

User Manual: CARO Tool ver: 1.0

March 15, 2021

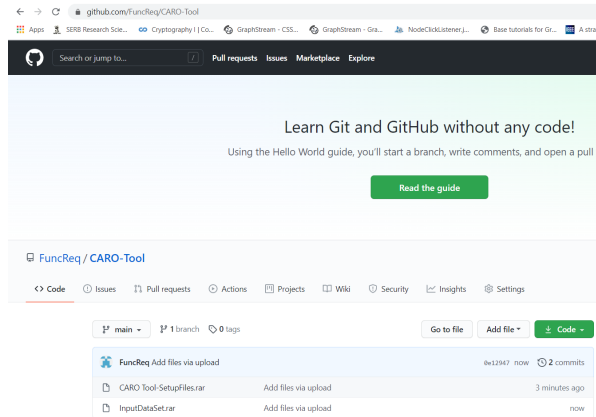
1 Download and Setup

The following steps need to be followed diligently for the correct setup of the tool in your machine.

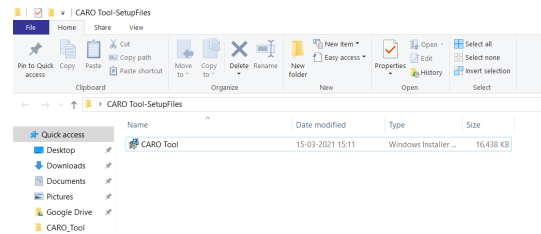
STEP-1. Pre-requisite: User must have Java SDK installed in their machine.

STEP-2. Download: User needs to download the following files from the github repository (refer to 1(a)) for using the tool:

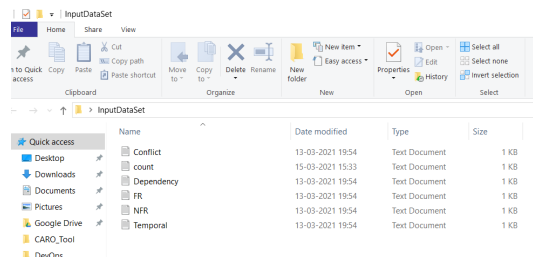
- *CARO_TOOL-SetupFiles.rar*: It contains the tool installation files (refer to 1(b)).
- *InputDataSet.rar*: It contains some sample data set that the user can use while running the tool (refer to 1(c)).



(a) Files in the repository



(b) Contents of CARO_TOOL-SetupFiles folder



(c) Contents of InputDataSet folder

Figure 1: Tool SetUp

STEP-3. Extract: The downloaded RAR files need to be extracted at any suitable location.

STEP-4. Installing the Tool:

- Open the CARO_TOOL-SetupFiles folder.
- Right click on CARO_Tool.msi file and select install option (refer to 2(a)).
- The installation wizard appears. Click on the "*Next*" button at the bottom of the wizard (refer to 2(b)).
- Next select a suitable installation location and click on "*Next*" button (refer to boxed portion in 2(c)).
- On the next screen of the wizard click on "*Install*" button at the bottom to start the installation process (refer to 2(d)).
- Finally on completion of the installation click on "*Finish*" button to exit the wizard (refer to 2(e)).

Now go to the location in your system where the tool is installed.

