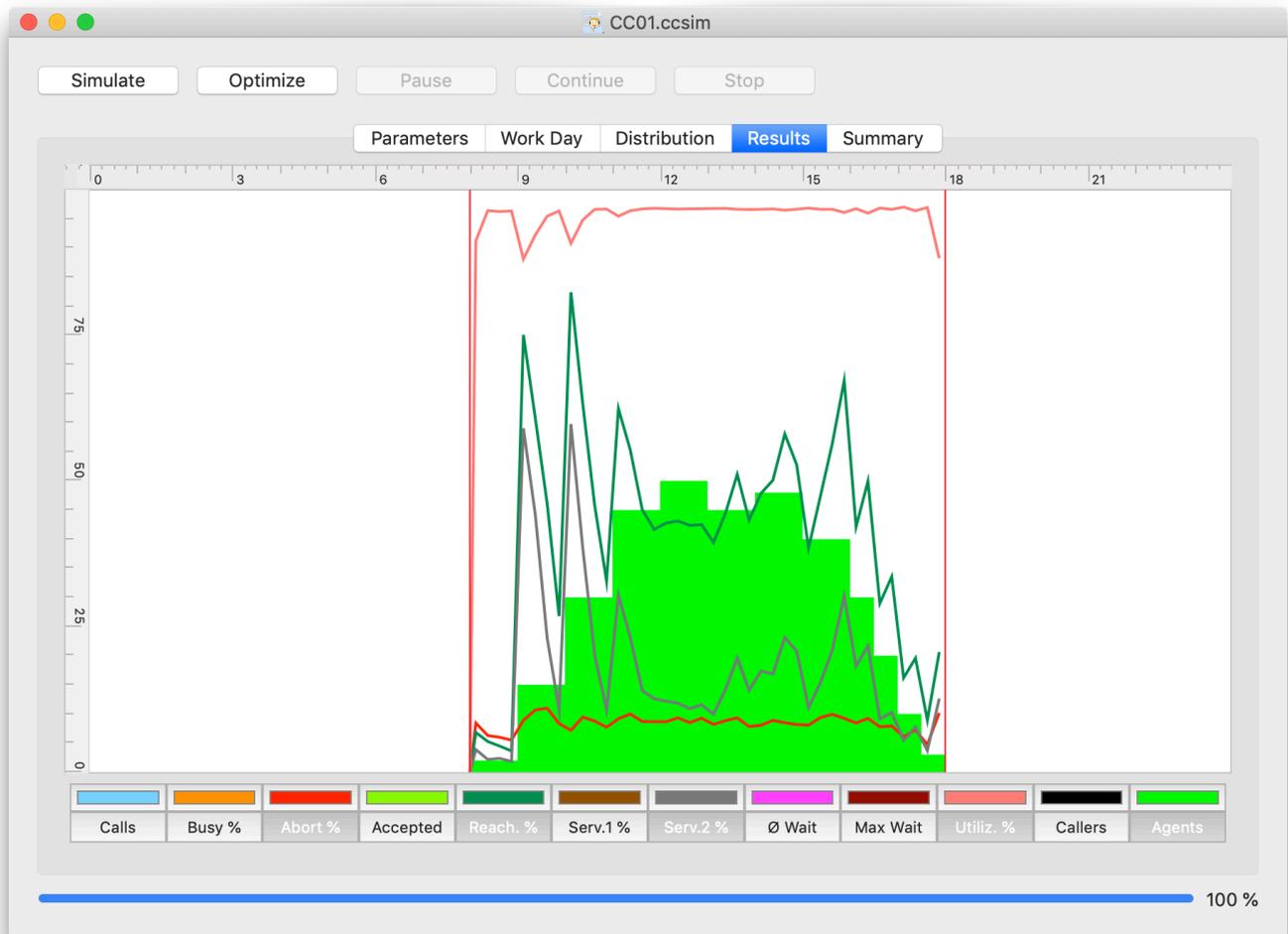


CCsim Manual

Call Center Simulator, V4.0

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1. Overview

The Call Center Simulator CCsim is an application to simulate incoming calls to a call center. Incoming of calls is a random process from the called person point of view and therefore not to be foreseen. Calls may accumulate at some time and all agents may get busy. Special technical installations (waiting queues) or increasing the number of agents can cope with such situations.

There are several key indicators to monitor the service quality of an inbound call center. Generally increasing the service quality (i. e. short waiting time for the caller) results in increasing the number of necessary agents at decreasing average work load. To predict the necessary resource (agents and trunk lines) at a requested service level and average number of incoming calls there is an analytical formula available (Erlang C) but involving a few simplifications and negligence.

This application works on a reverse standpoint. Assuming the number of available resources (agents, trunk lines), the number of incoming calls and the behavior of callers (call duration, waiting time until the call will be abandoned etc.) incoming calls are to be simulated (randomized), the service quality and the agents work load monitored. The simulation takes ACD functionality (Automatic Call Distribution) into account.

To achieve the call center's purpose respecting the service quality this Call Center Simulator application can be run to work out the optimal resource schedule and the parameters of the ACD switching unit (i.e. busy generation policy) by varying the simulation parameters.

2. Parameters of a simulation

Parameters

Work Day

Distribution

The Call Center Simulator needs some input parameters like “Available Agents” or “Call Duration”. These parameters are

specified in the first (leftmost) three tabs of the simulation window. This also includes a variety of distributions. You may get these parameters and distributions from your call center equipment directly (i.e. the Automatic Call Distribution (ACD) system), from your manual observations or you may just estimate them. The simulation parameters and the possibly already calculated results may always be saved and later restored for refinements or reviews.

In addition, distributions may be saved to text files and may also be loaded from text files (e.g. if you get the distributions from your ACD system).

2.1. Parameters tab

The screenshot shows the 'Parameters' tab of the CCsim01.ccsim application. The interface includes a top navigation bar with buttons for 'Simulate', 'Optimize', 'Pause', 'Continue', and 'Stop'. Below this is a tabbed interface with 'Parameters', 'Work Day', 'Distribution', 'Results', and 'Summary' tabs. The 'Parameters' tab is active and contains three main sections: 'Simulation', 'Busy Generation', and 'Other Parameters'. The 'Simulation' section includes fields for 'From' (8:00), 'to' (18:00), 'Number of iterations' (10), 'Random Number Start' (4711), and a checked 'Random' checkbox. The 'Repetition' section has 'Probability after Abort' (60%) and 'Probability after Busy' (80%). The 'Busy Generation' section includes 'Length of Wait Queue' (20), 'Busy On at' (15), 'Busy Off at' (15), a checked 'Relative to Available Agents (%)' checkbox, 'Longest Waiting Call' (0 s), 'Number of Simultaneous Calls' (0), and 'Minimum Time in Busy State' (10 s). The 'Other Parameters' section includes 'Time Raster' (15 m), 'Service Time 1' (30 s), 'Service Time 2' (20 s), 'Volume' (1,000), 'Available Agents' (55), and a checked 'Use Work Day distribution' checkbox. A progress bar at the bottom indicates 100% completion.

This screen shows some general parameters of the simulation. At this point there are no distributions involved but only scalar parameters.

2.1.1. Simulation times

The first time specifies the start time in hours:minutes from which on the resulting key figures are calculated.

Simulation

From

8:00

to

18:00

The simulation starts here independent of the possibly configured agents or call volumes before that time. The simulation stops at the “to” time. Calls entering or completed calls after this time can not affect the key figures within the service times.

2.1.2. Iterations

Extending the simulation time may not result in more reliable key figures. Since the key figures at a given time depend on the history of the preceding calls one simulation is not enough to get reliable results. Team leaders and call center managers may know this phenomenon: on one day everything works fine and the service levels are ok. An other day ends catastrophically because in the morning a waiting queue piled up accidentally and could not be emptied the whole day although nothing was principally different from the good day.

To get an indication of the stability of the resulting key figures the simulation has to be repeated several times with the same set of parameters but with different random number sequences. The Call Center Simulator is doing so with this number of iterations.

Number of iterations:

2.1.3. Random number generator

The random number generator calculates a non-predictable sequence of numbers. These numbers are used at several places of the Call Center Simulator and reflect the randomness and non-predictable behavior of a single call. Only a bunch of several calls will have a predictable behavior.

If the flag “Random” is set the random number generator always produces a new sequence of random numbers. The algorithm of the random number generator is designed in such a way that there will be probably no two equal random number sequences in your whole lifetime. So, running a simulation twice with this flag set will produce (slightly) different results as in the real world where one day is never exactly as the other one.

Random Number Start:
 Random

To get rid of this behavior you may fix the starting number of the random number generator by unsetting the flag “Random” and specifying a random number start value. Running the simulation twice will produce exactly the same results, as long as you run only one iteration. CCsim is built in such a way that several iterations are running in parallel with the usage of all possible cores of the CPU of your computer. The sequence of random numbers for one iteration is therefore not longer fixed and two runs of the simulator will give different results despite the fact that you have specified the random number start.

2.1.4. Repeated call trials

Call attempts may not be successful. Either the Automatic Call Distribution (ACD) already signals that the current load is too high, that the probable wait time would be unacceptable and rejects the call (i.e. Busy Generation) or the patience of the caller is exceeded and he aborts the call in the waiting queue before getting connected to an agent. Of course, the caller may try again at a later time.

After an abort

This field specifies the probability of a caller to repeat the call attempt after an abort. When this eventually happens rules a distribution (s. below).

Probability after Abort:

After a busy signal

This field specifies the probability of a caller to repeat the call attempt after a busy signal. Again, when this eventually happens rules a distribution (s. below).

Probability after Busy:

2.1.5. Busy generation

Sometimes it is better for a caller to get a clear and honest busy signal than to wait for minutes and minutes in a music queue without getting connected to an agent. So, for the configuration of the Automatic Call Distribution system (ACD) it is necessary to decide when is better to let the caller into the waiting queue or when to send a busy signal instead because the probable waiting time will be too much.

As a rule of thumb the rate of the busy signal should be similar to the rate of impatient callers who abort the call in the waiting queue before getting connected. If the rate of the busy signal is much lower you stress the patience of the callers. A lot of them finally give up and would have appreciated if they would have got an honest busy signal in the beginning. You may say, the rules for the busy generation are too weak. If the rate of aborts are much lower the rules for the busy generation are too strong. You reject too many callers although they would have had more patience than you thought.

It is important to remember that the rules for the busy generation always affect only new incoming calls. Once you have let a caller into the waiting queue you have promised to connect him at some time.

According to the length of the waiting queue

One obvious and often used possibility to set up rules for the busy generation is to measure the length of the waiting queue. If there are already a lot calls waiting in the queue the probability is high that the waiting time for a new caller will be high as well.

Length of Wait Queue

Busy On at waiting calls

Busy Off at waiting calls

Relative to Available Agents (%)

Busy on and busy off

These figures set the limit of the allowed queue length. If the number of waiting calls is higher than the number in "Busy on" a new call will be rejected. The call center enters the "busy state". Now the number of calls waiting must fall up to the figure in "Busy off" to let new callers into the waiting queue.

