

# COALA-3

## Simulation Environment

*Manual*

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# Chapter 1

## Preface

This manual describes the simulation environment `COALA-3`, written to simulate negotiations between information agents using the coalition algorithms `BSCA-Opp` and `BSCA-RC` developed in [5] and, for comparison purposes, the coalition algorithm `BSCA-TR*` developed in [3]. The original `coala` simulation environment was developed in [4] to simulate static coalition negotiations with the coalition algorithm `BSCA` introduced in [1]. It was further expanded in [3] to include newly developed dynamic coalition algorithms, and `COALA-3` as the latest expansion includes the new algorithms mentioned above which add a new type of malicious agent, called opportunistic agents, and new strategies of deceit and trust respectively. The `COALA-3` software can be found on the enclosed CD-ROM (for installation instructions see this manual), as can the thesis that developed the `BSCA-Opp` and `BSCA-RC` algorithms (found in the `/thesis` directory).

The rest of this manual is structured into three parts. Chapter two details the installation of `COALA-3` and the required `Tcl/Tk` software, chapter three guides through the graphic user interface of `COALA-3`, and chapter four lists the main procedures of the `COALA-3` source code.

## Chapter 2

# Installation

The COALA-3 software is implemented with Tcl/Tk, a combination of the Tool Command Language Tcl and the Toolkit Tk that facilitates the use of graphic user interfaces, developed by J.K. Ousterhout ([2]). The code for COALA-3 is written in the version for Linux platforms. In order to run COALA-3 you need to have the Tcl/Tk software of version 8.4 or higher installed.

### 2.1 Installing Tcl/Tk

The Tcl/Tk software is freely available on the web for Linux, Windows and other platforms, for example from <http://www.activestate.com/activetcl/downloads/> (link correct as of 19/03/09).

The following steps describe the installation of Tcl/Tk on a Linux system, assuming that the installation package has been downloaded to `/home/user1`, and that the name of the downloaded file is `TclTkpack.tar.gz`.

1. Unzip the file `TclTkpack.tar.gz` with the command:

```
% gunzip -c TclTkpack.tar.gz | tar xvf -
```

This will create a new folder `TclTkpack` in the `/home/user1` directory.

2. Execute the installation program with the command `% TclTkpack/install.sh`
3. When asked where the Tcl/Tk software should be installed, name the desired installation directory. In the following we assume the desired directory is called `/home/user1/TclTk`.
4. Next the Tcl/Tk files will be copied to the specified directory, e.g. `/home/user1/TclTk`. This may take a minute or two.
5. Once the word "Finish" appears on the screen, you have successfully installed Tcl/Tk. In the `/home/user1/TclTk` directory you will now find the following new directories:

<code>bin/</code>	binary files for Tcl/Tk
<code>demos/</code>	source files for demonstrations
<code>include/</code>	header files for Tcl/Tk
<code>lib/</code>	library files for Tcl/Tk
<code>man/</code>	manual for Tcl/Tk

Apart from the user manual, online help is also available, for example at <http://www.activestate.com/> (link correct as of 19/03/09).

## 2.2 Installing COALA-3

Once Tcl/Tk is installed, we are ready for COALA-3. The following installation steps assume that the CD-ROM directory lies under the root directory and is called `cdrom`, and that the current directory of the user is `/home/user1`. To install COALA-3:

1. Insert the enclosed CD-ROM into the CD-ROM drive. The COALA-3 software is found in the `coala3` directory.
2. Copy the file `coala3.zip` to the current directory using the command:

```
% cp /cdrom/coala3/coala3.zip
```

3. Unzip the `coala3.zip` file using:

```
% unzip coala3.zip
```

After unzipping, the following new directories are created in `/home/user1`:

<code>coala3</code>	the main directory of all source files for coala-3
<code>coala3/desc</code>	directory for saved simulations
<code>coala3/help</code>	directory for help-text files
<code>coala3/log</code>	directory for log files of simulations
<code>coala3/ps</code>	directory for .ps files exported from coala-3
<code>coala3/randomfiles</code>	directory for random number files

4. Change to the `coala3` directory:

```
% cd coala3
```

5. Open the `coala3` file with a text editing program such as *vi* or *emacs*. You will see that the first line looks like this:

```
#!/your_wish_directory/wish
```

6. Change this first line to the path for the program *wish*, which is part of Tcl/Tk (found in `/home/user1/TclTk/bin` after the above installation) by editing it to:

```
#!/home/user1/TclTk/bin/wish
```

If Tcl/Tk is already installed, you need to find the directory for the program *wish*, e.g. with the `locate wish` command, and modify the first line of the `coala3` file to the found path.

7. Save the edited `coala3` file and leave the editing program.

This concludes the installation of COALA-3. You can now run COALA-3 with the `coala3` command, and if the main screen of COALA-3 as depicted in fig. 3.1 appears, everything has been installed successfully.

## Chapter 3

# The COALA-3 Simulation Environment

This chapter provides a guided tour through the graphic user interface of COALA-3. The first section leads through the COALA-3 main screen and the options for setting simulation and agent variables, the second and third section lead through the various options COALA-3 provides for analysing the results of individual negotiations as well as the overall statistics of a simulation.

### Help Texts

Right-clicking on any button, display or list box in COALA-3 will open an explanatory help text on the respective topic.

