The background is a dark, abstract composition. It features several bright, colorful rays (yellow, orange, blue, and white) that originate from a central point on the left and fan out towards the right. Interspersed among these rays are white, stylized musical notes and lines, suggesting a connection between music and optimization. The overall effect is one of dynamic energy and creative problem-solving.

GRUBER & PETTERS

Untis Optimisation

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1 Timetable optimisation

The following chapter describes the timetable optimisation function and the diagnosis tools used before and after an optimisation run.

The optimisation tool of the Untis timetabling software manages the entire automated process of constructing a timetable. It consists of two main elements – the *placement run* and the *swap run*.

The programme starts with an empty time grid and proceeds to fill the grid with periods. Since this alone would not necessarily produce the best results, the constructed timetable then undergoes a series of specific period swaps to improve the final outcome. In the end, the weighting settings you have specified will determine the actual quality of the timetable.

An apt comparison is the board game Nine Men's Morris where two players place individual pieces on an empty board before attempting to improve their positions by strategically moving the pieces across the board.

Of course, the placements and swaps initiated by the programme are not done at random. Each violation of one of the specifications you have entered (e.g. the maximum number of periods per day) incurs a penalty point. With the help of the weighting settings, the software proceeds to re-evaluate the penalty points until it arrives at a value for the entire timetable. This value gives you an indication of how good the timetable really is. The lower the value, the higher the level of compliance with the given settings and the better the overall quality of the completed timetable.

2 Weighting

The weighting function forms the basis of the automated timetable optimisation tool. Untis offers 6 levels of importance ranging from "Unimportant" (0) to "Extremely important" (5) which allow you to specify the level of priority given to the individual settings.

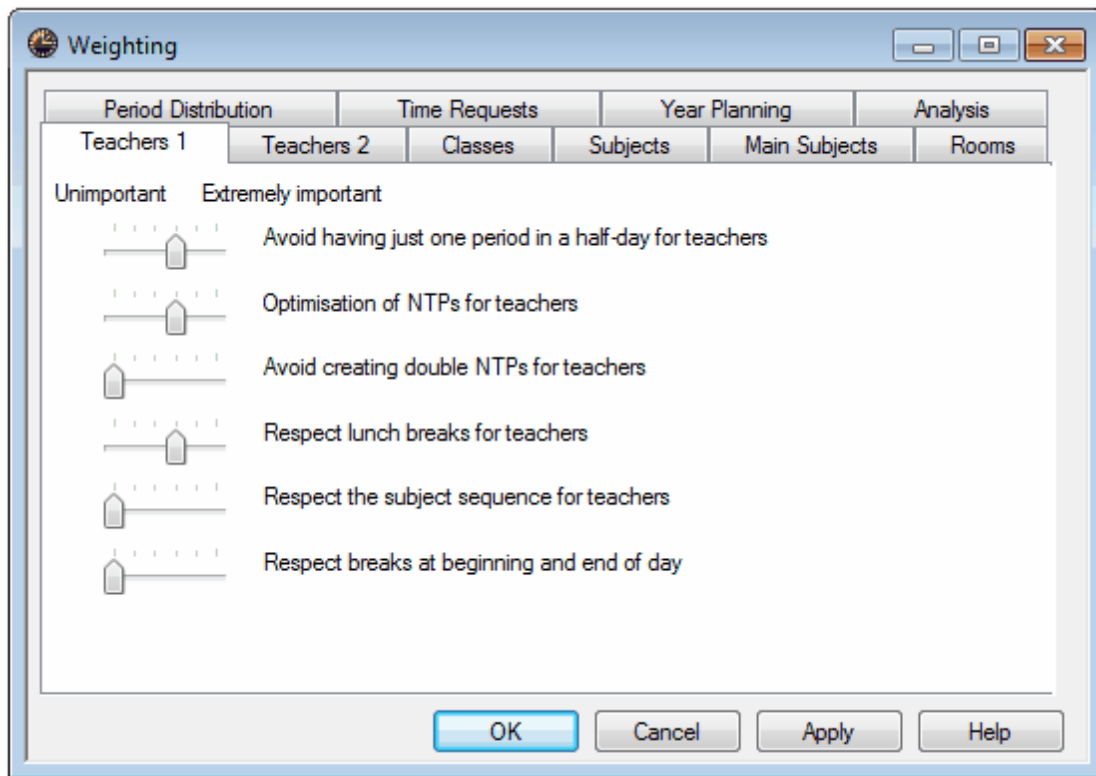
Hint!

Some weighting points only become effective after specific data has been entered in the master data or lesson window (see the chapter "Data input"). Other weightings, by contrast, are data independent and affect every optimisation run.

The function "Respect the maximum and minimum number of periods per day for teachers", for instance, is a dependent weighting point since it depends on data entered under "Periods day Min, Max" on the "Timetable" tab under "Master Data | Teachers" (e.g. "2, 4"). The weighting determines the level of importance of these settings (i.e. the degree of compliance with the settings). Leaving the field empty means that the weighting has no effect on the optimisation process.

Independent weighting points, by contrast, involve general settings such as "Avoid non-teaching periods (NTPs)" or "Avoid having just one period in a half-day for teachers" since window periods and single periods do not require additional specifications to be entered under master data or lessons.

The weighting settings can be accessed via the menu item "Scheduling | Weighting".



The weighting dialogue contains the different weighting parameters sorted by topic and organized on a number of different tabs. Increase or decrease individual weighting settings by using the slider provided. From left to right, the weighting sliders offer 6 different levels of importance:

- Position 0 - unimportant
- Position 1 - not very important
- Position 2 - fairly important
- Position 3 - important
- Position 4 - very important
- Position 5 - extremely important

The following chapter briefly describes the individual parameters with reference to the master data and lesson data settings relevant for dependent weighting points.

2.1 The weighting parameters

The weighting parameters are topic-based and can be modified on the appropriate tab.

2.1.1 The "Teachers (1)" tab

Period Distribution		Time Requests		Year Planning		Analysis	
Teachers 1	Teachers 2	Classes	Subjects	Main Subjects	Rooms		
Unimportant Extremely important							
		Avoid having just one period in a half-day for teachers					
		Optimisation of NTPs for teachers					
		Avoid creating double NTPs for teachers					
		Respect lunch breaks for teachers					
		Respect the subject sequence for teachers					
		Respect breaks at beginning and end of day					

Avoid having just one period in a half-day for teachers

- When a teacher has lessons on a half-day, a high weighting ensures that the teacher will teach more than a single period.

Optimisation of NTPs for teachers

- Under "Master Data | Teachers", you have entered values for maximum and minimum numbers of NTP's (Non Teaching Periods). Use this slide to control the level of compliance with the specified settings.

Avoid creating double NTPs for teachers

- In addition to controlling single NTPs, you can give penalty points for each double NTP scheduled by the software during optimisation.

Respect lunch break for teachers

- Applies to the settings entered for minimum/maximum length of lunch break for teachers under "Master Data | Teachers".

Respect subject sequence - teachers

- Controls the level of importance of the subject sequence codes entered under "Lesson | Teachers" or "Master Data | Subjects". For further details, please see the chapter "Subject sequences".

Respect breaks at beginning and end of day

- Controls the level of importance of breaks between days entered on the "Timetable" tab under "Master Data | Teachers". For further details on breaks between days, please see the chapter "Master data properties".

2.1.2 The "Teachers (2)" tab

Respect the maximum and minimum number of periods per day for teachers

- Controls the level of compliance with the values entered under "Master Data | Teachers" for maximum / minimum number of periods per day for teachers.

Respect the maximum number of consecutive periods per day

- Controls the level of compliance with the values entered under "Master Data | Teachers" for maximum number of periods per day in sequence.

Input block "Periods in last morning slot"

Maximum

Teachers scheduled to have lessons on the last period of the morning are often at a disadvantage. You can therefore specify the maximum number of last morning periods each teacher should teach.

Weighting

Indicates the level of compliance to this rule.

On the "Timetable" tab under "Master Data | Teachers", the weighting for NTPs, lunch break, maximum number of periods per day and maximum periods in sequence for individual teachers can be increased further (to "Very important").

2.1.4 The "Subjects" tab

The screenshot shows the 'Subjects' tab in a software interface. The tab is part of a larger window with other tabs like 'Period Distribution', 'Time Requests', 'Year Planning', 'Analysis', 'Teachers 1', 'Teachers 2', 'Classes', 'Main Subjects', and 'Rooms'. The 'Subjects' tab contains two sections: 'Optional subject' and 'Fringe period subject'. Each section has a visual timeline with a slider and three checkboxes: 'in the first period', 'in the last period', and 'between morning and afternoon'. The 'Optional subject' section has a slider positioned towards the end, while the 'Fringe period subject' section has a slider positioned towards the beginning. Below these sections is a label 'Lesson not to be held in fringe period if code = G' with a corresponding slider.

Use the following weighting settings to control the level of compliance with the specifications entered for fringe periods and optional subjects. These subjects are defined on the "Subject" tab under "Master Data | Subjects" (code "(F) Fringe period" or "(O) Optional subject").

Fringe periods and optional subjects are usually lessons not attended by all the students of a class. To avoid NTPs for the rest of the students, these subjects should preferentially be scheduled at the beginning or the end of a halfday.

Code (G) "Not a fringe period" has the opposite effect. A subject marked (G) should preferentially be scheduled in the middle of a half-day.

Optional subjects only in the last period of the half days

- Controls the scheduling of subjects marked "Optional subject" in the last periods of a half-day.

Opt. subjects in the 1st or last period of the half days

- Controls the scheduling of subjects marked "Optional subject" in the first or last periods of a half-day.

Fringe periods in the last period of the half days

- Controls the scheduling of subjects marked "Fringe period" in the last periods of a half-day.

Fringe periods in the 1st or last period of the half days

- Controls the scheduling of subjects marked "Fringe period" in the first or last periods of a half-day.

Lesson not to be held in fringe period is code = G

- Controls the scheduling of subjects marked (G) in the middle periods of a half-day.

The only differences between optional subjects and fringe period subjects are the different weighting settings specified by the timetabler.

For instance, if you have two subjects – Choir and Clarinet – both of which are attended by some of the students of the class. The subject Choir can take place either at the beginning or the end of a half-day, but you want the subject Clarinet to take place exclusively at the end of the day.

Meet both requirements by entering the code (O) for Choir and the code (F) for Clarinet and set the

weightings accordingly.

If you want the subject Choir to be scheduled exclusively at the beginning of a half-day, simply block the last periods of the halfday by entering the time request -3 (under "Master Data | Subjects").

Hint!

You can also control the scheduling of fringe period subjects and optional subjects exclusively via the time request function. However, the optimisation tool will profit from a higher degree of flexibility when working with weighting settings rather than time requests.