Absolute and relative thresholds

If the flag "relative to Available Agents" is set the figures above are not absolute but percent values relative to the actual number of available agents. A fractional part of the values is cut off. So, if there are currently 5 agents logged in and the "Busy on" value says 50 the actual threshold for the maximum number of calls waiting is 2.

According to longest waiting calls

Longest Waiting Call

Wait Time in Queue:

Another also often used measurement to set up the rules for busy regulation is the waiting time of the currently longest waiting caller. If there is already a caller who is waiting

for a long time the probability is high that a new call will have to wait also quite long. If this parameter is set to zero this method of busy regulation is switched off.

This method and the busy generation according to the length of the waiting queue are equivalent but produce slightly different effects.

According to maximum number of calls handled and calls waiting

Number of Simultaneous Calls

Maximum # of Calls:

There is an other occasion where you produce a busy signal accidentally. If you do not have enough trunk lines the number of calls waiting may be limited. If this parameter is non-zero and the

number of call handled plus the number of calls waiting reach this threshold additional callers will get a busy signal.

Minimum time in busy state

Minimum Time in Busy State:

To avoid a permanent switch between busy and non-busy states and to give the call center a chance to empty the waiting

queue you may specify a minimum time (in seconds) the call center stays in busy state.

2.1.6. Other parameters

There are some other parameters needed by the Call Center Simulator that are not related to the simulation but rather the presentation and calculation of the results.

Raster of intermediate results

This is the time interval in which the intermediate results are calculated and presented. It also specifies the granularity of the graphs shown in the Results tab. In addition, this raster will be used to split up the agents distribution on optimization runs ([s. below](#)).

Time Raster:

Service level times

The service level is defined to be the fraction of calls that was answered within a predefined time. In the Call Center Simulator you may specify two times to calculate two separate service levels (e.g. 20 s and 30 s).

Service Time 1:

Service Time 2:

2.1.7. Volumes in simple simulations

Volume

Callers per Hour:

Available Agents:

Use Work Day distribution

When the flag “Use Work Day distribution” is not set you'll start a simple simulation with fixed “Callers per Hour” and “Available Agents”. The parameters in the [Work Day tab](#) are disabled. This kind of simulation is useful if you are interested in a single result for a fixed set of parameters.

On the other hand, if this flag is set the values in this screen are invalid and the distributions in the Work Day tab are used instead.

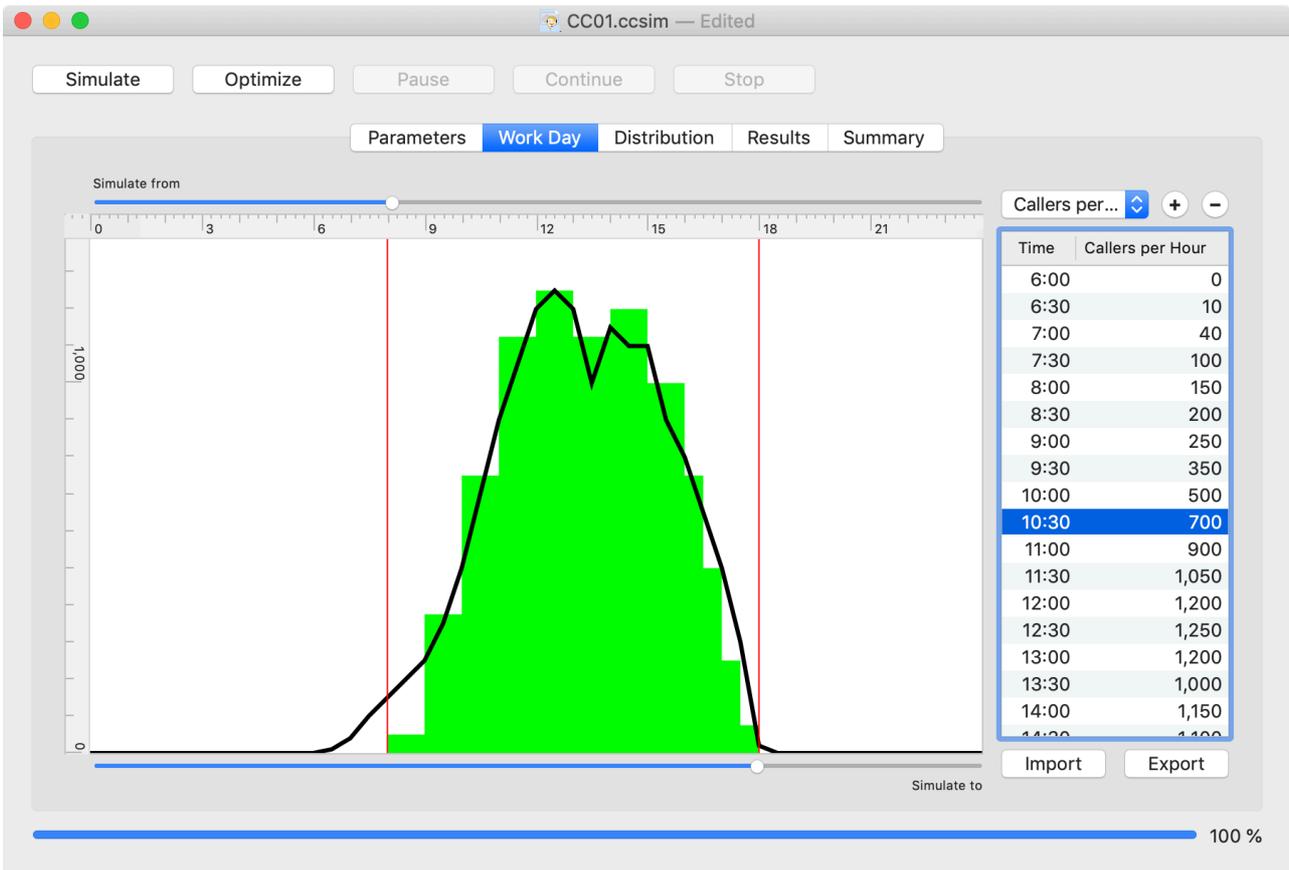
Callers per hour

This parameter specifies the number of callers per hour. If the service levels are low you may get repetitive call trials and the number of actually arriving calls per hour is higher than this parameter!

Available agents

This parameter specifies the number of available agents. These agents are present and can serve the incoming calls.

2.2. Work Day tab



The Work day tab specifies the variations of callers per hour and the staffing of the call center over a work day. This screen is only available if the flag “Use Work Day tab” in the Parameters tab is set.

2.2.1. Simulation times

The simulation times are indicated with the red vertical bars in the graph view. These parameters may also be changed with the sliders at the top and the bottom of the view. The values are directly connected to the fields in the Parameters tab.

2.2.2. Volume table

The volume table shows the values of either the changing Callers per Hour and or those of the Available Agents during the day.

Selecting “Callers per Hour” and “Available Agents”

The pop-up menu above the table selects the volumes to be shown in the table (i.e. either Callers per Hour or Available Agents). When you change the selection there the values in the table and the vertical scale on the view on the left hand side are exchanged.

Adding lines

To add a new line in the table click on the Plus button. The selected line will be duplicated and you can override the values (s. below).

Changing values

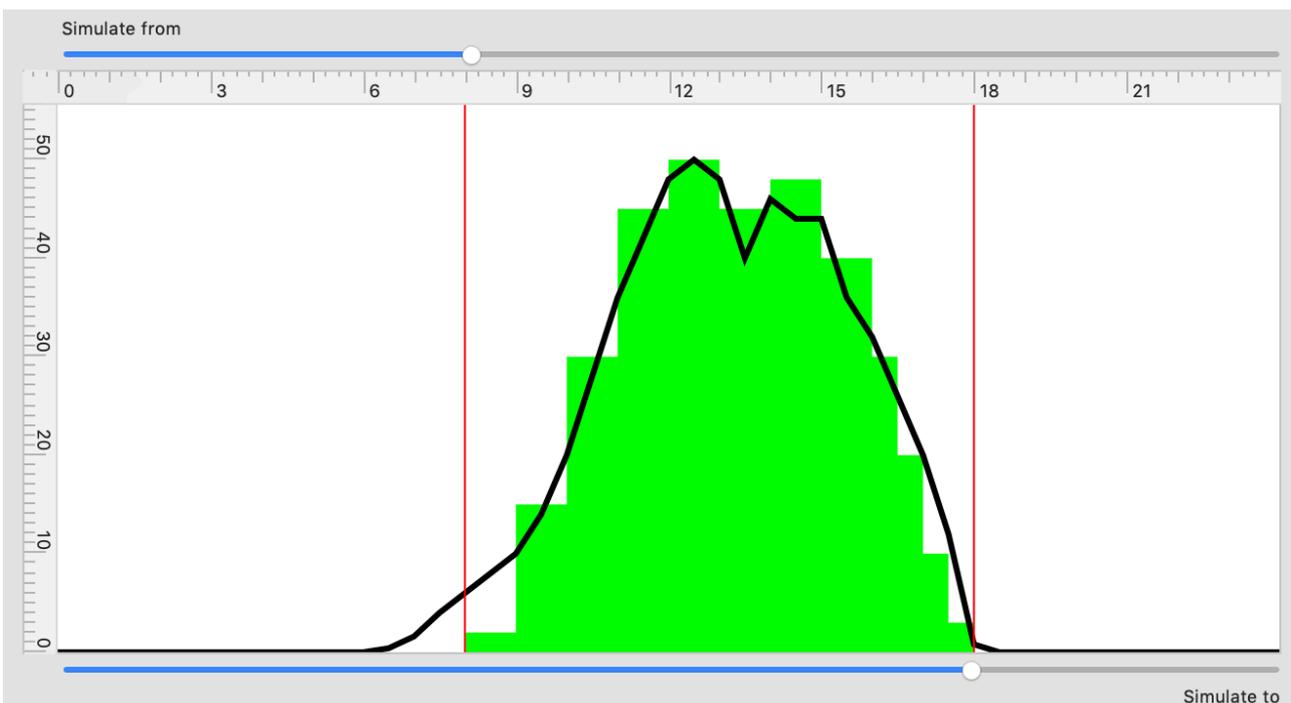
To change a value in the table just select it by double clicking and type in the new value. If you change the time of a row the rows are sorted automatically by increasing time values. B.t.w.: having two lines with the same time value is not a good idea; you may get unexpected results.

Deleting lines

For deleting a line in the table just select it and press the Minus button.

Available A...	
Time	Available Agents
8:00	2
9:00	15
10:00	30
11:00	45
12:00	50
13:00	45
14:00	48
15:00	40
16:00	30
16:30	20
17:00	10
17:30	3
18:00	0

Import Export



2.2.3. Graphical display of the volume distributions

This view displays the values of the volume tables graphically. On the top edge of the view the time of the day in hours is shown. The vertical scale on the left side depends on the currently selected volume table (i.e. Callers per Hour or Available Agents). In addition, the values of the simulation times are indicated as red vertical bars.

Callers per Hour

The number of callers per hour is indicated as a line. Intermediate values between the concrete values in the volume table are interpolated linearly. The color of the line is the same one as in the corresponding graph in the Results tab.

Available Agents

The number of available agents is shown as a solid step function. These numbers are not interpolated between the rows of the volume table but stay fixed up to the next time value. The color of the step function is the same one as the corresponding graph in the Results tab.

