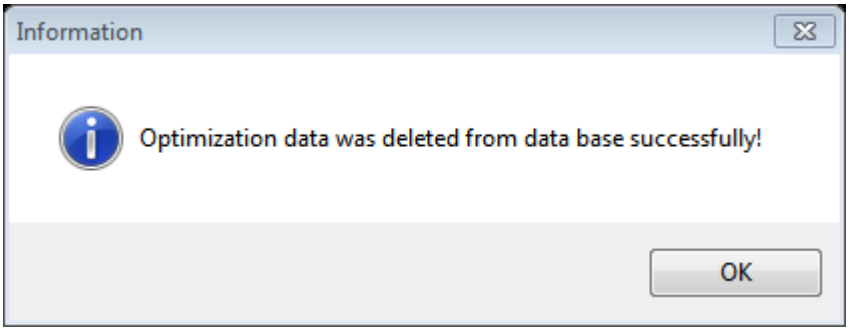

Figure 37. The window *"Information"* about successfully deleted optimization in ConvAn v2.0.

10. COMPARING OPTIMIZATION METHODS DEPENDING ON DIFFERENT ADJUSTABLE PARAMETER SETS

10.1. Maximization tasks

Maximization tasks for ConvAn v2.0 mean that the highest value of objective function is sought during optimization run. ConvAn v2.0 is able to perform statistical calculations to help user to compare optimization methods each other. This feature is available in the window *"Maximization analyzer"* (see **Figure 38**) by executing *Analyze* → *Maximization Analyzer* (see **Figure 7**).

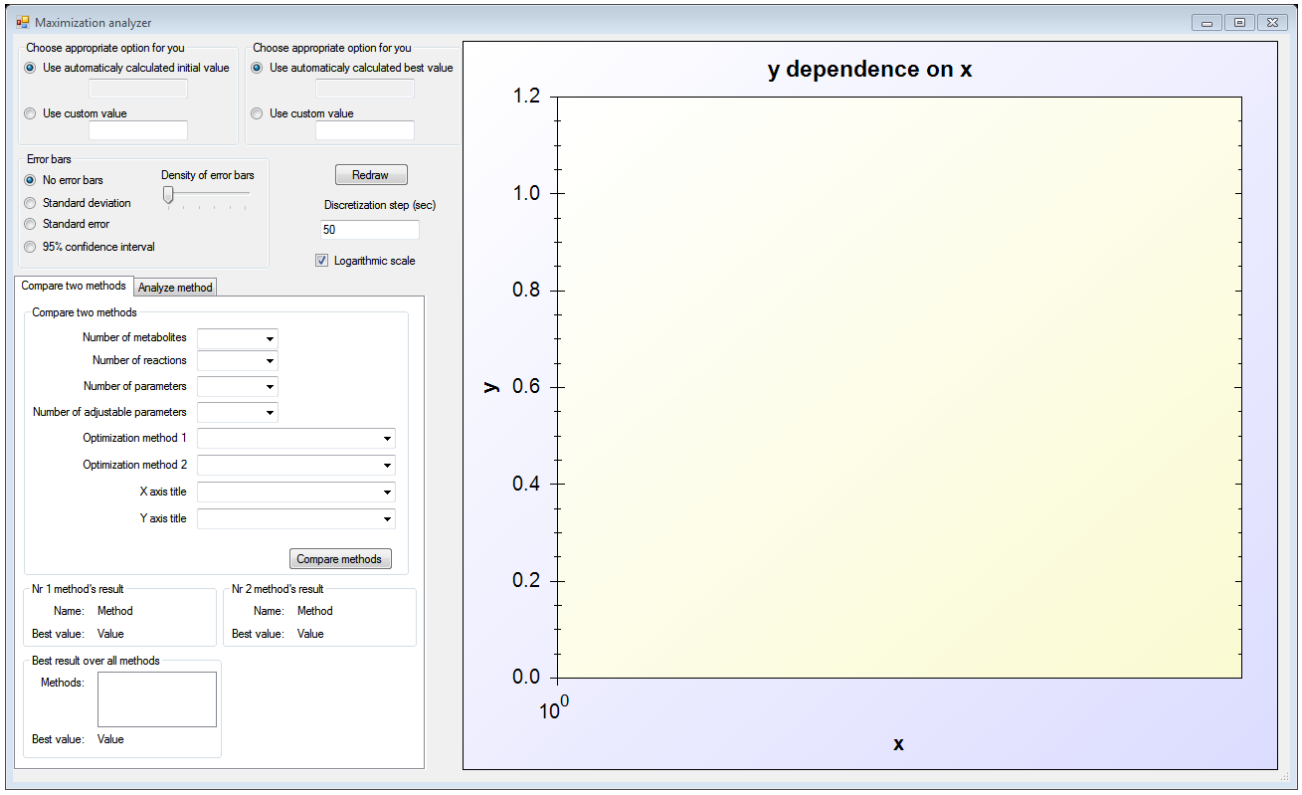

Figure 38. The box *"Compare two methods"* in the window *"Maximization analyzer"* in ConvAn v2.0.

