



# Automatic Shift Scheduling Software Schedule Nurse III Tutorial



Dec.04.2020 Sugawara Systems





# Structure of the document

## ■ Video Tutorial

[Dr. Planning](#) is an example of using the software, solving a problem from scratch.

## ■ Tutorial

The main part of the document. It outlines the usage method of the program using real-world examples. As you go through the tutorial, try the same things in the program yourself.

## ■ [User manual](#)

This part explains the usage method for each item. Please refer to the necessary sections.

## ■ Advanced user manual

Under Construction.

## ■ [Python3\\_Constraint Programming Tutorial/Manual](#)

This is a programming manual for more advanced users.





# Key Points

The critical thing to remember is that constraints create the shift work schedule. We have three main points:

- We, human beings, make Constraints.
- The machine (scheduling solver) calculates the solution that satisfies them.
- You can achieve your ideal assignments by adjusting the weight of constraints.

Let's start with a simple example and gradually move on to more complex models with the tutorial.

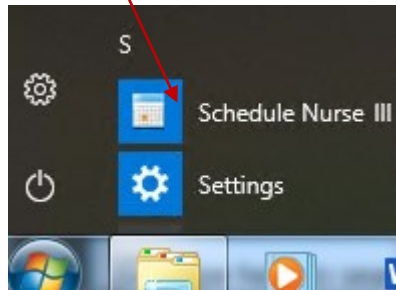
In this tutorial, we will use a two-shift work schedule as an example to explain the main points described above.





# Launching the program

Click the icon on start menu.

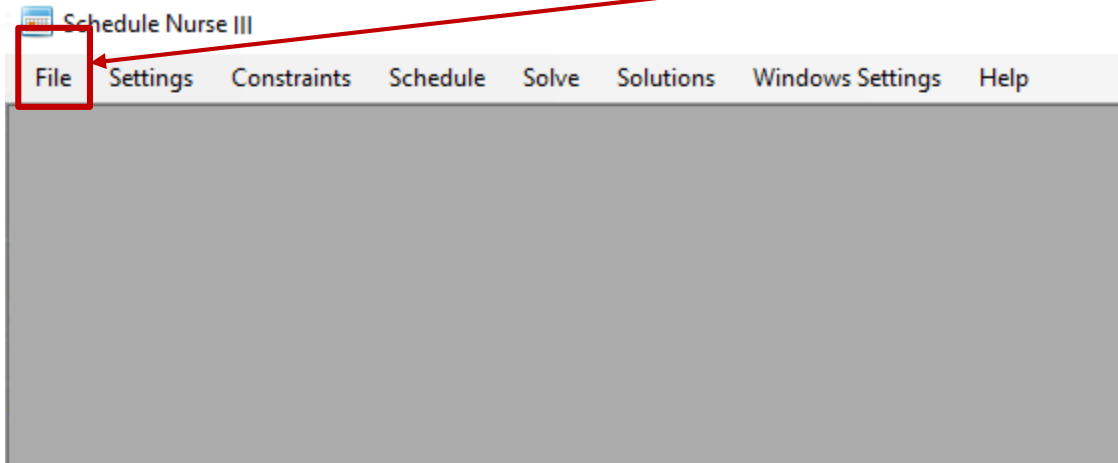






# The screen after launching the program

This is the screen just after launching the program. Click “File.”

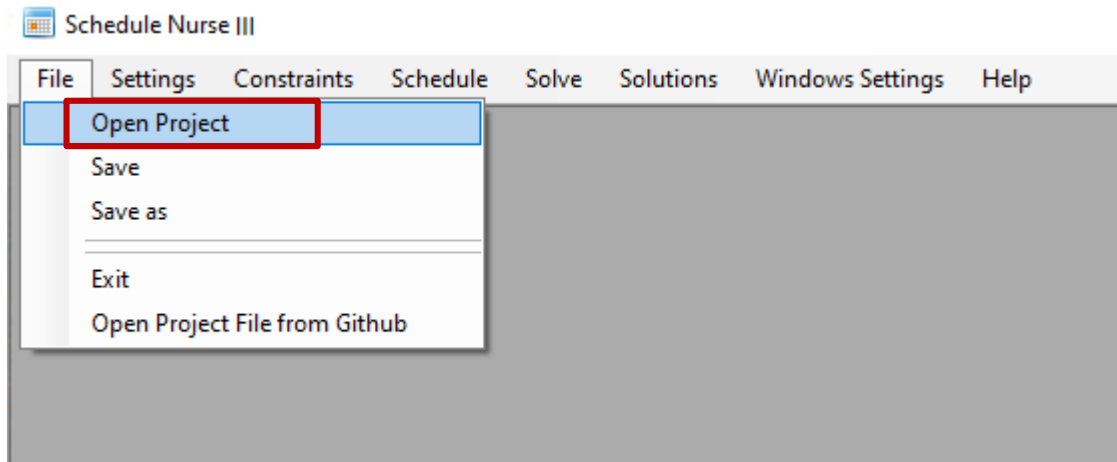






# Open Project

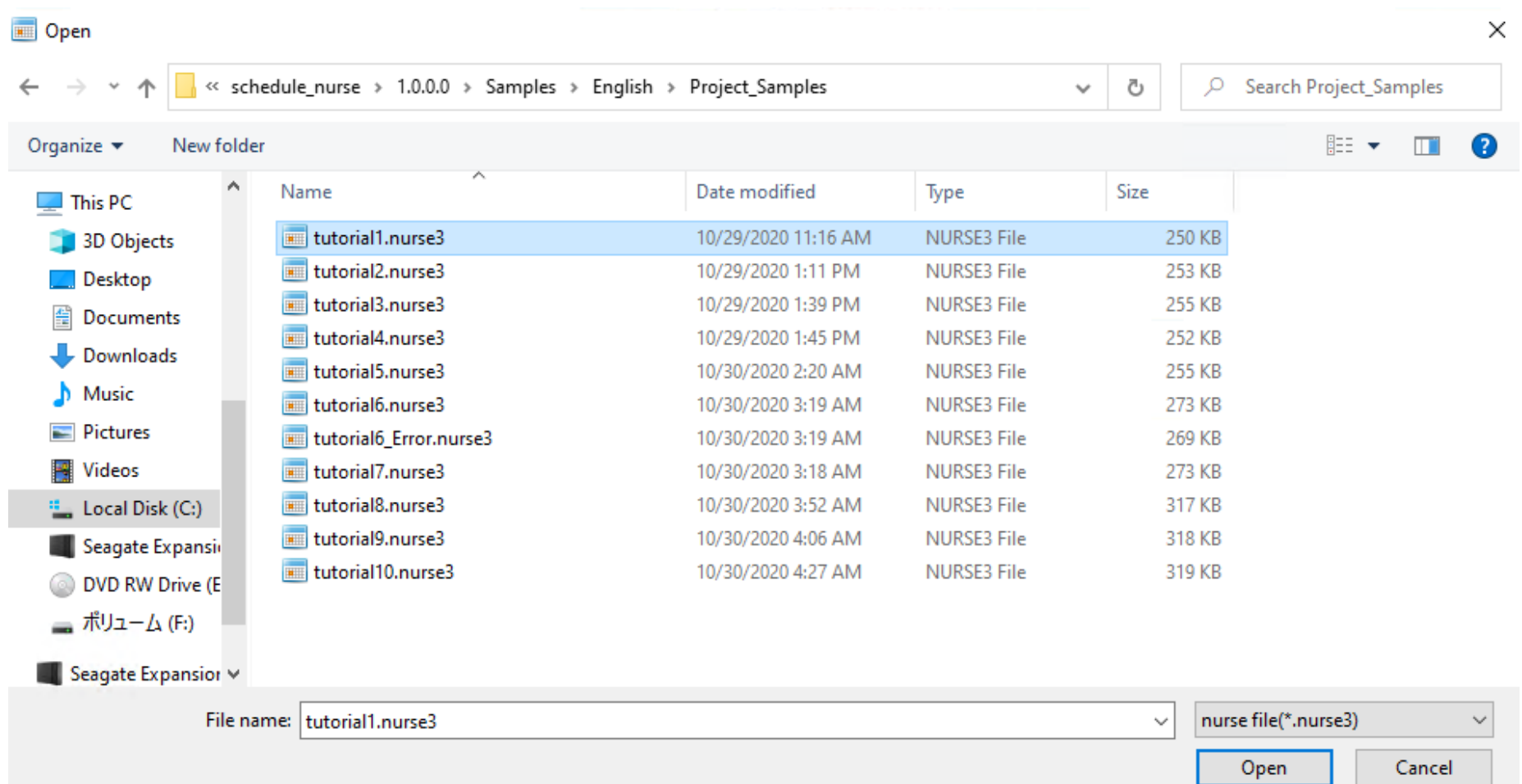
Click "Open project"





# Loading a project file

Open the folder where you installed the software and the folder "Project Samples" in it. In this folder, you will find the sample project files 1 through 10 meant for practice. Double-click on Tutorial 1.







# The screen after loading a project

This is the screen just after loading a project.

 Schedule Nurse III C:\Users\sugaw\AppData\Roaming\sugawara-systems\schedule\_nurse\1.0.0.0\Samples\English\Project\_Samples\tutorial1.nurse3

File Settings Constraints Schedule Solve Solutions Windows Settings Help





# Loading the “Solution” screen

The loaded project file contains a solution. Click on "Solution" and you will see the following screen.

The screenshot shows the 'Schedule Nurse III' application window. The 'Schedule' menu item is highlighted with a red box. The 'Solutions' window is open, showing a table with staff names and their schedules for the previous month and the next week.

Solution1		Staff Name	Filter	Previous Month					The1Week					
A	B			27	28	29	30	31	1	2	3	4	5	6
				Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
1		Staff1		A	A	A	A	A	D	D	D	D	D	D
2		Staff2		A	A	A	A	A	D	D	D	D	D	D
3		Staff3		A	A	A	A	A	D	D	D	D	D	D
4		Staff4		A	A	A	A	A	D	D	D	D	D	D
5		Staff5		A	A	A	A	A	D	D	D	D	D	D
6		Staff6		A	A	A	A	A	D	D	D	D	D	D

Column Constraint	Filter	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
1												
2												



# Maximizing the “Solution” screen

You can maximize the screen by clicking here.

The screenshot shows the 'Schedule Nurse III' application window. The title bar reads 'Schedule Nurse III C:\Users\sugaw\AppData\Roaming\sugawara-systems\schedule\_nurse\1.0.0.0\Samples\English\Project\_Samples\tutorial1.nurse3'. The menu bar includes 'File', 'Settings', 'Constraints', 'Schedule', 'Solve', 'Solutions', 'Windows Settings', and 'Help'. The 'Solutions' window is active, displaying a grid for 'Solution1'. The grid has columns for 'Staff Name', 'Filter', 'Previous Month' (days 27-31), and 'The1Week' (days 1-6). The 'Previous Month' and 'The1Week' columns contain cells with 'A' or 'D' values. A red arrow points to the maximize button in the 'Solutions' window's title bar.

	A	B	Staff Name	Filter	Previous Month					The1Week					
					27	28	29	30	31	1	2	3	4	5	6
					Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
1			Staff1		A	A	A	A	A	D	D	D	D	D	D
2			Staff2		A	A	A	A	A	D	D	D	D	D	D
3			Staff3		A	A	A	A	A	D	D	D	D	D	D
4			Staff4		A	A	A	A	A	D	D	D	D	D	D
5			Staff5		A	A	A	A	A	D	D	D	D	D	D
6			Staff6		A	A	A	A	A	D	D	D	D	D	D

	Column Constraint	Filter	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
1													
2													
3													





# How to operate the “Solution” screen

You can toggle between zooming in and out by double-clicking on any point on the "Solution" screen.

The image displays two side-by-side screenshots of the 'Solution' screen, illustrating the zoom functionality. The left screenshot shows a zoomed-in view of the staff schedule, while the right screenshot shows a zoomed-out view. A red arrow points from the zoomed-out view to the zoomed-in view, and a blue arrow points from the zoomed-in view back to the zoomed-out view.