### Export as Postscript

All analyzing functions come with an "Export as Postscript" button that saves the current display to a postscript file.

## 3.1 Settings

### 3.1.1 Creating a New Simulation

When starting COALA-3, the main window is displayed as seen in fig. 3.1. A new simulation can be created by selecting the option 'new simulation' from the 'File' menu, which opens up the window seen in fig. 3.3. After entering a simulation name, deciding on the number of agents and confirming with 'OK', the main screen is filled with the details of the newly created simulation (3.2). Alternatively, a saved simulation can be loaded via 'Menu → Load Saved Simulation'.

### 3.1.2 Using the 'Preset' Function

The preset function simplifies the creation of new simulations by assigning pre-defined settings to all agents and information units in the simulation. Both pre-defined sets of values can be changed via the 'Preset' menu.

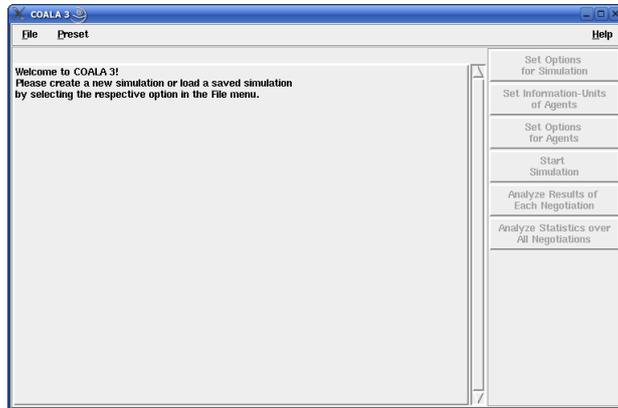


Figure 3.1: Main screen of COALA-3.

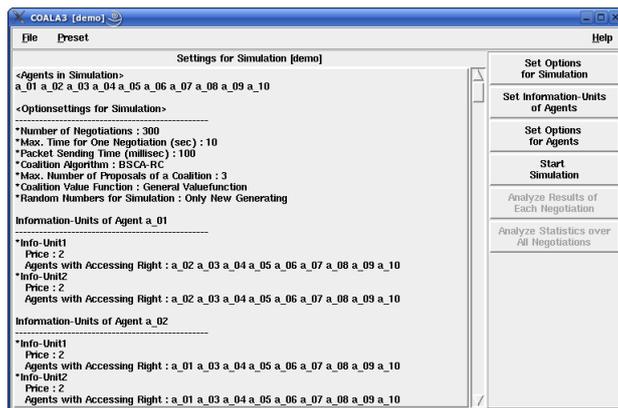


Figure 3.2: Main screen of COALA-3 with filled in details of simulation.

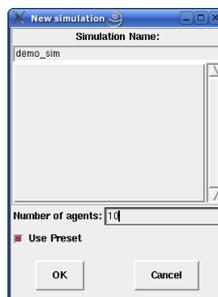


Figure 3.3: Creating a new simulation.

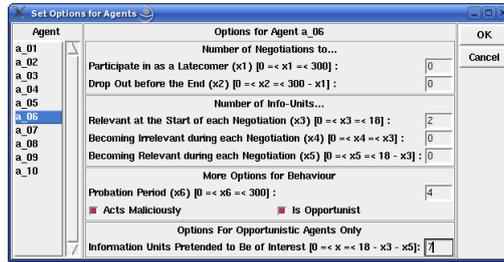


Figure 3.4: Setting the variables for individual agents.

### 3.1.3 Agent Settings

If the preset values are not wanted for all agents, the settings for individual agents can be changed via the 'Set Options for Agents' button on the right hand side of the main screen.

As can be seen in fig. 3.4, settings for agents include various options. In detail, they are:

1. "Participate in as a Latecomer": The number of negotiations in which the agent will enter the negotiation in some random round later than the first.
2. "Drop out before the End": The number of negotiations in which the agent will drop out of the negotiation in some random round before the negotiation is over.
3. "Relevant at the Start of each Negotiation": The initial number of information requests the agent is trying to fulfill by coalition forming per negotiation.
4. "Becoming Irrelevant during each Negotiation": The number of information requests that are withdrawn at some random point during the negotiation in every negotiation.
5. "Becoming Relevant during each Negotiation": The number of additional information requests that are made when the negotiation has already started, leading to additional relevant information units.
6. "Probation Period": The number of times an agent classifies another agent as neutral (BSCA-Opp) or reliable (BSCA-RC) by default before applying the respective trust model.
7. "Acts Maliciously": If only this option is selected, the agent in question will withdraw all requests for information that have become irrelevant as late as possible, i.e. during the last round of a negotiation (this corresponds to the malicious agent type introduced in BSCA-TR\*). The extent of the malicious behaviour depends on the user-defined number of initially relevant information units that subsequently become irrelevant.
8. "Is Opportunist": If both "Acts Malicious" and this option are selected, we have an agent of the type 'opportunist', who will withdraw information

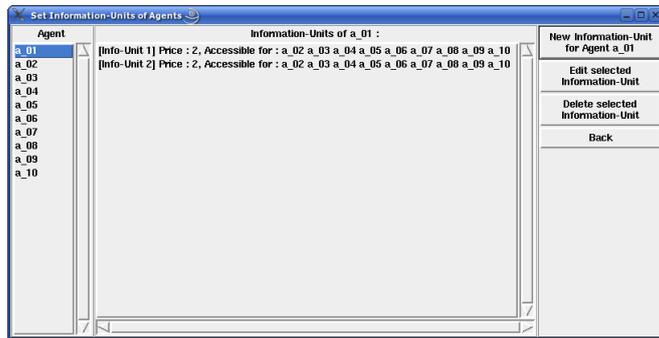


Figure 3.5: List of agents' information units.