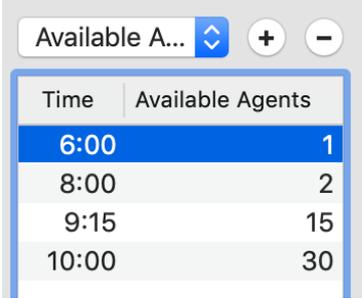
Quick entry of new lines

You may insert new lines in the volume table by clicking into the graphical view. Depending on the currently selected volume distribution the new entry is either in the table of Callers per Hour or in the number of Available Agents. The graph view and the volume table are updated simultaneously.

2.2.4. Import of volume distributions

By clicking on the Import button you may import the volume distributions from text files. The text file must have two columns, the first one with the time value in minutes and the second one with the volume (either Callers per Hour or Available Agents depending on the selection). Here is an example:

```
8.00,2
9:15 15
6;1
10-00 30
```



Time	Available Agents
6:00	1
8:00	2
9:15	15
10:00	30

The time value may be formatted as in the example above, hours and minutes separated by period, colon, dash or slash or just in plain integer numbers to represent the hour in a day. The volume values must be integers. Both numbers may be separated by blanks, tabs, semicolons or commas. The lines may be of arbitrary order; they are sorted during import by ascending time values.

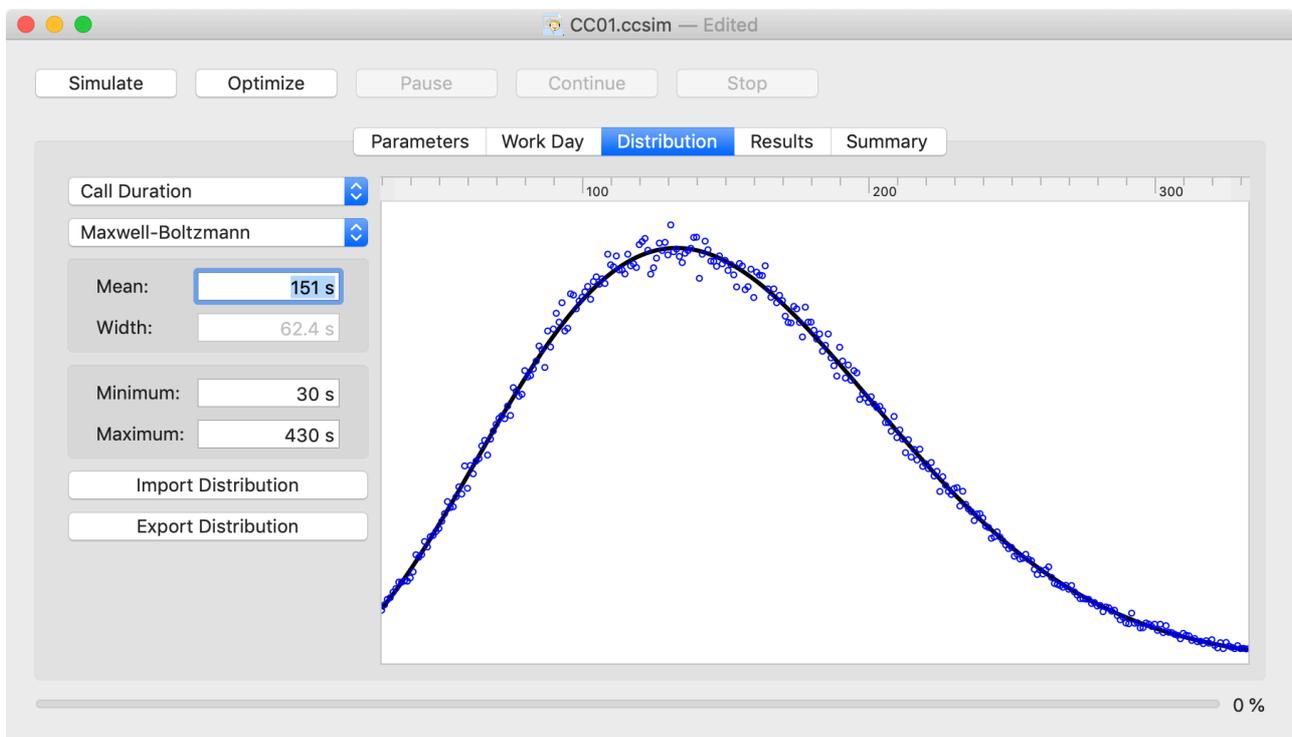
2.2.5. Export of volume distributions

To export the currently selected volume distribution click on the Export button. Depending on the current selection either the Callers per Hour or the Available Agents distribution will be exported to a text file as in this example:

```
8:00 2
9:00 15
10:00 30
11:00 45
12:00 50
13:00 45
```

The time of the day is formatted as hours:minutes. A tab is separating it from the volume values, which is a plain integer.

2.3. Distribution tab



In this screen the probabilities for several distributed values are specified. For example, the call duration varies randomly from call to call although the average call duration is well specified. While observing a large number of calls you may count the occurrences of specific call durations. When you draw a plot of these counts it forms a characteristic so called distribution as in this example.

This distribution may be used to predict the probabilities of the call durations for further calls, which is done in this Call Center simulator. The distributions in this screen may be obtained by

-
- measurements of the call center equipments (i.e. the ACD)
 - measurements of the average values and assumptions about the characteristic form of the distribution (e.g. Maxwell-Boltzmann)
 - just guesses

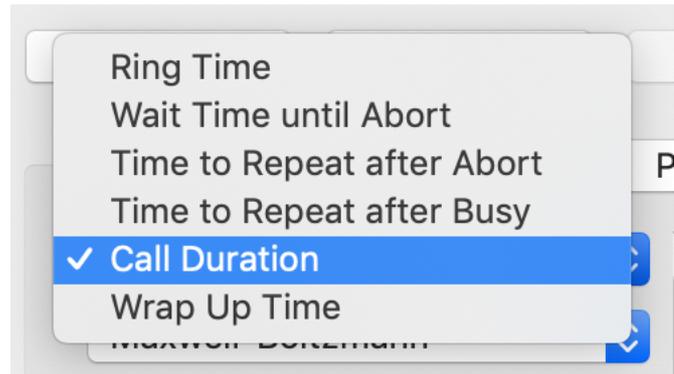
The actual form of the distribution is affecting the results not very much. The mean value and the width of the distribution are important.

2.3.1. Distributed parameters

With the top left pop-up menu you select the distributed parameter you want to review. All distributed parameters are specified in seconds.

Ring time

The ring time is the time an agent needs to pick up the phone. It is not the wait time for the caller because he may have waited in the wait queue before an agent was available. If you are working with Auto Answer phones this time should be zero.



Wait time until abort

This parameter specifies the patience of the caller. If the caller has to wait longer than this value before getting connected to an agent he aborts the call. Possibly he will try again after a certain amount of time. The probability for a repetitive trial after an abort is specified in the [Parameters](#) tab.

Time to repeat after abort

This is the time a caller waits until he starts another trial after an abort.

Time to repeat after busy

The caller may also be rejected by the Busy generation algorithm. Possibly he tries again after this time.

Call duration

This is the duration of a call in seconds. It does not include the wait time before nor the wrap up time after the call is disconnected.

Wrap up time

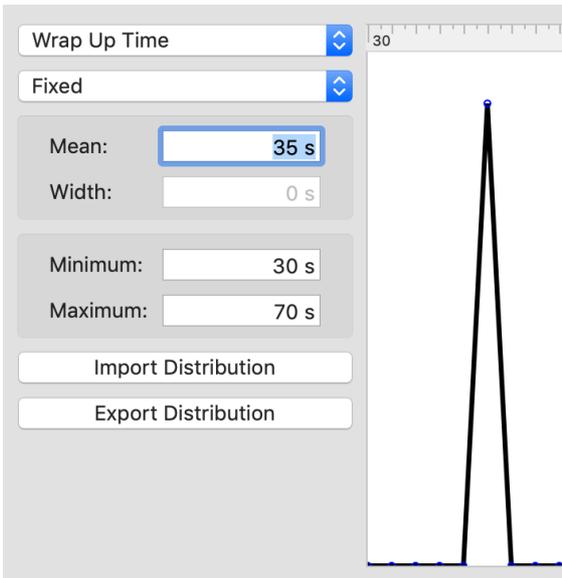
This is the time an agent needs to complete the call after the caller is disconnected. This time should also include any agreed pauses between two calls.

2.3.2. Distribution types

With this pop-up menu you select a specific form of the distribution selected above.

Fixed

This a rather simple distribution. In fact, it's not a distribution at all but all values are always the

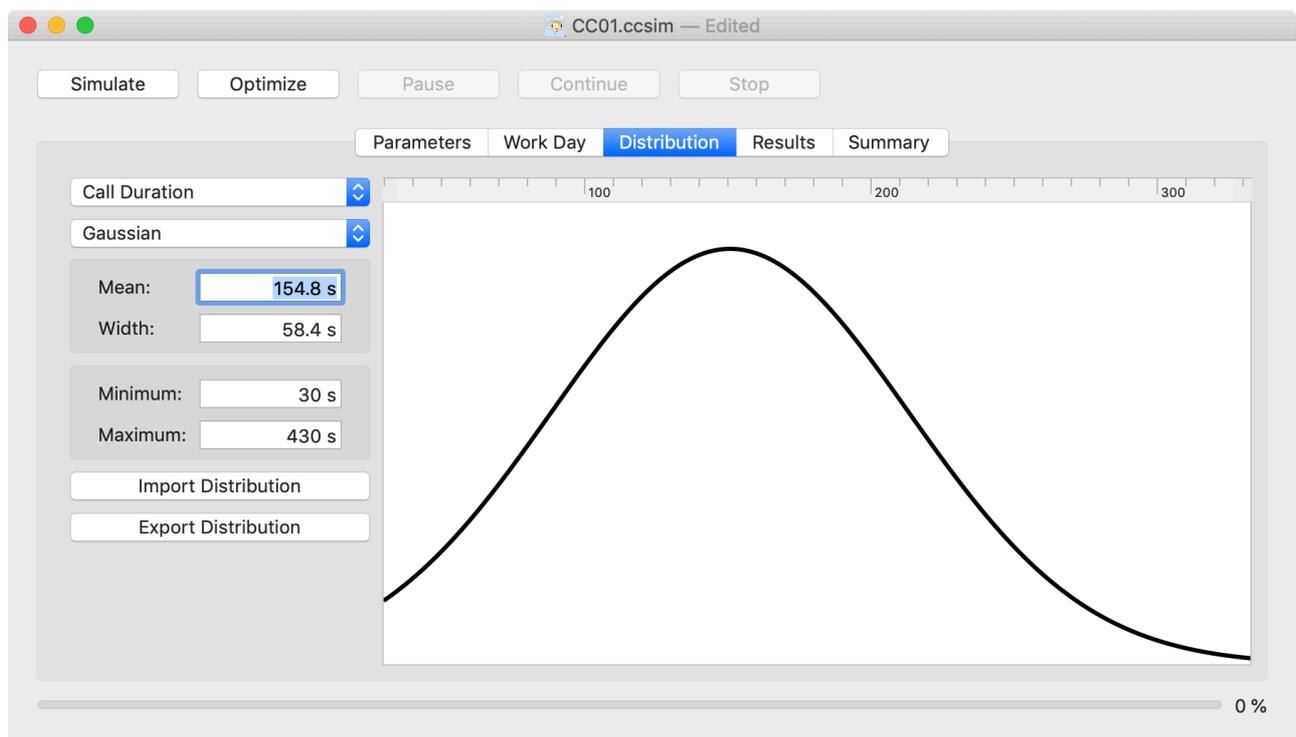
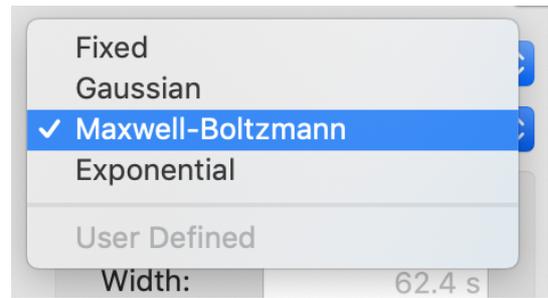


same. You may use this “distribution” for the wrap up time if you have agreed upon a fixed pause between two calls, for example. You may specify the mean of the “distribution” (i.e. the fixed value) on the left hand side. The width is always zero.