This is one of the biggest window in ConvAn v2.0 that contains not only optimization methods comparison functions but particular optimization method behavior analysis function as well (how to use optimization method behavior analysis function is described in the chapter 11 *"ANALYZE AND PREDICT BEHAVIOUR OF PARTICULAR METHOD DEPENDING ON DIFFERENT ADJUSTABLE PARAMETER SETS"*). How to use tuning settings (*"Error bars"*, *"Density of error bars"* slide bar and *"Discretization step (sec)"*) is previously described in the chapter 8 *"ANALYZE PROFILE OPTIMIZATION DATA"*. After parameter tuning user has to

choose values for input fields from drop down menus. *"Number of metabolites"* drop down menu indicates on number of metabolites in the model. *"Number of reactions"* drop down menu indicates on number of reactions in the model. *"Number of parameters"* drop down menu indicates on number of parameters of reactions in the model. *"Number of adjustable parameters"* drop down menu indicates number of those reactions parameters that were modified during the optimization process. *"Optimization method 1"* and *"Optimization method 2"* drop down menus indicate on two methods which user wants to compare depending on previously described configuration (drop down menus). *"X axis title"* and *"Y axis title"* drop down menus indicate on titles of axes which were given during profile creation. Finally user can compare methods by clicking on the button *"Compare methods"*. ConvAn v2.0 then shows information about the best values of interested methods in the result boxes (see **Figure 39**).