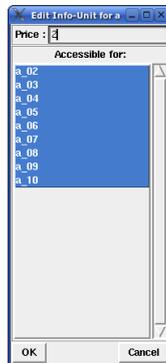


Figure 3.6: Settings for specific information units.

requests that have become irrelevant as late as possible, but will differentiate between truly relevant information units and information requests that are used as pretense only and will be withdrawn eventually.

9. "Information Units Pretended to be of Interest": This is the maximum number of information requests the opportunist can chose to use as fake requests. If the "Is Opportunist" option is not selected, the value defaults to 0.

### 3.1.4 Settings for Information Units

The button "Set Information-Units of Agents" opens a window that lists all agents and their assigned information units. The new buttons "New Information Unit for Agent [agentname]", "Edit selected Information-Unit" and "Delete selected Information-Unit" allow the fine-tuning of the number, prices and access-lists of agents' information units, as well as the addition or deletion of information units, as seen in figures 3.5 and 3.6.

### 3.1.5 Settings for the Simulation

The global settings for the simulation itself can be changed via the "Set Options for Simulation" button on the right-hand side of the COALA-3 main screen, as

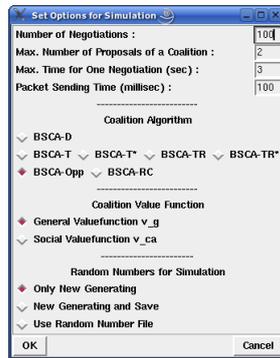


Figure 3.7: Global settings for a simulation.

seen in fig. 3.7. In detail, the possible settings are:

1. "Number of Negotiations": The number of negotiations in a game, i.e. over how many negotiations the simulation should run.
2. "Max. Number of Proposals of a Coalition": The maximum number of coalition proposals every coalition may send to other coalitions per round of a negotiation.
3. "Max. Time for One Negotiation": The time limit for one negotiation (in seconds).
4. "Packet Sending Time": The sending time of a communication packet.
5. "Coalition Algorithm": Here the desired coalition algorithm is selected. (For details about the available coalition algorithms, see [3] and [5]. The relevant helptext also offers a brief overview of all algorithms.)
6. "Coalition Value Function": Offers a choice between two available coalition value functions.
7. "Random Numbers for Simulation": There is an option of saving the random numbers created during a simulation and using them for other simulation.

After clicking the button "Start Simulation" on the right side of the COALA-3 main screen, a game with the defined settings, coalition algorithm and number of negotiations is run according to the algorithms presented in [3] (BSCA-D, BSCA-T/T\*, BSCA-TR/TR\*) and [5] (BSCA-Opp, BSCA-RC), and once the simulation is finished the buttons "Analyze Results of Each Negotiation" and "Analyze Statistics over All Negotiations" become selectable.

## 3.2 Negotiation Analysis

Selecting the "Analyze Results of Each Negotiation" button opens a new window that offers six different analyzing functions.

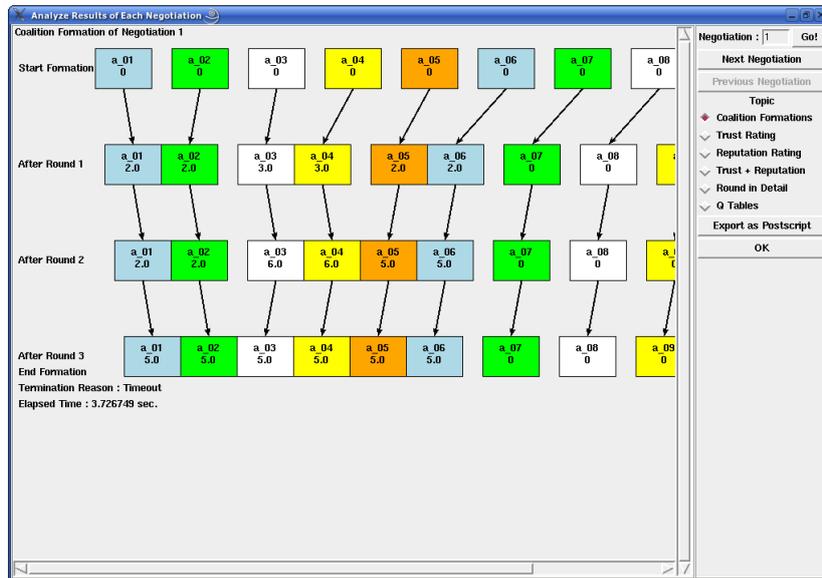


Figure 3.8: Coalition formations over the course of a negotiation.