Staff Name	Filter	Previous Month	The1Week	The2Week
Staff6		27 Tue	28 Wed	29 Thu
Staff7		30 Fri	31 Sat	1 Sun
Staff8		2 Tue	3 Wed	4 Thu
Staff9		5 Fri	6 Sat	7 Sun
Staff10		8 Mon	9 Tue	10 Wed
Staff11		11 Thu	12 Fri	13 Sat
Staff12		14 Sun	15 Mon	16 Tue
Staff13		17 Wed	18 Thu	19 Fri

Staff Name	Filter	Previous Month	The1Week	The2Week	The3Week	The4Week	The5Week
Staff1		27 Tue	28 Wed	29 Thu	30 Fri	31 Sat	1 Sun
Staff2		2 Tue	3 Wed	4 Thu	5 Fri	6 Sat	7 Sun
Staff3		8 Mon	9 Tue	10 Wed	11 Thu	12 Fri	13 Sat
Staff4		14 Sun	15 Mon	16 Tue	17 Wed	18 Thu	19 Fri
Staff5		20 Sat	21 Sun	22 Mon	23 Tue	24 Wed	25 Thu
Staff6		26 Fri	27 Sat	28 Sun	29 Mon	30 Tue	31 Wed
Staff7		1 Tue	2 Wed	3 Thu	4 Fri	5 Sat	6 Sun
Staff8		7 Mon	8 Tue	9 Wed	10 Thu	11 Fri	12 Sat
Staff9		13 Sun	14 Mon	15 Tue	16 Wed	17 Thu	18 Fri
Staff10		19 Sat	20 Sun	21 Mon	22 Tue	23 Wed	24 Thu
Staff11		25 Fri	26 Sat	27 Sun	28 Mon	29 Tue	30 Wed
Staff12		31 Thu	1 Fri	2 Sat	3 Sun	4 Mon	5 Tue
Staff13		6 Wed	7 Thu	8 Fri	9 Sat	10 Sun	11 Mon
Staff14		12 Tue	13 Wed	14 Thu	15 Fri	16 Sat	17 Sun
Staff15		18 Mon	19 Tue	20 Wed	21 Thu	22 Fri	23 Sat
Staff16		24 Sun	25 Mon	26 Tue	27 Wed	28 Thu	29 Fri





# Changing the screen layout

You can change the layout as shown below.

Solution1

	A	B		Filter	Previous Month							ThisWeek							ThisWeek							ThisWeek							ThisWeek						
			Staff Name		27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
					Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
1			Staff1		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
2			Staff2		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
3			Staff3		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
4			Staff4		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
5			Staff5		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
6			Staff6		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
7			Staff7		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
8			Staff8		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
9			Staff9		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
10			Staff10		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
11			Staff11		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
12			Staff12		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
13			Staff13		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
14			Staff14		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
Column Constraint					Filter							Filter							Filter							Filter							Filter						
1					Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	
2					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				
3																																							
4																																							
5																																							
6																																							
7																																							
8																																							

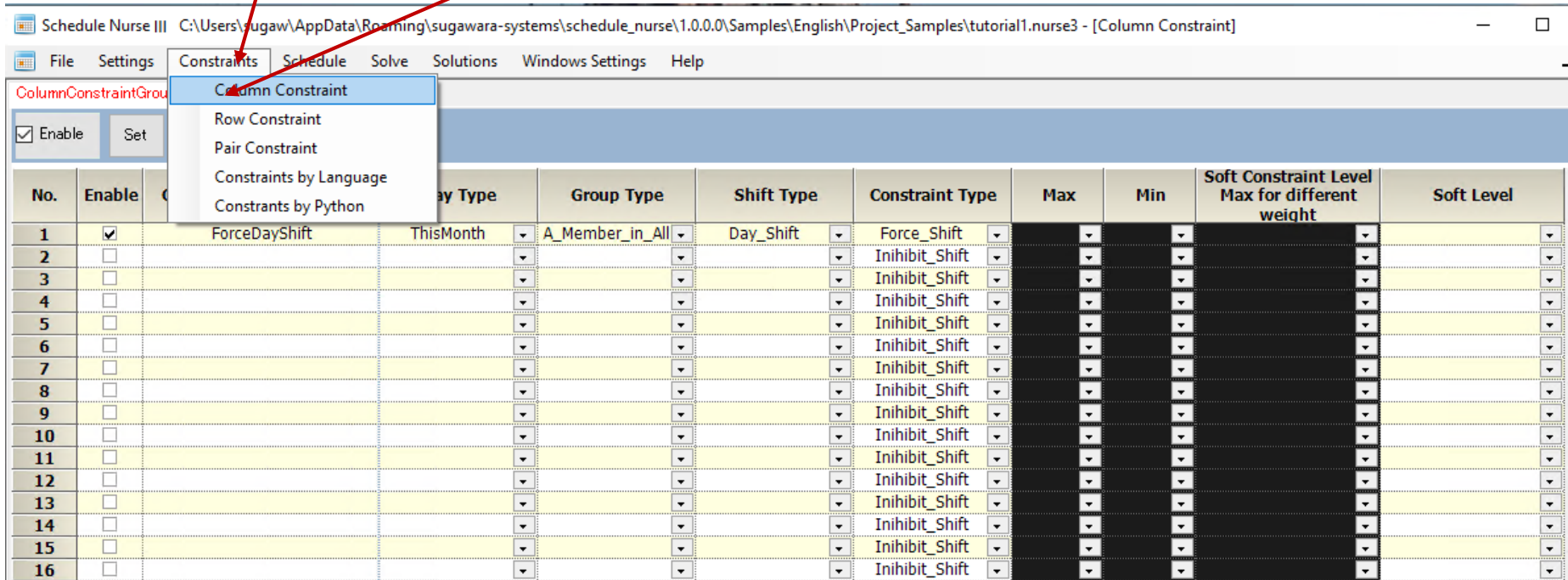
Solution1

	Staff Name	Filter	Previous Month							ThisWeek							ThisWeek							ThisWeek													
			27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
			Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon
1	Staff1		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
2	Staff2		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
3	Staff3		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
4	Staff4		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
5	Staff5		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
6	Staff6		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
7	Staff7		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
8	Staff8		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
9	Staff9		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
10	Staff10		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
11	Staff11		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
12	Staff12		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
13	Staff13		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
14	Staff14		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
15	Staff15		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
16	Staff16		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
17	Staff17		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
18	Staff18		A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
Column Constraint			Filter							Filter							Filter							Filter													
1			Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	
2			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				
3																																					



# Column constraints

There is only one constraint in this project. Let's take a look.  
Click "Constraints" → "Column constraints"



The screenshot shows the 'Schedule Nurse III' application window. The title bar indicates the file path: C:\Users\sugaw\AppData\Roaming\sugawara-systems\schedule\_nurse\1.0.0.0\Samples\English\Project\_Samples\tutorial1.nurse3 - [Column Constraint]. The menu bar includes File, Settings, Constraints, Schedule, Solve, Solutions, Windows Settings, and Help. The 'Constraints' menu is open, showing options: Column Constraint, Row Constraint, Pair Constraint, Constraints by Language, and Constraints by Python. The 'Column Constraint' option is selected. Below the menu, there is a table with columns: No., Enable, Day Type, Group Type, Shift Type, Constraint Type, Max, Min, Soft Constraint Level, and Soft Level. The table contains 16 rows of data.

No.	Enable	Day Type	Group Type	Shift Type	Constraint Type	Max	Min	Soft Constraint Level	Soft Level
1	<input checked="" type="checkbox"/>	ForceDayShift	ThisMonth	A_Member_in_All	Day_Shift	Force_Shift			
2	<input type="checkbox"/>				Inihibit_Shift				
3	<input type="checkbox"/>				Inihibit_Shift				
4	<input type="checkbox"/>				Inihibit_Shift				
5	<input type="checkbox"/>				Inihibit_Shift				
6	<input type="checkbox"/>				Inihibit_Shift				
7	<input type="checkbox"/>				Inihibit_Shift				
8	<input type="checkbox"/>				Inihibit_Shift				
9	<input type="checkbox"/>				Inihibit_Shift				
10	<input type="checkbox"/>				Inihibit_Shift				
11	<input type="checkbox"/>				Inihibit_Shift				
12	<input type="checkbox"/>				Inihibit_Shift				
13	<input type="checkbox"/>				Inihibit_Shift				
14	<input type="checkbox"/>				Inihibit_Shift				
15	<input type="checkbox"/>				Inihibit_Shift				
16	<input type="checkbox"/>				Inihibit_Shift				



# Description of the column constraint

This is the next screen. There is one constraint written. “**ForceDayshift**” is an arbitrary user-specified name for the constraint. The meaning of the constraint is

- [this month],
- for [all employees],
- for [day shifts],
- perform [Force\_Shift]

It's not that hard after all!

Screenshot of the 'Schedule Nurse III' software interface showing the 'Column Constraint' window. The window displays a table with 10 columns: No., Enable, Column Constraint Name, Day Type, Group Type, Shift Type, Constraint Type, Max, Min, Soft Constraint Level (Max for different weight), and Soft Level. Row 1 is highlighted in blue and contains the constraint 'ForceDayShift'.

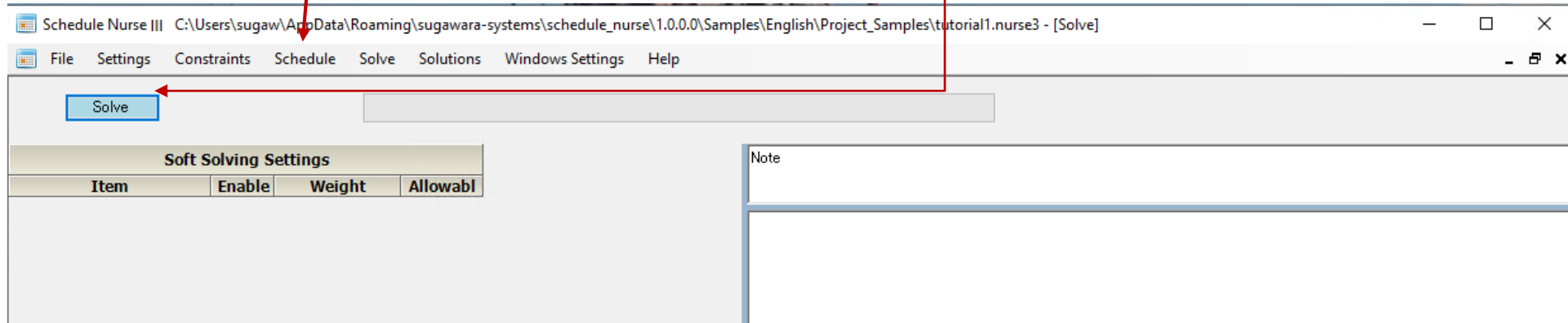
No.	Enable	Column Constraint Name	Day Type	Group Type	Shift Type	Constraint Type	Max	Min	Soft Constraint Level Max for different weight	Soft Level
1	<input checked="" type="checkbox"/>	ForceDayShift	ThisMonth	A_Member_in_All	Day_Shift	Force_Shift				
2	<input type="checkbox"/>					Inihibit_Shift				
3	<input type="checkbox"/>					Inihibit_Shift				
4	<input type="checkbox"/>					Inihibit_Shift				
5	<input type="checkbox"/>					Inihibit_Shift				





# Finding the solution

Click on **Find solution** here, and then click the **Find solution** button.

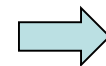






# The screen after finding the solution

Indeed, all staff members work “DayShift” this month.



This month

Schedule Nurse III

C:\Users\sugaw\AppData\Roaming\sugawara-systems\schedule\_nurse\1.0.0.0\Samples\English\Project\_Samples\tutorial1.nurse3 - [Solutions]

File

Settings

Constraints

Schedule

Solve

Solutions

Windows Settings

Help

Solution1

	A			Filter	Previous Month					The1Week							The2Week							
			Staff Name		27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
6			Staff6		A	A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
7			Staff7		A	A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
8			Staff8		A	A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
9			Staff9		A	A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
10			Staff10		A	A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
11			Staff11		A	A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
12			Staff12		A	A	A	A	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D

Column Constraint

Filter

Tue

Wed

Thu

Fri

Sat

Sun

Mon

Tue

Wed

Thu

Fri

Sat

Sun

1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								

16





# Turning column constraint groups on / off

There is only one column constraint here, but you can also write multiple column constraints. The column constraints on this page are called **Column Constraint Group 1**. (You can name the group however you want.)

You can also turn off the constraint on the enforcement test itself by clicking to remove the check mark from the "**Apply**" box. Let's try it out. Click "Apply." Let's try to [find the solution](#) again and see how it changes.

Schedule Nurse III C:\Users\sugaw\AppData\Roaming\sugawara-systems\schedule\_nurse\1.0.0.0\Samples\English\Project\_Samples\tutorial1.nurse3 - [Column Constraint]

File Settings Constraints Schedule Solve Solutions Windows Settings Help

ColumnConstraintGroup1 ColumnConstraintGroup2

☒ Enable Set ColumnConstraintGroup1

No.	Enable	Column Constraint Name	Day Type	Group Type	Shift Type	Constraint Type	Max	Min	Soft Constraint Level Max for different weight	Soft Level
1	<input checked="" type="checkbox"/>	ForceDayShift	ThisMonth	A_Member_in_All	Day_Shift	Force_Shift				
2	<input type="checkbox"/>					Inihibit_Shift				
3	<input type="checkbox"/>					Inihibit_Shift				
4	<input type="checkbox"/>					Inihibit_Shift				





# The “Find solution” screen without constraints

It is no longer true that all staff members are on the “DayShift” this month.