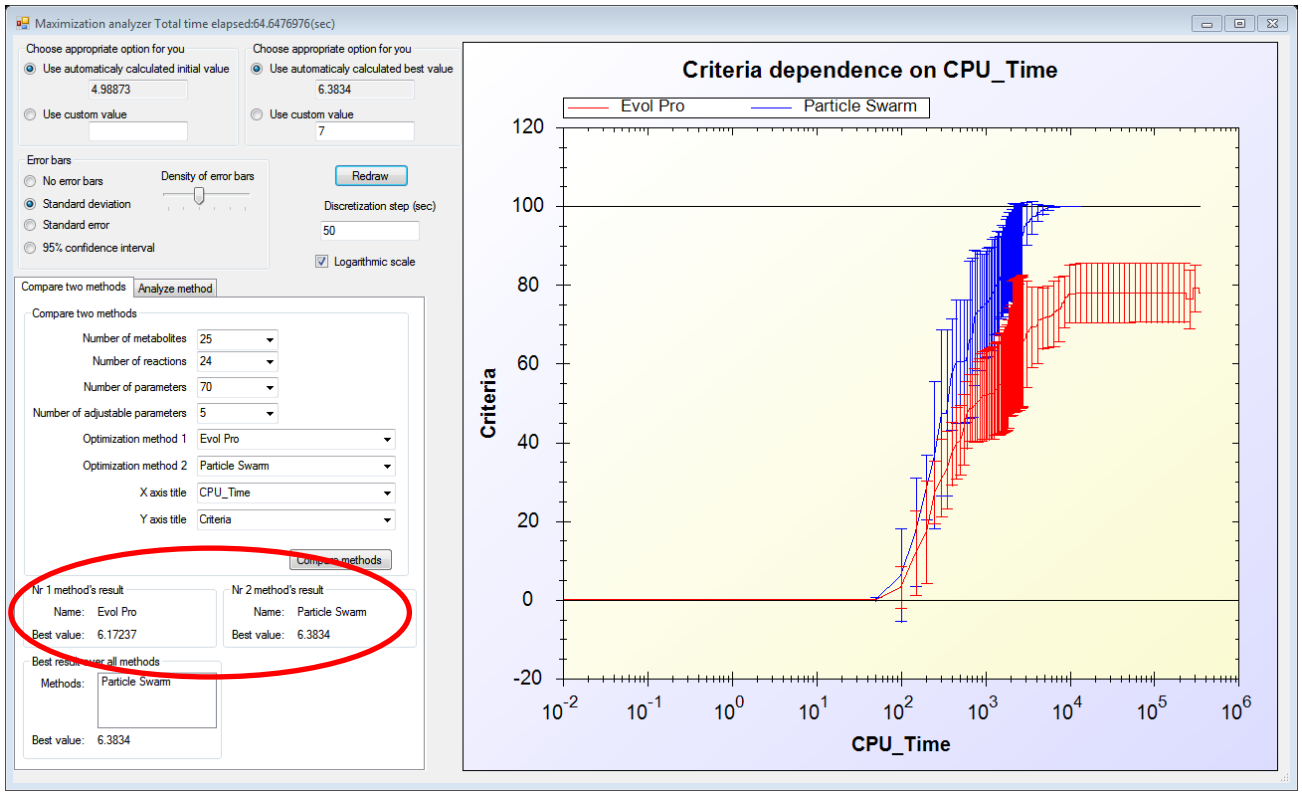

Figure 39. The result boxes in the window *"Maximization analyzer"* in ConvAn v2.0.

Another thing that ConvAn v2.0 returns is the best result over all methods in one box (see **Figure 40**) and finds out initial and the best value of optimization runs for interested methods in the other two boxes (see **Figure 41**). In the ***"Best result over all methods"*** box is shown not only the best value but those methods where this value was obtained during optimization runs depending on

methods' comparing parameters that were set before in the window *"Maximization analyzer"* in ConvAn v2.0.

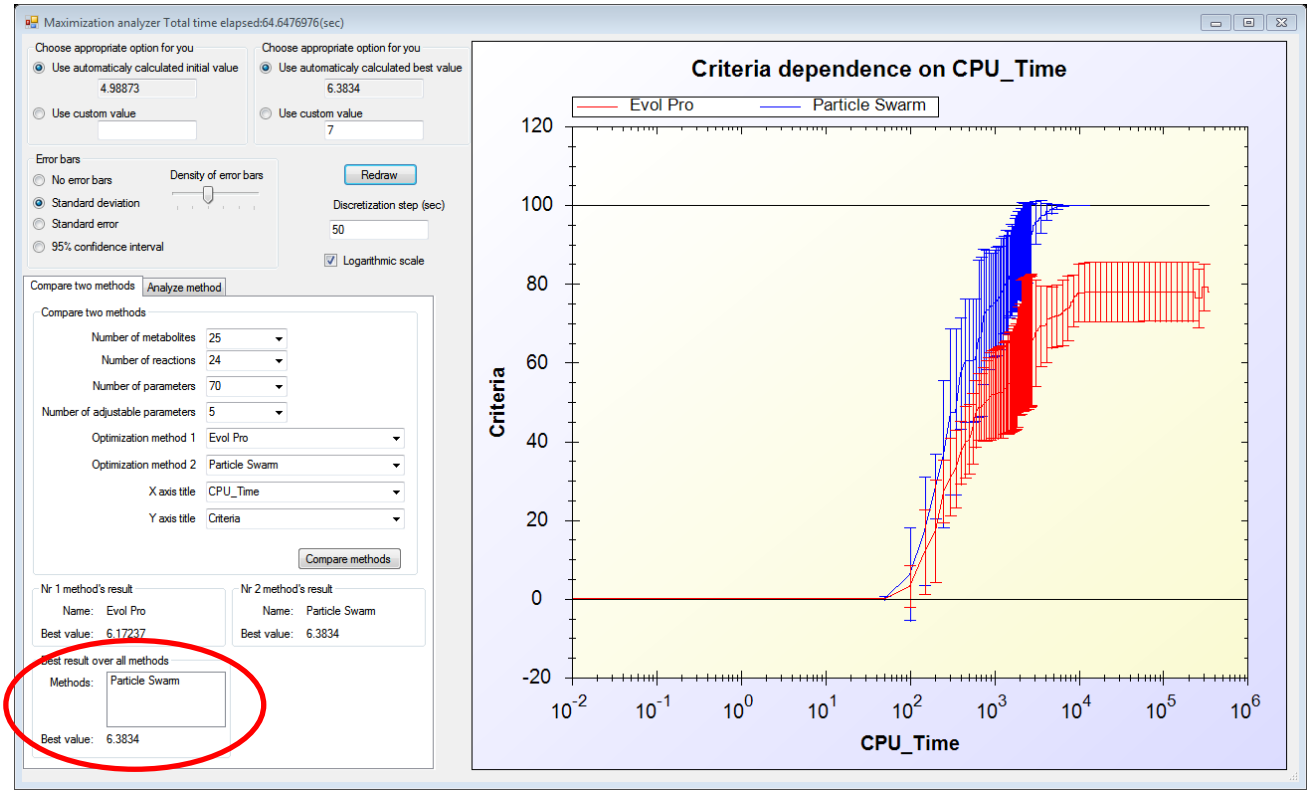

Figure 40. The box **"***Best result over all methods***"** in the window *"Maximization analyzer"* in ConvAn v2.0.