Gaussian

The Gaussian distribution is very popular in statistics. It's a symmetric distribution around the mean. You may specify the mean and the width on the left hand side. These values are used to determine the shape of the distribution. The actually resulting values may differ more or less, e.g. if you set asymmetric lower and upper limits of the distribution. You cut off significantly different parts of the in principle symmetric

distribution which will result in a shift of the mean value.



Maxwell-Boltzmann

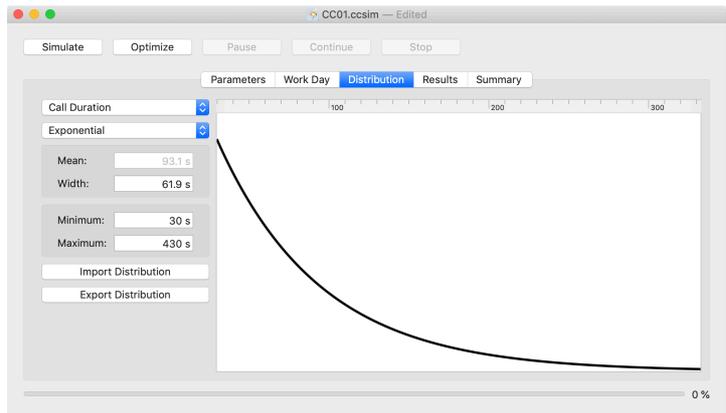
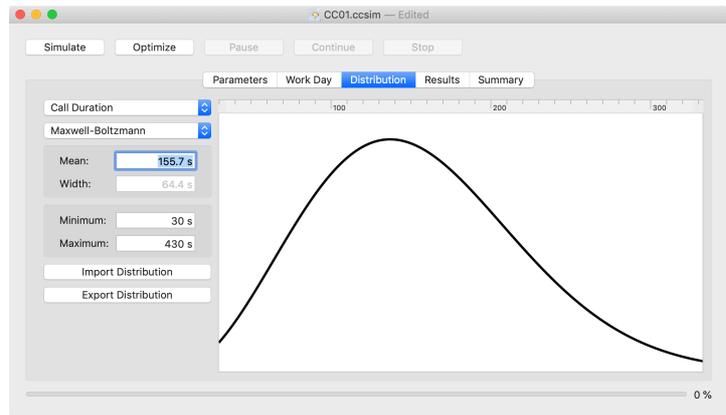
The Maxwell-Boltzmann distribution is also a good candidate to specify parameters in the call center since it is slightly asymmetric. It always starts at the zero-point and has a long tail to higher values. You may specify the mean value on the left hand side; the width is automatically calculated.

Exponential

This an exponentially falling distribution. You may use it if the bulk of the values should be small and you expect only a few higher values. The shape of this distribution is specified by its width on the left hand side.

User defined

If you have modified a standard distribution ([s. below](#)) or if you have widened the minimum and maximum values the distribution is automatically classified as “user defined”. This also happens if you import the distribution from a text file. You can change a user defined distribution to one of the standard types by selecting the type in the a.m. pop-up menu.



2.3.3. Distribution parameters

Mean:	<input type="text" value="153 s"/>
Width:	<input type="text" value="52.8 s"/>
Minimum:	<input type="text" value="30 s"/>
Maximum:	<input type="text" value="430 s"/>

The purpose of these fields on the right hand side is twofold. They reflect the calculated values of the selected distribution and you may change them by overwriting and change the form of the distribution accordingly.

Mean value

This is the mean value of the specified parameter. It is calculated by the Call Center simulator. You may change it for

- Fixed,
- Gaussian and
- Maxwell-Boltzmann

distributions. The resulting mean values may not be exactly the same as those you have typed. The value you have typed is the input to the formula of the distribution but the resulting mean may be distorted due to tight minimum or maximum values.

Width

This is the spread of the specified parameter. It is calculated by the Call Center simulator. You may change it for

- Gaussian and
- Exponential

distributions. The resulting spread may not be exactly the same as those you have typed. The value you have typed is the input to the formula of the distribution but the resulting spread may be distorted due to tight minimum or maximum values.

Minimum

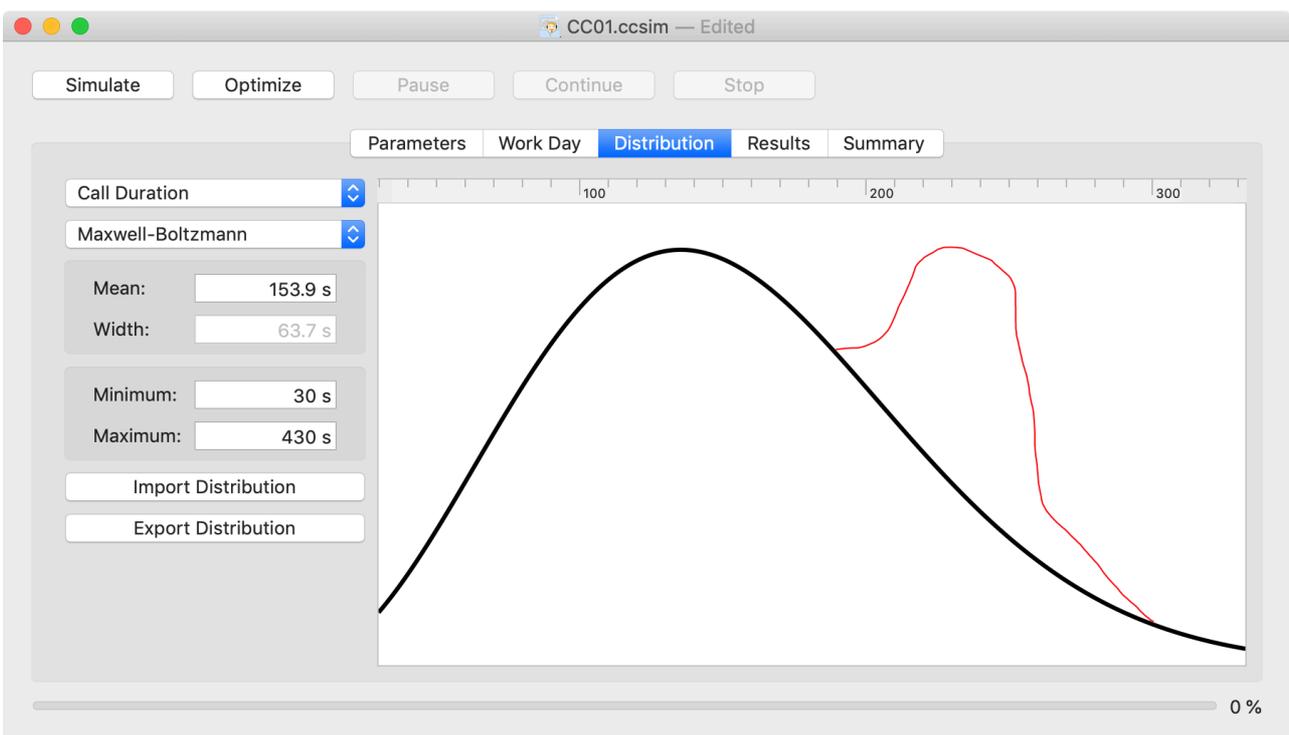
This is the minimum value of the specified parameter. You cut off the distribution at this point. No lower values will be used by the Call Center simulator.

Maximum

This is the maximum value of the specified parameter. You cut off the distribution at this point. No higher values will be used by the Call Center simulator.

2.3.4. Graphical display of distributions

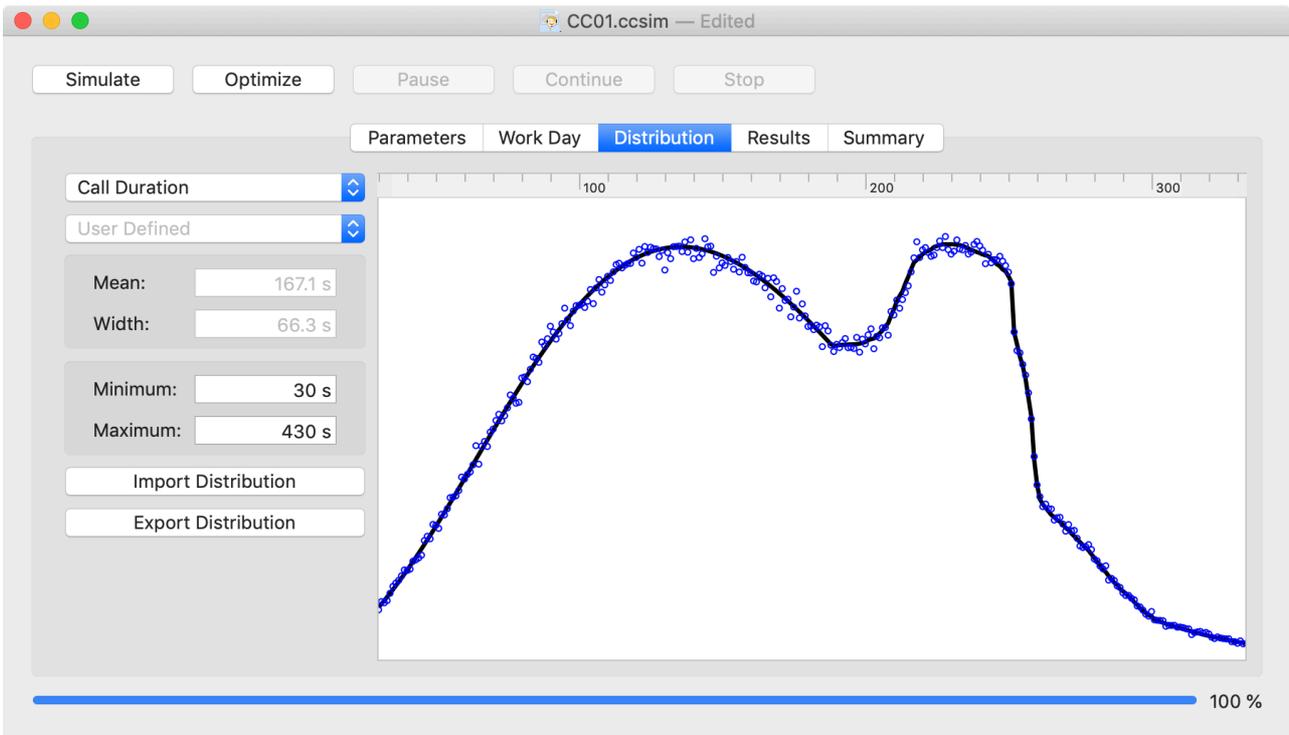
The currently selected distribution is drawn in the center view. The top ruler marks the time value in seconds. There is no vertical scale since the distribution is normalized and the scale is adjusted automatically so that the distribution fits into the view.