→ This month

Schedule Nurse IIIC:\Users\sugaw\AppData\Roaming\sugawara-systems\schedule\_nurse\1.0.0.0\SamplesEnglish\Project\_Samples\tutorial1.nurse3 - [Solutions]

FileSettingsConstraintsScheduleSolveSolutionsWindows SettingsHelp

Solution1

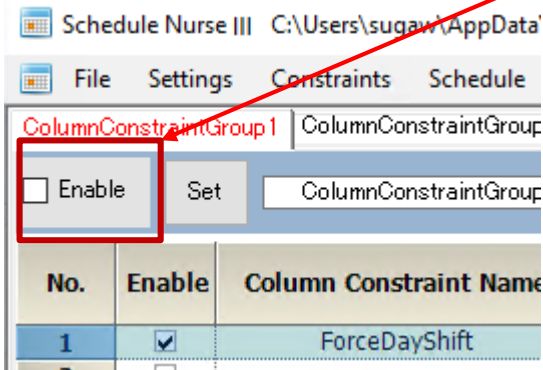
	A		Staff Name	Filter	Previous Month					The1Week							The2Week							
					27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Tue	Wed	Thu	Fri	Sa	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1			Staff1		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
2			Staff2		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
3			Staff3		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
4			Staff4		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
5			Staff5		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
6			Staff6		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
7			Staff7		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		



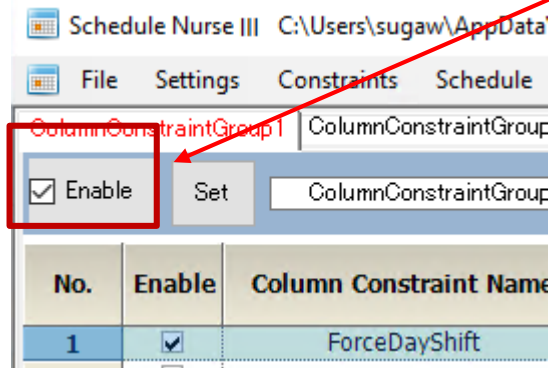
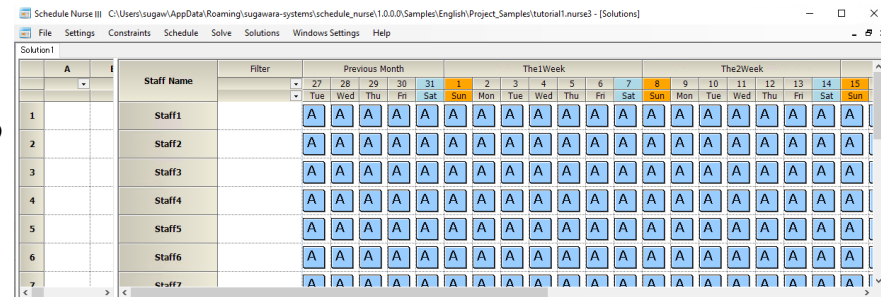


# The difference between having a constraint or not

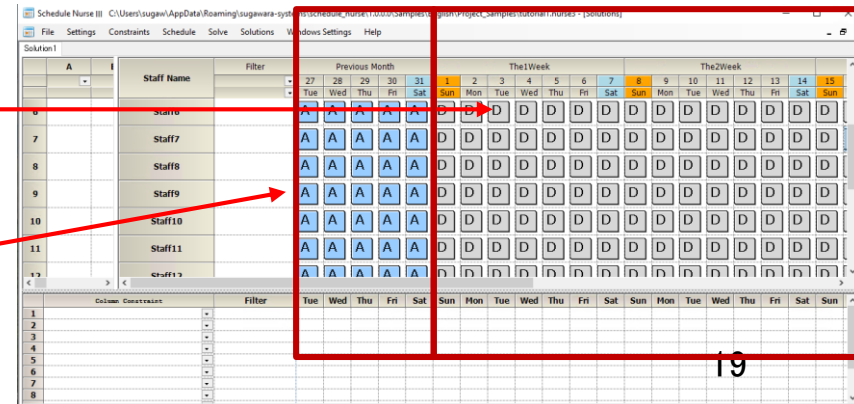
There is a change in the way the solution appears depending on whether there is a constraint or not. Try and see it yourself.



■ It is not clear what is going to get assigned when there are no constraints. The right screen just happened to turn out like this, and it might have turned out differently depending on the environment.



■ When there is a constraint, all staff members work “DayShift” this month. However, there was no constraint for previous month, so we cannot predict what will get assigned.







# When you don't place constraints

**You cannot predict what gets assigned.** In other words, you cannot control assignments without the constraint. So, you need to place some constraints (since there is nothing to control it).

We state this again, as it is especially important.





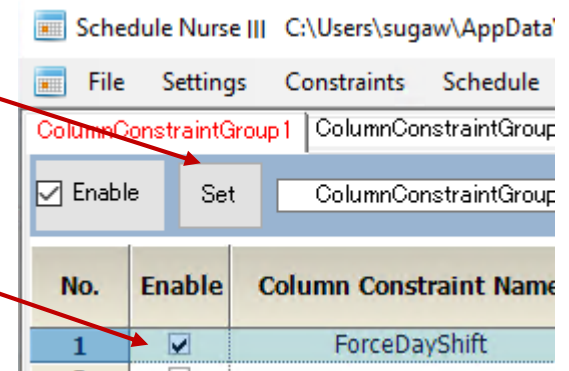
# Turning individual constraints on and off

To turn off individual constraints, uncheck the "Apply" box and **click** the "Set" button.

To turn on individual constraints, check the "Apply" box and **click** the "Set" button.

**Note that your settings won't be effective if you don't click the "Set" button.**

(This applies for all constraints that appear later on as well.)

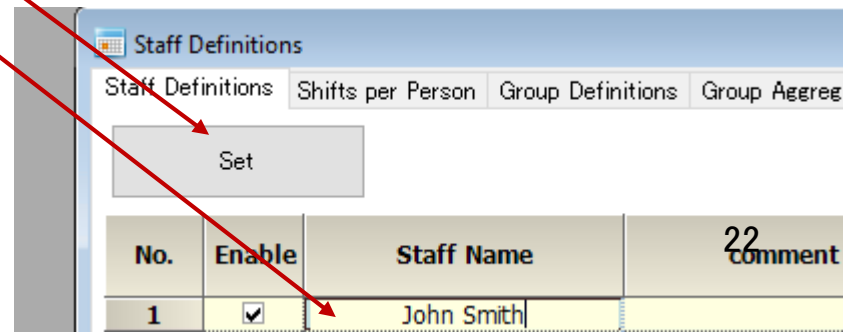
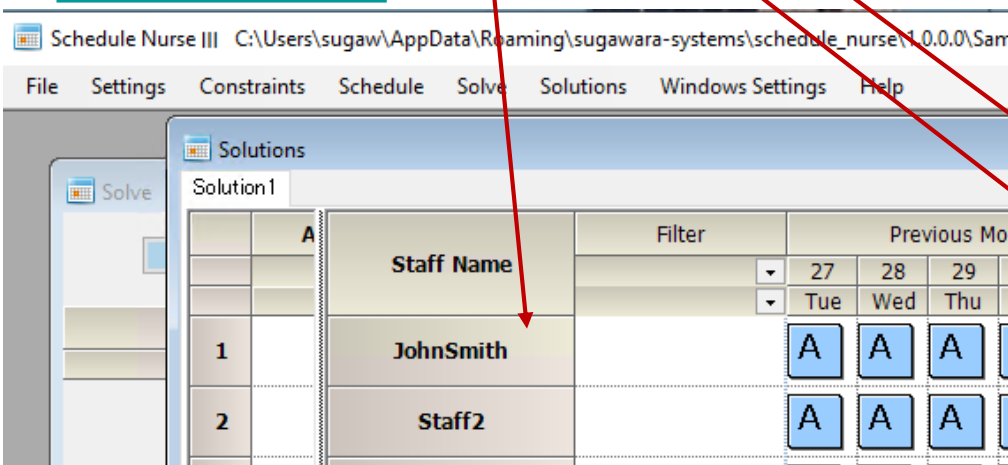
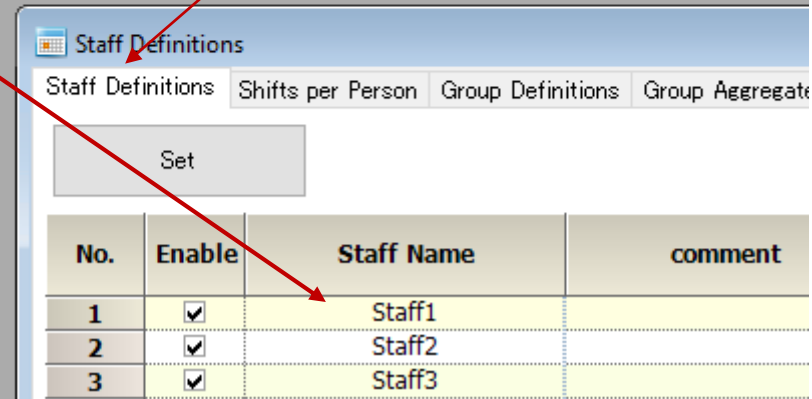
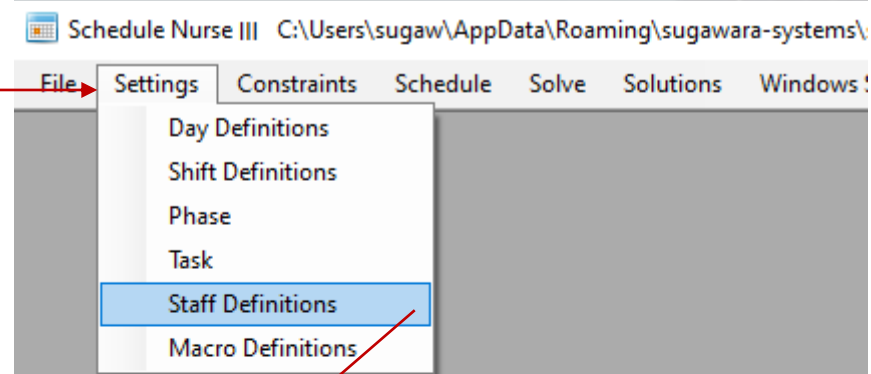




# Tutorial2 Changing staff member names

Click on **Settings**→ **Staff Definitions**→ **Staff Definitions**→ **Staff Name1**. Click again to remove the blue color and make it editable. Try typing in any name.

- After clicking the "**Set**" button, try to find a **solution**.
- See for yourself that the staff member names change in **the Solution screen**.





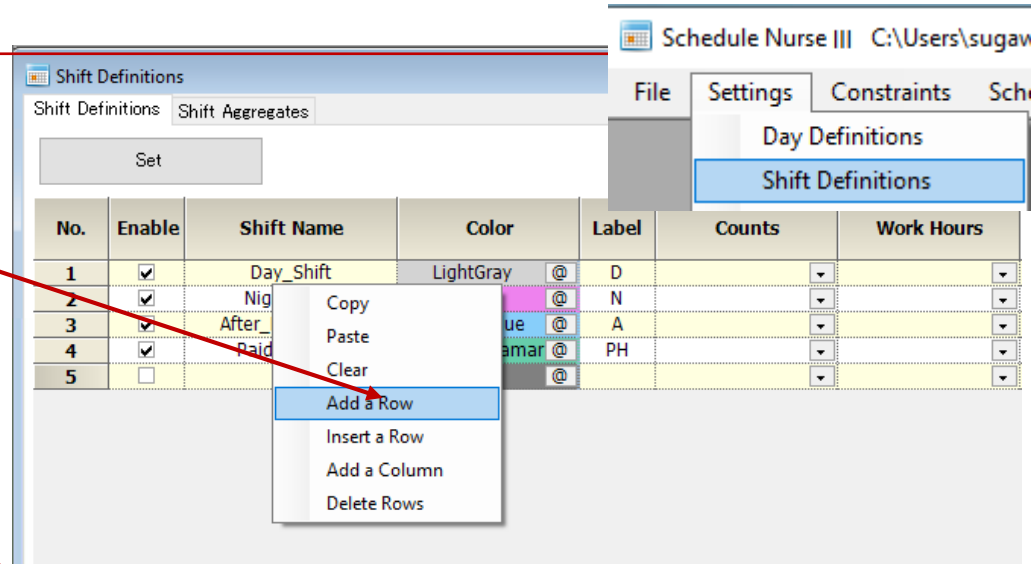


# Tutorial2 Adding Shifts

Go to **Settings** → **Shift Definitions** → right click inside the Shift Definitions table and a menu will appear. **Add a Row**. We added a **Late\_Shift** to try it out.

If you look at the column constraints after clicking the **Set** button, you will see the **late shift** we just added in a **shift type** column.