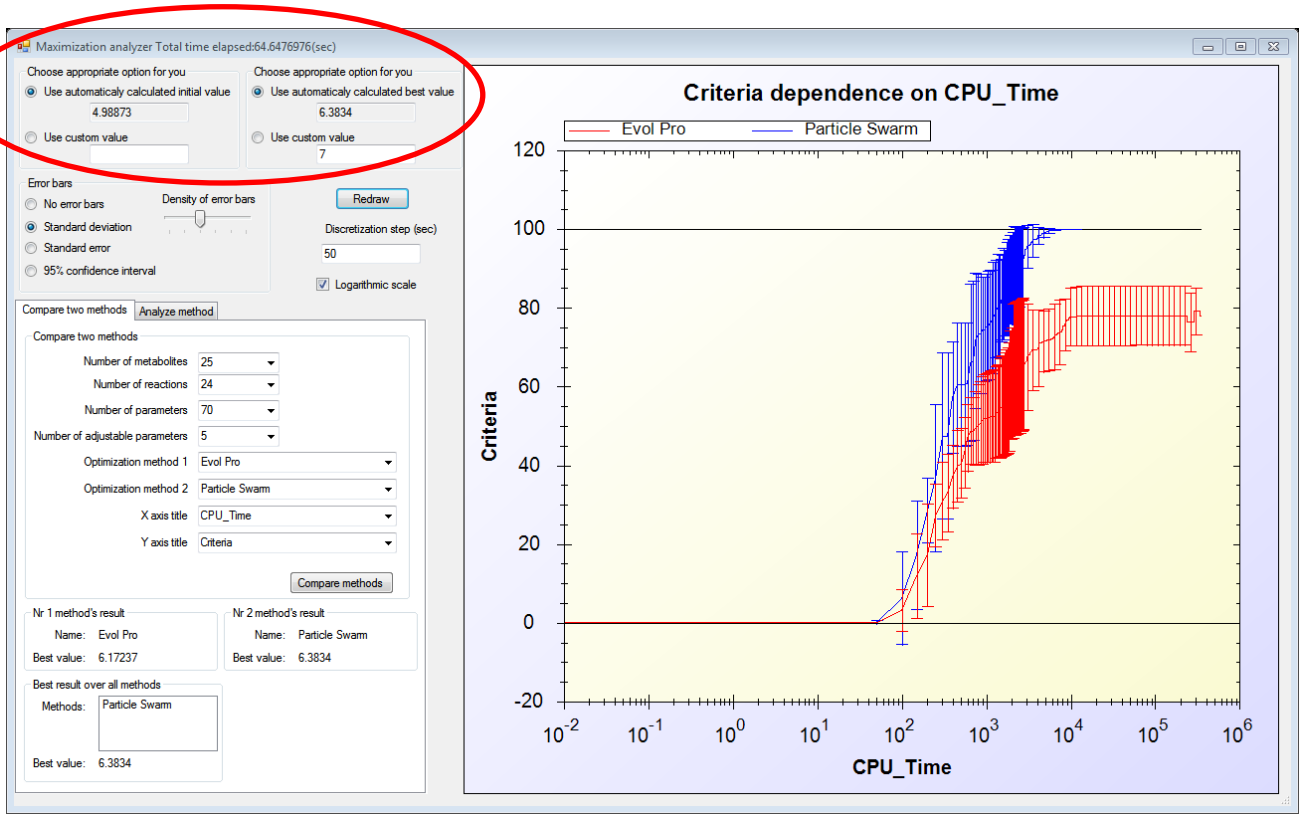

Figure 41. Initial value and the best value boxes in the window *"Maximization analyzer"* in ConvAn v2.0.

