



BECAUSE TIME MATTERS

Empowering Smart Health-Care Scheduling through Participation and Optimization

Overview



01 POLYPOINT

03 PARTICIPATION

02 SHIFT SCHEDULING

04 OPTIMIZATION

Company



> 1'000
customers

Switzerland
Liechtenstein
Germany
Belgium
Luxembourg



> 450'000
users (> 40'000 planers)

1986

company
foundation



Health-Care Industry

hospitals, clinics, rehabilitation centers, psychiatric facilities, long-term care homes



90
employees

Switzerland
Bern
Lausanne
Germany
Berlin



Workforce Management

Swiss-made software

Workforce Management

**Personnel Scheduling /
Shift Scheduling**

Time Management

Demand Management

...

Skill Management

Pooling

Employee Self-Service

...

Overview



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Shift Scheduling

Shift palette

presences



absences

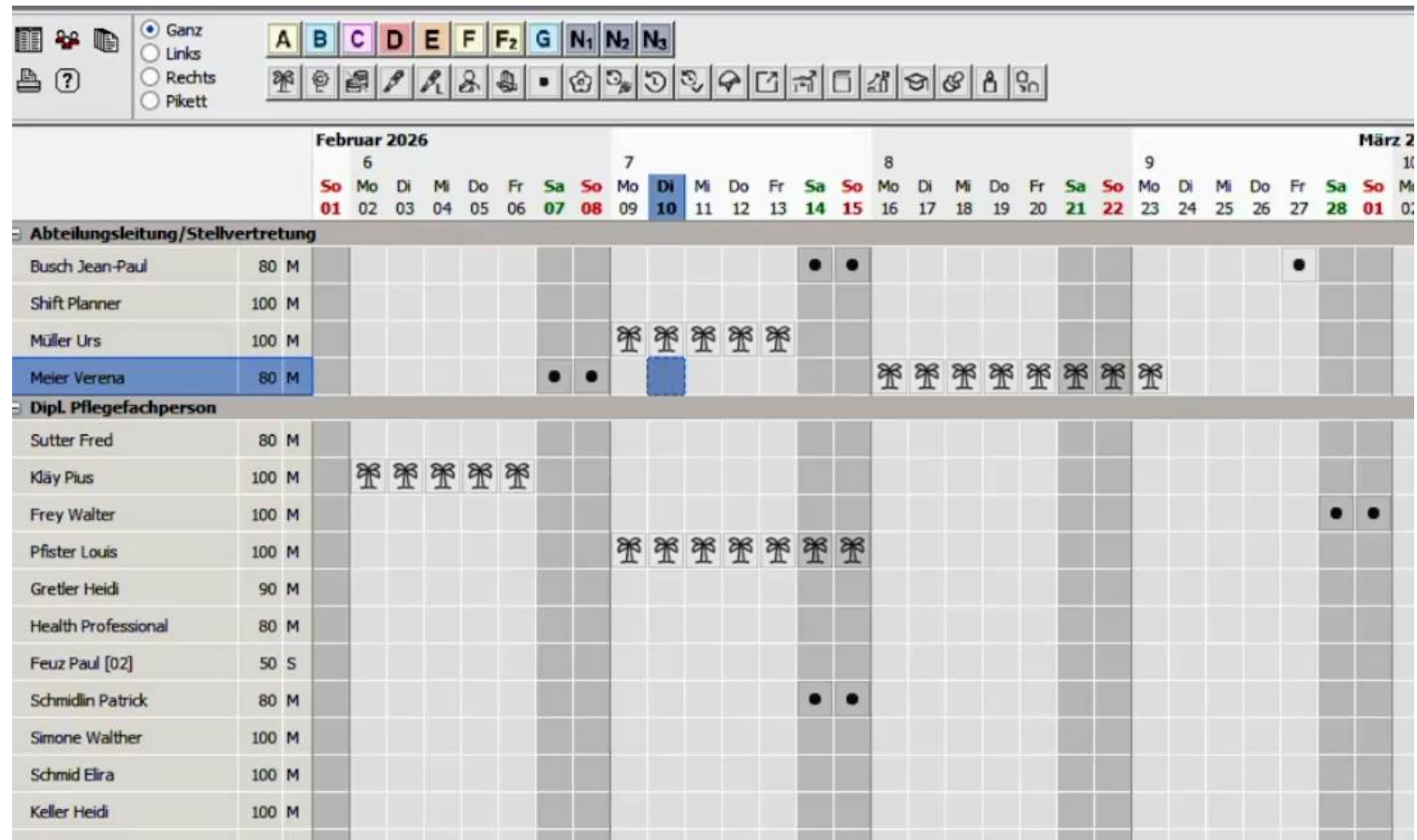


Shift Scheduling

Assign shifts to employees

Shift

- When (day + times)
- Where (unit / subunit)
- (responsibilities)



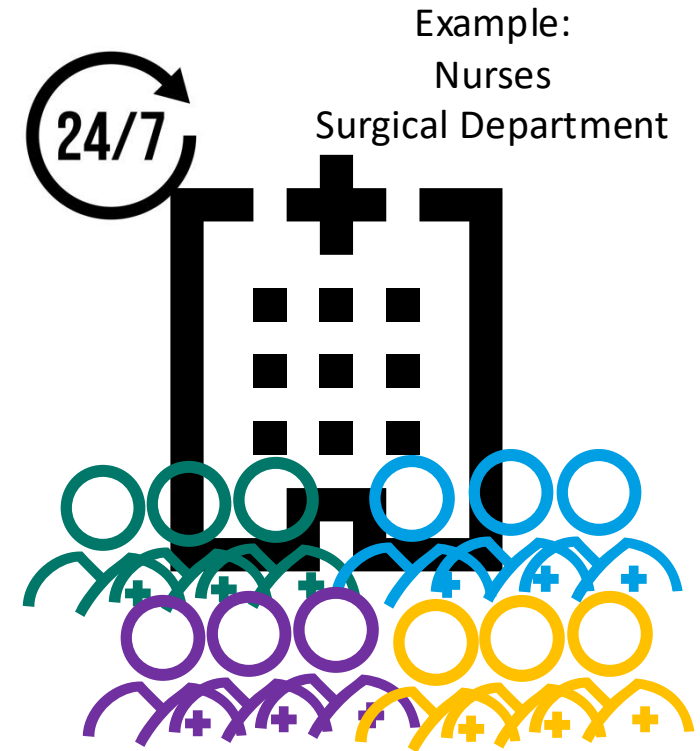
Shift Scheduling Characteristics

24/7 coverage

- ⇒ Shift work, including nights and weekends
- ⇒ Legal and regulatory compliance

High variety of tasks and large work volume

- ⇒ Variety of qualifications, skills and experience
- ⇒ Large number of employees to schedule simultaneously (typically 40 – 100)