2.1.5 The "Main Subjects" tab

Main subjects can be defined under "Master Data | Subjects".

Respect maximum number of main subjects per day for classes

- Controls the level of compliance with the specification "Maximum number of main subjects per day" entered on the "Timetable" tab or in the grid view under "Master Data | Classes".

Respect max. no. of consecutive main subject periods for classes

On the "Timetable" tab or in the grid view under "Master Data | Classes", you can specify the number of main subjects that may be scheduled in sequence for a class. This weighting controls the level of importance of the settings.

Input block "Boundary period for the following aspects"

Boundary period for the following aspects

Use this input field to specify a boundary period.

Main subjects max. once after boundary period

Controls the level of importance for the above specification (per week).

Main subject at least once up to boundary period

Controls the level of importance for the above specification (including the boundary period) per week.

The difference between the two weighting settings depends on what happens after the boundary period. The task of the first weighting is clear – a main subject must not be scheduled more than once per week

after the boundary period. The meaning of the second weighting, by contrast, is not as obvious. Choosing a high priority means that the main subject can be scheduled after a boundary period *as often as necessary* as long as it is scheduled *at least once before* the boundary period.

Let us assume you have defined period 5 as your boundary period. Now you want to schedule 4 periods of English (a main subject). If the software has already scheduled one period of English for Monday, period 6, a high weighting for "Main subjects max. once after boundary period" ensures that the other three periods are scheduled before or in period 5.

A high weighting for "Main subject at least once up to boundary period", by contrast, would ensure that English could be scheduled after period 5 on two other school days as long as it is scheduled at least once before or in period 5.

2.1.6 The "Rooms" tab

Optimisation of room allocation

Use the "Room weighting" tab under "Master Data | Rooms" to assign a value between 0 and 4 to each room in the school. 0 indicates that the room is non-essential for the lesson allocated to it, i.e. it is unimportant if a lesson takes place in this room or in an alternative room (for instance because the lesson requires no special fixed teaching aids). 4 indicates a high priority, i.e. a lesson should be scheduled in this room (or its designated alternative room), if at all possible.

A Chemistry lesson where a number of experiments will be performed should only take place in the Chemistry lab. A PE lesson only makes sense when the sports hall is available.

Caution!

If the weighting slider is set to 5 (extremely important) or 4 (very important) and if, in addition, the room weighting of the subject room is set to 4, the lesson will not be scheduled unless a suitable subject room can be found.

Optimisation of the off-site rooms

- Controls the level of compliance with the specified walking times required to reach off-site buildings

(external sites). Please see the chapter "Off-site rooms" for further details.

Take room capacity into consideration

As a rule, the optimisation tool and the room optimisation function attempt to allocate a room with a room capacity appropriate for the number of students in the class. If this presents a problem, the programme searches for a room that is slightly larger than required. In extreme cases, the software may allocate a room that is slightly smaller than required.

2.1.7 The "Period Distribution" tab

Teachers 1	Teachers 2	Classes	Subjects	Main Subjects	Rooms
Period Distribution		Time Requests		Year Planning	Analysis
<div> <div>Unimportant</div> <div>Extremely important</div> </div> <div> The same subject cannot be taught more than once on the same day </div> <div> Avoid errors with double periods </div> <div> 2 periods/week - subjects not on consecutive days </div> <div> 3 periods/week - subjects not on consecutive days </div> <div> Even distribution of periods of a subject across the day </div> <div> Try to place the same lesson at the same time on different days </div> <div> Large blocks in fringe periods on half-days </div>					

The same subject cannot be taught more than once on the same day

Specifies that a subject must not be scheduled more than once a day for a class (even if the subject is involved in a number of different coupled lessons).

Avoid errors with double periods

Untis identifies two types of double period errors: the splitting of desired double periods and the "accidental" emergence of undesirable double periods when the same subject is scheduled for consecutive periods. Of the two errors, the optimisation tool assigns a higher priority to the preservation of desired double periods.

This weighting is connected with codes "(2) More than once a day" and "(D) Respect double periods". You can find these settings in the master data and the lesson window. The two codes are mutually exclusive.

Code (2) causes the weighting for "Avoid errors with double periods" to be set to 0 (unimportant), while code (D) increases the importance of the weighting. This increase in importance can result in a situation where a lesson will not be scheduled because the software cannot comply with the double period condition.

When you set the weighting for "Avoid errors double periods" to 5 (extremely important), the optimisation tool rates the importance of the double period condition very high right from the very beginning of the optimisation run and even increases the importance during the run so that at the end of the optimisation process, all lessons are treated automatically as if the lessons had been coded "(D) Respect double periods".

Caution!

activate code (D) **only in exceptional cases or not at all** . Excessive use leads to a deterioration of the optimisation results .

2 periods/week - subjects not on consecutive days

This weighting applies to lessons with 2 periods per week (no double period) and is designed to ensure that the two periods are evenly spread throughout the week. A high weighting prevents the software from scheduling the two lessons on consecutive days or from scheduling one lesson on the last week day and the other on the first week day.

3 periods/week - subjects not on consecutive days

This weighting applies in the same way as the previous one, but for 3 periods per week.

Even distribution of periods of a subject across the day

A high weighting ensures that a subject scheduled for Monday, period 3, is scheduled for a different period on subsequent days of the week, i.e. not period 3. The following weighting point has the opposite effect.

Try to place the same lesson at the same time on different days

A high weighting ensures that a subject scheduled for Monday, period 3, is also scheduled for period 3 on other days of the week. The previous weighting point has the opposite effect.

Large blocks in fringe periods on half-days

For a variety of reasons, it is often desirable to schedule block lessons at the beginning or end of a half-day. A half-day consisting of 6 periods can therefore accommodate 2 blocks of 3 periods each. Since block lessons are often slightly shorter than the sum of the single periods (for instance, because there are no breaks between periods), students will be able to leave school early or start school later than the normal start time.

2.1.8 The "Time Requests" tab

Time requests can be entered via themaster data or the lesson window by clicking on the button <Time Requests>. For further details, please see the chapter "Time requests".

Time requests for teachers

- Controls the compliance with time requests entered under "Master Data | Teachers".

Time requests for classes

- Controls the compliance with time requests entered under "Master Data | Classes".

Time requests for subjects

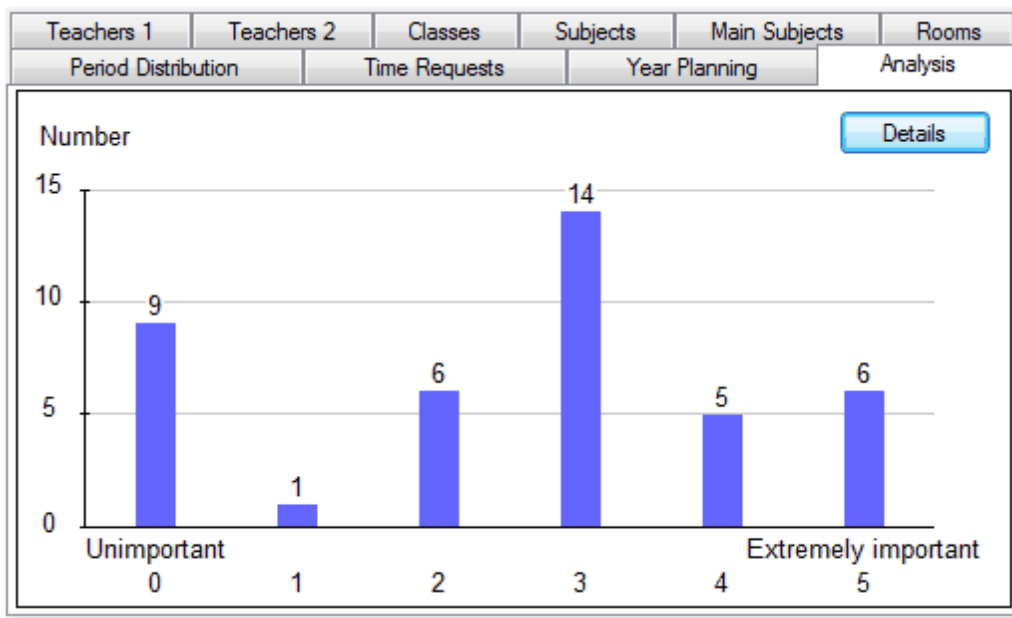
- Controls the compliance with time requests entered under "Master Data | Subjects".

Time requests for rooms

- Controls the compliance with time requests entered under "Master Data | Rooms".

Time requests for lesson periods

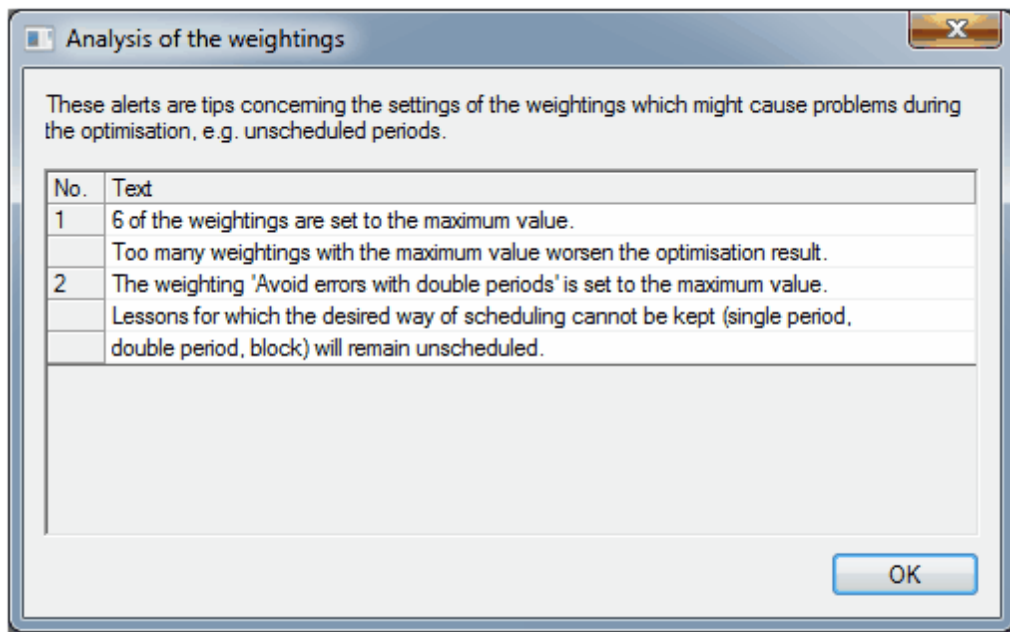
- Controls the compliance with time requests entered in the lesson window.

2.1.9 The "Analysis" tab

A well-balanced distribution of the weighting is the prerequisite for a good optimisation result. The "Analysis" tab offers an overview of the frequency of the different weighting levels.