Initial value and the best value are the key numbers for percentage normalization on the graph. ConvAn v2.0 offers automatically obtained numbers from data sets of optimization runs that are stored in the data base but it is possible to change these values manually by selecting the radio button *"Use custom value"* and filling in appropriate numbers in the input field (see **Figure 41**). Initial value corresponds to starting point of normalization – 0% but the best value corresponds to ending point of normalization - 100%. By setting these values manually user can change potential minimum and maximum that would be necessary if user knows according to other sources that these values could be different from those that were obtained automatically from data series of optimization runs.

Manually curated values will take effect after clicking on the button *"Redraw"* as a result graphical representation changes according to new values.

10.2. Minimization tasks

Minimization tasks for ConvAn v2.0 mean parameter estimation when the smallest distance between experimental data and optimization data is sought during optimization runs. ConvAn v2.0 is able to compare optimization methods in minimization tasks as well. This feature is available in the window *"Minimization analyzer"* (see **Figure 42**) by executing *Analyze* → *Minimization Analyzer* (see **Figure 7**).

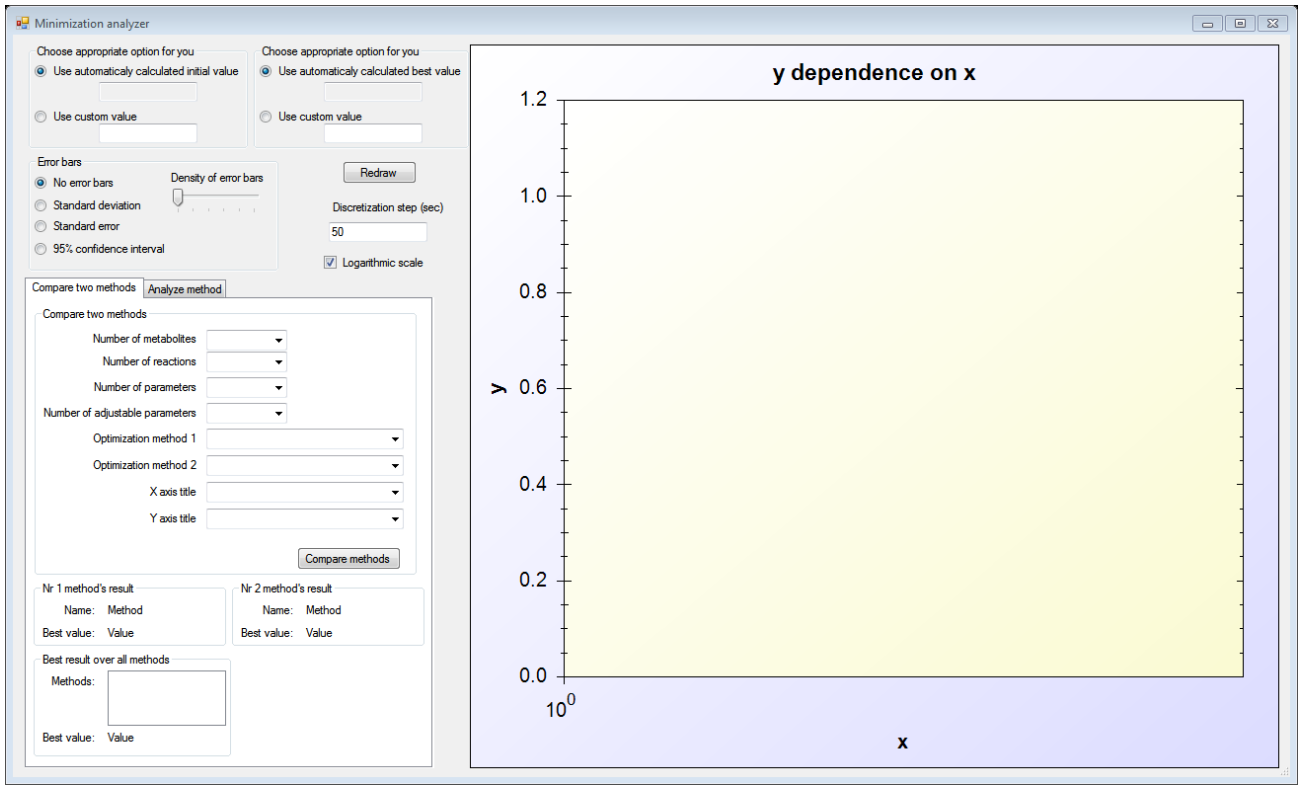

Figure 42. The box *"Compare two methods"* in the window *"Minimization analyzer"* in ConvAn v2.0.