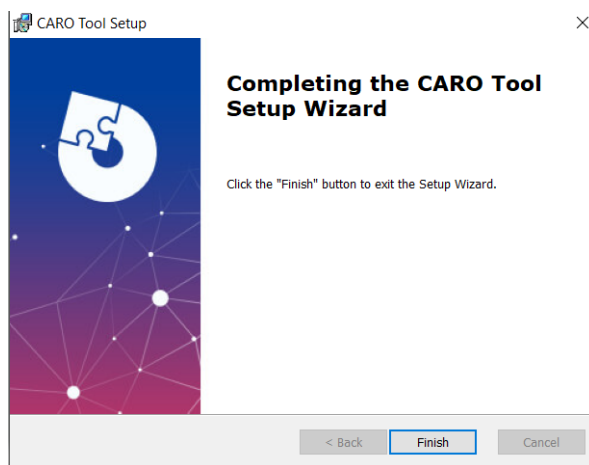
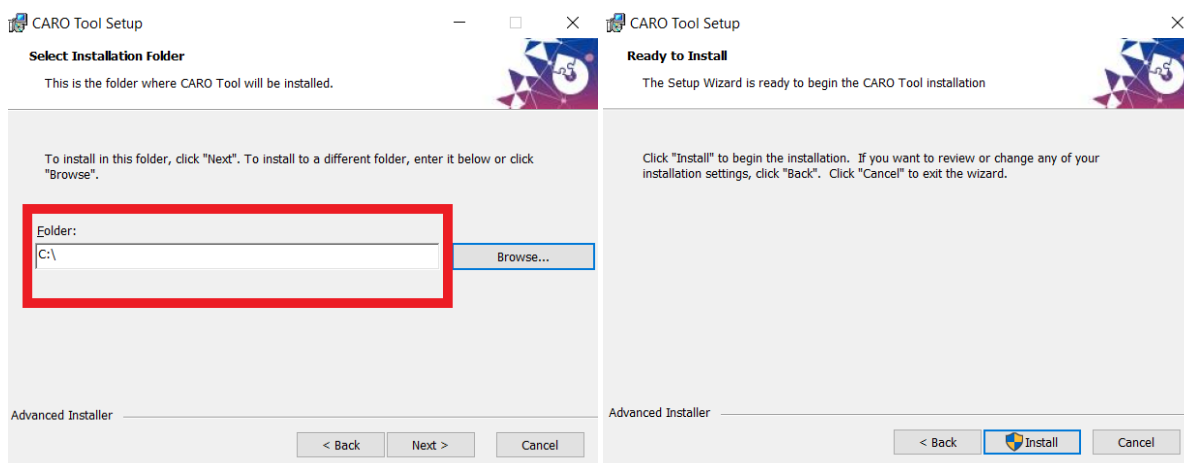
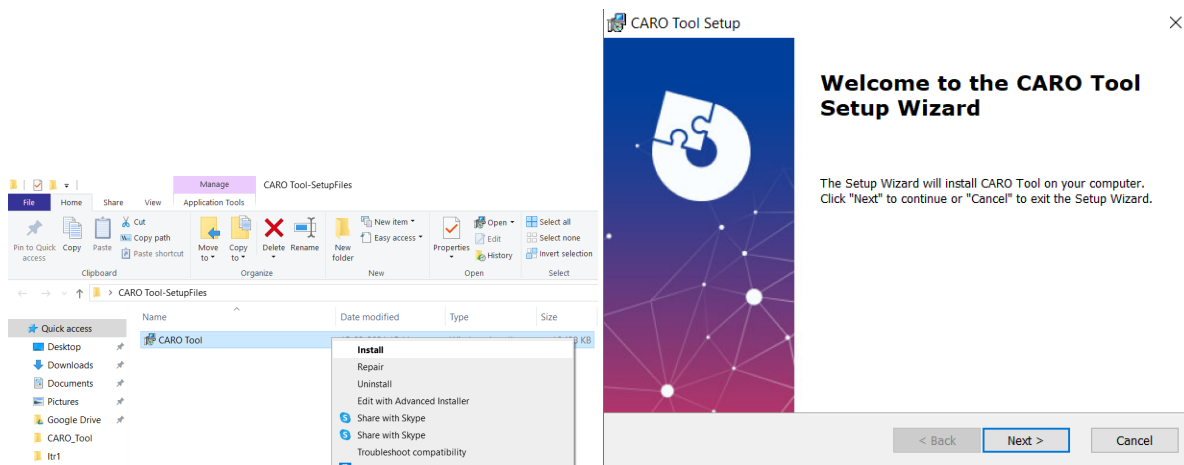


Figure 2: Installing CARO Tool

2 Using the CARO Tool

Before starting the tool, if you want to use the sample data set extract the contents of *InputDataSet.rar* folder and copy the files into same location as that of the tool (refer to Figure 3).

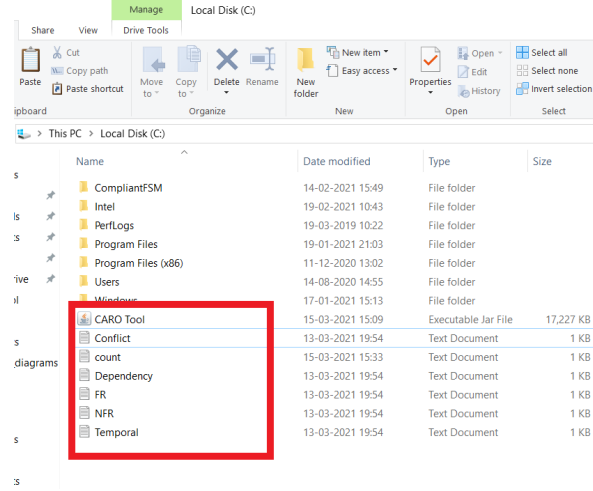


Figure 3: Tool and data set at the same location

The CARO Tool consists of the following three components-

- Requirement specification component.
- Partial order generation and risk assessment component.
- A dashboard to view different statistics.