In our example about six weighting parameters are set to the highest weighting level 5 (extremely important).

You can get more information about possible problems because of the distribution of the weighting by clicking on the button <Details>.



2.2 General notes

If you have not worked with the weighting parameters before, we would suggest you proceed as follows:

First, familiarise yourself with all the weighting parameters and their functions.

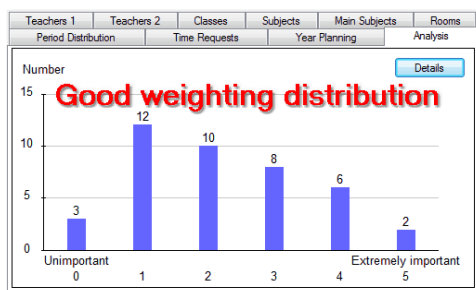
Then, move the sliders for all the attributes that **do not apply to your school under any circumstances** to the very left (position 0 = unimportant), for instance, for "Optimisation of the off-site rooms" if your school has no off-site rooms.

Hint!

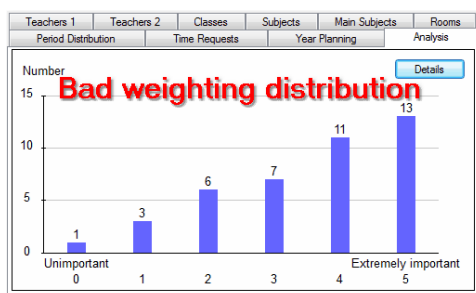
If in doubt about the relative importance of an attribute, set the slider to position 1 (not very important) instead of 0.

Next, adjust the remaining sliders in order of increasing importance from "not very important" to "extremely important".

Watch the frequency with which you assign the different levels of importance. As a general rule, it is desirable to assign the weighting settings between 1 (not very important) and 5 (extremely important) in roughly equal numbers, or in decreasing frequency as the level of importance increases. Please see the example shown in the two graphs (the x axis shows the 6 weighting levels, the y axis shows the relative frequency of each weighting).



You should never end up with a distribution where a disproportionately large number of weightings are set to 0 or 1 (unimportant/not very important) or to 5 (extremely important). Another undesirable situation is a frequency that increases with increasing weighting importance.



Caution

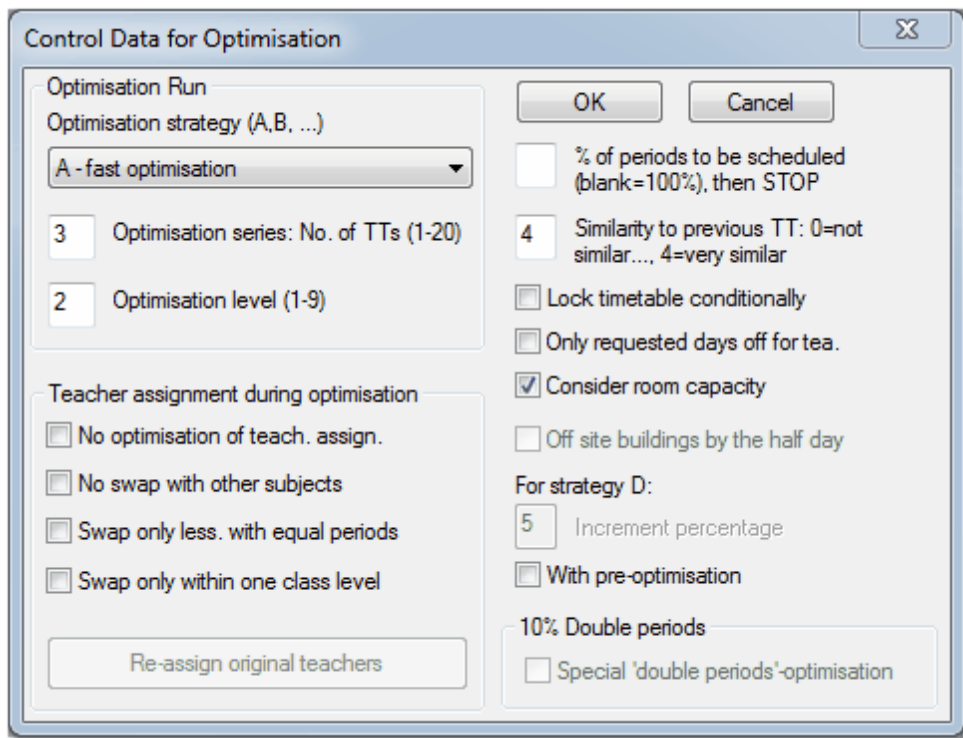
The difference between the weighting level 4 and 5 is much higher than between 3 and 4. If you have selected too many settings of "extremely important", the optimisation tool will be restricted to the extent that it can only schedule a fraction of the periods. Hence, set levers on level 5 only if it is absolutely necessary.

The construction of a good timetable is not a matter of frequently selecting the highest weighting, but of accurately representing the different conditions at your school.

3 Optimisation

3.1 Control data for optimisation

The optimisation dialogue is accessible via the menu item "Scheduling | Optimisation". The following chapter describes the individual input fields in this window.

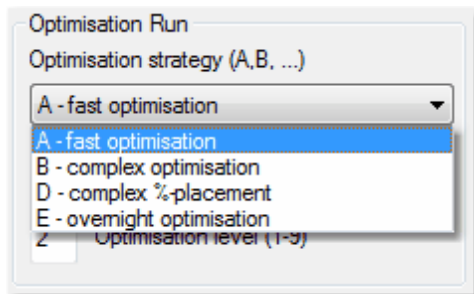


3.1.1 Optimisation process

You have a choice of different strategies and optimisation depths.

3.1.1.1 Optimisation strategy (A, B, C, D, E)

Untis offers five different strategies for the construction of your timetable. These strategies offer different levels of complexity. Strategy A represents the lowest and Strategy E the highest level of complexity. As a general rule, the more complex the optimisation strategy, the better the result, but the longer it takes the software to compute the result. The differences between the individual strategies are described in a later chapter.



3.1.1.2 Optimisation series: No. of TTs (1-20)

Use this option to specify how many different timetables you want the software to construct per series. Each timetable is saved in a dedicated file (work x .gpn where x is the number of the file) in the active Untis directory (it is advisable, however, to enter a dedicated path for these *work files* on the

"Directories" tab under "Settings | Miscellaneous"). Depending on the selected optimisation strategy (see the chapter "Strategies"), the programme will carry out further optimisation runs for the timetables.

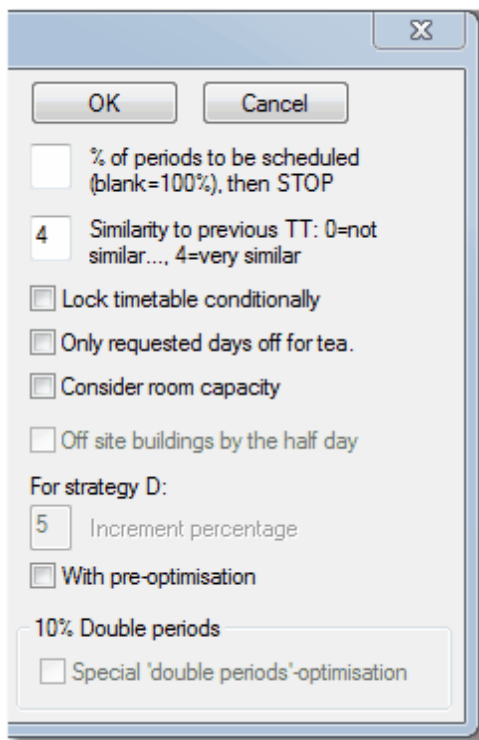
3.1.1.3 Optimisation level (1-9)

This function allows you to specify the extent of the software's "pre-calculation function" for each optimisation run. Like a chess game programme, the Untis programme calculates before each "move" (i. e. before each placement of a lesson) how the move will affect the situation as a whole. Depending on the computer, the size of the school and the figure entered for this option, the optimisation of a timetable can take between a few seconds and a few minutes. As a general rule, the longer it takes the computer to arrive at a result, the better the final outcome. In the early stages of a timetable construction, however, long optimisation runs are often counter-productive since initial results often indicate that certain changes need to be made to the input data.

Further input options can be found on the right hand side of the control data window:

3.1.1.4 % of periods to be scheduled

Allows you to specify the percentage of periods you want the software to schedule. Leaving the field empty means that the optimisation tool will attempt to schedule all the available periods.



The screenshot shows a dialog box titled 'Control Data' with a close button (X) in the top right corner. It contains several settings:

- Buttons: OK, Cancel
- ☐ % of periods to be scheduled (blank=100%), then STOP
- 4 Similarity to previous TT: 0=not similar..., 4=very similar
- ☐ Lock timetable conditionally
- ☐ Only requested days off for tea.
- ☐ Consider room capacity
- ☐ Off site buildings by the half day
- For strategy D:
 - 5 Increment percentage
 - ☐ With pre-optimisation
- 10% Double periods
 - ☐ Special 'double periods'-optimisation

Hint!

The percentage refers to the periods of the entire school. So if you schedule 10% of a total of 1,000 lessons then Untis selects those 100 lessons that are regarded as to be the most difficult ones. This helps you to find out quickly which lessons are hard to schedule.

3.1.1.5 Similarity to previous timetable

Allows you to specify if and how much the next timetable should resemble the previously constructed timetable. The input options range from 0 (no similarity) to 4 (great similarity). Of course, the new

timetable always reflects the modifications you make in the scheduling dialogue between optimisation runs. Leaving this field empty equals a value of 0 (no similarity).

3.1.1.6 Lock timetable conditionally

If you lock the timetable conditionally, the next optimisation run will skip the placement run and only carry out a swap run. This means that the resulting timetable will be very similar to the previous one. This constitutes an even higher level of similarity than the highest similarity setting (4 = great similarity) in the function described above. Use this function when you have carried out manual changes in the scheduling dialogue and want to start another optimisation run. Ticking this option means that your manual changes will be preserved.

When you combine the two previous functions by ticking the box "Lock timetable conditionally" and increasing the percentage under "% of periods to be scheduled", the software proceeds by first locking the previous timetable, then scheduling the remaining periods and finally carrying out a swap optimisation run for all the periods.

3.1.1.7 Only requested days off for teachers

Tick this option to instruct the software to schedule only the free days specified under time requests for teachers (and no additional days).

3.1.1.8 Consider room capacity

Activate this function to instruct the optimisation tool to compare the specified room capacity with the number of students in a class or lesson and allocate rooms accordingly.

3.1.1.9 Off site buildings by the half day

This option is only active if you have entered off-site codes in "Master Data | Rooms". The algorithm tries to avoid that classes and teachers have to move from one site to another during one half-day.