1. "Coalition Formations": This displays the progression of coalition formations over the course of the selected negotiation's rounds (see fig. 3.8).
2. "Trust Rating": This displays the trust ratings the selected agent assigns to all other agents before and after the selected negotiation, and also the trust ratings given to the selected agent by all other agents (see fig. 3.9).
3. "Reputation Rating": This function displays the same graph for the respective reputation values.
4. "Trust + Reputation": This function displays the corresponding graphs for the sum of trust and reputation values.
5. "Round in Detail": This function offers three sub-functions, "Trust Relations", "Coalition Proposals" and "Dynamic Events".
  - (a) "Trust Relations" displays the trust classifications for all other coalitions by the selected coalition at the beginning of the selected negotiation and round (see fig. 3.10). This function is not selectable for simulations run with BSCA-RC, since it does not use trust classes.
  - (b) "Coalition Proposals" displays all coalition proposals made in the selected round and negotiation. An additional button "View Table of Bilateral Proposals" that is selectable under this option shows all mutual proposals, including the computed profits (see figures 3.11 and 3.12).
  - (c) "Dynamic Events" shows all dynamic events that happen in the selected round and negotiation (see fig. 3.13).

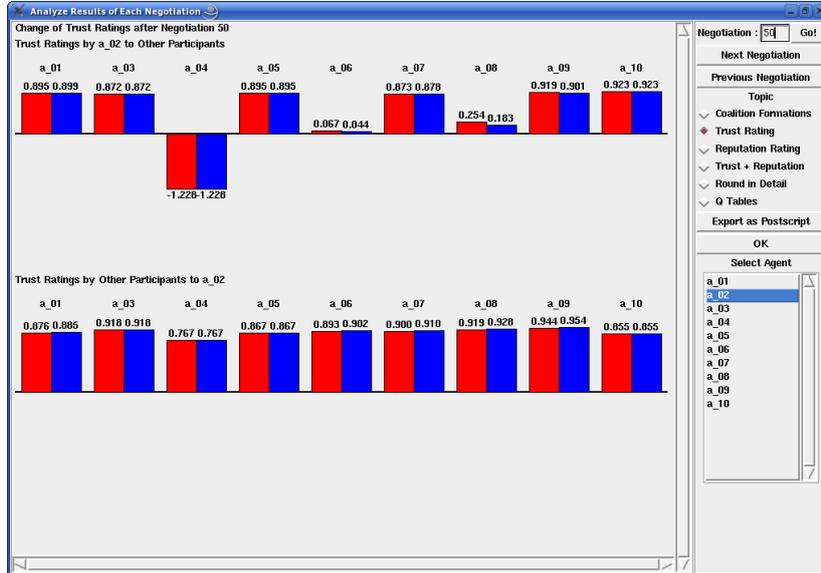


Figure 3.9: Trust ratings between agents before and after a negotiation.

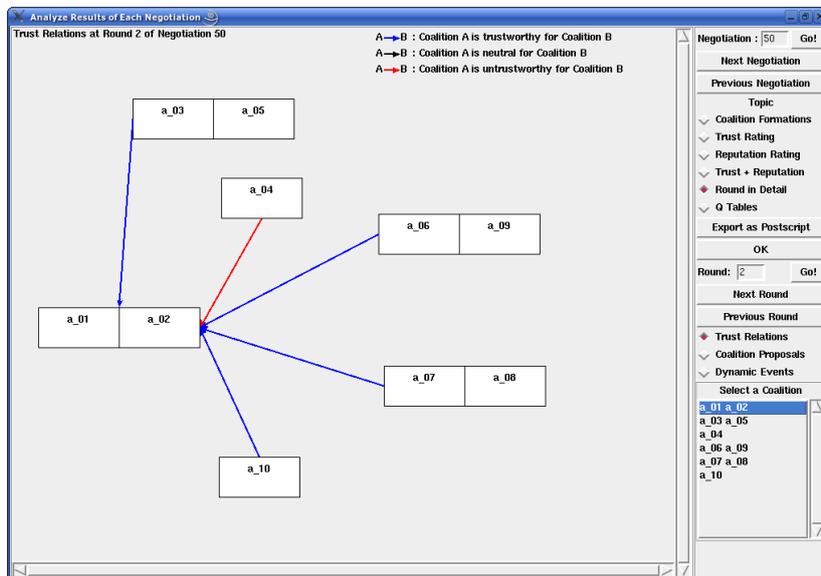


Figure 3.10: Display of trust classifications between coalitions.

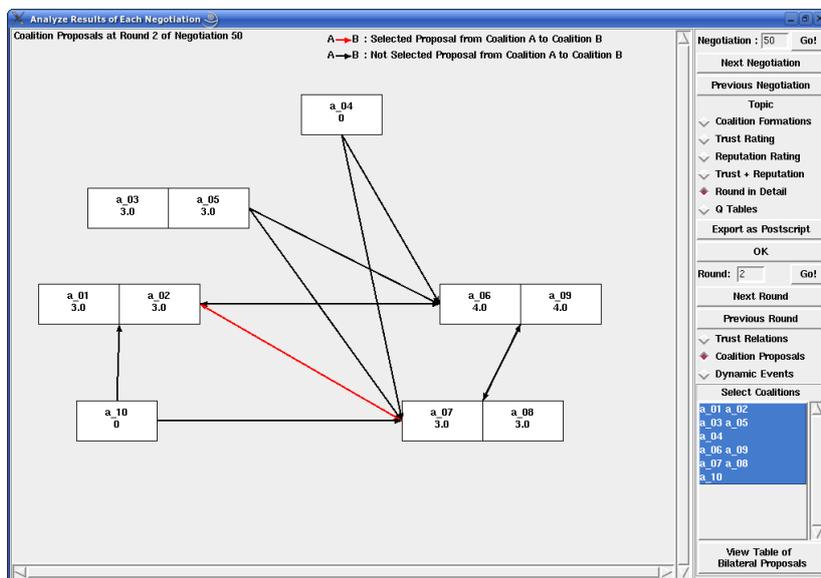


Figure 3.11: Display of coalition proposals in a given round.