Making a user defined distribution

You can change the shape of the distribution quickly by clicking and dragging in the view. The resulting new shape is drawn when you release the mouse button.

Population produced by the random number generator



When you have run the Call Center simulator the actual population of the different time values is indicated in the distributions as small blue circles. The more calls are generated the better these circles follow the predefined distributions.

2.3.5. Importing a distribution

Every distribution may be imported from a text file by pressing the button "Import Distribution". The format of the text file is as follows:

30	0.00065824619737	378
31	0.00070053113274	440
32	0.00074390065556	431
33	0.00078832722309	448
34	0.00083378267383	503
35	0.00088023824973	555
36	0.00092766461872	580
37	0.00097603189765	601
38	0.00102530967565	635

The first column contains the time in seconds. The second column contains the probability of this time value in arbitrary units as floating point numbers. After the import the distribution

is normalized by the Call Center simulator. The last column is optional and contains the hit count of this time value. This column is generated by the Call Center simulator during export of a distribution (s. below). These values are thrown away during import.

In the import text file the time rows may be in arbitrary order. The Call Center simulator is ordering them during import. It may also contain holes. The probabilities for missing time values are linearly interpolated between the neighboring ones.

2.3.6. Exporting a distribution

If you press the button “Export Distribution” the currently selected distribution is exported as a text file. The format of the text file is as follows:

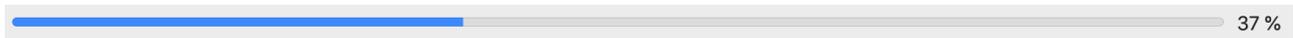
30	0.00065824619737	378
31	0.00070053113274	440
32	0.00074390065556	431
33	0.00078832722309	448
34	0.00083378267383	503
35	0.00088023824973	555
36	0.00092766461872	580
37	0.00097603189765	601
38	0.00102530967565	635

The first column contains the time in seconds. The second column contains the probability of this time value in arbitrary units as floating point numbers. The last column contains the hit count of this time value for a statistical analysis.

3. Running a simulation



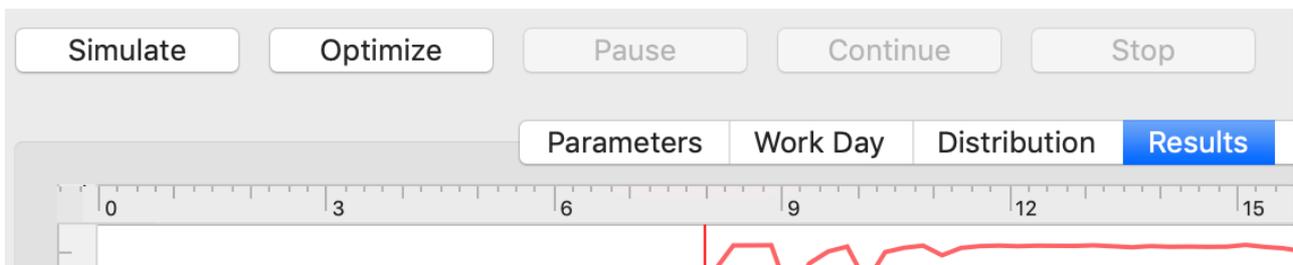
During the execution of a simulation the progress is indicated at the bottom of the simulation window. The progress bar and the corresponding number on the right hand side give a rough estimation of the percentage of the completion of the current simulation.



You may run several simulations in parallel if you really think this makes sense (e.g. if you are lucky and have multi-processor machine). Nevertheless even for a single simulation all iterations are running in parallel on all available core / processors.

All simulations run in their own parameter set.

3.1. Start a simulation



To start a simulation with the current set of parameters press the Simulate button. Parameter entry is disabled to avoid misleading results. The Call Center simulator switches to the Results tab to display intermediate results graphically. You may also switch to the Summary tab to observe the numerical (intermediate) results.

3.2. Pause a simulation or optimization

With the Pause button you interrupt the current simulation or optimization. Parameter input is still disabled.

3.3. Continue a simulation or optimization

To continue an interrupted simulation press the Continue button. With the pause and continuation of a simulation or optimization no simulated calls are lost; the results are not effected by this.

3.4. Stop and abort a simulation or optimization

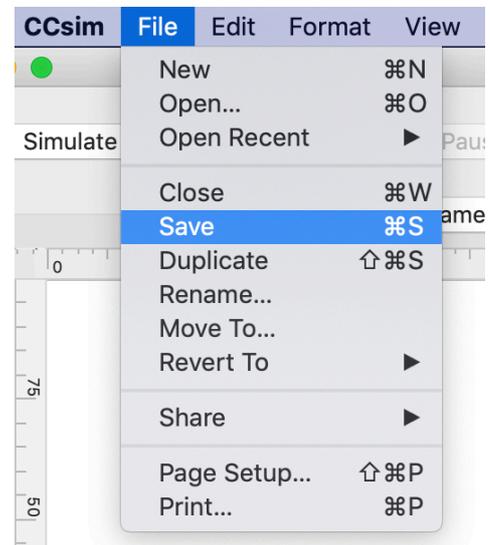
If you press the Stop button the current simulation or optimization is aborted. You cannot continue a once aborted simulation but have to start over again from the beginning.

3.5. Save and open a simulation

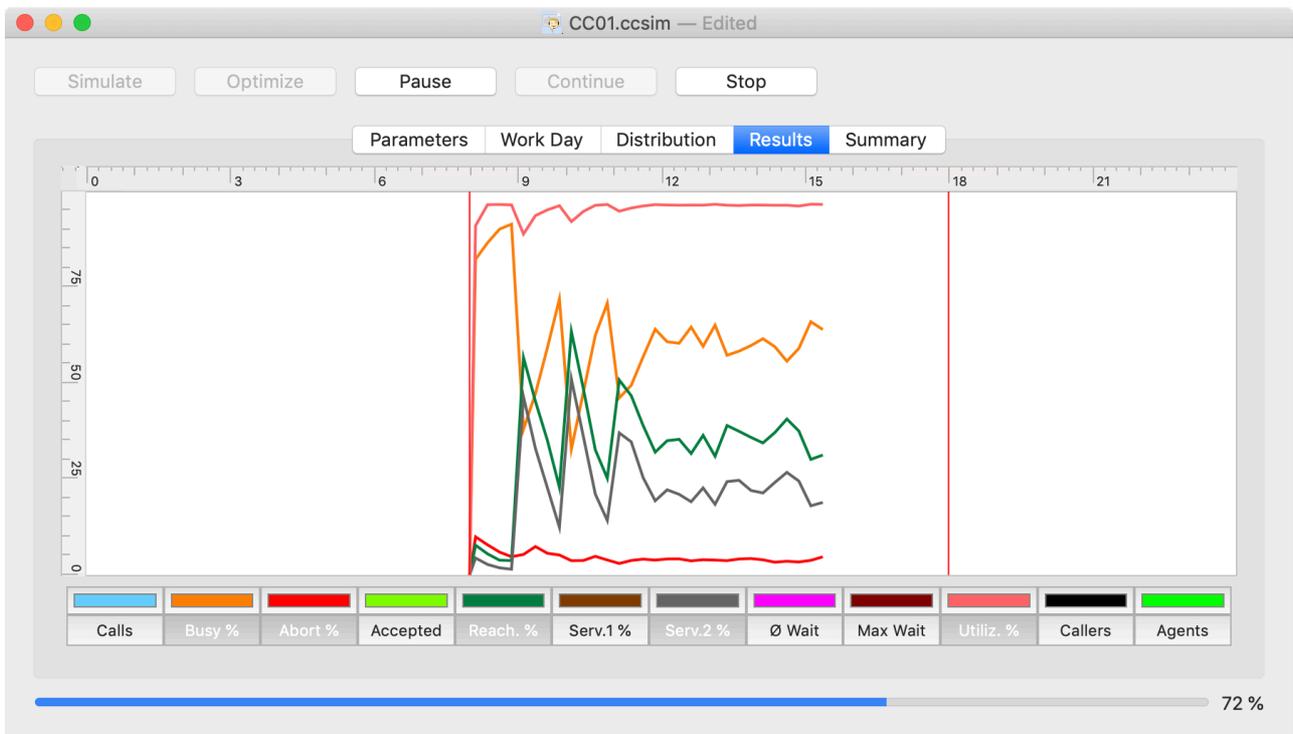
You may save the complete simulation including the parameter setup and the possibly obtained results with the menu commands “Save” and “Save As...”. The file format for the save file is CCsim proprietary. If you want to use the parameter setup or the results in an other application use the Export buttons in the Work Day and Distribution tab and the Save Results button in the Results tab.

The CCsim save file may be opened in the usual way by double clicking and with the Open menu command. You may open several simulations simultaneously.

To create a new simulation use the New command.



3.6. Results tab



The Results tab displays the simulation results graphically. You can see the development of key figures over the day.

3.6.1. Simulation times

The simulation times are indicated with the red vertical bars in the graph view. They correspond to the numerical values in the [Parameters tab](#).

3.6.2. The graphs

The key values of the simulation are drawn as colored graphs. The top ruler marks the simulation time in hours. The vertical left ruler represents the scale of the different graphs. If the standard range from 0 to 100 is not sufficient you may scroll the graph view upwards. The curves always end at the current simulation time of the most advanced iteration. Even if that has reached the upper simulation time limit the curves may still vary (slightly) since other iteration may not have been finished yet.

Call attempts entering the call center

This graph displays the call attempts entering the call center within the currently specified [time raster](#) (e.g. 15 min). This number is usually higher than the predefined number of callers because of the repetitive trials after an abort or a busy signal.

Busy rate

This graph shows the development of the busy rate, which is the fraction of busy calls with respect to the call attempts in %.

Abort rate

The abort rate is the fraction of calls that were aborted before getting connected to an agent with respect to the number of call attempts in %.

Accepted calls

This is number of actually connected calls within the specified [time raster](#).

Reachability

This key figure displays the probability of a caller getting connected to an agent in %. It is always $100\% - \text{Busy rate} - \text{Abort rate}$.

Service Level 1

This is the fraction of calls getting connected to an agent within the specified Service Time 1 (e.g. 30 s) with respect to the number of call attempts in %.

Service Level 2

This is the fraction of calls getting connected to an agent within the specified Service Time 2 (e.g. 20 s) with respect to the number of call attempts in %.

Mean wait time

This graph shows the mean wait time within the time raster.