3.1.1.10 Percentage increase

This field is relevant only with strategies [C](#) and [D](#). It is discussed in the respective chapters.

3.1.1.11 Special optimisation for double periods

You can check this option when at least 80 % of the lessons you have entered are to be scheduled as double periods. Special importance is then attached to scheduling double periods in subsequent optimisation.

Internally, this process halves the time grid and the number of periods for the lessons meaning that only single and half periods need to be scheduled during the run.

Caution:

Please ensure that there is an even number of periods defined in the morning in the time grid. If the time grid has a total of 10 periods per day, only 4 or 6 periods should be declared for the morning, and not 5.

3.1.2 Teacher assignment during optimisation

When the software encounters bottlenecks during the optimisation run (see also the chapter "CCC analysis"), the programme attempts to bypass them by swapping teachers. If the software finds a suitable teacher and if a swap with this teacher would improve the quality of the timetable, the programme automatically proceeds with the swap during the optimisation run.

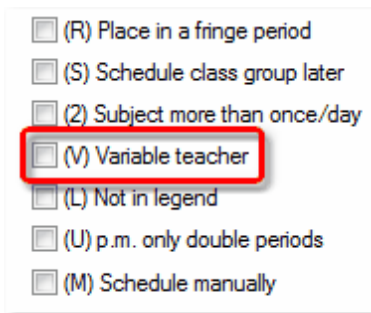
The module *Lesson Planning* offers an extended version of this function.

Automated teacher swaps can only be carried out when at least one of the following two conditions can be met:

- The code "(V) Variable teacher" is active for some lessons;
- The function "? teachers" is active for some lessons (for use with the module *Lesson Planning and Value Calculation*)

3.1.2.1 (V) Variable teacher

A teacher may only be swapped if the code "(V) Variable teacher" has been activated. You can find this option on the "Codes" tab under "Lessons | Teachers". A teacher who is the cause of an optimisation bottleneck and for whom the code (V) is active may be replaced with another teacher.



As a rule, the code (V) applies to *all* the teachers of a lesson. Tick the option „Teacher allocation locked“ in the appropriate row in the lesson details window (under "Lessons | Teachers") if an individual teacher involved in the lesson should not be swapped under any circumstances. This deactivates the code (V) *for this particular teacher* in this coupled lesson (see example below).

A screenshot of the 'Lessons / Teacher' window. It displays a table with columns: L-No., Cl,Te., UnS, Per 2rds, Teacher, Subject, Class(es), Subject room, Home room, Double pers., and Teacher allocation locked. The table contains data for lessons 43, 81, 79, and 28. The 'Teacher allocation locked' column has checkboxes, with the checkbox for teacher 'Callas' in lesson 43 checked. A red rectangle highlights the 'Teacher allocation locked' column.

L-No.	Cl,Te.	UnS	Per 2rds	Teacher	Subject	Class(es)	Subject room	Home room	Double pers.	Teacher allocation locked
43	2, 2		2	Ander	MU	3a,3b		Ps1	1-1	<input type="checkbox"/>
				Callas	AR	3a,3b		R3a		<input checked="" type="checkbox"/>
81	2, 2		2	Ander	DS	2b,2a	WS	R2a	1-1	<input type="checkbox"/>
79	2, 2		2	Ander	DS	3a,3b	WS	R3a	1-1	<input type="checkbox"/>
28			1	Ander	HI	1b		R1b		<input type="checkbox"/>

3.1.2.2 ?-Teacher

For use with the Lesson Planning module. This function enables the software to search for a suitably qualified teacher for the lessons for which this function is active.

L-No.	CI,Te	UnSc	Per	/rsPrds	Teacher	Subject	Class(es)	Subject room	Home room	Double per	Block
11	4, 1		2		Hugo	GEc	1a,1b,2a,2b		R1a		
7	2, 3		2		?	DS	1a	WS	R1a	1-1	
73	2, 2		3		Arist	PEG	1a,1b	SH2	R1a		
31			5		Arist	MA	1a		R1a		
33			5		Arist	EN	1a		R1a		

The automated teacher swap function offers the following settings:

3.1.2.3 No optimisation of teacher assignment

Ticking this box deactivates the teacher swap function. All "(V) Variable teacher" codes will be ignored.

The following two input options are only available for use with the Lesson Planning module.

No swap with other subjects

Teachers can only be swapped between lessons of the same subject.

Swap only lessons with equal periods

Teachers can only be swapped between lessons with the same number of periods.

3.1.2.4 Re-assign original teachers

Tick this option to delete all teacher swaps carried out in previous optimisation runs. This means that each subject will again be taught by the teacher originally assigned to the lesson under "Lesson | Teachers".

After a successful teacher swap, a display of all swapped and originally assigned teachers can be viewed via ["Scheduling | Diagnosis"](#). The figure on the left shows a situation where the "?-Teacher" function (i.e. teachers suitably qualified to teach the subject) is active and teacher "New" was replaced by "Gauss" for lesson 94.

The lesson details window displays the current and the replaced teacher (see figure).

The screenshot shows two windows from a scheduling software. The 'Timetable diagnosis' window on the left has a 'Diagnosis' tab with a table showing various categories and their counts. A red box highlights the 'Lessons' category with the value '11' and the text 'In optimisation teacher was changed'. The 'Lessons / Class' window on the right displays a table of lessons. A red box highlights a question mark in the 'Subject root (Teacher)' column for lesson 31. A red arrow points from this question mark to a list of teachers below the table, where 'Ander (?)' is highlighted with a red box.

Category	Wtg	Num
Lessons	All	>= 1
Class		3
Teacher		52
Room		17
Subject		27
Students		

L-No.	Cl,Te	UnSc	Per	/rsPrds	Teacher	Subject	Class(es)	Subject root (Teacher)	Double per.
11	4, 1	2	Hugo	GEc	1a,1b,2a,2b	?			
7	2, 3	2	Ander	DS	1a	WS	?	1-1	
73	2, 2	3	Arist	PEG	1a,1b	SH2	?		
33		5	Hugo	EN	1a	?			
35		2	Callas	MU	1a	?			
39		2	Callas	AR	1a	?		1-1	
31		5	Ander	MA	1a	?			
46		2	Nobel	RE	1a	?			
53		5	Nobel	DE	1a	?			
63		2	Cer	BI	1a	?			

63	Cer (?)
39	Callas (?)
46	Nobel (?)
35	Callas (?)
53	Nobel (?)
33	Hugo (?)
31	Ander (?)

3.1.2.5 Teacher optimisation code

The module Lesson Planning offers with the teacher optimisation code a further method to limit swaps with variable teachers.

You can find the code in "Master Data | Teachers" and in the lesson windows. The codes in these two types of windows are independent of each other.

The code can be used to select a pool of lessons or teachers in which swaps are possible. Identical codes mean that the teachers of the marked lessons can be swapped.

You can assign the codes 1-9 and A-Z. The codes are always an additional limitation. For instance, if you have activated the option "Swap only within one class level" and you have entered the code 1 for the teachers Gauss and Newton then swaps of Newton's lessons are only possible with lessons of Gauss in the same class level.

Name	Surname	Room	NTPs	Periods/c	Lunch brs	TeOptCo
Gaus	Gauss	0-3	2-6	1-2	1	1
New	Newton	0-1	4-6	1-2	1	1
Hugo	Hugo	0-1	4-7	1-2		
Ande	Andersen	0-1	4-6	1-3		
Arist	Aristotle	0-1	4-6	1-2		
Callas	Callas	0-1	4-6	1-2		
Nobel	Nobel	0-1	4-6	1-2		
Rub	Rubens	0-1	4-7	1-3		
Cer	Cervantes	0-1	4-7	1-2		
Curie	Curie	0-1	4-7	1-3		

3.2 Strategies

Untis offers five different optimisation strategies for the construction of your timetable:

[Strategy A - Fast optimisation](#)

[Strategy B - Intensive optimisation](#)

[Strategy C - Fast percent placement](#)

[Strategy D - Intensive percent placement](#)

Strategy E - Overnight optimisation

3.2.1 Strategie A - Fast Optimisation

Using strategy A, Untis constructs a series of timetables with n individual timetables where n stands for the number you have entered under "Optimisation series: No. of TTs (1-20)".

The best timetable is loaded and displayed at the end of the optimisation run. If you have activated the option "Save the results of the optimisation in work files" on tab "Auto-save" under "Settings | Miscellaneous" then this timetable is saved additionally as file work0.gpn.

3.2.2 Strategy B - Intensive optimisation

Using Strategy B, Untis initially constructs a series of n individual timetables – as for Strategy A. The best timetable of the series is then used as the starting point for a new series of n individual timetables, all of them very similar to the best previous timetable.

This process (the construction of a series of new timetables, each based on the best timetable of the previous series) is repeated until the final timetable can no longer be improved upon.

3.2.3 Strateg D - Intensive percent placement

Optimisation strategy D is a combination of strategies B and C.

Untis initially schedules the percentage of periods specified under „% of periods to be scheduled“, as in strategy B. This means that the software constructs a number of series of n timetables until the final timetable can no longer be improved upon. As with strategy C, the best timetable is locked conditionally and used as the basis for the next optimisation step where the percentage of the periods to be scheduled is increased by increments. The default value for the increase is 10% (unless you have specified a different value).

The percentage of periods to be scheduled is increased by increments until the software reaches the point where it attempts to schedule all the periods (100%).

3.2.4 Strategy E - Overnight optimisation

Strategy E is a genetic algorithm which involves a huge amount of computations and provides excellent results.

First, Untis calculates a series of timetables. On contrary to strategy B, where only one timetable is the base of new series, this strategy uses two timetables (mother and father timetable) as the base for new series.

You should use this strategy if you have got already good results with other strategies. Usually strategy E can still improve the result. The length of the optimisation depends on the size of the school, the number of timetables to be calculated, the optimisation level and the performance of your computer. This can take "overnight", indeed.

3.3 The accompanying window

Start the [optimisation](#) process by opening the optimisation dialogue under "Scheduling | Optimisation", entering the desired settings and clicking on <OK>.

	Evaluation	Unscheduled	NTPs	Core Time Infr.	Subj 2X / Day	DblPrds - Error
Current timetable :	207	0	0	2	0	7
Best TT :	145	0	0	0	0	9
1. Timetable No.	147	0	0	0	0	8
2. Timetable No.	168	0	0	0	0	10
3. Timetable No.	145	0	0	0	0	9
4. Timetable No.	167	0	0	1	0	9
5. Timetable No.						
6. Timetable No.						
7. Timetable No.						
8. Timetable No.						
9. Timetable No.						

If the [data analysis](#) window appears, check the displayed messages and/or rectify the displayed errors and click on <OK>.