This window looks identical to the window *"Maximization analyzer"* (how to use optimization method behavior analysis and prediction functions is described in the chapter 11 *"ANALYZE AND PREDICT BEHAVIOUR OF PARTICULAR METHOD DEPENDING ON DIFFERENT ADJUSTABLE PARAMETER SETS"*). How to use tuning settings (*"Error bars"*, *"Density of error bars"* slide bar and *"Discretization step (sec)"*) is previously described in the chapter 8 *"ANALYZE PROFILE OPTIMIZATION DATA"* and usage of other input fields and drop down menus is previously described in the chapter 10.1 *"Maximization tasks"*.

It is important to remember that in the window *"Minimization analyzer"* initial value is bigger than the best value because during optimization runs distance between experimental data and model data is decreasing.

11. ANALYZE AND PREDICT BEHAVIOUR OF PARTICULAR METHOD DEPENDING ON DIFFERENT ADJUSTABLE PARAMETER SETS

11.1. Maximization tasks

ConvAn v2.0 offers opportunity to analyze one particular method deeper that can help to predict method behavior with different adjustable parameter sets. This is the other feature that is available in the window *"Maximization analyzer"* (see **Figure 43**) by executing *Analyze* → *Maximization Analyzer* (see **Figure 7**).

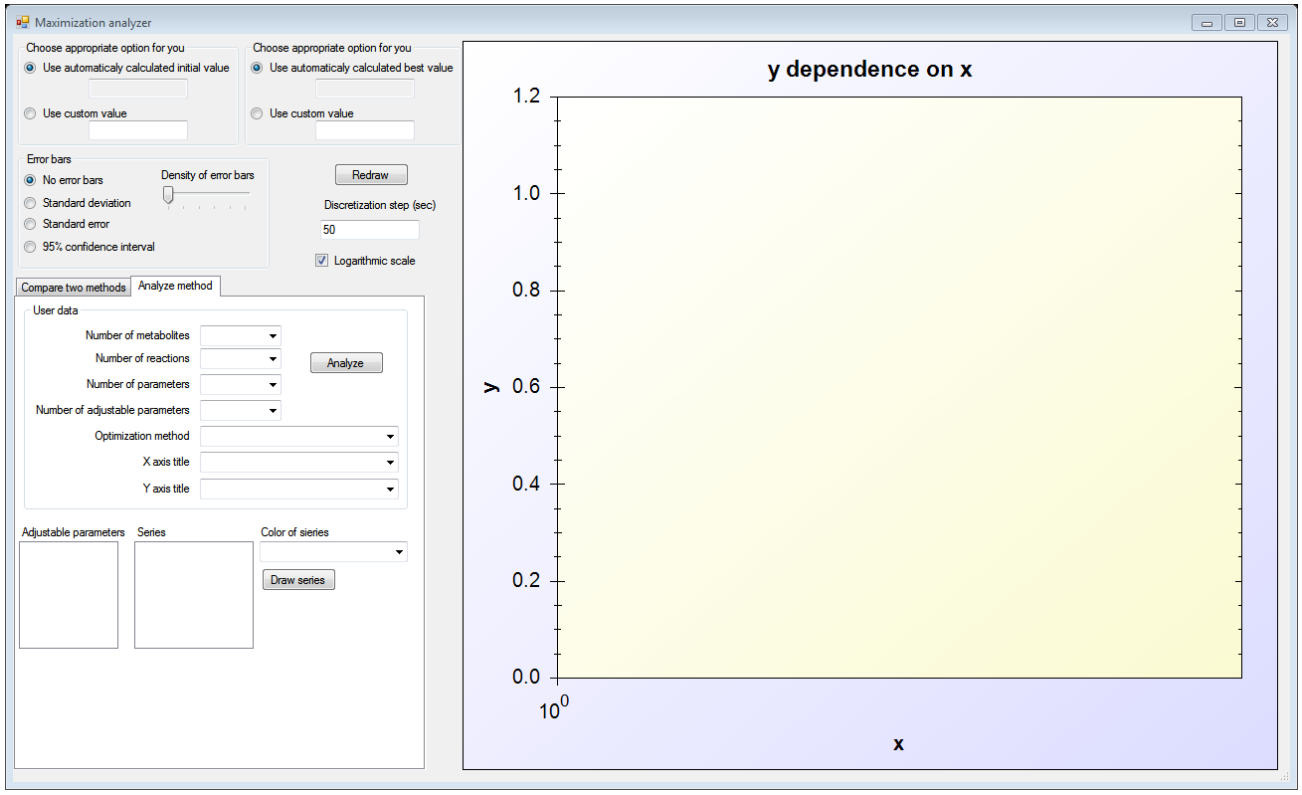

Figure 43. The tab *"Analyze method"* in the window *"Maximization analyzer"* in ConvAn v2.0.