Shift Scheduling Characteristics

Volatile and stochastic demand

Supply: unplanned and short-notice events

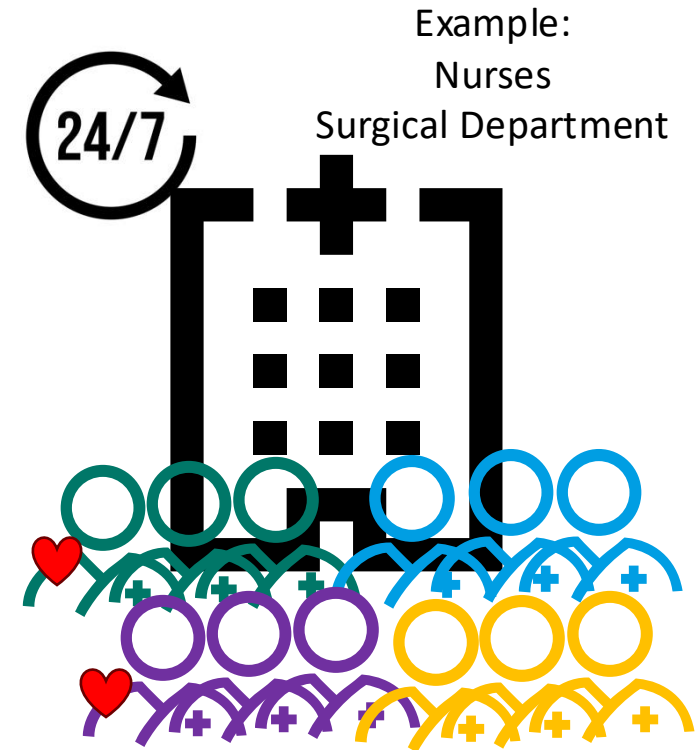
⇒ “Robust” schedule

Scarce resources

⇒ High personnel autonomy in work agreements

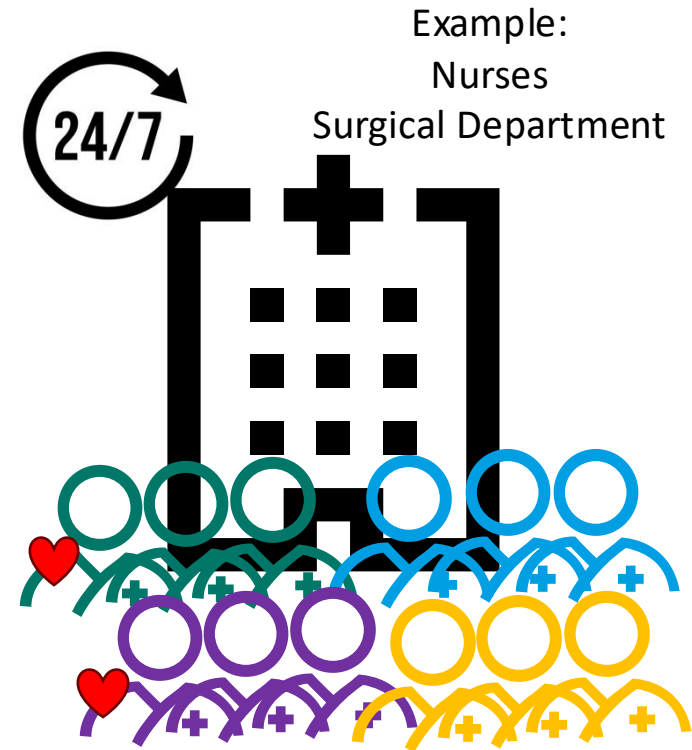
In summary

Complex personalized scheduling setting



Shift Scheduling Process

		Februar 2026								März 2026								Ferien	FT K.																									
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	01	02	03	04	05	06	07	08	2026	2026										
		So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So														
Abteilungsleitung/Stellvertretung																																												
Busch Jean-Paul	80 M			A	B	B	A	B				A	A	•	•			B	N ₁	N ₁	N ₁	N ₁	N ₁															168.0	0					
Shift Planner	100 M			A	B	B	B				N ₁	N ₁			B	A	A	A			B	A	A	A	A															143.5				
Müller Urs	100 M	A	A			A	A	B	A	☞	☞	☞	☞	☞					A	A	A	N ₁	N ₁																	21.5				
Meier Verena	80 M					•	•		A	A	A				A	B	☞	☞	☞	☞	☞	☞	☞	☞	☞			A	A	B	B								18.5					
Dipl. Pflegefachperson																																												
Sutter Fred	80 M			A	A	B						B	B	B	B	B			A	A	B	B	B																	-41.5	0			
Kläy Plus	100 M			☞	☞	☞	☞	☞				A	B	A	A							X	B	A	A			A	B	A	A	N ₁								183.0	0			
Frey Walter	100 M	A	A			B	B	B	B						A	N ₁	N ₁	N ₁	N ₁							B	A	B	B	B	•	•								216.0	0			
Pfister Louis	100 M			B	A	A	A	A			☞	☞	☞	☞	☞	☞	☞				B	A				A	N ₁	N ₁	N ₁	N ₁											180.0	0		
Gretler Heidi	90 M				A	B	B	B					A	B	A						A	B	B	B			B	N ₁	N ₁	N ₁											209.0	0		
Health Professional	80 M	B	B	B	B			N ₁	N ₁				A	B							A	☎	☎	B	B																159.0			