Maximum wait time

This graph shows the maximum wait time within the time raster.

Agent utilization

This graph displays the fraction of the agents' time serving a caller or being in wrap up mode in %.

Callers per time interval

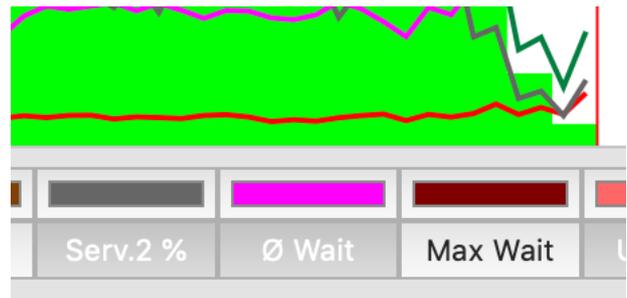
This is essentially the same graph as in the Work Day tab but is is the number if callers per time raster interval and not per hour to make it comparable with the actual number of call attempts and the number of accepted calls within the refresh interval. If the flag "Use Work Day tab" in the Parameters tab is not chosen this graph is just a horizontal line indicating the value of the Parameters tab.

Available agents

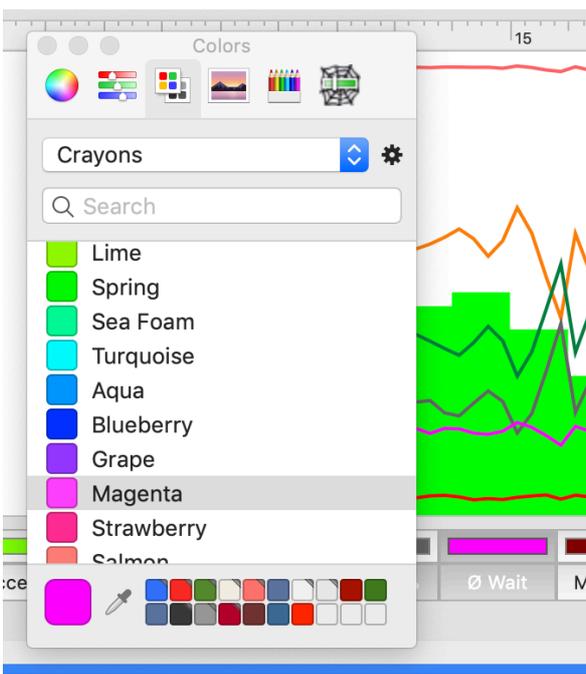
This is the same graph as that in the Work Day tab. If the flag "Use Work Day tab" in the Parameters tab is not chosen this graph is just a horizontal block indicating the value of the Parameters tab.

3.6.3. Switching a graph on and off

You may switch all the graphs on and off at any time by pressing the corresponding push button in the bottom line of this tab. This setting is also recorded to the save file.



3.6.4. Changing the color of a graph



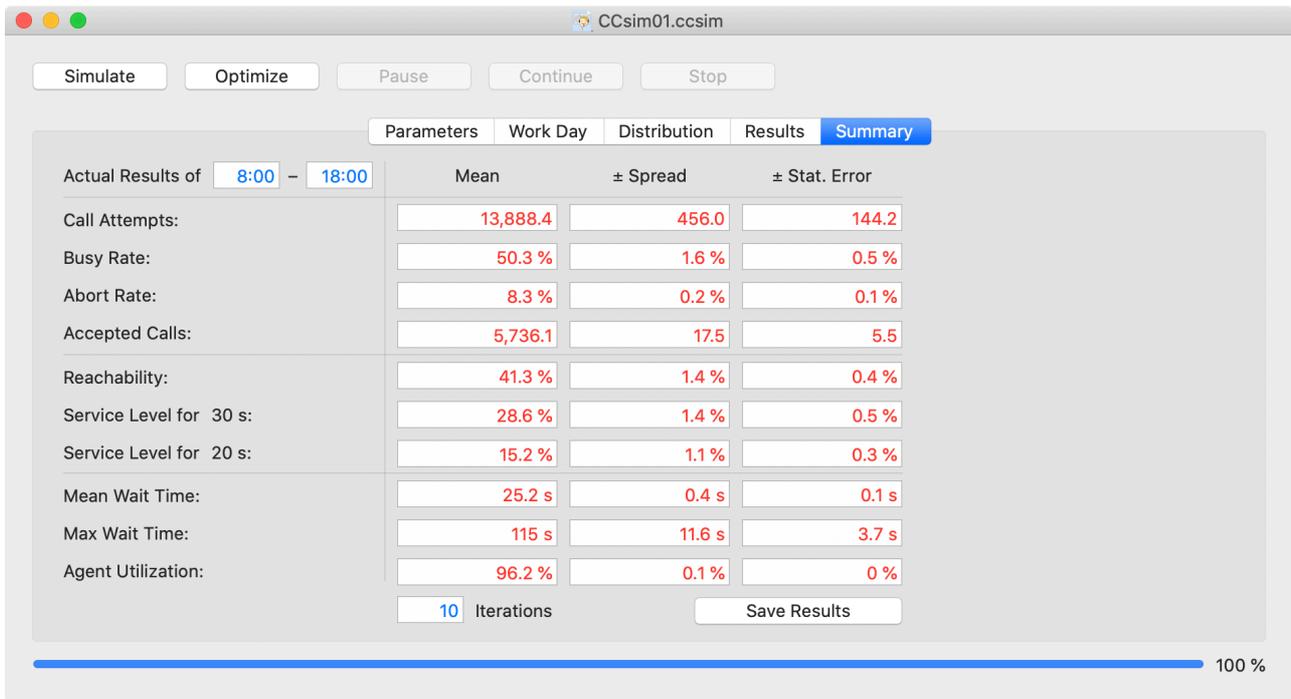
You may also change the color of any graph by selecting the color well above the corresponding button in the bottom row. This setting is also recorded in the save file.

3.7. Summary tab

The Summary tab shows the results in a numerical form.

3.7.1. Key figures

The key figures have the same meaning as in the Results tab excepts they are always the mean and the sum of the whole iteration.



3.7.2. Mean values

The first column shows the mean values of all completed iterations. If there are still iterations going on (the Progress bar has not reached 100 % yet) the results just reflect the current state of the simulation.

3.7.3. Spread of values

The second column shows the spread of the results in the iterations. App. 2/3 of all iteration results fall within these limits. It gives an indication how stable the results are.

Increasing the number of iterations does not necessarily lead to a smaller variance of the results. The spread of the key figures is an indication that some days end up rather bad while on others days there is no problem at all although the parameter sets are the same.

3.7.4. Statistical errors on mean values and spreads

The reported mean values do not only have a spread but a statistical error as well. If the simulation would be repeated a very big number of iterations the resulting mean values would deviate (slightly) from the here shown values. The statistical error in the third column indicates that the true mean value of a key figure lies with 68% probability within the reported interval. The same applies to the true value of the spread.

3.7.5. Save the results

By pressing the button “Save Results” you may save the results of the current simulation to a text file. This text file contains all important information about this simulation for further analysis and processing (e.g. in MS Excel):

CCsim:

Simulation performed at 23 Apr 2020 at 17:16:13:

Parameters:

Random number start:	random		
Repetition probability after abort:	60	%	
Repetition probability after busy:	80	%	

Busy Generation:

Busy On at	20	% waiting calls	
Busy Off at	15	% waiting calls	

relative to Available Agents

Longest Wait Time in Queue:	0	s	
Maximum number of Calls:	0		
Minimum Time in Busy State:	10	s	

Distributions:

Ring Time:	6.0	+/-	2.5	s
Wait Time until Abort:	55.3	+/-	25.7	s
Time to Repeat after Abort:	122.2	+/-	43.8	s
Time to Repeat after Busy:	35.9	+/-	32.3	s
Call Duration:	151.0	+/-	62.4	s
Wrap Up Time:	35.0	+/-	0.0	s

Callers per Hour:

Time (hh:mm)	Callers
6:00	0
6:30	10
7:00	40
7:30	100
8:00	150
8:30	200
9:00	250
9:30	350
10:00	500
10:30	700
11:00	900
11:30	1,050
12:00	1,200
12:30	1,250
13:00	1,200
13:30	1,000
14:00	1,150
14:30	1,100
15:00	1,100
15:30	900
16:00	800
16:30	650
17:00	500
17:30	300

18:00 20
 18:30 0

Available Agents:

Time (hh:mm)	Agents
8:00	2
9:00	15
10:00	30
11:00	45
12:00	50
13:00	45
14:00	48
15:00	40
16:00	30
16:30	20
17:00	10
17:30	3
18:00	0

Results:

Mean of 10 iterations from 8:00 to 18:00:

Time (hh:mm)	Call Attempts	Busy Rate (%)	Abort Rate (%)	Accepted Calls	Reachability (%)	Service Level for 30 s (%)	Service Level for 20 s (%)	Mean Wait Time (s)	Max Wait Time (s)	Agent
8:07	125.4	85.5	7.2	8.7	7.3	5.2	4.7	37.7	92.7	91.0
8:22	188.3	88.5	6.5	9.0	5.0	3.0	2.7	40.4	91.8	96.2
8:37	234.4	90.3	5.6	9.1	4.1	2.0	1.8	40.3	90.7	96.9
8:52	231.9	90.3	5.5	9.3	4.2	2.5	1.8	40.0	95.1	96.3
9:07	82.8	14.7	8.9	59.9	76.4	66.3	59.5	15.9	62.7	87.3
9:22	110.5	26.0	8.2	67.2	65.8	56.1	45.9	18.3	58.8	92.4
9:37	193.2	49.8	10.0	69.2	40.2	29.5	21.0	24.3	67.6	95.5
9:52	257.9	62.6	9.6	69.5	27.8	17.5	10.7	28.0	72.7	96.5
10:07	145.6	5.9	5.5	127.2	88.6	80.5	69.6	14.1	56.3	89.6
10:22	188.2	17.9	7.1	136.0	74.9	66.2	51.7	16.8	51.7	94.2
10:37	354.6	50.9	8.7	139.4	40.4	27.1	15.3	25.5	59.9	96.7
10:52	433.1	58.5	7.9	140.9	33.6	21.7	11.1	26.4	60.7	96.7
11:07	315.9	25.7	8.7	203.9	65.6	50.0	31.3	21.9	54.7	95.8
11:22	417.7	39.7	9.2	208.5	51.0	36.3	18.4	24.7	55.1	96.7
11:37	446.7	41.2	9.2	211.8	49.5	35.6	17.6	24.9	54.5	96.6
11:52	550.5	52.4	8.3	211.1	39.3	25.7	12.1	26.1	60.1	96.8
12:07	490.1	42.9	9.2	230.1	47.9	32.1	15.8	25.8	58.2	96.7
12:22	584.1	50.0	8.3	235.1	41.7	27.1	12.4	26.4	56.4	96.7
12:37	568.6	49.3	8.8	235.0	42.0	27.5	10.6	26.6	56.7	96.7
12:52	530.7	46.1	9.2	231.9	44.7	29.8	12.7	26.4	57.0	96.7
13:07	538.6	50.6	8.2	217.6	41.1	26.3	10.5	26.8	56.4	96.7
13:22	416.0	39.6	9.4	210.6	51.0	34.9	15.7	25.5	53.1	96.7
13:37	391.2	35.1	8.8	212.2	56.1	41.4	23.3	24.0	53.5	96.7
13:52	486.3	46.8	8.8	211.6	44.4	30.4	14.3	25.7	59.1	96.7
14:07	496.9	44.6	8.3	224.7	47.2	34.4	17.8	24.3	54.0	96.6
14:22	451.4	40.1	8.3	228.5	51.6	37.6	20.2	24.2	56.0	96.7
14:37	447.2	38.7	8.6	220.6	52.7	39.9	22.0	23.8	54.5	96.2
14:52	432.8	38.0	9.4	222.6	52.5	38.2	19.5	24.4	55.3	96.7
15:07	529.4	55.0	8.0	193.0	37.0	23.4	9.9	27.2	62.8	96.8
15:22	414.1	43.8	9.1	188.4	47.1	30.8	14.7	26.3	58.9	96.8
15:37	345.8	34.8	10.0	187.9	55.2	39.5	20.1	25.1	56.0	96.5
15:52	298.6	27.1	9.7	186.1	63.2	46.6	26.1	23.6	56.1	96.4
16:07	373.9	50.7	8.8	146.3	40.5	28.6	16.6	25.1	66.0	96.7
16:22	283.4	38.9	9.3	142.3	51.8	35.1	19.5	25.4	59.7	96.6
16:37	345.2	61.0	7.8	103.0	31.2	19.3	11.0	27.6	67.9	96.8
16:52	287.7	56.6	9.4	94.6	34.0	20.9	11.5	27.9	69.5	96.7
17:07	333.3	76.7	6.4	54.8	16.9	10.0	6.4	30.9	78.6	97.0
17:22	243.0	73.6	7.0	46.3	19.4	11.7	7.3	31.2	79.8	96.7
17:37	239.7	87.3	4.6	19.0	8.1	4.4	3.2	36.6	97.0	96.9
17:52	83.7	72.8	9.4	13.2	17.8	13.6	10.3	32.8	93.6	91.6