Now, right click on the Tool icon (i.e. CARO_Tool.exe) and select "Open" option (refer to 3). The tool interface opens (refer to 4). Figure 4 shows the starting interface of the tool. The buttons marked as **C-1** is used to navigate to requirement specification module, **C-2** button to partial order generation and risk assessment module and **C-3** to view the dashboard.



Figure 4: Starting interface of CARO Tool

2.1 Requirement Specification Component

Click on button marked as **C-1** (refer to Figure 4) to open requirement specification interface. Figure 5 shows the requirement specification interface.

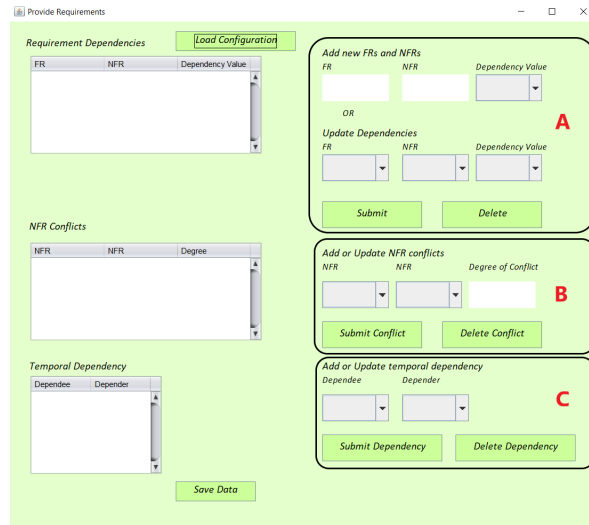


Figure 5: Requirement Specification Interface

The set of functional, non-functional requirements, dependencies and conflicts can be provided in the following ways:

STEP-1. Specifying the requirements.

- *Option 1:* The user can choose to use the sample data set that is installed along with the tool (refer to Figure 1(c)).

- (a) Click on the "Load Configuration" (refer to Figure 5) button to load the data of the sample data set in the tool.
- (b) Figure 6 shows the data sets that are loaded in the tool.

Provide Requirements

Requirement Dependencies

Load Configuration

FR	NFR	Dependency Value
f1	nf1	8
f1	nf2	4
f2	nf3	8
f2	nf4	2
f3	nf3	7
f3	nf4	4
f4	nf5	6
f4	nf6	6

NFR Conflicts

NFR	NFR	Degree
nf4	nf3	80
nf6	nf7	60
nf8	nf9	80

Temporal Dependency

Dependee	Depender
f1	f4

Save Data

Figure 6: Data Loaded

- *Option 2:* User can directly provide input in the tool as follows:
 - (a) **Adding new FR & NFR:** In the "Add new FRs and NFRs" (refer to portion marked as **A** in Figure 5) section type the label of FR, its corresponding NFR and select the dependency value from the drop-down list (refer to to portion marked as **A** in Figure 5). Then click on the "Submit" button. The table at the left column (refer to Figure 5) displays the input submitted.
 - (b) **Adding new NFR conflict:** FRs and NFRs has to be added into the list manually or to be loaded from existing set before specifying the conflicts. In the "Add or Update NFR conflicts" (refer to to portion marked as **B** in Figure 5) section select the pair of NFR that are in conflict using the drop-down list and also specify the degree of conflict (an integer value). Then click on the "Submit Conflict" button.

- (c) **Adding temporal dependency between FRs:** Similarly here also FRs has to be added into the list manually or to be loaded from existing set before specifying the dependencies. In the "Add or Update temporal dependency" (refer to to portion marked as **C** in Figure 5) section select the dependee and depender FR using the drop-down list. Then click on the "Submit Dependency" button.