Feuz Paul [D2]	50 S	A		•									A	A	A										A				☞	☞	☞	☞	☞								123.0			
Schmidlin Patrick	80 M			B	B	A					N ₁	N ₁	N ₁	N ₁		•	•							B	A			A	B	A											220.0	0		
Simone Walther	100 M	B	A	A	N ₁	N ₁					B	B	A								B	B	B	A	B			B	B												97.0			
Schmid Elira	100 M			☞	☞	☞	☞	☞					A	B	B												B	B	B	A													21.5	
Keller Heidi	100 M	B	B	B	B			B	A	B					B	N ₁	N ₁	N ₁	N ₁							B	A	B	B													26.5		
Weber Petra	90 M	B	B			N ₁	N ₁	N ₁	N ₁						B	A										A	B			B	B	B	B	B								26.5		
Huber Seraina	70 M	N ₁	N ₁	N ₁	N ₁		•	•							B	B	A									A	B															26.5		
Fischer Beatrice	100 M		B	A							B	B	A	N ₁	N ₁						B	☎	☎	A			A	B	B	A	B										26.5			
Graf Jonas	100 M			B	A	N ₁	N ₁				☞	☞	☞	☞	☞						A	B	B	B				B	B	B	A											21.5		
Wyss Ladina	50 M										B	B	B														B	A														26.5		
Mitarbeitende EFZ																																												
Zimmermann Heidi	100 M												A	N ₁	N ₁	N ₁	N ₁										A	A	A													166.7	0	
Gasser Isabelle	60 M					N ₁	N ₁																					A	A	A													160.3	0
Lehmann Peter	100 M			A	A	A	A	A																		A	N ₁	N ₁	N ₁	N ₁													26.5	

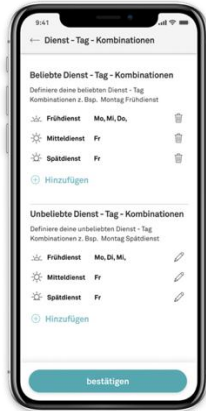


Lead time: 12 – 6 months 1.5 - 2 months weeks to some days days to “real-time”

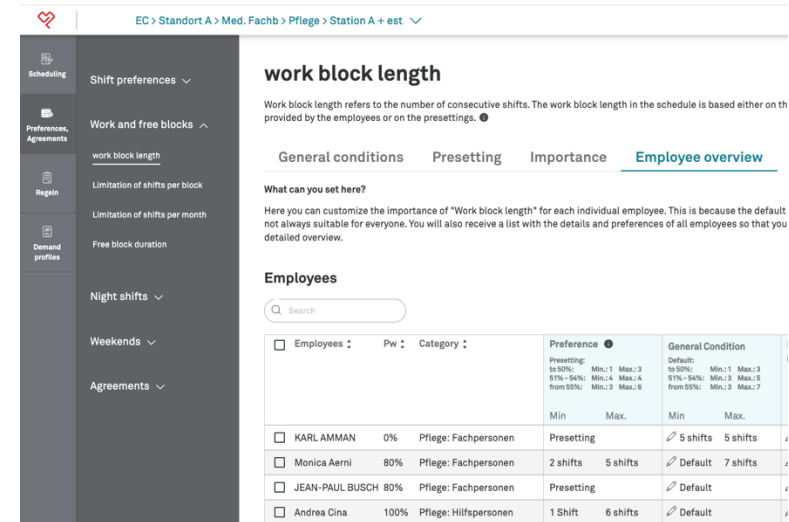


Participation

Employee
(nurses,
physicians,)



Shift planner



work block length

Work block length refers to the number of consecutive shifts. The work block length in the schedule is based either on that provided by the employees or on the presettings.