Before running this function user has to perform methods comparison in order to get initial value and the best value (how to compare methods is described previously in the chapter 10.1 *"Maximization tasks"*) for percentage normalization on the graph. Another option is to fill in initial value and the best value manually (how to fill in initial and the best value is described previously in the chapter 10.1 *"Maximization tasks"*).

For analysis user has to provide ConvAn v2.0 with all necessary data in the box *"User data"* (how to fill the drop down menu input fields is described in the chapter 10.1 *"Maximization tasks"*). The next step is to start analysis by clicking on the button *"Analyze"*. ConvAn v2.0 tries to return

the nearest graph depending on the value in the drop down menu *"Number of adjustable parameters"* input field, for example, if user has filled in value of 5 but in the data base there are no records with such number of adjustable parameters, then ConvAn v2.0 for calculation uses next smaller and next higher available number of adjustable parameters and returns two curves instead of one (see **Figure 44**).

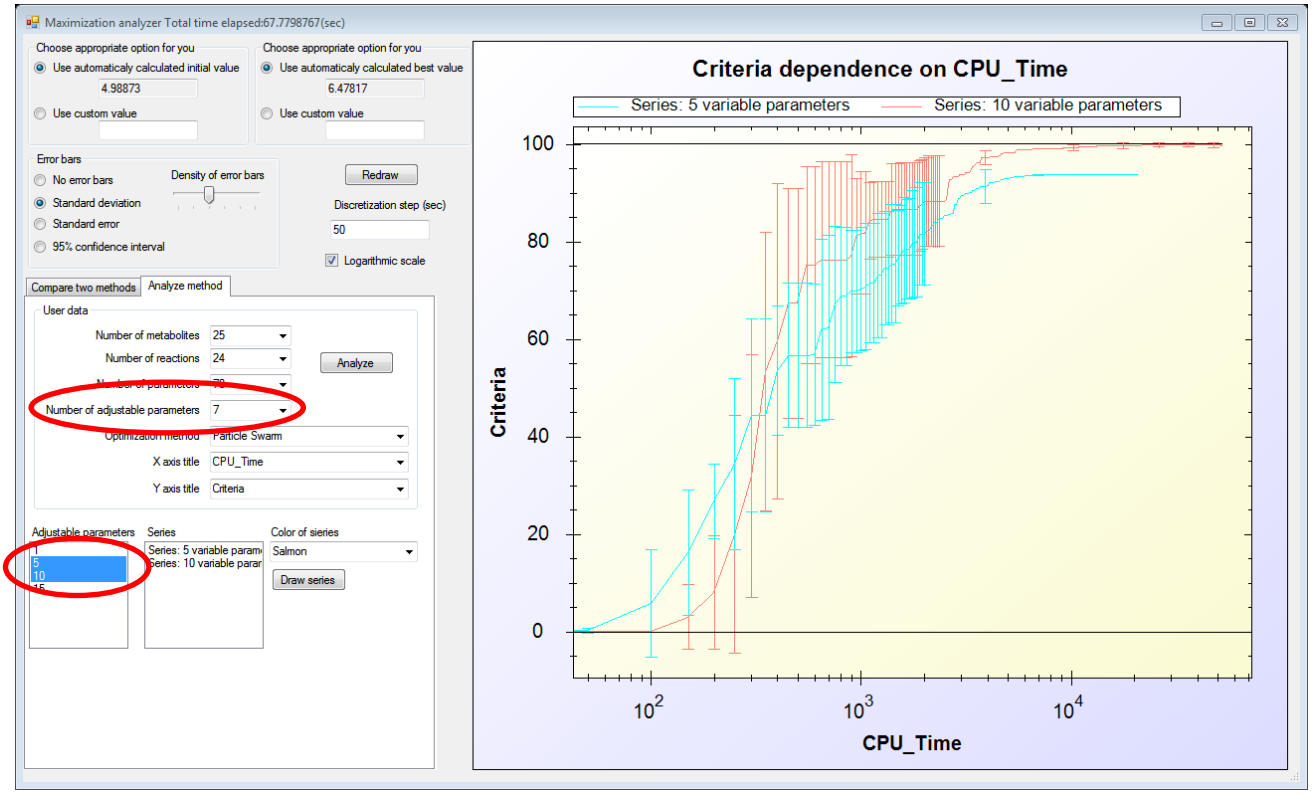

Figure 44. Two curves of the closest adjustable parameter numbers in the window *"Maximization analyzer"* in ConvAn v2.0.