STEP-2. The existing list of inputs can be modified or deleted as follows:

- **Modify FR-NFR dependency Value:** In the "Update Dependencies" section select a FR, NFR and a new dependency value from the drop-down list (refer to to portion marked as **A** in Figure 5) and click on "Submit" button. The change can be viewed in the table at left.
- **Delete FR-NFR association:** In the "Update Dependencies" section select the FR and NFR from the drop-down list (refer to to portion marked as **A** in Figure 5) and click on "Delete" button. The change can be viewed in the table at left.
- **Modify NFR conflict value:** In the "Add or Update Conflicts" section select the pair of NFRs from the drop-down list and type the new conflict value (refer to to portion marked as **B** in Figure 5) and click on "Submit Conflict" button. The change can be viewed in the table at left.
- **Delete NFR conflict:** In the "Add or Update Conflicts" section select the the pair of NFRs from the drop-down list (refer to to portion marked as **B** in Figure 5) and click on "Delete Conflict" button. The change can be viewed in the table at left.
- **Delete temporal dependency:** In the "Add or Update temporal dependency" section select the pair of FRs from the drop-down list (refer to to portion marked as **C** in Figure 5) and click on "Delete Dependency" button. The change can be viewed in the table at the left.

STEP-3. Once all the required dependencies and conflicts have been fixed click on "Save Data" button.

2.2 Partial Order Generation & Risk Assessment

Click on button marked as **C-2** (refer to Figure 4) to open partial order generation and risk assessment interface. Figure 7 shows the partial order generation and risk assessment interface.

Figure 7: Setting NFR priority

Now do the following steps-

- STEP-1.* Click on "Load NFR" button to load the NFR and set their priority values (refer to to portion marked as **A** in Figure 7). Put priority value against each NFR and then click on "Save Priority" button.
- STEP-2.* Now select any one of the parameters in the "Select a Parameter" section on the right (refer to to portion marked as **B** in Figure 7). In the case of parameter Weighted Sum, specify the weight to be assigned by dragging the slider to a position. The value at the left portion of the slider indicates weight assigned to the conflict and the right portion to the NFR priority. After selecting the parameter click on the "Submit" button to set the parameter.
- STEP-3.* Now, click on the "Generate Optimal PO" button to generate the Optimal Partial Order (refer to to portion marked as **C** in Figure 7). Partial order in the form of linear sequence(s) that will be displayed in the white text area (refer to Figure 8(a)) .
- STEP-4.* Click on "View Optimal PO Graph" button (refer to to portion marked as **C** in Figure 7) to see the optimal partial order in the form of a graph (refer to Figure 8(b)).