An accompanying window appears which consists of two panes. The upper part of the window is the information window containing functions for the management of the optimisation process (pause, cancel etc.).

The window also provides a continuous display of key data of the current optimisation run, including an evaluation of the current timetable (penalty points), the number of unscheduled periods, window periods (for classes) and core time infringements (these are periods with a time request of +3 that the software is unable to fill for some reason). These data provide a first, rough impression of the quality of the timetable under construction. The tools for a more detailed diagnostic runs are described in the chapter "Diagnostics tools" below.

The lower part of the window is used for the display of errors (i.e. lessons that cannot be scheduled) and the number of timetables and series the tool has finished optimizing.

When the yellow-blue <OK> button appears on the screen, the optimisation run is complete.

3.4 View optimisation results

When the [optimisation](#) is completed the best result is loaded. Via the optimisation window you can switch to other timetables, too. Click on the respective line in the upper part of the window.

After you have confirmed by clicking on the yellow-blue button, you can switch to the different optimisation results either by loading the work.gpn files or via the menu item "Scheduling | Optimised Timetables". The latter method is only possible during the session in which the optimisation was started. If Untis was closed then this menu item is greyed out.

Optimisation Run

Optimised schedules 09

Opt. strategy: A (9/9) 0/0/0

1. Series

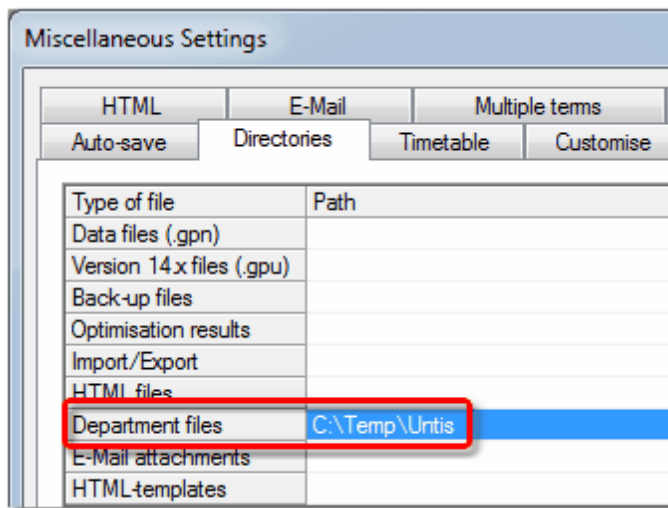
	Evaluation	Unscheduled	NTPs	Core Time Infr.	Subj 2X / Day	DblPrds - Error
Best TT	152	0	0	1	0	5
Timetable 2	157	0	0	0	1	9
Timetable 3	159	0	0	1	0	8
Timetable 4	162	0	0	1	0	8
Timetable 5	165	0	0	2	0	5
Timetable 6	171	0	0	1	0	8
Timetable 7	181	0	0	1	0	9
Timetable 8	204	0	0	2	0	9
Timetable 9	218	0	0	2	0	10

Click

1a - Class 1a (Gauss) Tim

	Mo	Tu	We	Th	Fr	Sa
1	MA	MA	EN	DE	MA	EN
2	RE	EN	PEG.	GEc	RE	BI
3	BI	AR	MA	MA	EN	MU
4	PEG.		MU	EN	DE	GEc
5	DE	DE			PEG.	DE
6						
7						
8						

Every individual timetable can be stored as a separate file (work1.gpn to work n .gpn) by selecting the option "Save the results of the optimisation in work files" on tab "Auto-save" under "Settings | Miscellaneous". This gives you the possibility to load, view and analyse all the results anytime.

**Hint!**

You can change the directory of the work.gpn files by defining a path via "Settings | Miscellaneous", tab "Directories" field "Optimisation results".

4 Diagnostics tools

The master and lesson data of your school contain a vast store of information and it is often difficult to keep track of the amount of data. This means that it is easy for inaccuracies, mistakes and errors to creep in when entering or modifying data. Searching for these inaccuracies and errors is a bothersome, but necessary task. The diagnosis tool is designed to facilitate this task.

This chapter not only deals with errors, but also with so-called "input weaknesses". Input weaknesses are data that, while not technically wrong, can cause inferior or unexpected results.

[Percentage planning](#)

[Diagnosis](#)

[Overall diagnosis](#)

4.1 Percentage planning

After finishing your data entry, you should initially carry out a percentage planning run (e.g. at 30%) to identify lessons that the Untis software categorizes as "difficult". As a rule, the programme attempts to place such lessons as quickly as possible to prevent them from causing an obstruction later during the process.

Hint!

The "difficulty" of a lesson is determined by the number of unavailable lesson elements, the number of element couplings and the size of the lesson block.

Caution!

Specifying a planning priority for lessons (on the ["Timetable"](#) tab) has a profound effect on this aspect of the optimisation process. Do not use this option lightly and use it only when you have good reason to do so!

If Untis encounters problems during the scheduling of the very first 30% of periods and if this very first optimisation run is unable to schedule certain periods, the first thing to do is to increase the number of timetables to be constructed and the number of optimisation steps. If the tool is still unable to schedule the periods, you can assume that the input data contain input weaknesses or even errors.

4.1.1 Example

Errors and input weaknesses are described in greater detail below. The following example provides a brief introduction to the percentage planning function.

1. Open the file *demo2.gpn* .
2. Delete all timetables via the menu item "Scheduling | Delete the Timetable".
3. An information window appears. Click on <OK>.
4. Carry out a timetable [optimisation run](#) (via "Scheduling | Optimisation") and enter the value 30 in the field "% of periods to be scheduled".
5. Display the timetable for class 1a ("Timetable | Classes").

The timetable for class 1a should correspond approximately to the timetable shown in the figure below. There may be slight variations in display depending on the software version you are using.

As mentioned before, the percentage applies to the entire school and not to individual classes. The example shows that more than 50% of the periods for class 1a have been scheduled. The software would have scheduled proportionately fewer periods for other classes. The high percentage of scheduled periods indicates that the lessons of class 1a are more "difficult" to schedule than the lessons of other classes.

Click on the subject "Design".

	Mo	Tu	We	Th	Fr	Sa
1						
2						PEG.
3		PEG.	GEC.	PEG.		
4					GEC.	
5						
6					DS.	
7	AR.					
8						

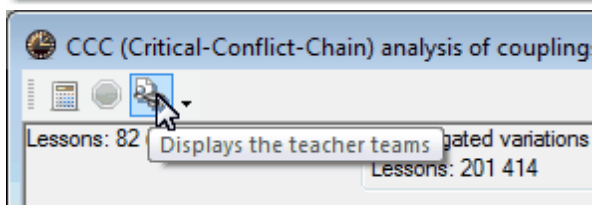
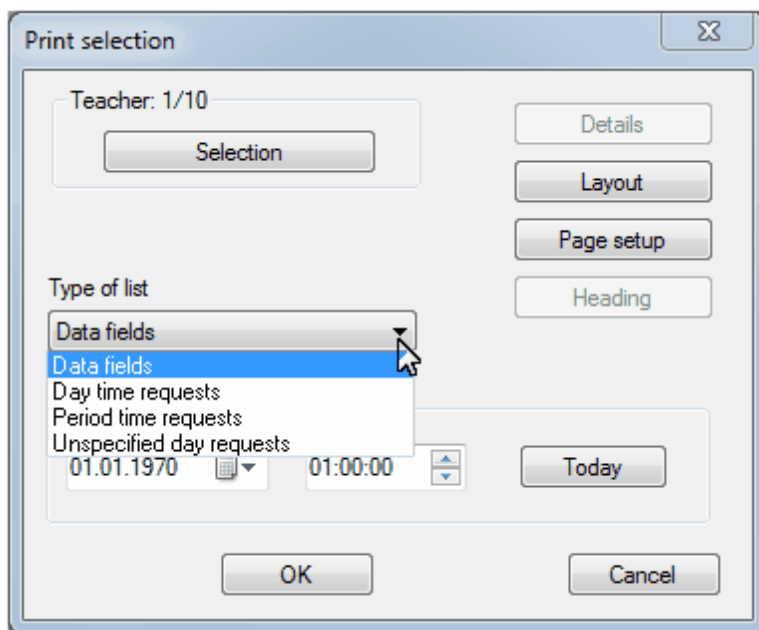
L-No.	Tea. Subj. Rm.	Cla.
7	Ander, DS, WS	1a
	Gauss, DS, WS	1b
	Curie, TX, TW	1a, 1b

The period details window shows that the subject Design is difficult to schedule because three teachers are involved in the lesson (Andersen, Gauss and Curie) and two rooms are required (the Chemistry lab and the Physics lab). Furthermore, another class (1b) takes part in the lesson. If Untis attempted to schedule this lesson towards the end of the optimisation run, the software would find it much more difficult to find a slot on the timetable that would suit all teachers, rooms and classes involved in the lesson.

When the percentage planning function is unable to schedule periods, you can assume that inaccuracies and errors during data input are to blame.

4.2 Time requests

Time requests are another reason why the software may find it difficult to construct the perfect timetable. A number of predefined lists can help you search for input weaknesses and errors caused by time requests. Access the lists by clicking on <Print> or <Print Preview> in the master data or lesson window.



Under "Print selection", a number of different types of lists are available (e.g. teacher teams, day requests, etc.).

1 Teacher team

Name	Mo	1	2	3	4	5	6	7	8	Tu	1	2	3	4	5	6	7	8	We	1	2	3	4	5	6	7	8	Th	1	2	3	4	5	6	7	8	Fr	1	2	3	4	5	6	7	8
Callas																																													
Gauss																																													
Ander																																													
Rub																																													
Hugo																																													
Nobel																																													
?-1																																													

The following example is based on the conflicting period requests of a teacher team. If you have the module Lesson Planning select "Teacher teams" as type of list in "Master Data | Teachers". If not, you

can get this list via "Scheduling | CCC-Analysis", button <Displays the teacher teams>.

The only days not blocked for any of the involved teachers are Thursday and Friday.

A lesson consisting of three single periods could not be scheduled for this teacher team without violating a "-3" time request (something the optimisation tool would never do) or the single period condition (something the optimisation tool might do, depending on your weighting settings for conditions such as "Avoid errors with double period").

For further information on teacher teams, please see the chapter "Teacher teams".

4.3 Options

An important point is the distinction between " *must* " and " *can* ".

The settings "1,1" under "Master Data | Subjects" in the input field "Afternoon periods/week Min, Max" on the "Timetable" tab **forces** Untis to schedule exactly one afternoon period. The setting "0,1", by contrast, **enables** Untis to schedule exactly one afternoon period. If you come across an undesired or even unnecessary afternoon period in your timetable, check the values in this input field. For the same reason, you should try to keep your options open when it comes to double period conditions and enter "0,1" or "1,2".