Mean 13,888.4 50.3 8.3 5,736.1 41.3 28.6 15.2 25.2 115.0 96.2

Spread:

Time (hh:mm)	Call Attempts Level for 30 s (%)	Call Attempts Service Level for 20 s (%)	Busy Rate (%)	Abort Rate (%)	Accepted Calls Mean Wait Time (s)	Accepted Calls Max Wait Time (s)	Reachability (%)	Service Agent		
8:07	36.3	3.5	2.5	1.3	1.8	1.6	1.6	4.2	19.3	3.1
8:22	30.8	1.7	0.7	0.9	1.4	1.0	1.1	3.9	10.9	1.2
8:37	51.2	2.5	1.5	1.5	1.3	0.5	0.5	1.9	10.1	0.7
8:52	42.2	2.3	1.6	0.7	1.0	0.7	0.8	4.4	17.1	0.8
9:07	24.3	12.7	4.0	4.4	15.5	16.6	18.4	3.2	8.0	5.0
9:22	31.2	16.2	4.6	3.7	19.8	24.9	25.3	5.6	14.3	4.5
9:37	63.9	16.7	3.2	3.6	15.6	15.5	13.0	5.6	14.3	1.2
9:52	50.3	6.3	2.0	3.3	5.3	4.6	3.3	1.9	9.1	0.1
10:07	22.7	6.5	2.8	6.7	8.8	12.1	18.9	4.2	6.3	4.4
10:22	39.4	12.9	1.9	4.3	14.3	17.0	19.4	3.9	7.9	2.1
10:37	64.9	8.0	1.7	4.0	6.8	6.9	4.6	2.0	7.6	0.2
10:52	81.1	7.6	1.5	4.3	6.6	5.2	4.1	1.6	6.0	0.2
11:07	42.5	8.8	1.5	2.6	9.1	10.6	10.1	2.4	4.4	0.5
11:22	70.8	7.9	1.4	6.1	7.3	7.0	5.7	1.3	4.4	0.1
11:37	99.1	11.5	1.6	3.4	10.8	10.0	7.7	1.8	5.4	0.2
11:52	83.3	9.0	2.4	6.9	6.8	7.1	4.1	1.4	6.9	0.1
12:07	71.8	8.2	1.4	4.6	7.5	7.8	5.6	1.7	6.5	0.1
12:22	116.3	9.2	0.8	6.2	8.7	8.8	5.5	1.8	5.4	0.2
12:37	73.3	6.0	1.0	4.4	5.7	5.3	2.6	0.8	7.9	0.2
12:52	86.7	8.4	1.8	5.3	7.1	6.5	3.2	1.2	6.6	0.1
13:07	79.4	6.1	1.0	4.6	5.7	4.4	2.9	0.9	5.0	0.1
13:22	37.7	5.3	1.4	7.5	4.8	5.3	5.6	1.4	3.0	0.1
13:37	79.8	10.7	1.3	5.8	10.3	11.0	9.7	2.7	4.4	0.2
13:52	71.3	8.0	1.1	7.0	7.2	6.7	4.5	1.6	6.1	0.1
14:07	93.1	12.0	1.3	7.4	11.8	13.1	10.2	2.4	5.1	0.3
14:22	59.3	9.1	1.0	4.9	8.4	8.0	7.0	1.5	4.6	0.3
14:37	110.2	15.6	1.7	4.6	15.9	18.6	17.6	4.2	5.8	0.9
14:52	67.5	9.0	1.5	4.8	8.0	8.1	7.7	1.9	3.8	0.2
15:07	68.6	6.1	1.3	5.1	5.2	5.2	3.7	1.3	7.1	0.1
15:22	88.3	9.5	1.8	4.3	8.4	7.9	6.3	1.7	4.7	0.1
15:37	46.2	8.0	1.1	4.4	7.4	7.7	5.4	1.8	3.9	0.2
15:52	40.0	7.3	2.3	5.9	7.9	9.9	9.3	2.1	5.8	0.5
16:07	70.9	9.3	1.5	4.4	8.4	10.0	8.5	2.8	8.6	0.5
16:22	54.8	9.4	1.3	5.6	9.3	7.6	4.5	1.4	7.4	0.2
16:37	74.4	8.2	1.6	3.1	7.0	6.0	4.3	1.4	10.1	0.1
16:52	54.9	8.1	1.8	3.5	6.8	5.8	4.3	1.8	5.6	0.2
17:07	64.1	3.7	1.4	3.2	2.7	1.9	1.3	1.3	10.6	0.3
17:22	33.2	4.0	1.5	2.5	3.2	3.4	2.1	2.5	8.4	0.3
17:37	31.4	2.2	1.3	1.1	1.4	1.4	1.3	1.4	4.8	0.7
17:52	36.9	8.1	3.3	1.3	5.8	6.3	4.1	5.1	8.6	3.4
Mean	456.0	1.6	0.2	17.5	1.4	1.4	1.1	0.4	11.6	0.1

Statistical Error:

Time (hh:mm)	Call Attempts Level for 30 s (%)	Call Attempts Service Level for 20 s (%)	Busy Rate (%)	Abort Rate (%)	Accepted Calls Mean Wait Time (s)	Accepted Calls Max Wait Time (s)	Reachability (%)	Service Agent		
8:07	11.5	1.1	0.8	0.4	0.6	0.5	0.5	1.3	6.1	1.0
8:22	9.7	0.6	0.2	0.3	0.4	0.3	0.3	1.2	3.4	0.4
8:37	16.2	0.8	0.5	0.5	0.4	0.2	0.2	0.6	3.2	0.2
8:52	13.3	0.7	0.5	0.2	0.3	0.2	0.3	1.4	5.4	0.2
9:07	7.7	4.0	1.3	1.4	4.9	5.3	5.8	1.0	2.5	1.6
9:22	9.9	5.1	1.5	1.2	6.3	7.9	8.0	1.8	4.5	1.4
9:37	20.2	5.3	1.0	1.1	4.9	4.9	4.1	1.8	4.5	0.4
9:52	15.9	2.0	0.6	1.0	1.7	1.5	1.1	0.6	2.9	0.0
10:07	7.2	2.1	0.9	2.1	2.8	3.8	6.0	1.3	2.0	1.4
10:22	12.5	4.1	0.6	1.4	4.5	5.4	6.1	1.2	2.5	0.7
10:37	20.5	2.5	0.5	1.3	2.1	2.2	1.5	0.6	2.4	0.1
10:52	25.7	2.4	0.5	1.3	2.1	1.6	1.3	0.5	1.9	0.1

11:07	13.4	2.8	0.5	0.8	2.9	3.4	3.2	0.7	1.4	0.2
11:22	22.4	2.5	0.4	1.9	2.3	2.2	1.8	0.4	1.4	0.0
11:37	31.4	3.6	0.5	1.1	3.4	3.2	2.4	0.6	1.7	0.1
11:52	26.3	2.8	0.7	2.2	2.2	2.2	1.3	0.5	2.2	0.0
12:07	22.7	2.6	0.4	1.5	2.4	2.5	1.8	0.6	2.1	0.0
12:22	36.8	2.9	0.2	2.0	2.8	2.8	1.7	0.6	1.7	0.1
12:37	23.2	1.9	0.3	1.4	1.8	1.7	0.8	0.3	2.5	0.1
12:52	27.4	2.6	0.6	1.7	2.2	2.1	1.0	0.4	2.1	0.0
13:07	25.1	1.9	0.3	1.4	1.8	1.4	0.9	0.3	1.6	0.0
13:22	11.9	1.7	0.5	2.4	1.5	1.7	1.8	0.5	1.0	0.0
13:37	25.2	3.4	0.4	1.8	3.3	3.5	3.1	0.8	1.4	0.1
13:52	22.5	2.5	0.4	2.2	2.3	2.1	1.4	0.5	1.9	0.0
14:07	29.4	3.8	0.4	2.3	3.7	4.2	3.2	0.7	1.6	0.1
14:22	18.7	2.9	0.3	1.6	2.7	2.5	2.2	0.5	1.5	0.1
14:37	34.8	4.9	0.5	1.5	5.0	5.9	5.6	1.3	1.8	0.3
14:52	21.3	2.9	0.5	1.5	2.5	2.6	2.4	0.6	1.2	0.1
15:07	21.7	1.9	0.4	1.6	1.7	1.6	1.2	0.4	2.2	0.0
15:22	27.9	3.0	0.6	1.4	2.7	2.5	2.0	0.5	1.5	0.0
15:37	14.6	2.5	0.3	1.4	2.3	2.4	1.7	0.6	1.2	0.1
15:52	12.7	2.3	0.7	1.9	2.5	3.1	3.0	0.7	1.8	0.2
16:07	22.4	3.0	0.5	1.4	2.7	3.2	2.7	0.9	2.7	0.1
16:22	17.3	3.0	0.4	1.8	2.9	2.4	1.4	0.4	2.3	0.1
16:37	23.5	2.6	0.5	1.0	2.2	1.9	1.4	0.4	3.2	0.0
16:52	17.3	2.6	0.6	1.1	2.2	1.8	1.4	0.6	1.8	0.1
17:07	20.3	1.2	0.4	1.0	0.9	0.6	0.4	0.4	3.4	0.1
17:22	10.5	1.3	0.5	0.8	1.0	1.1	0.7	0.8	2.7	0.1
17:37	9.9	0.7	0.4	0.3	0.4	0.4	0.4	1.5	4.6	0.2
17:52	11.7	2.5	1.0	0.4	1.8	2.0	1.3	1.6	2.7	1.1
Mean	144.2	0.5	0.1	5.5	0.4	0.5	0.3	0.1	3.7	0.0