See for yourself that **finding a solution** after you click the **Set** button produces addressed solution with forced **Late\_Shift** this month.



5	<input checked="" type="checkbox"/>	Late_Shift	BurlyWood	@	L
---	-------------------------------------	------------	-----------	---	---

Solutions

ution I

A	B

No.	Enable	Column Constraint Name	Day Type	Group Type	Shift Type	Constraint Type
1	<input checked="" type="checkbox"/>	ForceDayShift	ThisMonth	A_Member_in_All	Late_Shift	Force_Shift
2	<input type="checkbox"/>				Night_Shift	Inhibit_Shift
3	<input type="checkbox"/>				After_Night_Shift	Inhibit_Shift
4	<input type="checkbox"/>				Paid_Holiday	Inhibit_Shift
5	<input type="checkbox"/>				Late_Shift	Inhibit_Shift
6	<input type="checkbox"/>				phase_var1	Inhibit_Shift
					phase_var2	Inhibit_Shift





# Tutorial3 Cardinal constraints

A constraint where a number is counted is called a cardinal constraint. For example, this is the constraint we use where there are 2 staff members on the night shift. Tutorial 3 shows an example of a cardinal number constraint. Let's open the column constraint from Tutorial 3.

Column Constraint

ColumnConstraintGroup1 | ColumnConstraintGroup2

☒ Enable    Set    ColumnConstraintGroup1

No.	Enable	Column Constraint Name	Day Type	Group Type	Shift Type	Constraint Type	Max	Min
1	<input checked="" type="checkbox"/>	TwoNightShift	ThisMonth	A_Member_in_All	Night_Shift	Max-Min_Staffs	2	2

The constraint type is the maximum and minimum staff number. Both are set to 2, so this instruction means

- [this month],
- for [all staff members],
- set the [night shift]
- for 2 people.

Let's check it by [finding a solution](#).



[illegible]





# Tutorial3 Adding a column constraint

Add the following statement to secure two people for the day after the night shift.

Column Constraint

ColumnConstraintGroup1 | ColumnConstraintGroup2

☒ Enable    Set    ColumnConstraintGroup1

No.	Enable	Column Constraint Name	Day Type	Group Type	Shift Type	Constraint Type	Max	Min
1	<input checked="" type="checkbox"/>	TwoNightShift	ThisMonth	A_Member_in_All	Night_Shift	Max-Min_Staffs	2	2
2	<input checked="" type="checkbox"/>	TwoAfterNightShift	ThisMonth	A_Member_in_All	After_Night_Shift	Max-Min_Staffs	2	2

Click on the **Set** button and then [find a solution](#).

**Insert All** by right-clicking menu, is convenient for adding undisplayed constraints automatically.

	Column Constraint	Filter	Tue	Wed	Thu	Fri	Sat	Sun	Mo
1	TwoNightShift							2	2
2	TwoAfterNightShift							2	2
3									
4									
5									

Insert All

Insert a Row

Delete Rows

Show Unsatisfactory Items Undersched



Column Constraint

ColumnConstraintGroup1

ColumnConstraintGroup2

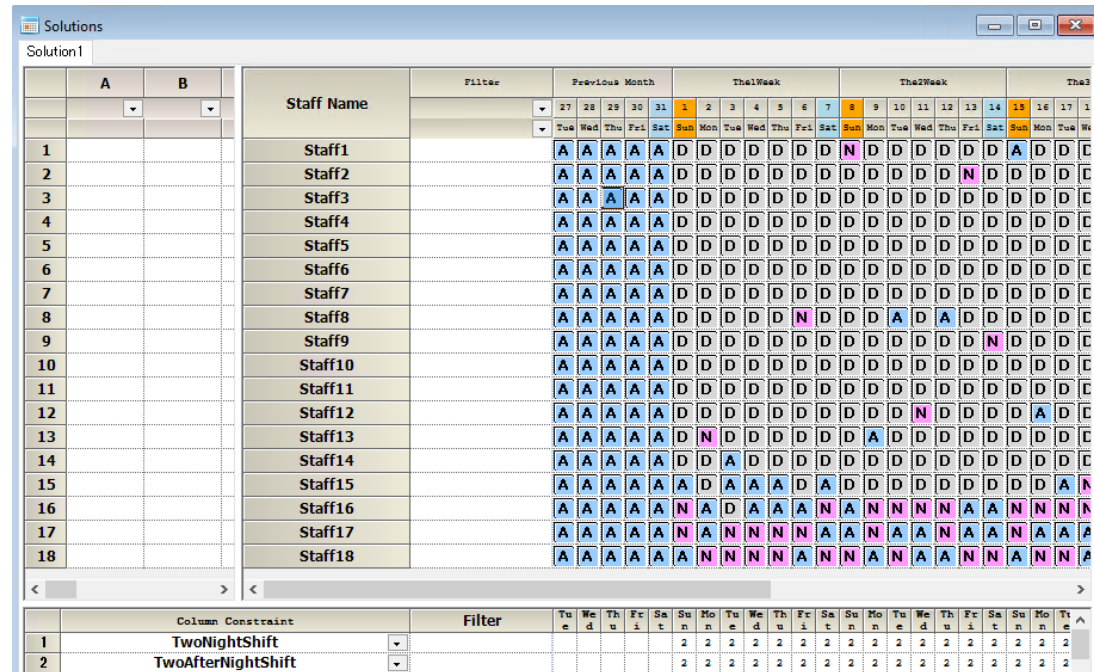
☒ Enable
 

Set

ColumnConstraintGroup1

No.	Enable	Column Constraint Name	Day Type	Group Type	Shift Type	Constraint Type	Max	Min
1	<input checked="" type="checkbox"/>	TwoNightShift	ThisMonth	A_Member_in_All	Night_Shift	Max-Min_Staffs	2	2
2	<input checked="" type="checkbox"/>	TwoAfterNightShift	ThisMonth	A_Member_in_All	After_Night_Shift	Max-Min_Staffs	2	2

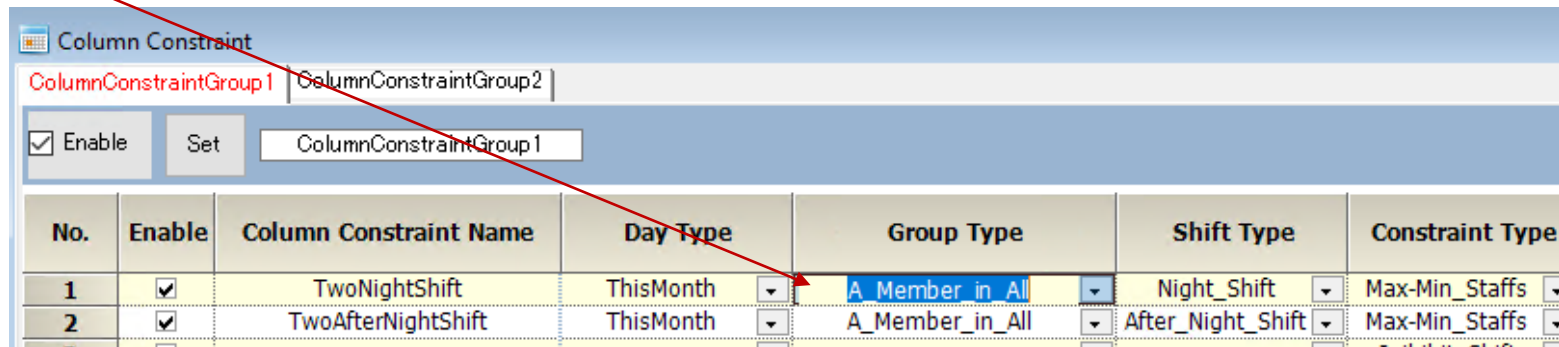
The pattern of night shifts is explained in [two-shift patterns](#).





# Defining a group type

We will add a constraint that makes it so that at least one nurse is on Night Shift out of nurses and assistant nurses. Currently, the only group type option is "A member in all." We will show you how to add the nurse group and assistant nurse separately.



Column Constraint

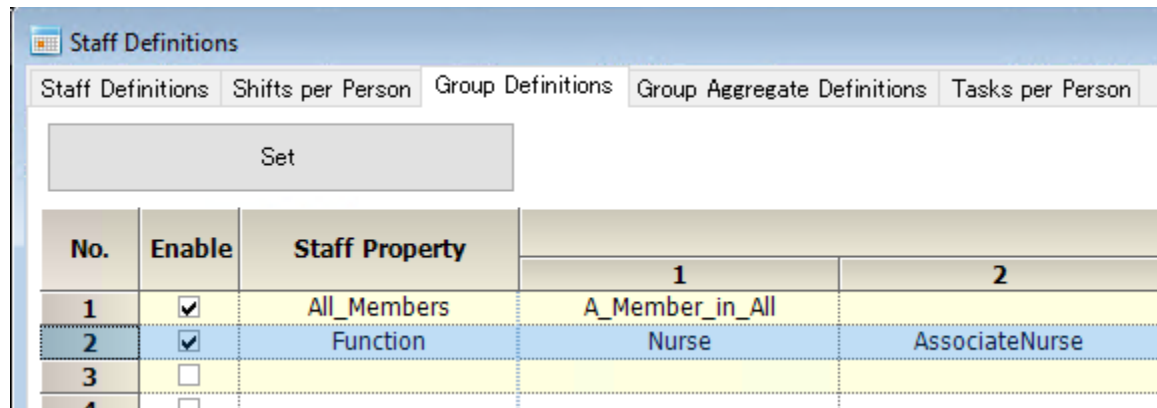
ColumnConstraintGroup1 | ColumnConstraintGroup2

☒ Enable    Set    ColumnConstraintGroup1

No.	Enable	Column Constraint Name	Day Type	Group Type	Shift Type	Constraint Type
1	<input checked="" type="checkbox"/>	TwoNightShift	ThisMonth	A Member in All	Night_Shift	Max-Min_Staffs
2	<input checked="" type="checkbox"/>	TwoAfterNightShift	ThisMonth	A_Member_in_All	After_Night_Shift	Max-Min_Staffs

Go to [Settings](#) → [Staff Definitions](#) → [Group Definitions](#) to get to the Group Definitions screen.

Enter the information as shown in the blue part on the right, then click the Set button. ◦



Staff Definitions

Staff Definitions    Shifts per Person    Group Definitions    Group Aggregate Definitions    Tasks per Person

Set

No.	Enable	Staff Property	1	2
1	<input checked="" type="checkbox"/>	All_Members	A_Member_in_All	
2	<input checked="" type="checkbox"/>	Function	Nurse	AssociateNurse
3	<input type="checkbox"/>			
4	<input type="checkbox"/>			



## Defining the group type 2

If you look at the Staff Definitions page, you'll see an attribute section called Function where you can select alternatives. With this, you can set up each staff member. You can leave it blank for those who do not fall into this category (e.g., administrators).

Staff Definitions Shifts per Person Group Definitions Group Aggregate Definitions Tasks per Person

Set

No.	Enable	Staff Name	comment	All_Members	Function
1	<input checked="" type="checkbox"/>	Staff1		A_Member_in_All	
2	<input checked="" type="checkbox"/>	Staff2		A_Member_in_All	
3	<input checked="" type="checkbox"/>	Staff3		A_Member_in_All	Nurse
4	<input checked="" type="checkbox"/>	Staff4		A_Member_in_All	AssociateNurse

There is now a selection for group types in column constraints as well.

This way, you can create ~~whichever~~ group attributes you want. You can select only those who have the attribute and apply the constraint to them.

Column Constraint

ColumnConstraintGroup1 ColumnConstraintGroup2

☒ Enable Set ColumnConstraintGroup1

No.	Enable	Column Constraint Name	Day Type	Group Type
1	<input checked="" type="checkbox"/>	TwoNightShift	ThisMonth	A_Member_in_Al
2	<input checked="" type="checkbox"/>	TwoAfterNightShift	ThisMonth	A_Member_in_Al
3	<input type="checkbox"/>			Nurse
4	<input type="checkbox"/>			AssociateNurse





# Tutorial5 Setting the day of the week

Open Tutorial 5 and see its column constraints. We added No.5 and 6 on the previous page.