4.4 Locked periods

Try not to restrict the [optimisation](#) tool by manually scheduling a large number of lessons. Reconsider if some periods really need to be scheduled manually (see also the chapter "Manualtimetabling").

4.5 Weightings

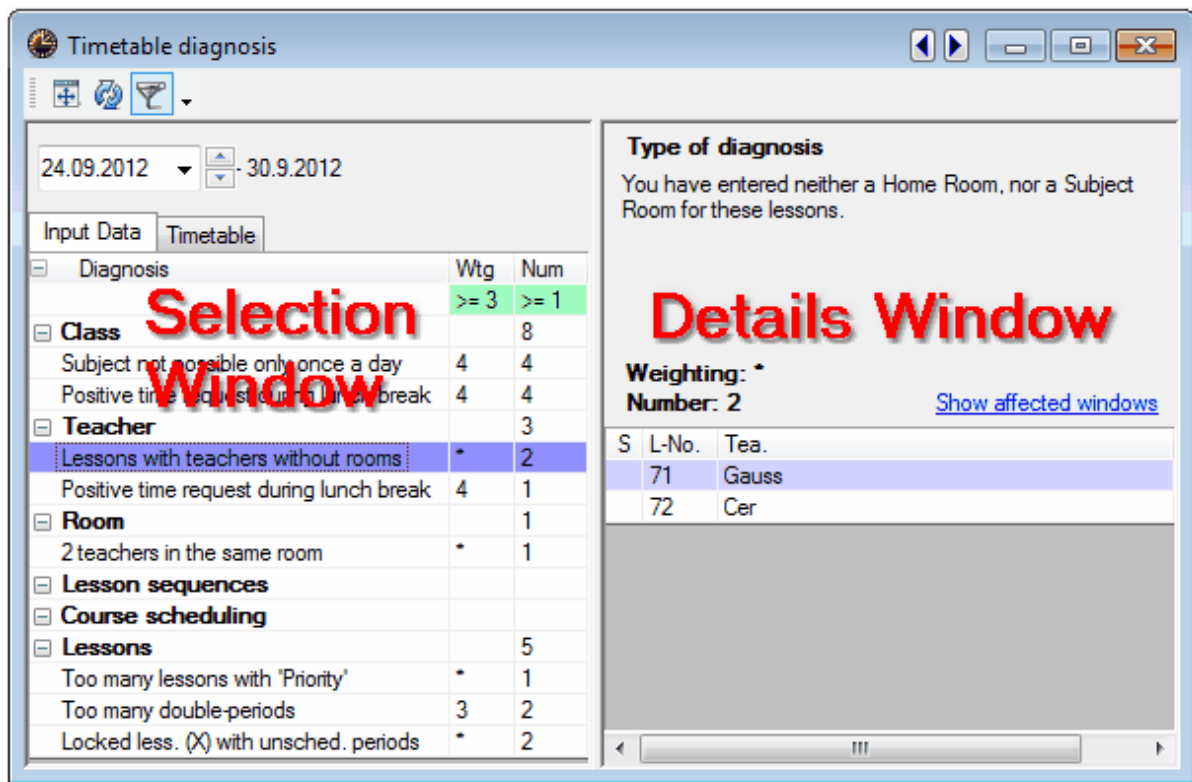
When the software is unable to schedule large numbers of periods, it makes sense to call up the [weighting dialogue](#) again and to determine if the setting "extremely important" (5) is strictly necessary in all of the cases. In order to resolve an input weakness, it is often sufficient to reduce the setting of one or two items by one level to "very important" (4) (see also the chapter ["General notes"](#) under "Weighting" above).

Increase the [percentage](#) of the periods to be scheduled until you are certain that all the input weaknesses have been resolved.

Use the more complex [optimisation strategies](#) only when you are certain that all entries are correct. An important tool for the identification and location of input errors and violations of conditions are the ["Diagnosis"](#) and ["Overall Diagnosis"](#) tools. These are described in the following chapter.

4.6 Diagnosis

Open the diagnosis window via the menu item "Scheduling | Diagnosis". The window is divided into two sections – the [selection window](#) on the left and the [details](#) window on the right.



4.6.1 The selection window

The largest space in the selection window is devoted to the list of items diagnosed by the diagnosis tool. On the right-hand side of the diagnosis items you can see the sum of infractions for this particular item. The number is marked red if there is at least one severe (highly weighted) problem. You can open the items individually by clicking on the symbol "+" (like the Windows Explorer) or you can open all items at once by clicking on <Details>.

	Wtg	Num
Diagnosis	All	>= 1
Class		46
Subject not possible only once a day	5	6
Positive time request during lunch break	4	40
Teacher		1
Lessons with teachers without rooms	*	1
Room		2
2 teachers in the same room	*	2
Lesson sequences		
Course scheduling		
Lessons		1
Too many lessons with 'Priority'	*	1

Wtg (Weighting)

The second column is entitled "Wtg" (Weighting) and shows the level of importance you assigned to the individual items in the weighting dialogue.

For example, if the slider for "Respect lunch break requests for classes" is set to 5 (extremely important), the value "5" is displayed in the column "Wtg" for "Lunch break too long" and "Lunch break too short".

An asterisk (*) in this column means that the item is not weightable.

Num (Number)

The third column entitled „Num“ displays the number of violations of this particular item. In some cases, a second figure appears in brackets. This figure refers to the number of periods.

For example, the entry "10 (24)" under "Les." for item "Missingteachers" means that there are 10 lessons with a total of 24 periods per week where teachers are missing.

Diagnosis

The fourth and last column entitled „Diagnosis“ describes the actual item.

Please note that items with a weighting of "5" or marked (*) for non-weightable are highlighted with a different colour under "Num." to indicate that the timetable contains a violation.

Next are the control elements in the upper part of the selection window:

<Refresh list>

Click this button to start a new diagnosis run. This also applies when you close the diagnosis window and carry out a new diagnosis run via "Scheduling | Diagnosis".

<Data analysis>

Click this button to carry out a [data analysis](#) (see the appropriate chapter).

Minimum weighting (0-4)

Items with a weighting below the value you enter in this window are no longer displayed. Items categorized as non-weightable (*) will still be shown.

Only show report total >0

Tick this box if you want to see only the items where a violation has been detected on the timetable.

Please note that the diagnosis tool only diagnoses the timetable for one week – an essential precaution when using the modules Multi-Week Timetable or Multiple Terms Timetable where different timetables may be in use in different consecutive weeks (e.g. for term teaching or block lessons). When analyzing such timetables, specify by means of the date setting (below the control elements) which week you want to analyse.

Timetable diagnosis

24.09.2012 - 30.9.2012

Input Data Timetable

Diagnosis

Lessons

Lessons with no teacher specified

Class

+3 time request not respected

Not enough periods per day

Too many periods per day

Teacher

Too many NTP's

Double Non-Teaching-Period

Lunchbreak too short

Teacher's free day moved

Day request not achieved

Half day request not achieved

Not enough periods per day

Too many periods per day

Too many consecutive periods

Just one period on a half day

Scheduled in a -3 timed period

Room

Period(s) without a room

Subject

Un-requested double periods

Less. with 2 perds/week on consec. days

Illegal morning period

Illegal afternoon period

Main subject too often after period n (n=4)

Main subject not in per. 1-n (n=4)

Fringe period request not respected

Students

Wtg Num

All >= 1

Wtg Num

24.09.2012 - 30.9.2012

Input Data Timetable

Diagnosis

Wtg Num

>= 4 >= 1

Lessons

Lessons with no teacher specified

Class

Teacher

Teacher's free day moved

Day request not achieved

Half day request not achieved

Scheduled in a -3 timed period

Room

Subject

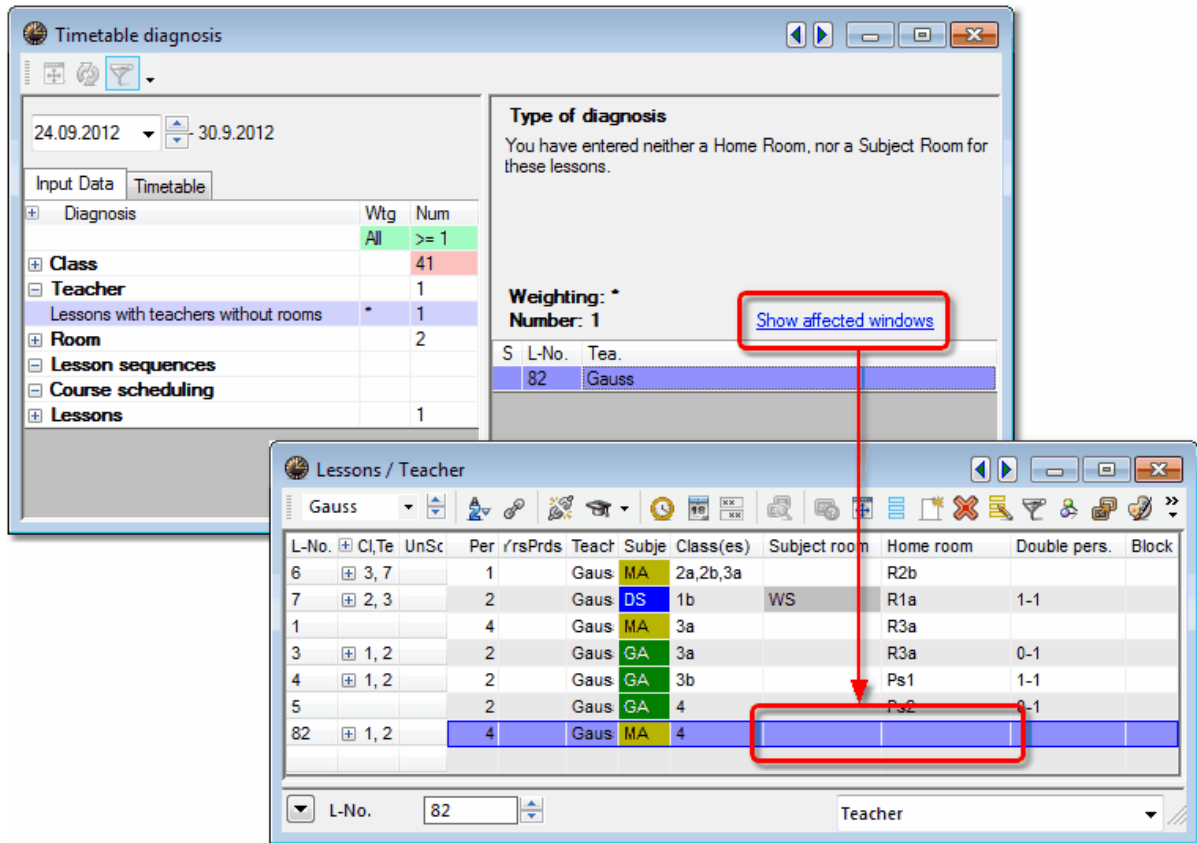
Fringe period request not respected

Students

4.6.2 The details window

The details window on the right-hand side of the diagnosis window allows you to obtain further information about individual items by selecting the item in the selection window. The problem will be displayed in a separate timetable window.