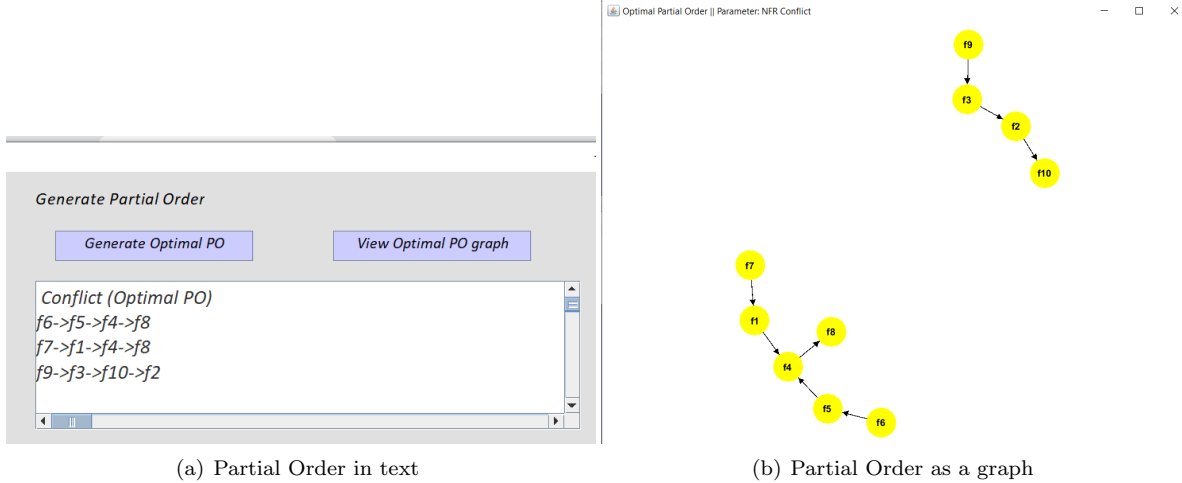


Figure 8: Optimal Partial Order in Iteration 1

- STEP-5.* Select the set of FRs to be frozen in the next increment in the "Select FRs to be frozen" section (refer to to portion marked as **D** in Figure 7). Click on the drop-down list to select an FR and then click on "Add" button. We will see that the FR is added to the text area in portion marked as **D** in Figure 7. To remove an FR from the list, select the FR from the drop-down list and click on "Delete" button.
- STEP-6.* Click on the "Generate Alternate PO" button (refer to to portion marked as **E** in Figure 7) to generate the Alternate Partial Order. Partial order in the form of linear sequence(s) that will be displayed in the white text area (refer to boxed portion Figure 9(b)).
- STEP-7.* Click on "View Alternate PO Graph" button (refer to to portion marked as **E** in Figure 7) to see the alternate partial order in the form of a graph (refer to Figure 9(b)).
- STEP-8.* Click on the "Compare Partial Orders" button to see the set of conflicting precedences (refer to to portion marked as **F** in Figure 7). It also displays the quantitative risk exposure values (refer to Figures 10).