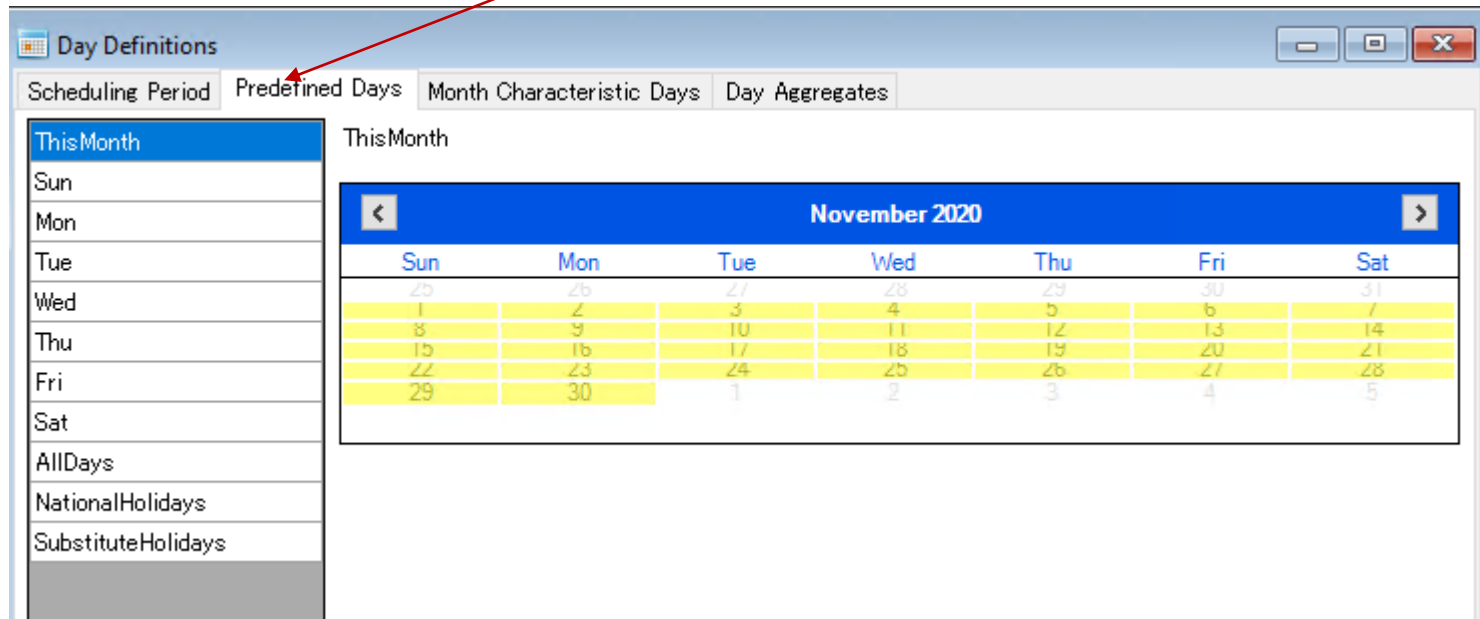
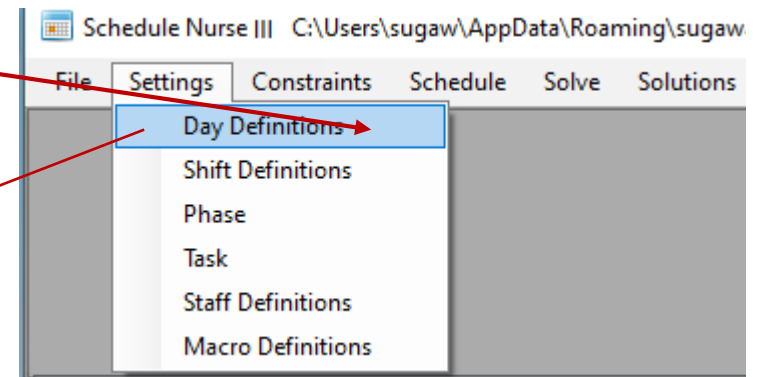
Column Constraint								
ColumnConstraintGroup1		ColumnConstraintGroup2						
<input checked="" type="checkbox"/> Enable		Set ColumnConstraintGroup1						
No.	Enable	Column Constraint Name	Day Type	Group Type	Shift Type	Constraint Type	Max	Min
1	<input checked="" type="checkbox"/>	TwoNightShift	ThisMonth	A_Member_in_All	Night_Shift	Max-Min_Staffs	2	2
2	<input checked="" type="checkbox"/>	TwoAfterNightShift	ThisMonth	A_Member_in_All	After_Night_Shift	Max-Min_Staffs	2	2
3	<input checked="" type="checkbox"/>	At_least_1_nurse_per_Night_S	ThisMonth	Nurse	Night_Shift	Max-Min_Staffs		1
4	<input checked="" type="checkbox"/>	At_least_1_nurse_per_After_Ni	ThisMonth	Nurse	After_Night_Shift	Max-Min_Staffs		1
5	<input checked="" type="checkbox"/>	At_least_10_persons_on_Days	ConsultationDay	A_Member_in_All	Day_Shift	Max-Min_Staffs		10
6	<input checked="" type="checkbox"/>	At_least_5_persons_on_Days_	Day_on_Closed	A_Member_in_All	Day_Shift	Max-Min_Staffs		5

The new constraint is Day\_Shift. An additional rule is applied, making it so that there are at least ten people on working days and at least five on weekends. Let's see how to set the days of the week, such as working days and weekends.



# Tutorial5 Setting the day of the week 2

You will see the following by clicking on [Settings](#) → [Day Definitions](#) → [Scheduling Period](#) → [ThisMonth](#). The section marked in yellow is the definition of the month.







# Tutorial5 Setting the day of the week 3

See the definition of a weekday. "WeekDay" can be Monday, Tuesday, Wednesday, Thursday, or Friday. We can define "WeekDay" using the operator OR. And "Weekends" means Saturday or Sunday. "Day\_on\_Closed" is weekends or holidays. We can determine the working days using "Day\_on\_Closed". Working days (Consultation days) are the negation of "Day\_on\_Closed," so we use the NOT operator. In this way, we can create any day of the week by themselves. Don't forget to click on the Set button after you've made changes.

You can tell if your weekday definition is correct by looking at the calendar.

Day Definitions

Scheduling Period Predefined Days Month Characteristic Days Day Aggregates

Set

No.	Enable	Day Aggregate Name	Operator	1	2	3	4	5
1	<input checked="" type="checkbox"/>	WeekDay	OR	Mon	Tue	Wed	Thu	Fri
2	<input checked="" type="checkbox"/>	WeekEnds	OR	Sat	Sun			
3	<input checked="" type="checkbox"/>	Day_on_Closed	OR	WeekEnds	NationalHolidays			
4	<input checked="" type="checkbox"/>	ConsultationDay	NOT	Day_on_Closed				
5	<input checked="" type="checkbox"/>	StartDateMinus1	-1	StartDate				
6	<input checked="" type="checkbox"/>	StartDateMinus2	-2	StartDate				
7	<input checked="" type="checkbox"/>	StartDateMinus3	-3	StartDate				
8	<input checked="" type="checkbox"/>	StartDateMinus4	-4	StartDate				
9	<input checked="" type="checkbox"/>	StartDateMinus5	-5	StartDate				
10	<input checked="" type="checkbox"/>	StartDateMinus6	-6	StartDate				
11	<input checked="" type="checkbox"/>	StartDateMinus7	-7	StartDate				
12	<input checked="" type="checkbox"/>	StartDatePlus1	+1	StartDate				
13	<input checked="" type="checkbox"/>	StartDatePlus2	+2	StartDate				
14	<input checked="" type="checkbox"/>	StartDatePlus3	+3	StartDate				
15	<input checked="" type="checkbox"/>	StartDatePlus4	+4	StartDate				
16	<input checked="" type="checkbox"/>	StartDatePlus5	+5	StartDate				

WeekEnds

October 2020

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
1	2	3	4	5	6	7

November 2020

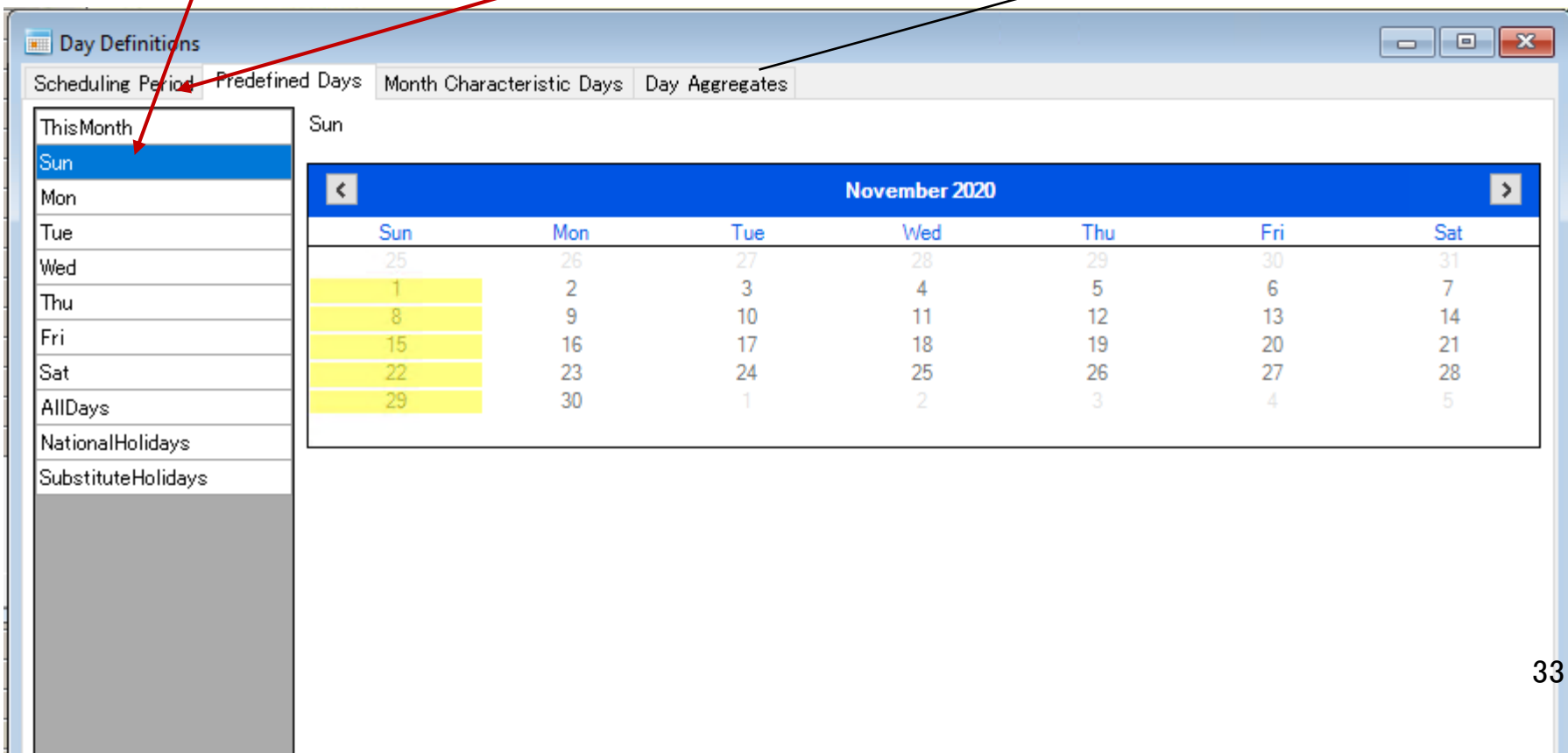
Sun	Mon	Tue	Wed	Thu	Fri	Sat
25	26	27	28	29	30	31
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5



# Tutorial5 Setting the day of the week 4

Click on **Sunday**. The calendar is displayed.

These weekdays are determined when you set Scheduling Period and cannot be changed. On the other hand, the user can freely define the weekdays formed by Day Aggregates.



The screenshot shows the 'Day Definitions' window with the 'Predefined Days' tab selected. The 'Scheduling Period' is set to 'ThisMonth'. The 'Sun' day is selected in the left sidebar. The main area displays a calendar for November 2020, with days of the week as columns and dates as rows. The 'Sun' column is highlighted in yellow.

Sun	Mon	Tue	Wed	Thu	Fri	Sat
25	26	27	28	29	30	31
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5



# Tutorial5 Check your synthesis by the Calendar



Click on **Day Aggregates** → **WeekDay**. The yellow on the calendar represents that definition.