View Table of Bilateral Proposals

Bilateral Proposals at Round 2 of Negotiation 50

Repr. 1	Repr. 2	Increase in Profit	Selected
a_01	a_07	16	Yes
a_06	a_07	12	No
a_01	a_06	6	No

Buttons: Close, Export as Postscript

Figure 3.12: Table of mutual coalition proposals.

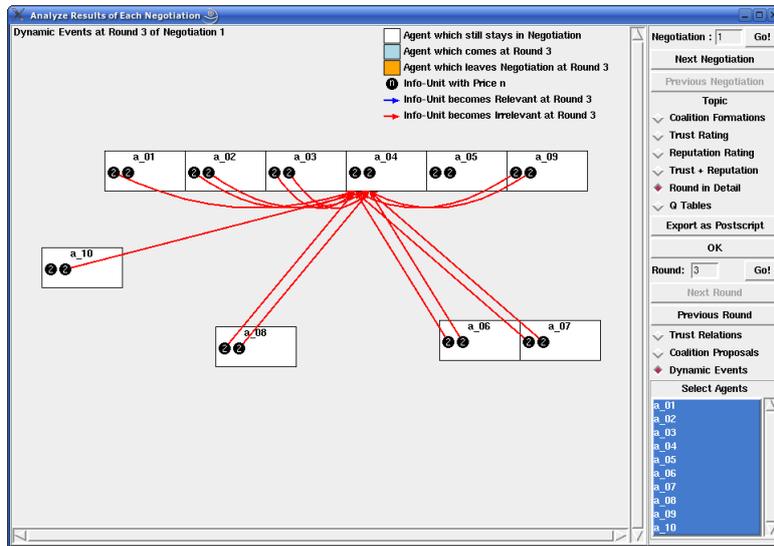


Figure 3.13: Dynamic events in a given round.

6. "Q Tables" shows the Q table and learned trust loss of the selected opportunist after the selected negotiation and shows both the action chosen and the reason for the choice (see fig. 3.14).

### 3.3 Simulation Statistics

Selecting the "Analyze Statistics over All Negotiations" button opens a new window that offers eleven different analyzing functions.

1. "Total Utility" displays the development of the total utilities of all selected agents over the entire game (see fig. 3.15).
2. "Average Utility" displays the average total utilities of all agent types in the game, i.e. cooperative, malicious and opportunistic agents (see fig. 3.16).
3. "Trust Rating" shows the development of the trust values of the agents selected in the left column on the bottom right for the selected agents in the right column (see fig. 3.17).
4. "Reputation Rating" does the same thing for the development of reputation values.
5. "Trust + Reputation" shows the corresponding development of the sums of trust and reputation values.
6. "Probation Period" shows any changes to the selected agents' probation time (see fig. 3.18).
7. "Dynamic Events" shows the statistics of which agents caused how many dynamic cases of which type (see fig. 3.19).

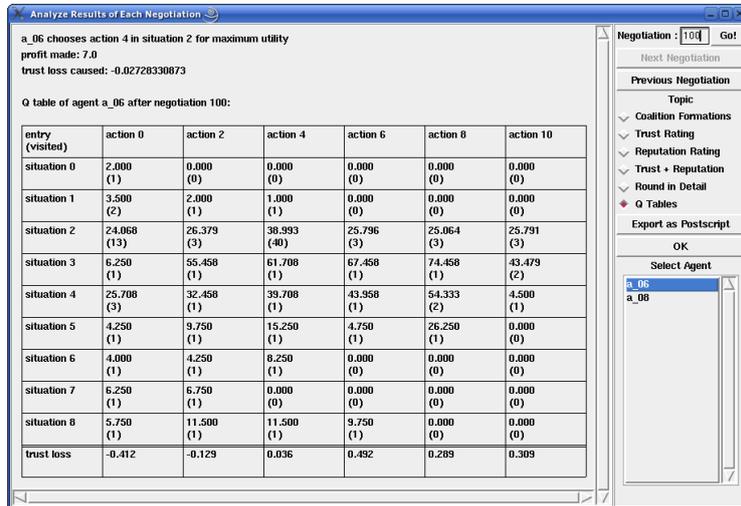


Figure 3.14: Q tables of opportunists.