In such cases it means that user's curve should be somewhere between those two. User can draw the other curves for method just by clicking on entries in the list box *"Adjustable parameters"* and then by clicking on the button *"Draw series",* selected series appear in the near list box *"Series"* and on the plot.

11.2. Minimization tasks

In ConvAn v2.0 is possible to analyze behavior of method for minimization tasks as well. This is the other feature that is available in the window *"Minimization analyzer"* (see **Figure 45**) by executing *Analyze* → *Minimization Analyzer* (see **Figure 7**).

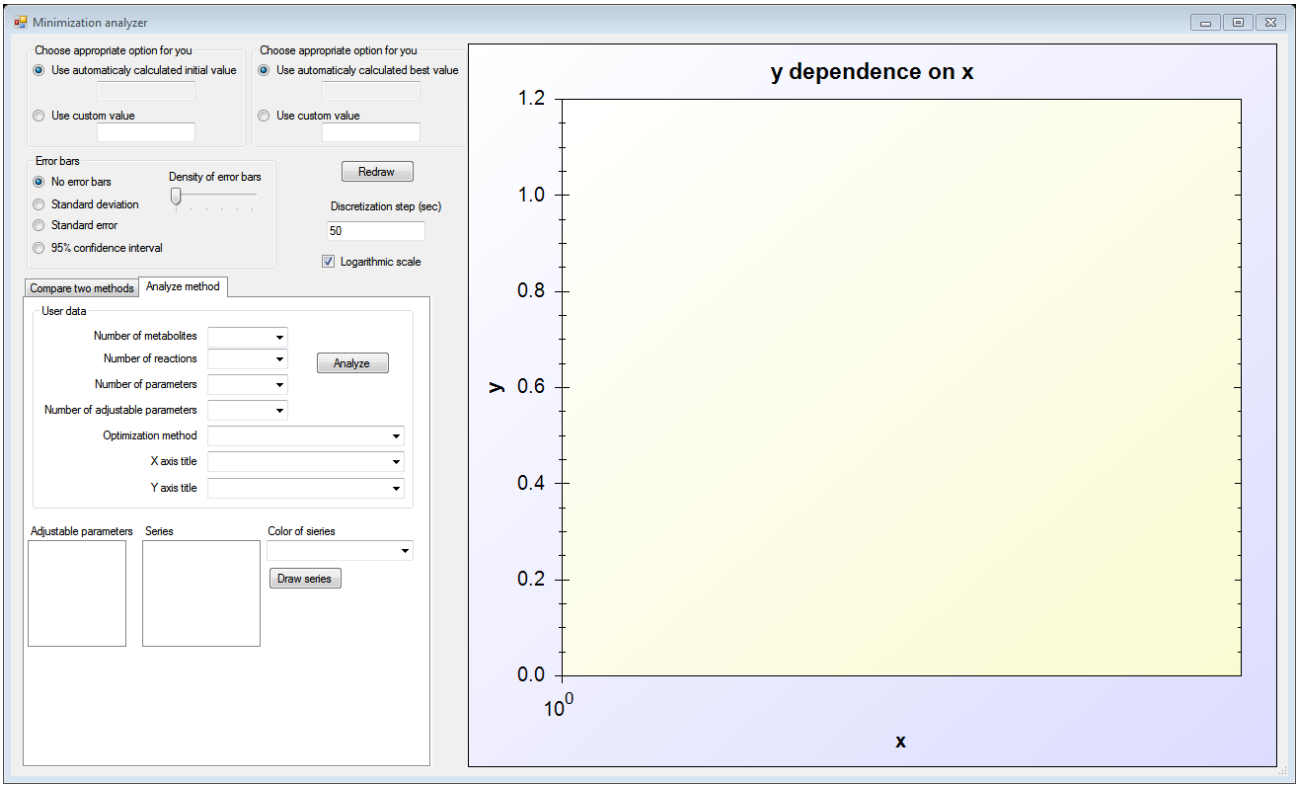

Figure 45. The tab *"Analyze method"* in the window *"Minimization analyzer"* in ConvAn v2.0.

How to perform method analysis is previously described in the chapter 11.1 *"Maximization tasks"*.