Summary:

Mean of 10 iterations from 8:00 to 18:00:

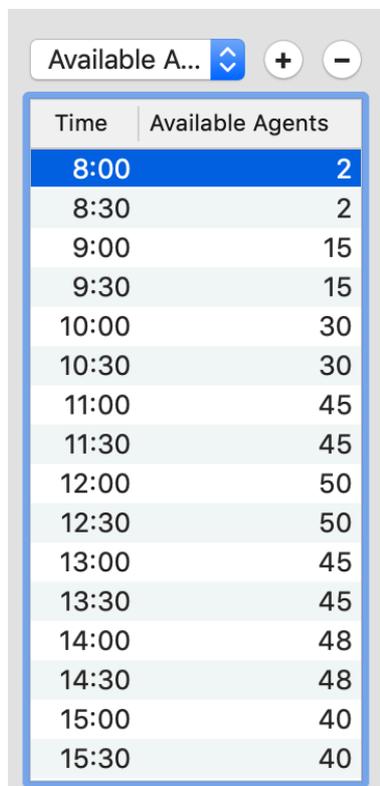
Call Attempts:	13,888.4 +/-	456.0 +/-	144.2
Busy Rate:	50.3 +/-	1.6 +/-	0.5 %
Abort Rate:	8.3 +/-	0.2 +/-	0.1 %
Accepted Calls:	5,736.1 +/-	17.5 +/-	5.5
Reachability:	41.3 +/-	1.4 +/-	0.4 %
Service Level for 30 s:	28.6 +/-	1.4 +/-	0.5 %
Service Level for 20 s:	15.2 +/-	1.1 +/-	0.3 %
Mean Wait Time:	25.2 +/-	0.4 +/-	0.1 s
Max Wait Time:	115.0 +/-	11.6 +/-	3.7 s
Agent Utilization:	96.2 +/-	0.1 +/-	0.0 %

4. Running an optimization

In an optimization the Call Center simulator tries to adjust the number of available agents during the day in such a way that a predefined quality criterion is fulfilled. In doing so it also tries not to have too many agents on board but only the minimum number for the defined criterion. But it is not guaranteed that with the resulting staff distribution the quality criterion could always be respected. As mentioned already we have a statistical process here and even with a very luxuriant agent allocation it is possible that one day runs rather bad, that there is a waiting queue built up in the morning which does not vanish the whole day.

4.1. Time raster

The optimization run modifies the agent allocation over the day. For that the time raster of the



Time	Available Agents
8:00	2
8:30	2
9:00	15
9:30	15
10:00	30
10:30	30
11:00	45
11:30	45
12:00	50
12:30	50
13:00	45
13:30	45
14:00	48
14:30	48
15:00	40
15:30	40

parameter tab is used to determine the time points where the agent allocation may change. E.g. if the time raster is set to 30 minutes agents may come or leave the call center every half hour.

The first thing the optimization does is split up the agents distribution by means of the time raster specified in the parameters tab.

Other Parameters

Time Raster:

30 m

4.2. Start of an optimization

You start an optimization by clicking in the button “Optimize”. It can be interrupted or aborted in the same way as a simulation run (with the buttons “Pause”, “Continue” and “Stop”). In fact, an optimization run is just a chain of simulation runs with varying agent allocation.

Simulate

Optimize

Pause

Continue

Stop

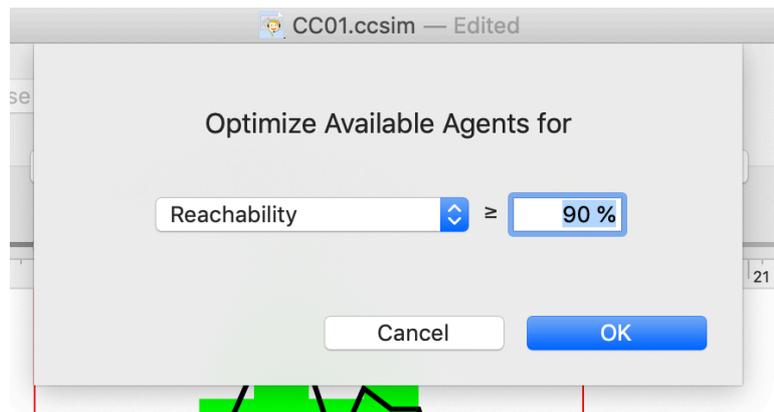
4.3. Optimization criteria

When you start an optimization you have to specify the quality criterion which should be respected by optimizing the agent allocation. It can be one out of these four:

4.3.1. Reachability

By selecting this criterion the agent allocation will be modified until the reachability in each time interval of the raster reaches at least the specified value. If the reachability is already above this value (here 90 %) the algorithm tries to reduce the number of agents in this time interval.

Since the values in this relatively small time raster have a rather broad spread a repetition of the simulation may nevertheless give time intervals with violations of the quality criterion.

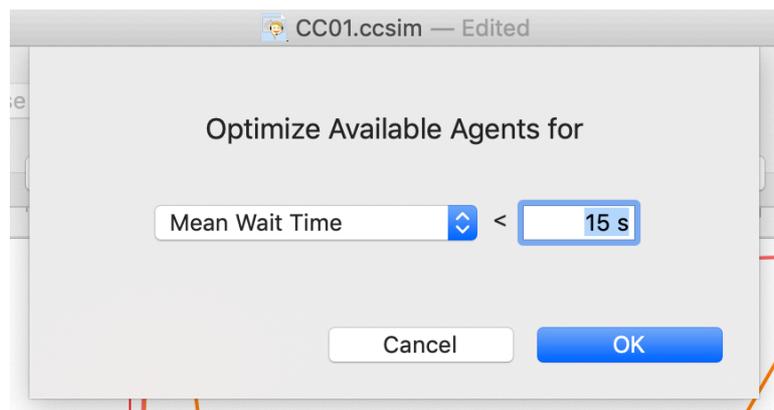


4.3.2. Service Level

Instead of the reachability you may also choose the Service Level for one of the defined service level time as an optimization criterion.

4.3.3. Mean wait time

Finally you may also specify a limit for the mean wait time that should not be exceeded as the quality criterion.

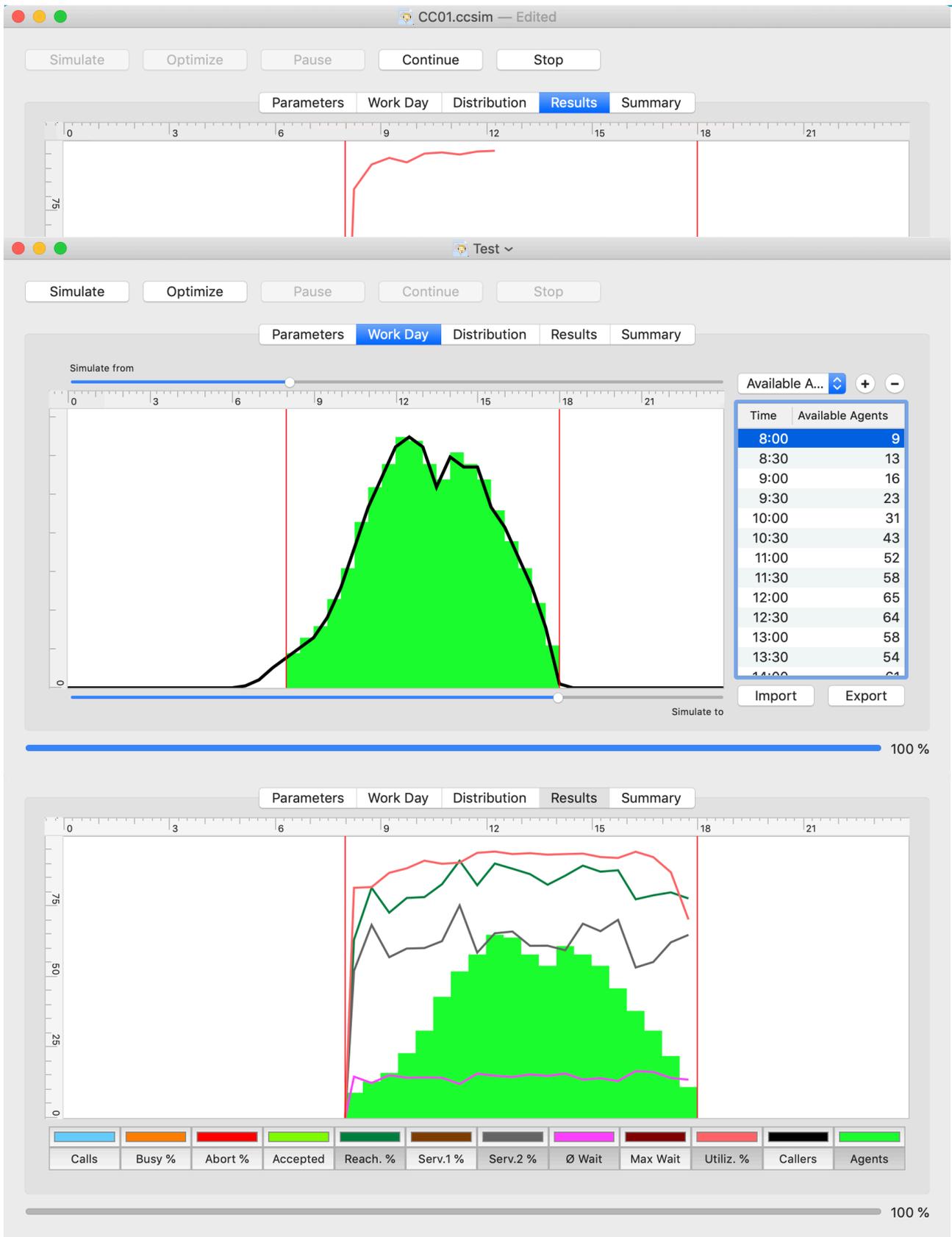


4.4. Process of an optimization

Firstly at the actual optimization run a rough guess about the agent allocation in each time slot is taken by setting up simulation runs with only one iteration each. This rough guess of the staffing is taken as a starting points for the final set of similar simulation runs with the number of iterations specified in the parameters tab.

Since the results in each time slot depend on the measurements of the day up to that point the simulation runs have always to start a little bit earlier than the currently optimized agent shift.

The progress bar always shows the progress of the actual simulation run, not that of the complete optimization. The total time consumption of the optimization is not to be foreseen and may result in a quite lengthy period.



During an optimization run the resulting agent allocation is displayed automatically in the results tab.

4.5. Result of an optimization run

The result of an optimization run is a new agent allocation distribution. You may revert to the previous agent allocation by selecting the usual undo function from the Edit menu (Undo:  Z).

With the button “Save Results” of the summary tab you may export the new agent allocation as well.