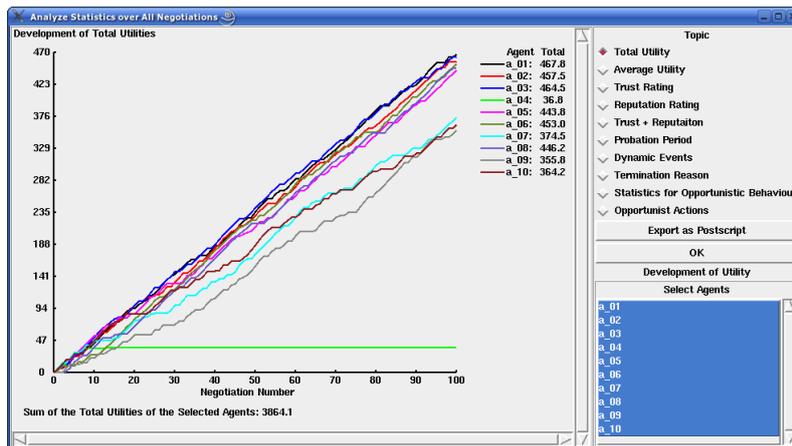


Figure 3.15: Development of total utilities.

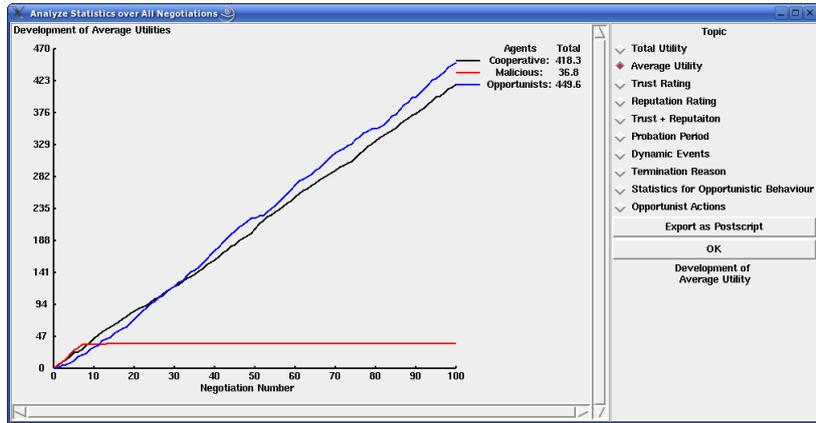


Figure 3.16: Development of average total utilities of different agent types.

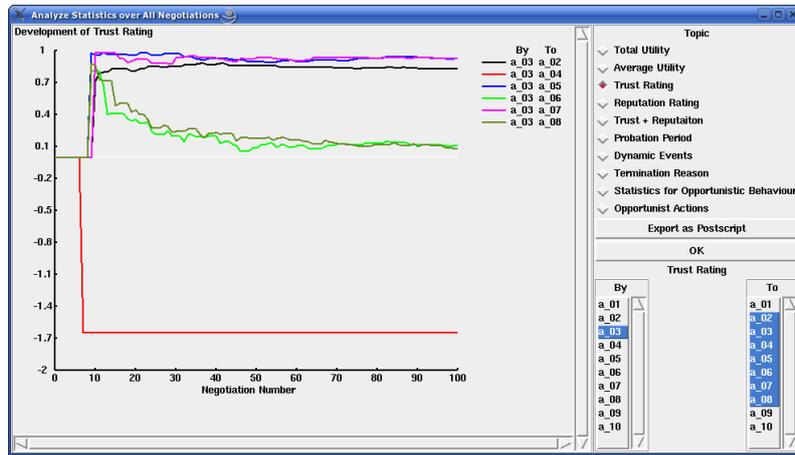


Figure 3.17: Development of trust ratings between agents.

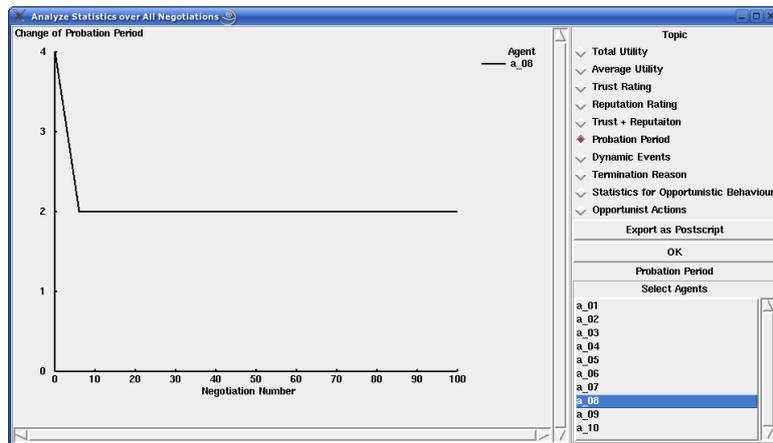


Figure 3.18: Development of probation times for agents.

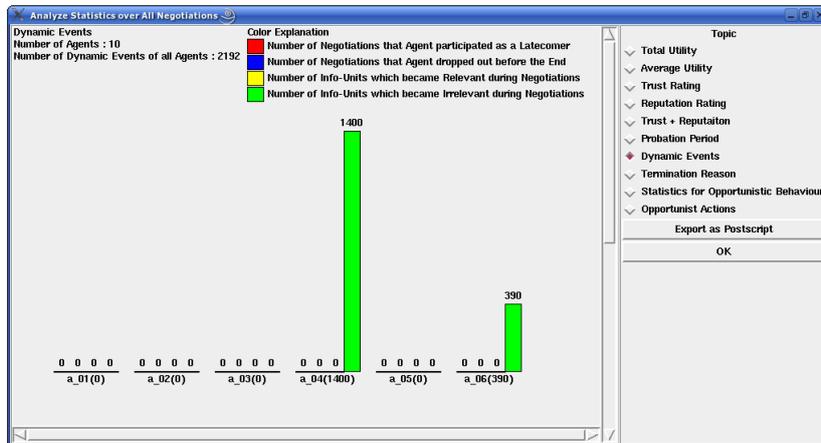


Figure 3.19: Statistics of dynamic cases.