Day Definitions

Scheduling Period Predefined Days Month Characteristic Days Day Aggregates

Set

No.	Enable	Day Aggregate Name	Operator	1	2
1	<input checked="" type="checkbox"/>	WeekDay	OR	Mon	Tue
2	<input checked="" type="checkbox"/>	WeekEnds	OR	Sat	Sun
3	<input checked="" type="checkbox"/>	Day_on_Closed	OR	WeekEnds	NationalHolidays
4	<input checked="" type="checkbox"/>	ConsultationDay	NOT	Day_on_Closed	
5	<input checked="" type="checkbox"/>	StartDateMinus1	-1	StartDate	
6	<input checked="" type="checkbox"/>	StartDateMinus2	-2	StartDate	
7	<input checked="" type="checkbox"/>	StartDateMinus3	-3	StartDate	
8	<input checked="" type="checkbox"/>	StartDateMinus4	-4	StartDate	
9	<input checked="" type="checkbox"/>	StartDateMinus5	-5	StartDate	
10	<input checked="" type="checkbox"/>	StartDateMinus6	-6	StartDate	
11	<input checked="" type="checkbox"/>	StartDateMinus7	-7	StartDate	
12	<input checked="" type="checkbox"/>	StartDatePlus1	+1	StartDate	
13	<input checked="" type="checkbox"/>	StartDatePlus2	+2	StartDate	
14	<input checked="" type="checkbox"/>	StartDatePlus3	+3	StartDate	
15	<input checked="" type="checkbox"/>	StartDatePlus4	+4	StartDate	
16	<input checked="" type="checkbox"/>	StartDatePlus5	+5	StartDate	
17	<input checked="" type="checkbox"/>	StartDatePlus6	+6	StartDate	

WeekDay

October 2020

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
1	2	3	4	5	6	7

November 2020

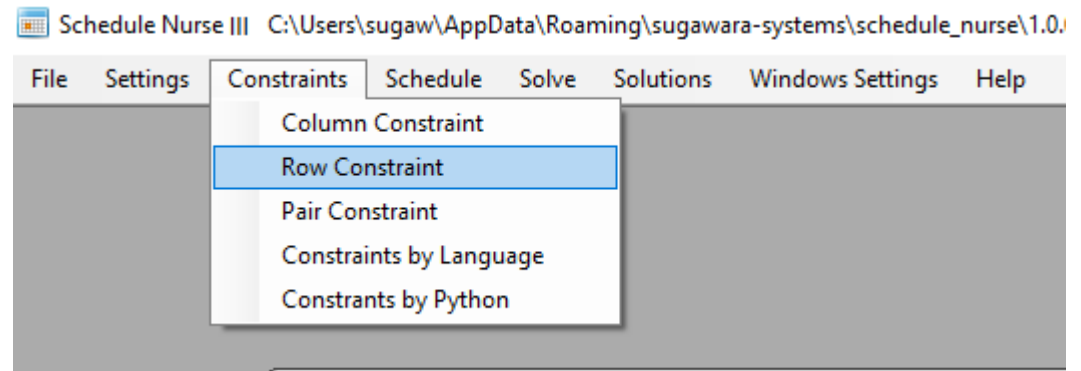
Sun	Mon	Tue	Wed	Thu	Fri	Sat
25	26	27	28	29	30	31
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5





# Tutorial6 Row constraints

Open **Constraints** → **Row Constraints**.







# Tutorial6 Two-shift patterns

Open Constraints → Row Constraints → Two-Shift.

Row Constraint

Consecutive\_Off\_Days | Flattening | **Two-Shift** | CardinalityConstraint

☒ Enable    Set    Two-Shift    ☐ ☐ D ☒ N ☒ A ☒ PH

No.	Enable	Row Constraint Name	Day Type	Group Type	Constraint Type	Shift Pattern							
						0	1	2	3	4	5	6	
1	<input checked="" type="checkbox"/>	NightShift_followed_by_After_Night_Shift	FromStartDateMinus1	A_Member_in_All	Inhibit_Pattern	<input type="checkbox"/>	N	<input checked="" type="checkbox"/> A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	<input checked="" type="checkbox"/>	After_Night_Shift_preceded_by_NightShift_Shift	FromStartDateMinus1	A_Member_in_All	Inhibit_Pattern	<input checked="" type="checkbox"/>	N	<input type="checkbox"/> A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	<input checked="" type="checkbox"/>	After_Night_Shift_followed_by_Paid_Holiday	FromStartDateMinus1	A_Member_in_All	Inhibit_Pattern	<input type="checkbox"/>	A	<input checked="" type="checkbox"/> PH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Three constraints are defined.

"✓" means negation(Boolean NOT operator).

The first constraint prohibits the pattern of "Night\_Shift," followed by NOT operation of "After\_Night\_Shift".

The second constraint prohibits the pattern of NOT operation of "Night\_Shift," followed by "After Night Shift".

As a result, "Night\_Shift," followed by "After\_Night\_Shift," becomes mandatory with those constraints.

Third constraint forces "Paid\_Day" must be followed by "After\_Night\_Shift".





# Tutorial 6 Cardinality Constraint

Open Constraints → Row Constraints → CardinalityConstraint

Row Constraint

Consecutive\_Off\_Days | Flattening | Two-Shift | **CardinalityConstraint**

☒ Enable    Set    CardinalityConstraint

☐ ☐ D ☒ N ☐ A ☐ PH

No.	Enable	Row Constraint Name	Day Type	Group Type	Constraint Type	Shift Pattern							Max	Min	
						0	1	2	3	4	5	6			
1	<input checked="" type="checkbox"/>	Number_of_Paid_Holidays	ThisMonth	A_Member_in_All	Max-Min_Pattern	<input type="checkbox"/>	<input checked="" type="checkbox"/> PH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9	9
2	<input checked="" type="checkbox"/>	Number_of_Night_Shifts	ThisMonth	A_Member_in_All	Max-Min_Pattern	<input type="checkbox"/>	<input checked="" type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5	3

The first constraint allocates 9 “Paid Holidays” for all staff members this month.

The second constraint allocates 3-5 “Night Shift” for all staff members this month.





## Tutorial6 Changing the number of night shifts and public holidays

Let's try to change the number of public holidays to 8 and [find a solution](#). Don't forget to click on the **Set** button.

Make sure that the number is eight after finding the solution.

Solutions

Solution1

	A	B	C	D	
	Nights	After	Af	Number_of_Pai	Nun
1	0	0	0	8	
2	0	0	0	8	
3	0	0	0	8	
4	0	0	0	8	
5	0	0	0	8	
6	0	0	0	8	
7	0	0	0	8	
8	0	0	0	8	
9	0	0	0	8	
10	0	0	0	8	
11	0	0	0	8	
12	0	0	0	8	
13	0	0	0	8	
14	0	0	0	8	
15	0	0	0	8	
16	0	0	0	8	
17	0	0	0	8	
18	0	0	0	8	

Staff Name

Filter	Previous Month	The1Week	The2Week	The3Week	T
	27 28 29 30 31	1 2 3 4 5 6 7	8 9 10 11 12 13 14	15 16 17 18 19 20 21	22 23 24
	Tue Wed Thu Fri Sat Sun	Mon Tue Wed Thu Fri Sat Sun	Mon Tue Wed Thu Fri Sat Sun	Mon Tue Wed Thu Fri Sat Sun	Mon Tue Wed Thu Fri Sat Sun
Staff1	A A A A P D	N A P D N A P D	D D P D D D D D	P D D D D D P D	D D D D P N A
Staff2	D A A A P D	D D D P D D N A	P D N A P D D D	N A P D D D N A	P D N A P D D
Staff3	D A A A P D	D D D D D P P P	N A P D D D P D	D D D D P D D D	D D P D D D
Staff4	D A A A P D	N A P P P D D N	A P D D D D P D	D D D D P D D D	P D N A P D N
Staff5	P A A A N A	P D D D D P D P	D D D D P D D D	D N A P D P N A	P P N A P D P
Staff6	A A A A P A	P N A P D D D P	D D P D D D N A	P D D D P D N A	P D N A P D P
Staff7	A A A D P D	D D D P D D P D	D D P D D D N A	P D D D P D D D	D D D D N A P
Staff8	D D D A D P	D N A P D N A P	D D P D N A P D	D D P D P D D D	P D D D P D D
Staff9	A D A D P D	D D P D D D P D	D D D D P D D D	P N A P D D N A	P D P D P D D
Staff10	D D D D P D	D D D D P N A P	D D D D P D D D	D D D D P D D D	P D N A P D P
Staff11	A D D D P D	D D D N A P D D	N A P D D D P D	P P P D D D P D	D D D D P D D
Staff12	D D D D P D	P D D P D N A P	D D D N A P P P	N A P D D D N A	P D D D P D D
Staff13	P D D D N A	P D D D D P D D	D D D N A P P D	N A P D D D P D	D D D D P D D
Staff14	A D D P D D	D D D N A P D D	D D D D P D D D	P D D D P D D D	P N A P D P D
Staff15	D A D D P D	P D D D D P P D	D D P D D D P D	P D P D D D N A	P D D D N A P
Staff16	D D D D P D	D D D D D P P D	D D D N A P P D	D D D P P D D D	D D D D P D P
Staff17	D D D D P D	P D D N A P D N	A P D N A P D D	P D P D D D P D	D D D D P D N
Staff18	D D D D P N	A P D N A P D P	D D D N A P D D	D D D P D D P D	D D D D P D D

Column Constraint

Filter	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo
1 TwoNightShift						2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2 TwoAfterNightShift						2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3 At_least_1_nurse_per_Night_Shift						1	2	1	1	1	2	2	1	2	1	2	1	1	2	1	1	2	1	2	1	2	1
4 At_least_1_nurse_per_After_Night_Shift						1	1	2	1	1	1	2	2	1	2	1	1	2	1	1	2	1	2	1	2	1	2
5 At_least_10_persons_on_Days_on_Open	10	10	10	10			12	10	10	10	10			10	10	10	10			10	10	10	10			10	
6 At_least_5_persons_on_Days_on_Closed					5	10						5	8					7	5						8	7	





# Tutorial6\_Error

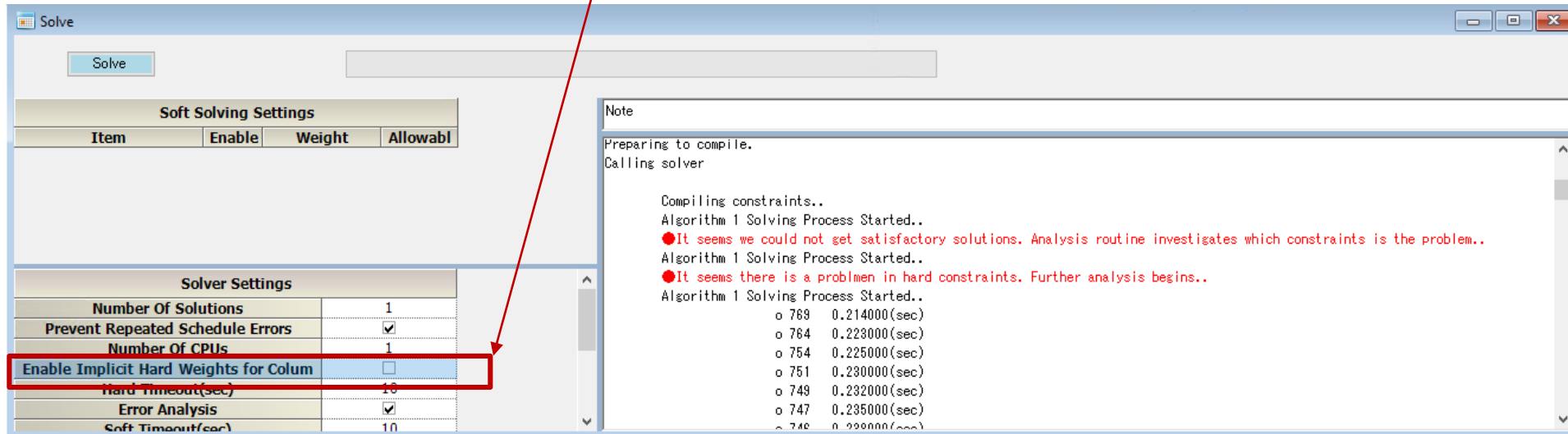
Open Tutorial6\_Error and try to [find a solution](#). You can see that there are many areas marked in red, as shown below. Red Mark shows the hard constraint is not satisfactory.

Solutions			Solution1		



# Tutorial6 Error 2

Now uncheck **Enable Implicit Hard Weight Column** and find a solution. It will take some time, but it will show an error, as on the screen on the bottom right. Checking "Enable Implicit Hard Weight Column" makes softening the hard column constraints, which may result in an infeasible solution. We recommend unchecking it when we investigate conflicting rules and discover the real cause.



The screenshot shows the 'Solve' window with the following settings:

Soft Solving Settings			
Item	Enable	Weight	Allowabl

Solver Settings	
Number Of Solutions	1
Prevent Repeated Schedule Errors	<input checked="" type="checkbox"/>
Number Of CPUs	1
Enable Implicit Hard Weights for Colum	<input type="checkbox"/>
Hard Timeout(sec)	10
Error Analysis	<input checked="" type="checkbox"/>
Soft Timeout(sec)	10

The console output shows the following messages:

```
Preparing to compile.
Calling solver

Compiling constraints..
Algorithm 1 Solving Process Started..
●It seems we could not get satisfactory solutions. Analysis routine investigates which constraints is the problem..
Algorithm 1 Solving Process Started..
●It seems there is a problem in hard constraints. Further analysis begins..
Algorithm 1 Solving Process Started..
o 769 0.214000(sec)
o 764 0.223000(sec)
o 754 0.225000(sec)
o 751 0.230000(sec)
o 749 0.232000(sec)
o 747 0.235000(sec)
o 746 0.238000(sec)
```



[illegible]



# Tutorial 6 Error 4

- This result shows that it is physically impossible to have everyone do four Night Shifts.
- We want to make everyone equal from the perspective of load leveling, but in reality, we need to give it some play, somewhere, as an inequality constraint.
- It is clear from the results on the right that in this example, 3-4 is an appropriate constraint.
- Thus, it is essential to adjust the constraints **while looking at the solution**.