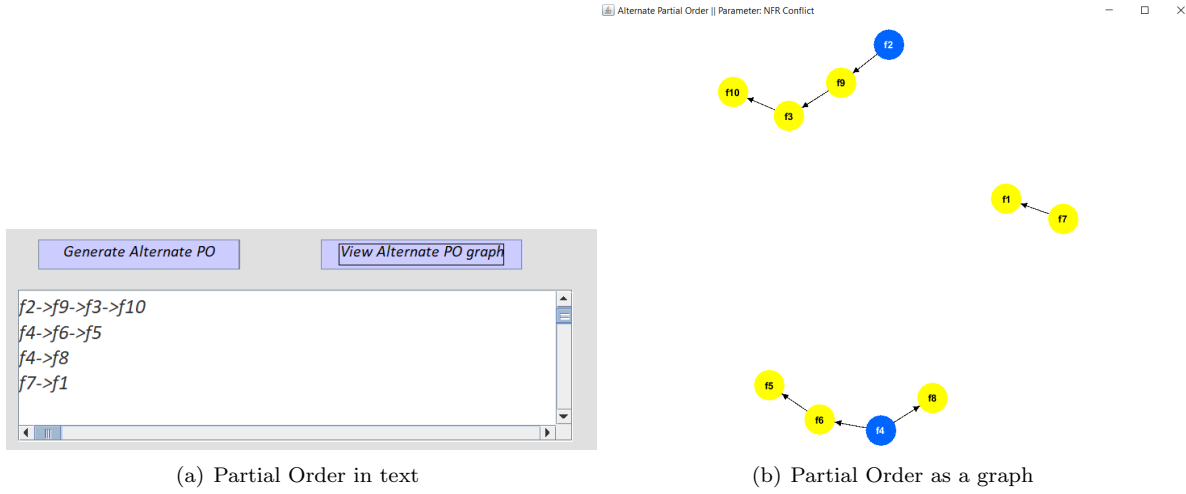


Figure 9: Alternate Partial Order in Iteration 1

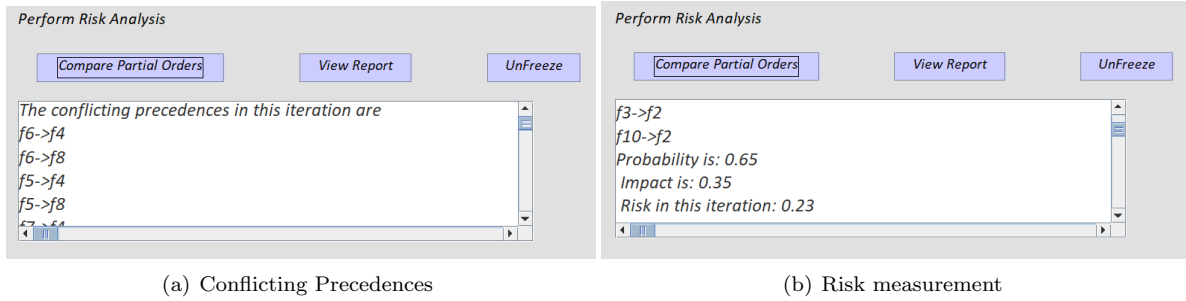


Figure 10: Partial Order comparison result

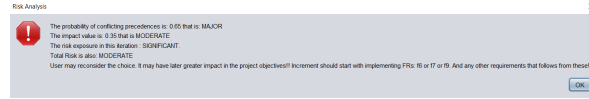


Figure 11: Qualitative Risk Analysis

- STEP-9.* Then click on the "View Report" button (refer to to portion marked as **F** in Figure 7) to view the qualitative risk analysis and risk reduction strategies (refer to Figure 11).
- STEP-10.* Before moving to next iteration click on "Save Configuration" button to save the results of the present iteration.
- STEP-11.* Then click on the "Next Iteration" button (refer to Figure 4 to move to the next iteration of the software development.
- STEP-12.* Add new FR, NFR dependencies, conflicts, or modify them using the steps mentioned in Section 2.1.
- STEP-13.* If there are new NFRs then repeat *STEP – 1* to set the priority of the new NFR.
- STEP-14.* To set a new parameter follow the instruction in *STEP – 2*, otherwise one can also continue with the already set parameter in the previous iteration.
- STEP-15.* Follow steps *STEP – 3* to *STEP – 8* to generate partial orders and to perform risk analysis.

STEP-16. At any $n - th$ ($n > 1$) iteration user can click on "*UnFreeze*" button (refer to to portion marked as **F** in Figure 7) to remove choices from previous iterations to reduce the risk. Figure 12(a) shows user need to select the increment from which requirements need to be removed. Figure 12(b) demonstrates the risk that can be reduced against different choices. Figure 12(c) shows the result of how much risk is reduced.

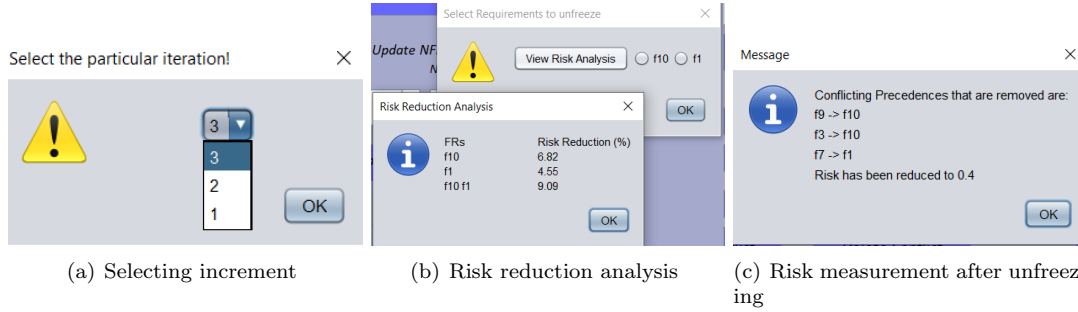


Figure 12: Unfreezing requirements

"*Load Configuration*" button is used to save data for each iteration. When an application is re-opened and "*Load Configuration*" button is clicked the data of the last iteration saved gets loaded into the system.

2.3 Dashboard

Click on button marked as **C-3** (refer to Figure 4) to open requirement specification interface. Figure 13 shows the requirement specification interface.

- The dashboard shows all possible data of different iterations.
- In the **Partial Order** column the buttons can be clicked to view the partial order of any particular iteration.
- In the **User Choice** column the buttons are used to open a text file that shows the requirements frozen in any iteration.
- At the bottom of the interface user can select any parameter from the drop-down list and click on "*Submit*" button. The data for the selected parameter in the form of a graph is displayed (refer to Figure 14).

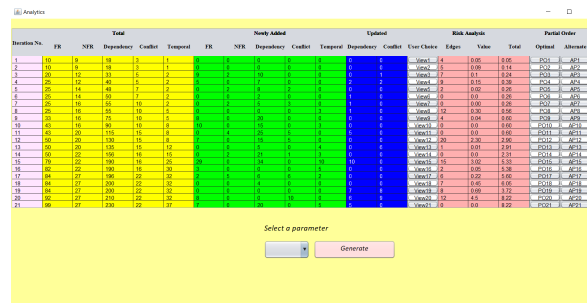


Figure 13: Dashboard

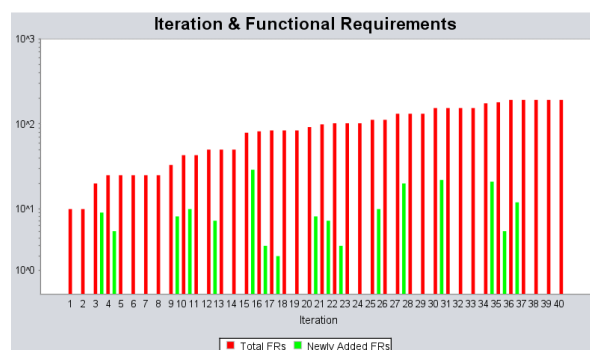


Figure 14: Graphical Analysis