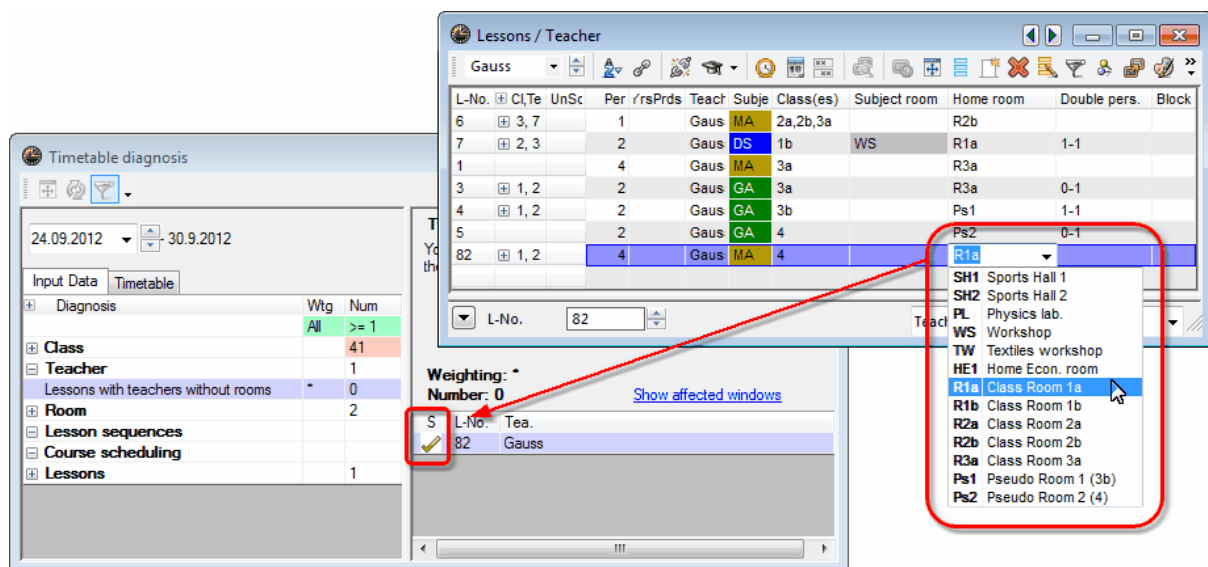
The following example demonstrates the function of the diagnosis tool. Depending on which version of Untis you are using, the optimisation results may differ from the results shown in this example.



When the optimisation run is complete, you can see in the optimisation information window that the constructed timetable contains several core time violations (unscheduled periods with the time request „+3“). But you cannot see where these violations occur.

Open the diagnosis function ("Scheduling | Diagnosis").

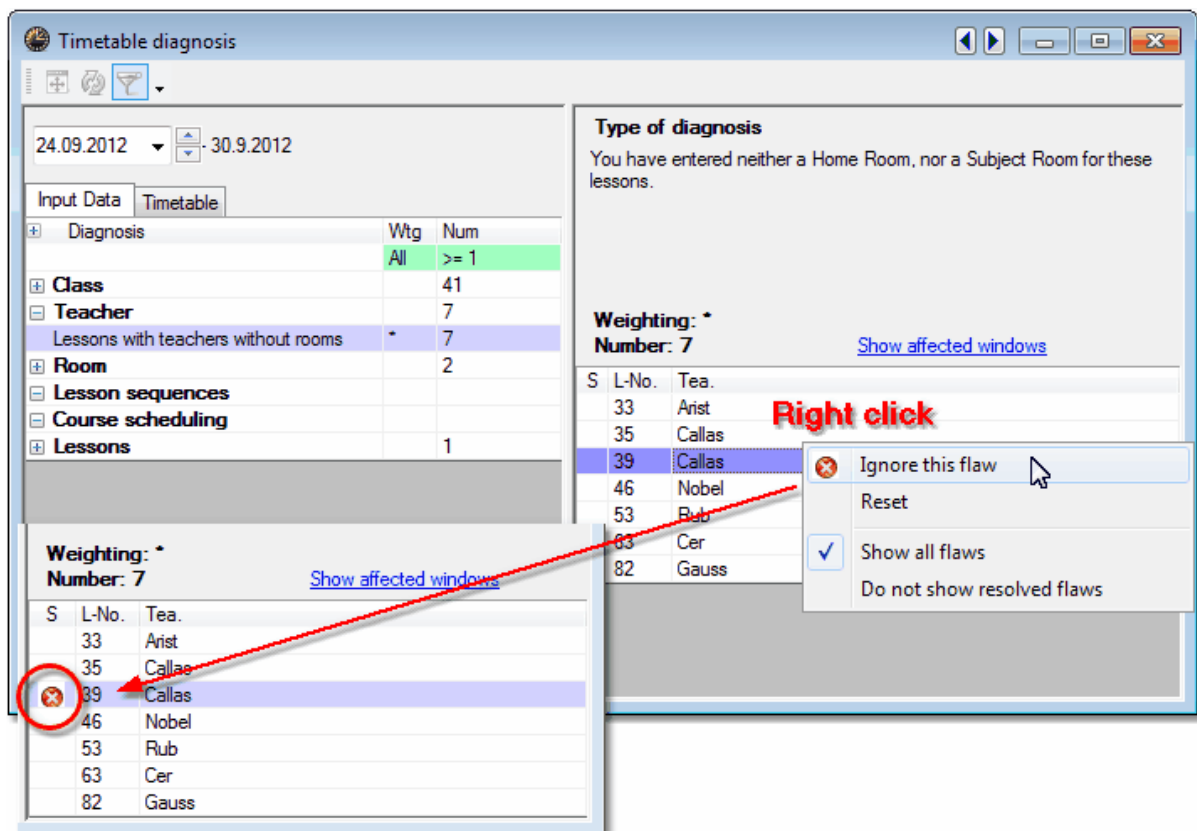
Detach the "pin" from the timetable (button <Lock Type>). The class timetable now becomes an "accompanying" timetable, which means that the display in the timetable window is now independent from the active window.



Open the category "Teacher" and click on "Double NTP".

The details window displays all teachers whose timetable contains double NTPs.

Click on an entry in the details window. The accompanying timetable switches to affected teacher and the period in question is highlighted.



You now need to decide if you want to accept the displayed violations or take evasive action. One option would be to increase the weighting for "Avoid creating double NTPs for teachers" to enable the optimisation tool to place a greater emphasis on this function.

While working with the diagnosis tool, keep checking items to which you have assigned a low weighting as there could also be hidden input errors in areas often regarded as unimportant.

4.6.3 Subject 1/day impossible

An explanatory text is displayed in the details window of the diagnosis for each diagnosis item. However, the item 'Subject 1/day impossible' under the heading 'Input Data | Class' deserves special attention. By default, the scheduling algorithm attempts to schedule a subject only once per day. The relevant subjects will be listed in the diagnosis if this is not possible since too many periods have to be spread over the days available.

The figure below shows that a special tuition teacher is scheduled to take class 1a for the subject ST comprising 5 periods each of English and German. This means that 10 weekly periods are defined for the subject SN with class 1a. Untis would attempt to schedule this subject just once per day. However, since 10 individual periods cannot be fitted into a 5-day week, the issue will be listed.

The screenshot shows the 'Timetable diagnosis' window. On the left, a list of diagnosis items is shown with columns for 'Wtg' (Weighting) and 'Num' (Number). The item 'Subject only once per day not possible' is highlighted with a weighting of 4 and a number of 2. The right pane shows the details for this item, including a description of the rule and a table of affected lessons.

Type of diagnosis
 Untis tries to schedule a certain subject no more than once per day per class. Untis enforces this rule comprehensively, such that it checks the 'names' of the subjects of the individual lessons of a class and does not schedule these lessons on the same day, even if you actually meant different student-groups, e.g. in Math. The subjects listed would have to be scheduled on more days per class than there actually are available for scheduling.

Weighting: 4
Number: 2 [Show affected windows](#)

S	Cla.	Sub.	PerWk	L-No.
1a	FU	10	33	
2b	DE	6	6	

The 'Lessons / Class' window shows a detailed view of class 1a. It lists lessons with columns for L-No., Cl, Te, UnSc, Per, r/sPrds, Teacher, Subject, Class(es), Subject roo, Home room, Double per, and Block. The lessons for class 1a are highlighted in red:

L-No.	Cl,Te	UnSc	Per	r/sPrds	Teacher	Subject	Class(es)	Subject roo	Home room	Double per	Block
33	1, 2		5		Arist	FN	1a		R1a		
					Huber	FU	1a				
11	4, 1		2		Hugo	GEc	1a, 1b, 2a, 2b		R1a		
53	1, 2	2	5		Rub	DE	1a		R1a		
					Maier	FU	1a				
7	2, 3		2		Ander	DS	1a	WS	R1a	1-1	

Possible solutions for this concrete example:

- Set up double periods or block conditions
- Activate the '(2) More than once a day' option for the subject ST in the subjects master data
- Change the subject name of one of the lessons taught (e.g. 'ST_GE' for special tuition in German)

4.7 Overall diagnosis

The overall diagnosis function provides an overview of the classes and teachers that have ended up with the worst timetables (measured against your settings).

Call up the total diagnosis function via "Scheduling | Overall Diagnosis".

The screenshot shows a window titled "Overall diagnosis" with a close button (X) in the top right corner. Below the title bar, there is a date selector set to "24.09.2012" and a "Class(es)" dropdown menu. To the right of these are "Refresh" and "Print" buttons. Below the date and class fields, it displays "School week: 2" and "Calendar week: 39". To the right, it shows "Penalty points (total): 12 707" and "Total unsch. per.: 6".

The main part of the window contains a table titled "The 3 worst periods". The table has columns for "Points", "UnSc", and three columns for "1.", "2.", and "3." periods, each with a "Points" sub-column, and a final "Reason" column. The first row of data is highlighted with a red box around the "1." period details.