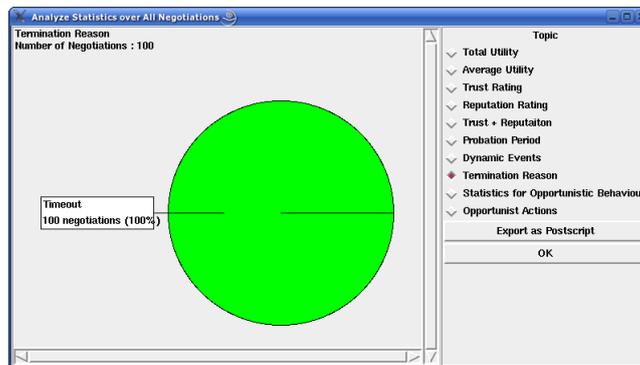


Figure 3.20: Statistics of termination reasons.

8. "Termination Reasons" displays the frequency of the occurrence of the different possible termination reasons (see fig. 3.20). The possible reasons are great coalition, no change in coalition structure and time out.
9. "Statistics for Opportunistic Behaviour" displays the statistics of how frequently the selected opportunist chose which behaviour, and also statistics on learning time and time spent rebuilding trust (see fig. 3.21).
10. "Opportunist Actions" shows a graph of the actions the selected opportunist chose over the course of the negotiation (see fig. 3.22).

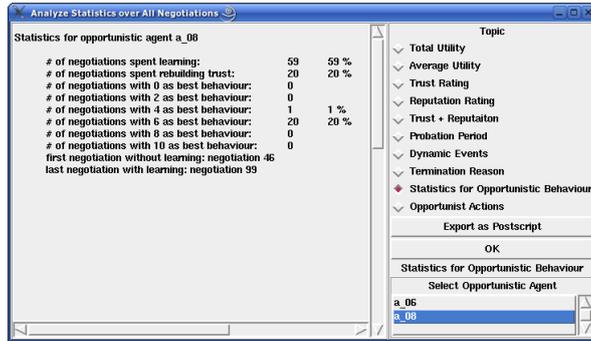


Figure 3.21: Statistics of opportunistic behaviour.

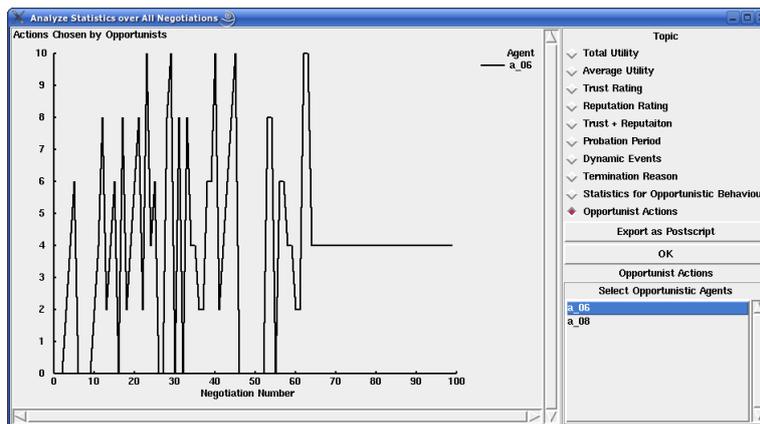


Figure 3.22: Development of opportunistic actions.

## Chapter 4

# The Implementation of COALA-3

This chapter gives a brief overview over the most important procedures of the COALA-3 source code found in the `/coala3` directory.

### 4.1 File Operations

file: `coala_new.tcl`  
procedure: `coala_new`  
description: creates a new simulation

file: `coala_load.tcl`  
procedure: `coala_load`  
description: loads a previously created simulation

file: `coala_save.tcl`  
procedure: `coala_save`  
description: saves the current simulation

file: `coala_save_as.tcl`  
procedure: `coala_save_as`  
description: saves the current simulation under a different name

file: `coala_opp_procs.tcl`  
procedure: `coala_write_q_table_files`  
description: write current Q table of opportunist to logfile  
procedure: `coala_write_opp_statfile`  
description: write opportunist statistics to logfile

## 4.2 Main Screen and Dialogue

file: coala\_main.tcl  
procedure: coala\_main  
description: creates the main screen

file: coala\_dialog.tcl  
procedure: coala\_dialog  
description: creates a generic dialogue

file: coala\_filebrowser.tcl  
procedure: coala\_filebrowser\_load  
description: creates a dialogue for loading a saved simulation  
procedure: coala\_filebrowser\_randomfile  
description: creates a dialogue for loading a saved random number file

file: coala\_message.tcl  
procedure: coala\_message  
description: creates a message dialogue