Solutions			
Solution1			
	E		Staff Name
	Number_of_Night_S	Six	
1	3		Staff1
2	3		Staff2
3	3		Staff3
4	4		Staff4
5	3		Staff5
6	3		Staff6
7	3		Staff7
8	4		Staff8
9	3		Staff9
10	4		Staff10
11	3		Staff11
12	4		Staff12
13	3		Staff13
14	4		Staff14
15	3		Staff15
16	3		Staff16
17	3		Staff17
18	4		Staff18

Column Constraint		
1	TwoNightShift	
2	TwoAfterNightShift	
3	At_least_1_nurse_per_Night_Shift	
4	At_least_1_nurse_per_After_Night_Shift	
5	At_least_10_persons_on_Days_on_Open	
6	At_least_5_persons_on_Days_on_Closed	





# Tutorial6 Error Summary

- If you see many red areas in a column constraint, suspect a hard constraint violation.
- Uncheck “[Enable Implicit Hard Weight Column](#)”, and discover the cause.
- Rework or soften (see below) the hard constraints.
- A single constraint violation can lead to errors in unexpected places. In constraint design, it is vital to ensure a solution every time you have written one constraint.
- Don't panic, even if there is no solution. Conflicting constraints may easily cause the problem. Let's get to the cause and brush up on rules, as we have seen in Tutorial6.



# Tutorial7 Soft Constraints

Open **Constraints** → **Row Constraints**.

No.	Enable	Row Constraint Name	Day Type	Group Type	Constraint Type	Shift Pattern							Max	Min	Soft Level	First Day Type			
						0	1	2	3	4	5	6							
1	<input type="checkbox"/>	SatSunOff	Automatic_This Month	A_Member_in_All	Max-Min_Pattern	<input type="checkbox"/>	PH	<input type="checkbox"/>	PH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1	5	Sat
2	<input type="checkbox"/>	TwoDaysOffafterAfter_Night_S hift_ifpossible.	Automatic_This Month	A_Member_in_All	Inhibit_Pattern	<input type="checkbox"/>	A	<input type="checkbox"/>	PH	<input checked="" type="checkbox"/>	PH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3	

This constraint is a soft constraint. A soft constraint is a constraint with a number from **1 to 7** in the soft level section. For now, check the **Apply** box, click the **Set** button, and find a solution.

Soft Solving Set	
Item	Enable
Row Constraint:5	<input type="checkbox"/>
Row Constraint:3	<input type="checkbox"/>

Check “Apply”  
and find a  
solution.



Soft constraints, ~~at least one weekend holiday(SatSunOff), and two consecutive holidays after Night Shifts if possible are shown. (The results depends on your PC's performance.)~~

Solutions

Solution1

	I	J	Staff Name	Filter	Previous Month					ThisWeek							The2Week																
	SatSunOff	TwoDaysOffafter			27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15									
					Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun									
1	1	0	Staff1		P	A	A	A	N	A	P	P	D	D	D	P	P	D	D	D	D	D	P	D									
2	2	0	Staff2		A	A	A	P	P	D	D	D	N	A	P	P	N	A	P	P	D	D	D	P									
3	1	0	Staff3		A	A	A	P	N	A	P	P	D	D	D	D	P	D	D	D	D	D	P	D									
4	1	0	Staff4		A	A	D	P	P	D	P	D	D	D	D	D	P	D	D	D	N	A	P	P									
5	1	0	Staff5		A	D	D	A	P	P	D	D	N	A	P	P	D	D	D	N	A	P	P	D									
6	1	0	Staff6		P	A	P	A	D	D	N	A	P	P	N	A	P	P	D	D	D	D	D	P									
7	1	0	Staff7		A	D	D	A	P	P	D	D	D	D	D	P	D	D	D	N	A	P	P	N									
8	1	0	Staff8		D	P	D	D	D	N	A	P	P	D	D	D	P	D	N	A	P	P	D	P									
9	1	0	Staff9		A	D	D	D	P	P	D	D	D	D	D	P	D	N	A	P	P	D	D	P									
10	2	0	Staff10		D	D	A	D	P	P	D	D	D	N	A	P	P	D	D	D	D	D	P	N									
11	1	0	Staff11		D	D	P	D	D	D	N	A	P	P	D	N	A	P	P	D	D	N	A	P									
12	1	0	Staff12		D	D	D	D	P	P	D	N	A	P	P	N	A	P	P	D	D	D	N	A									
13	1	0	Staff13		D	D	P	D	D	N	A	P	P	D	N	A	P	P	D	D	D	D	P	P									
14	1	0	Staff14		D	D	D	D	P	D	D	N	A	P	P	D	D	D	N	A	P	P	D	D									
15	1	0	Staff15		D	A	D	P	P	D	D	D	D	D	P	D	N	A	P	P	N	A	P	P									
16	1	0	Staff16		D	A	D	P	P	D	P	D	D	D	D	P	D	D	D	N	A	P	P	P									
17	1	0	Staff17		D	D	A	D	D	P	D	D	D	N	A	P	P	D	D	D	D	D	P	D									
18	1	0	Staff18		D	D	D	D	P	P	D	D	D	D	D	P	N	A	P	P	D	D	N	A									

[illegible]





# Tutorial8 The meaning of soft constraints

You will get the following result if you find a solution. You can also see violated portions in yellow marking for the soft constraint. You can set the weight for each level. The larger the value, the higher priority. For example, if the weight is set to 10, its importance is increased tenfold compared to 1.

**Solutions**

Solution1

	I	J
	SatSu	TwoD
1	1	0
2	1	0
3	1	0
4	1	0
5	1	1
6	1	0
7	1	1
8	1	1
9	1	1
10	1	0
11	1	1
12	1	0
13	1	0
14	1	0
15	1	0
16	1	1
17	2	0
18	1	1

**Solve**

Solve

**Soft Solving Settings**

Item	Enable	Weight	Allowabl
Row Constraint:5	<input checked="" type="checkbox"/>	1	3
Row Constraint:3	<input checked="" type="checkbox"/>	1	3

**Solver Settings**

Number Of Solutions	1
Prevent Repeated Schedule Errors	<input checked="" type="checkbox"/>
Number Of CPUs	1
Enable Implicit Hard Weights for Colum	<input checked="" type="checkbox"/>
Hard Timeout(sec)	30
Error Analysis	<input checked="" type="checkbox"/>

**Note**

Weight	Errors	Cost
100	0	0
1	7	7
Total		7

o 7(0)  
56228 [KB] used.  
42.541000(sec)

Staff14 D D P D D P D D D N A P P D D D D P D  
Staff15 D D D D D P D D D D P D D N A P P D P  
Staff16 D P D D P P D D D D P D D N A P P N  
Staff17 D P D D D P D D N A P P D D D N A P P  
Staff18 D D P D P P D D D D D P N A P P D D N A





## Tutorial8 The meaning of soft constraints 2

- Constraints that are not soft are called hard constraints.
- Almost all the constraints can become soft if desired.
- All hard constraints must be all satisfactory, which means that no violations are allowed in them. Otherwise, we have no feasible solution.
- The best scenario is to mix hard and soft constraints with some ratio, to get a feasible solution while getting rational solving speed.
- We have many actual samples in the Gallery. Please refer to them on how to describe hard and soft constraints.





# What is the difference between Tutorial 7-8?

[Find a solution](#) and open [the solution page](#). There are seven soft errors (soft constraints not being met) marked in yellow (this may vary slightly depending on the environment).

The column and row constraints are the same as in Tutorial 7, with 0/1 errors. Where did this difference come?

**Solutions**

Solution1

	I	J
	SatSu	TwoD
1	1	0
2	1	0
3	1	0
4	1	0
5	1	1
6	1	0
7	1	1
8	1	1
9	1	1
10	1	0
11	1	1
12	1	0
13	1	0
14	1	0
15	1	0
16	1	1
17	2	0
18	1	1

**Solve**

Solve

**Soft Solving Settings**

Item	Enable	Weight	Allowabl
Row Constraint:5	<input checked="" type="checkbox"/>	1	3
Row Constraint:3	<input checked="" type="checkbox"/>	1	3

**Solver Settings**

Number Of Solutions	1
Prevent Repeated Schedule Errors	<input checked="" type="checkbox"/>
Number Of CPUs	1
Enable Implicit Hard Weights for Colum	<input checked="" type="checkbox"/>
Hard Timeout(sec)	30
Error Analysis	<input checked="" type="checkbox"/>

**Note**

Weight	Errors	Cost
100	0	0
1	7	7
Total		7

o 7(0)  
56228 [KB] used.  
42.541000 (sec)

Staff14  
Staff15  
Staff16  
Staff17  
Staff18

D D P D D P D D D N A P P D D D D P  
D D D D D P D D D D D D P D D N A P P D  
D P D D P P D D D D D P D D D N A P P  
D P D D D P D D D N A P P P D D D N A P  
D D P D P P D D D D D P N A P P D D N

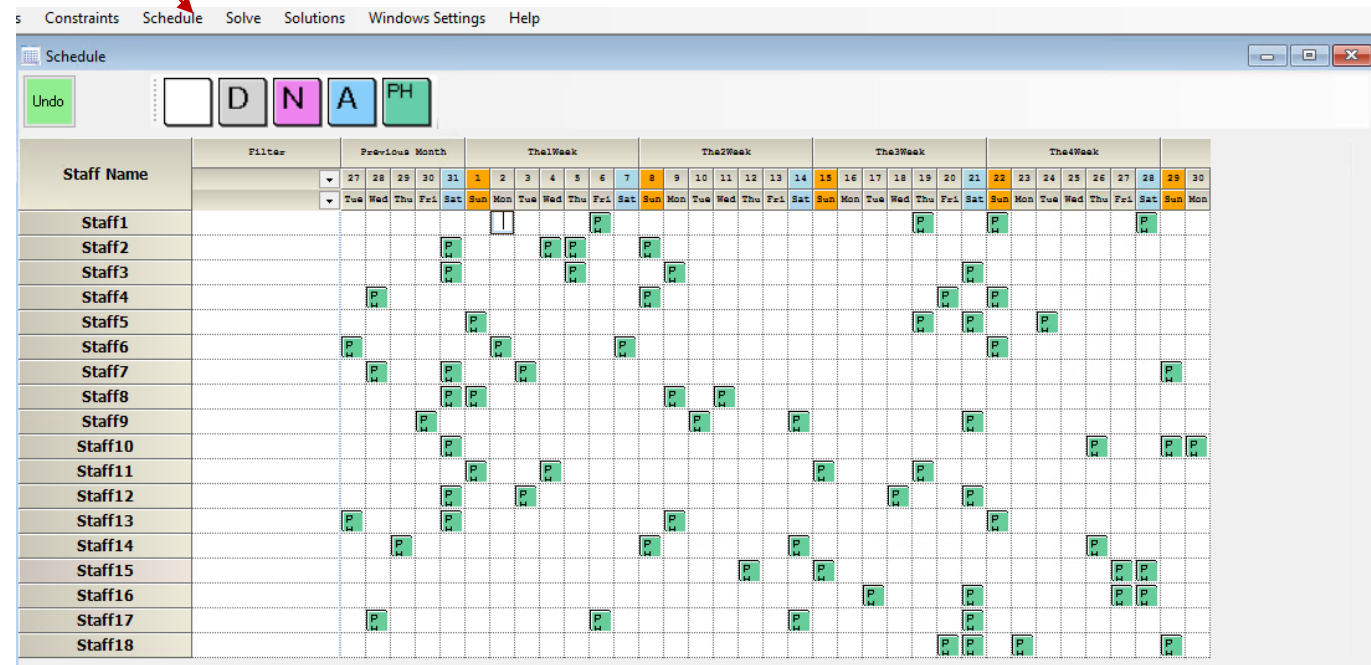




# Tutorial 8

Open "Schedules." Because of the scheduling constraints, there were some cases other condition couldn't be met (no schedules were in place in Tutorial 7).

Refer to the [user manual](#) for details on how to enter schedules.






The screenshot shows the 'Solutions' window in the Solver interface. The window displays a table with columns I, J, and K. Column J is highlighted with a red box. The table contains data for 18 staff members across 28 days. The 'Filter' column is also visible. The 'TwoNightShift' constraint is highlighted in the bottom table.