	Points	UnSc	1.	Points	2.	Points	3.	Points	Reason
4	2587	2	Tu-6	66	Fr-2	62	Th-6	60	Just one period on a half day
1a	2381	2	Fr-8	60	Fr-5	50	Fr-7	50	Just one period on a half day
2a	2208		We-2	645	We-3	645	Fr-5	247	Subject twice a day
2b	2146	1	Sa-2	308	Sa-3	308	Sa-1	140	Subject twice a day
1b	1924	1	Sa-2	311	Sa-3	311	Sa-1	140	Subject twice a day
3a	1007		We-2	323	We-6	229	Mo-7	84	Subject twice a day
3b	454		Mo-5	57	Tu-3	49	Tu-4	49	Main subjects - Boundary period

The overall diagnosis function applies to only one week – for the same reasons stated above for the [diagnosis function](#) (see previous chapter). Select the desired week via the date combo box.

Next to the date combo box, you will see another box where you can specify if you want to display a teacher list or a class list.

The list itself is organized in order of least desirable timetable. The first column of the list entitled "Points" contains the total number of penalty points. Additionally, the list displays the three worst periods in each timetable, again with their respective values.

Click on one of the three periods in the list to display the causes of the bad result under "Reason". When you have an accompanying timetable open at the same time, the period is displayed immediately. Please note that when you first open the overall diagnosis window or click on <Refresh> (and before you click on any of the periods), the cause displayed under "Reason" always refers to the first period in the row.

	Mo	Tu	We	Th	Fr	Sa
1	PEG.	DS.	GA	PH	BI	MA.
2	CK		RE	HI	GA	
3	HI	MU	MA.	CK	RE	DE
4	DE	BI	GEc	DE	GEc	EN
5						
6	AR	PEG.		PEG.		
7						
8						

The example shows that the overall diagnosis tool detected a split double period. Click on the entry in the overall diagnosis window to highlight the period in the accompanying timetable. The other periods of this subject – in this case, only one other period on Friday – are also highlighted.

The problem can be resolved by increasing the weighting of point "Avoid errors with double periods" by one level.

An empty field under "Reason" indicates that the timetable for this class or teacher is already very good (i.e. has relatively few penalty points). In relation to the other periods, the displayed period may be one of the three worst placed ones. Overall, however, it is fairly well placed. It is unnecessary, therefore, to change the period manually.

In short, the diagnosis function provides an overview of all timetables while the overall diagnosis function targets the worst timetables in the school and aims to improve them. The overall diagnosis window also displays the causes of violations.

4.8 CCC-Analysis

In order to obtain a good timetable, it is important to locate possible bottlenecks that might cause an obstruction for the scheduling tool, and to eliminate these **before the optimisation**.

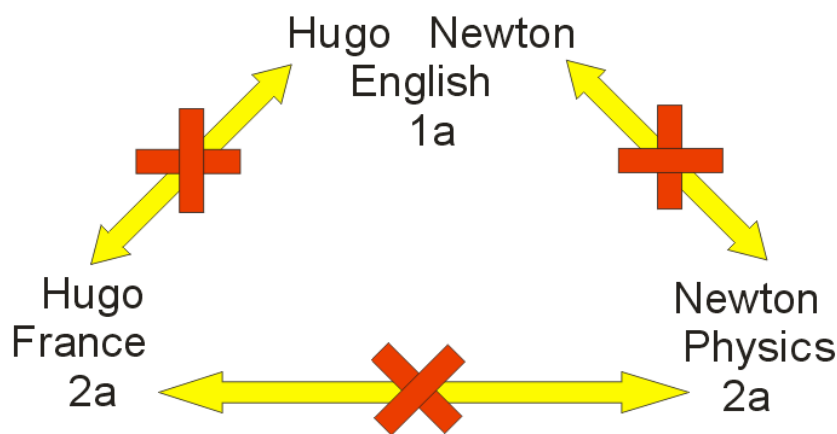
Such bottlenecks occur in the form of Critical-Conflict-Chains (CCC). These are defined as groups of lessons that cannot be scheduled at the same time due to a conflict between classes and/or coupled teachers.

The CCC analysis locates the longest chains in your lesson input data and identifies the coupled

teacher at the heart of the obstruction. Replacing this teacher will often result in a shortening of the chain, permitting the scheduling of all periods.

If, for example, teacher Hugo is assigned to teach English (lesson 1) to class 1a and French (lesson 2) to class 2a, these two lessons cannot be scheduled at the same time. If lesson 1 (English, 1a) involves a coupled teacher (e.g. Newton) who is also assigned to teach Physics to class 2a, the number of lessons in this chain increases to three.

This means that whenever teacher Hugo teaches English to class 1a, two further lessons are automatically blocked (see diagram on the following page). Furthermore, Newton, who teaches Physics to class 2a, would also block the other two lessons since Hugo could not teach French to the same class at the same time, and Newton could not teach English to class 1a at the same time.

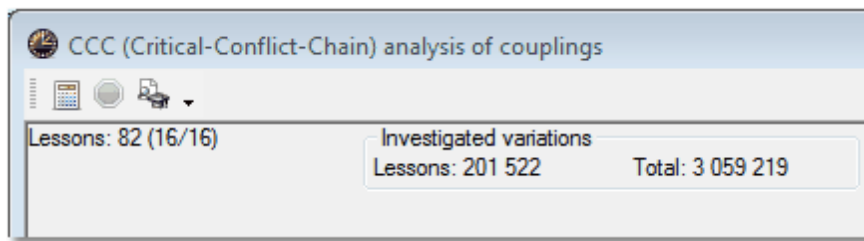


The total number of periods per week involved in a chain is a measure of how difficult it is for the software to schedule the lessons in the chain. It is easy to see, for instance, that a large number of different teacher teams will mean a rapid increase in the total number of periods in the chain. If this number is greater than the number of periods available in the time grid, it is mathematically impossible to schedule all the lessons in this chain.

The task of the CCC analysis is to locate the longest conflict chains. Start the analysis by accessing the menu item "Scheduling | CCCAnalysis". The CCC window appears and the CCC analysis starts automatically. The analysis can take up to several minutes, depending on the size of your school.

4.8.1 Information during the analysis

During the analysis, you will see the number of the lesson currently being analyzed, i.e. scanned for its dependency on other lessons, in the upper part of the window (on the right hand side of the word "Lesson"). The two numbers in brackets denote the number of couplings the software has finished analyzing and the total number of couplings to be analyzed, respectively.



In addition, the information field "Investigated variations" displays the number of combinations the software has finished analyzing.

4.8.2 The CCC window

As you can see in the upper part of the window, there are 86 lessons and 15 couplings, resulting in over 2.8 million combinations that need to be analyzed.

The middle part of the window

The middle part of the window shows a table of all CCCs listed in rows. The first column contains the total number of periods per week involved in each chain. The figures on the right are the lesson numbers of the lessons involved in the chains. The table also displays the abbreviated names of teachers in brackets next to some of the elements. The purpose of this function is described in a later chapter.

2. Click on "8 (New)" in the first row of the middle part of the window (see figure).

CCC (Critical-Conflict-Chain) analysis of couplings

Lessons: 70 (15/15)

Investigated variations
Lessons: 207 047 Total: 2 843 898

Click

Per	Lessons									
27	1	4 (New)	25 (New)	26 (New)	28 (New)	36 (New)	39 (New)	49 (New)	56 (New)	69 (New)
24	2 (Arist)	10 (Arist)	76	78	79 (Arist)	80 (Arist)				
24	2 (Arist)	6 (Arist)	78	79 (Arist)	80 (Arist)	84 (Rub)				
23	10 (Arist)	76	77	78	79 (Arist)	80 (Arist)				
23	1	22 (Cer)	23 (Cer)	24 (Cer)	34 (Cer)	45 (Cer)	46 (Cer)	54 (Cer)	68 (Cer)	72 (Cer)
22	1	2	3	4	25 (New)	26 (New)	28 (New)	36 (New)	76	
21	1	2	3	4	19 (Callas)	20 (Callas)	29 (Callas)	30 (Callas)	31 (Callas)	76
21	2 (Rub)	6 (Arist)	10 (Arist)	13 (Rub)	78					
21	1	18 (Hugo)	40 (Hugo)	50 (Hugo)	51 (Hugo)	59 (Hugo)	60 (Hugo)	61 (Hugo)	72 (Hugo)	76 (Hugo)
20	1	3 (Curie)	4 (New)	25 (New)	26 (New)	28 (New)	36 (New)	69 (New)		
17	1	5	6	7	39 (New)	49 (New)	56 (New)			
17	1	18 (Hugo)	22 (Cer)	23 (Cer)	24 (Cer)	72 (Cer)	76 (Hugo)			

Les.	Per	Classes				Teachers	
1	1	2a	2b	3a	3b	4	Callas
4	1	2a	2b				New
25	4	2a					New
26	2	2a					New
28	2	2b					New
36	5	2b					New
39	2	3a					New
49	3	3b					New
56	4	3b					New
69	3	4					Curie

The CCC details window

The bottom part of the window - *the details window* – displays the details of the lesson selected in the middle part of the window. The example shows that the cells for lesson numbers and the number of periods per week are now shaded light blue. Several other cells are now shaded red.

The details window now displays the following information: the elements involved in lesson 8 with a total of 2 periods per week are the class 2b and the teacher Newton (abbreviated name "New").

Lesson 6 with one period per week, by contrast, involves several classes (2a, 2b, 3a, 3b and 4) and teacher Callas.

Some lessons such as lesson 74 (3 periods per week) may only involve one class (here class 4), but several teachers (Curie and Newton).

The cells shaded red highlight the reason why the displayed lesson cannot be scheduled at the same time as the lesson selected in the middle part of the window. Lesson 6, for instance, cannot be scheduled at the same time as lesson 8 since both lessons involve the class 2b. Lesson 10, by contrast, involves a different class, but the same teacher (Newton), and therefore cannot be scheduled at the same time as lesson 8, either.

4.8.3 Shortening CCCs

The longest chain – the first row in the middle part of the window – contains 27 periods that cannot be scheduled at the same time since this would lead to conflicts, as described above. If you consider that there may be time requests defined for each teacher, class and lesson, that each lesson may have additional conditions imposed on it (e.g. main subjects should not be scheduled too late in the day), that rooms are not always available, and that all this applies equally to the elements of all the other chains (the second longest still has a total number of 24 involved lessons).

Hint!

A large number of chains with many periods can be the cause of a serious timetabling bottleneck.

You now have the option of shortening the chain by assigning a different teacher to individual lessons.

Please note that swapping teachers may not necessarily result in a shortening of the chain. In the worst case scenario, it may even result in a lengthening of the chain.

A lengthening of the chain can occur when a re-assigned teacher is a member of a different teacher team that is not yet part of the chain. When two (or more) teacher teams end up sharing a teacher after a swap, the increased number of teacher teams means there is a high probability that the teachers will block each other.

4.8.3.1 List of teacher teams

Display or print the list of teacher teams (by clicking on the corresponding buttons in the CCC analysis window) to have a handy reference of the composition of the teacher teams at your school.

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