## 4.3 Simulation Settings

file: coala\_set\_info\_unit.tcl  
procedure: coala\_set\_info\_unit  
description: defines the settings for agents' information units

file: coala\_opt\_agent.tcl  
procedure: coala\_opt\_agent  
description: configures the setting options for agents

file: coala\_opt\_sim.tcl  
procedure: coala\_opt\_sim  
description: configures the settings for the simulation

file: coala\_change\_agent\_preset.tcl  
procedure: coala\_change\_agent\_preset  
description: configures the details of preset agent settings

file: coala\_change\_infounit\_preset.tcl  
procedure: coala\_change\_infounit\_preset  
description: configures the details of preset information unit settings

## 4.4 Running a Simulation

file: coala\_start\_simulation.tcl  
procedure: coala\_init\_simulation  
description: initialises all simulation variables  
procedure: coala\_start\_simulation  
description: starts the simulation

file: coala\_bsca\_sim.tcl  
procedure: coala\_run\_negotiation  
description: runs a simulation

file: coala\_react.tcl  
procedure: coala\_react\_for\_leaving\_agents  
description: executes reactions to leaving agents  
procedure: coala\_react\_for\_late\_agents  
description: executes reactions to latecomers  
procedure: coala\_react\_for\_extra\_rel\_infos  
description: executes reactions to newly relevant information units  
procedure: coala\_react\_for\_rel\_info\_loss  
description: executes reactions to newly irrelevant information units

file: coala\_write\_proc\_for\_sim.tcl  
procedure: coala\_write\_negotiation\_result  
description: writes negotiation results to a logfile  
procedure: coala\_write\_statistics  
description: writes simulation statistics to a logfile

file: coala\_opp\_decide\_behaviour.tcl  
procedure: coala\_opp\_decide\_behaviour  
description: decides the behaviour of opportunists for the current negotiation

file: coala\_opp\_add\_experience.tcl  
procedure: coala\_opp\_add\_experience  
description: adds a new experience to an opportunist's Q table

file: coala\_reliability\_procs.tcl  
procedure: coala\_compute\_reliability\_of\_coals  
description: computes the reliability of one coalition for another

## 4.5 Analysing Negotiation Results

file: coala\_display\_neg\_coal\_form.tcl  
procedure: coala\_display\_neg\_coal\_form  
description: displays the development of coalitions in a negotiation

file: coala\_display\_neg\_dyn\_event.tcl  
 procedure: coala\_display\_neg\_dyn\_event  
 description: displays the dynamic cases in a negotiation round

file: coala\_display\_neg\_proposal.tcl  
 procedure: coala\_display\_neg\_proposal  
 description: displays the coalition proposals in a negotiation round

file: coala\_display\_neg\_reputation\_rating.tcl  
 procedure: coala\_display\_neg\_reputation\_rating  
 description: displays the reputation ratings

file: coala\_display\_neg\_trust\_rating.tcl  
 procedure: coala\_display\_neg\_trust\_rating  
 description: displays the trust ratings

file: coala\_display\_neg\_sum\_of\_ratings.tcl  
 procedure: coala\_display\_neg\_sum\_of\_ratings  
 description: displays the sum of trust and reputation ratings

file: coala\_display\_neg\_trust\_relation.tcl  
 procedure: coala\_display\_neg\_trust\_relation  
 description: displays the trust classifications between coalitions

file: coala\_display\_q\_table.tcl  
 procedure: coala\_opp\_display\_q\_tables  
 description: displays the current Q table of an opportunist

## 4.6 Analysing Simulation Statistics

file: coala\_display\_sim\_dyn\_events.tcl  
 procedure: coala\_display\_sim\_dyn\_events  
 description: displays the respective number of dynamic cases

file: coala\_display\_sim\_probation\_period.tcl  
 procedure: coala\_display\_sim\_probation\_period  
 description: displays the changes to probation times of agents

file: coala\_display\_sim\_reputation\_rating.tcl  
 procedure: coala\_display\_sim\_reputation\_rating  
 description: displays the changes to reputation ratings

file: coala\_display\_sim\_trust\_rating.tcl  
 procedure: coala\_display\_sim\_trust\_rating  
 description: displays the changes to trust ratings

file: coala\_display\_sim\_sum\_of\_ratings.tcl  
 procedure: coala\_display\_sim\_sum\_of\_ratings  
 description: displays the changes to the sum of trust and reputation ratings

file: coala\_display\_sim\_termination\_reason.tcl  
 procedure: coala\_display\_sim\_termination\_reason  
 description: displays the reasons for termination of negotiations

file: coala\_display\_sim\_total\_utility.tcl  
 procedure: coala\_display\_sim\_total\_utility  
 description: displays the development of total utilities of agents

file: coala\_display\_opps\_actions.tcl  
 procedure: coala\_display\_opps\_actions  
 description: displays the development of opportunist's actions

file: coala\_display\_opp\_stats.tcl  
 procedure: coala\_display\_opp\_stats  
 description: displays the statistics of opportunist's behaviour

file: coala\_display\_sim\_average\_utility.tcl  
 procedure: coala\_display\_sim\_average\_utility  
 description: displays the development of average total utility of the different agent types

## 4.7 Miscellaneous Procedures

file: coala\_exit.tcl  
 procedure: coala\_exit  
 description: ends `coala-3`

file: coala\_random.tcl  
 procedure: coala\_random  
 description: returns a random number

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