# 11 other value

 **Solve**

**Solve**

Soft Solving Settings			
Item	Enable	Weight	Allowabl
Row Constraint:5	<input checked="" type="checkbox"/>	10	3
Row Constraint:3	<input checked="" type="checkbox"/>	10	3
Scheduled Constraint:2	<input checked="" type="checkbox"/>	1	3

The screenshot displays the 'Schedule' application interface. At the top, there's a title bar with 'Schedule' and standard window controls. Below it is a toolbar with an 'Undo' button and a color palette with buttons labeled 'D', 'N', 'A', and 'PH'. The main area is a grid with 'Staff Name' on the vertical axis (Staff1 to Staff9) and dates on the horizontal axis, organized into 'The1Week' through 'The4Week'. The grid cells are colored blue for available slots and green for 'PH' (Presumably 'Part-time' or 'Holiday'). A right-click context menu is open over the grid, listing actions such as 'Paste', 'Copy', 'Copy as Text', 'Clear Selected Portions', 'Clear All', 'Set Hard Constraint on Selected Portions', 'Set Soft Constraint Level on Selected Portions', 'Lock', 'Generate Random Schedule', 'Print', 'Print as HarcopyImage', 'Export to Excel', 'Copy to Clipboard', and 'Output CSV File'. A red arrow points from the top of the grid to the context menu.



The screenshot displays the 'Schedule' application interface. On the left, a staff roster shows 18 staff members (Staff1 to Staff18) over a 30-day period. A red arrow points to a specific cell in the roster. On the right, the 'Solutions' panel shows a detailed view of the schedule for Staff1, with a context menu open over it. The menu options include 'Send to Input View', 'Copy', 'Copy as Text', 'Compare Result with Schedule', 'Print', 'Print as HarcopyImage', 'Export to Excel', 'Copy to Clipboard', and 'Output CSV File'.





# Tutorial9 Summary 1

- You can soften the schedule by every day and the staff with 1-7 level at any weight.
- You can get the desired result by adjusting the weights of soft constraints. This process is optimization itself, minimizing the sum of values.
- The role of the solver is to find assignments minimizing the objective value. However, please note the solver does not know what is crucial for you. So, determining the weight of the constraint is your job.
- As a conclusion, the computer considers the minimum possible amount of the sum to be optimal. The user's role is to adjust the weights so that the computer's and the user's ideas of what's an optimal match.





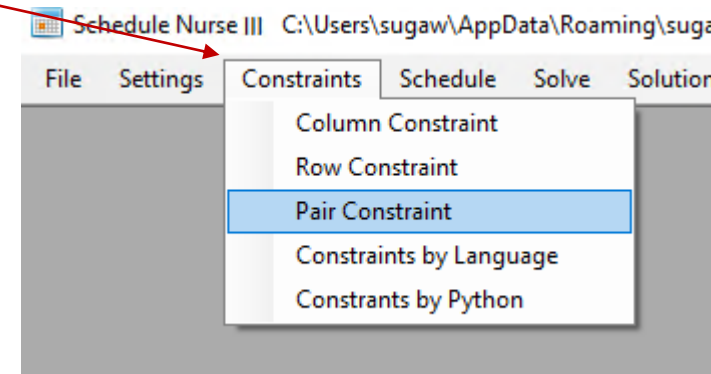
## Tutorial9 Summary 2

- We, as humans, tend to constrain things overly. If you take everything to be a hard constraint, there will usually be no solution. Therefore, we need to properly weave in some soft constraints to get to the solution.
- We all often experience not being able to please everyone. There is called a trade-off, where one thing increases and another must decrease. If we take one thing, we must discard another in limited human resources. Please note that what you think is essential and trivial is entirely up to you, using hard and soft constraints with arbitrary weight.



# Tutorial10

Find a solution. Open **Constraints** → **Pair Constraints**. Just enter the pair prohibitions as is. Below, night shifts between staff members 1 to 2-5 are prohibited.



Pair Constraint

PairConstraintGroup1 | PairConstraintGroup2

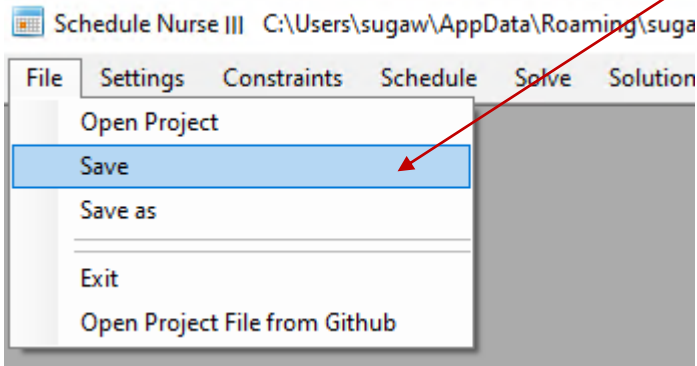
☒ Enable    Set    PairConstraintGroup1

No.	Enable	Pair Constraint Name	Constraint Type	A				B			
				Staff Definition	Operator	Shift Type	Day Type	Staff Definition	Operator	Shift Type	Day Offset
1	<input checked="" type="checkbox"/>	Prohibit_Staff1-2_Nishift_Shift	Pair_Inhibited	Staff1	OR	Night_Shift	ThisMonth	Staff2	OR	Night_Shift	
2	<input checked="" type="checkbox"/>	Prohibit_Staff1-3_Nishift_Shift	Pair_Inhibited	Staff1	OR	Night_Shift	ThisMonth	Staff3	OR	Night_Shift	
3	<input checked="" type="checkbox"/>	Prohibit_Staff1-4_Nishift_Shift	Pair_Inhibited	Staff1	OR	Night_Shift	ThisMonth	Staff4	OR	Night_Shift	
4	<input checked="" type="checkbox"/>	Prohibit_Staff1-5_Nishift_Shift	Pair_Inhibited	Staff1	OR	Night_Shift	ThisMonth	Staff5	OR	Night_Shift	



# Saving a project

- Click **File** → **Save** to save a project.
- In some cases, you may want to revert to the earlier settings, so you can save it as a different version with the option "**Save As**."







# Transitioning to the next month

- A project consists of the following three dates.

- **StartDate**

This marks the beginning of the month. It doesn't necessarily have to be the first day of the month.

- **FinshDate**

This marks the end of the month. It doesn't necessarily have to be the last day of the month.

- **StartDisplayDate**

Indicates the start date of the display.

Solutions  
Solution1

	A	B	Staff Name	Filter	Previous Month	The1Week	The2Week	The3Week	The4Week
					27 28 29 30 31	1 2 3 4 5 6 7	8 9 10 11 12 13 14	15 16 17 18 19 20 21	22 23 24 25 26 27 28 29 30
					Tue Wed Thu Fri Sat Sun	Mon Tue Wed Thu Fri Sat Sun	Mon Tue Wed Thu Fri Sat Sun	Mon Tue Wed Thu Fri Sat Sun	Mon Tue Wed Thu Fri Sat Sun
1			Staff1		A A A A A	D D D D D D D	D D D D D D D	D D D D D D D	D D D D D D D
2			Staff2		A A A A A	D D D D D D D	D D D D D D D	D D D D D D D	D D D D D D D
3			Staff3		A A A A A	D D D D D D D	D D D D D D D	D D D D D D D	D D D D D D D
4			Staff4		A A A A A	D D D D D D D	D D D D D D D	D D D D D D D	D D D D D D D
5			Staff5		A A A A A	D D D D D D D	D D D D D D D	D D D D D D D	D D D D D D D





# Transitioning to the next month 2

Let's try to do it with Tutorial 10. Click [Settings](#) → [Date Definitions](#) → [Scheduling Period](#) → [Start Date](#). Click here to go to the next month.

The screenshot shows the 'Day Definitions' window with the 'Scheduling Period' tab selected. The 'Start Date' field is highlighted in the left sidebar. The main area displays a calendar for November 2020. The calendar header has a right arrow button highlighted with a red box. The calendar grid shows the following dates:

Sun	Mon	Tue	Wed	Thu	Fri	Sat
25	26	27	28	29	30	31
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5





# Transitioning to the next month 3

Click 1 and then click the **Set** button. This sets the **Start Date**.

The screenshot shows the 'Day Definitions' window with the 'Predefined Days' tab selected. On the left, a light blue box labeled 'StartDate' is visible. On the right, a calendar for December 2020 is displayed. The calendar has a header with navigation arrows and the month/year. The days of the week are listed as columns. The date '1' (Tuesday) is highlighted in yellow. A 'Set' button is located at the top right of the calendar area.

December 2020						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9





# Transitioning to the next month 4

Click on **FinishDate**, click 31, and then click the **Set** button. This sets **FinishDate**.

The screenshot shows the 'Day Definitions' window with the 'Month' tab selected. The window has a 'Scheduling Period' section on the left with 'StartDate' and 'FinishDate' fields. The 'FinishDate' field is highlighted with a blue border. A calendar for December 2020 is displayed in the center, with the date '31' highlighted in yellow. A 'Set' button is located at the top right of the calendar area. Red arrows indicate the sequence of actions: clicking the 'FinishDate' field, clicking the date '31' on the calendar, and clicking the 'Set' button.

December 2020						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9



# Transitioning to the next month 5



Click on **StartDisplayDate**, click on the 26th of the previous month, and then click on the **Set** button. This sets the **display start date**.

The screenshot shows the 'Day Definitions' window with the 'Predefined Days' tab selected. On the left, there are three input fields: 'StartDate', 'FinishDate', and 'StartDisplayDate'. The 'StartDisplayDate' field is highlighted with a blue border, and a red arrow points from its label to the button at the bottom. On the right, there is a 'Set' button and a calendar for 'November 2020'. The calendar shows the 26th of November highlighted in yellow.

Sun	Mon	Tue	Wed	Thu	Fri	Sat
25	26	27	28	29	30	31
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5

Click on the **StartDate**, **FinishDate**, and **StartDisplayDate** to make sure that they are all set up correctly.





# Transitioning to the next month 6

Click on the solution and then click [Send to Input View](#). This will send the solution to the schedule.

The screenshot shows the 'Solutions' application window with a table of staff schedules. The table has columns for Staff Name, Filter, Previous Month, The1Week, and The2Week. The 'The1Week' view shows a calendar grid for the week of Sunday, January 1st, to Saturday, January 7th. A context menu is open over the date '1' (Sunday), with the option 'Send to Input View' highlighted. A red arrow points from the text 'Send to Input View' in the instruction above to this menu item.

	A	B	C	Staff Name	Filter	Previous Month	The1Week	The2Week													
	Nights	After_	After_			27 Tue	28 Wed	29 Thu	30 Fri	31 Sat	1 Sun	2 Mon	3 Tue	4 Wed	5 Thu	6 Fri	7 Sat	8 Sun	9 Mon	10 Tue	11 Wed
1	0	0	0	Staff1		A	PH	A							A	PH	PH	D	D	D	N
2	0	0	0	Staff2		D	D	D							PH	D	D	PH	D	N	A
3	0	0	0	Staff3		D	D	A							PH	PH	N	A	PH	PH	D
4	0	0	0	Staff4		A	PH	A							PH	D	N	A	PH	PH	D
5	0	0	0	Staff5		A	A	A							D	D	D	PH	D	N	A
6	0	0	0	Staff6		PH	A	A	A	D	D	PH	D	D	N	A	PH	PH	D	D	D
7	0	0	0	Staff7		A	PH	D	PH	PH	PH	D	D	D	D	D	PH	D	N	A	PH





After adding work and vacation requests, find a solution for the next month's project.

[illegible]





# Tutorial summary

- Congratulations! You now know the outlines of this program.
- The standard form for two shifts is Tutorial9. It's a good idea to use this as the base and then make changes and additions depending on the customer's specifications.





# Glossary

Solver	The software equivalent of a brain which solves a problem.
Constraint	A work rule
Solution	An answer which satisfies the constraints
Hard constraint	A constraint that must be satisfied
Soft constraint	A constraint that should be satisfied if possible
Optimization	Minimizing the sum of weights times the number of errors by reducing the number of errors one at a time
Resource	Human resources.
Row	A horizontal line
Column	A vertical line
Satisfying	Satisfying a constraint
Error	Failure. Mistake (deviation from a target, a penalty)
Bottleneck	A state where there is no solution due to the difficulty of satisfying the constraints
Trade-off	A relationship in which you have to sacrifice something else in65 order to achieve something.





# Glossary 2

Project file	A customer-specific configuration file containing constraint, schedule entries and solutions. It is usually created with a different name for each month.
Company SE	Our system engineer
Hard error	The absence of a solution (the error that the solver shows when it finds a contradiction)
Solution1	The first answer. Solution2 is the second answer.
Soft error	Where soft constraints cannot be satisfied.
Optimizing	Minimizing the soft errors, including the weights
Conflict	Contradictions between hard constraints. A state in which there is no solution that satisfies both at the same time
Over-constraining	A state in which there are too many constraints and it is difficult to find a solution which satisfies all of them at the same time.
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