General conditions Presetting Importance Employee overview

What can you set here?

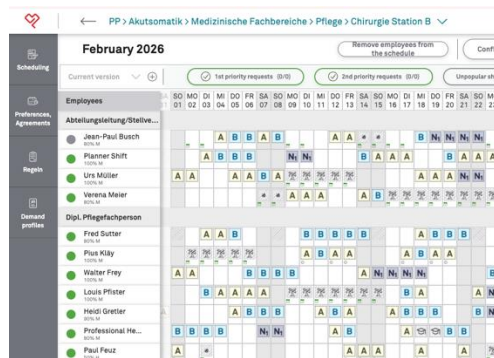
Here you can customize the importance of "Work block length" for each individual employee. This is because the default not always suitable for everyone. You will also receive a list with the details and preferences of all employees so that you detailed overview.

Employees

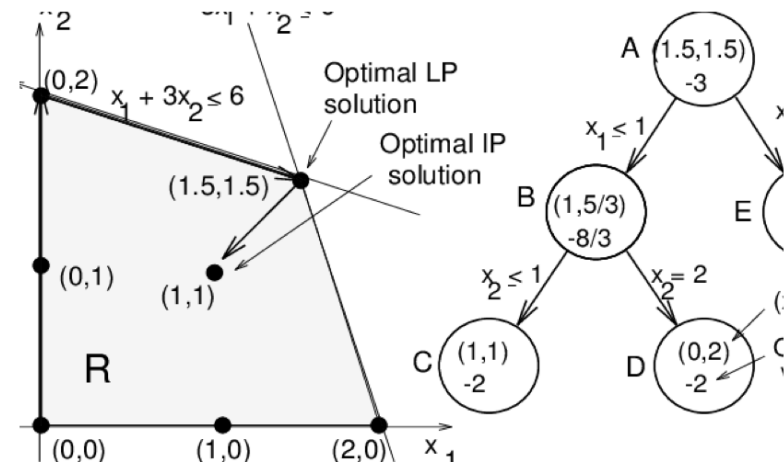
Employee	Pw	Category	Preference		General Condition	
			Min	Max	Min	Max
<input type="checkbox"/> KARL AMMAN	0%	Pflege: Fachpersonen	5 shifts	5 shifts	5 shifts	5 shifts
<input type="checkbox"/> Monica Aerni	80%	Pflege: Fachpersonen	2 shifts	5 shifts	Default	7 shifts
<input type="checkbox"/> JEAN-PAUL BUSCH	80%	Pflege: Fachpersonen	Presetting	Default		
<input type="checkbox"/> Andrea Cina	100%	Pflege: Hilfspersonen	1 Shift	6 shifts	Default	

Optimization

Interactive
scheduling board



Mathematical
Optimization



Overview



01 POLYPOINT

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Employee Participation

← Scheduling preferences ⓘ

Shift preferences

Popular shifts >

Unpopular shifts >

Work blocks

Work block length >

Limiting shifts per block >

Weekends

Weekends off >

Sequence of weekends >

Night shifts

Number of night shifts per month >

Number of night shifts per block >

Number of blocks with night shifts >

Back

← Popular shifts ⓘ

Select your popular shifts below.

Select shift +

Selected combinations of shift- and weekdays

C Dienst C TU, WE, TH ⋮

N Nachtdienst 1 MO, TU, WE, TH ⋮

1 Dienst 1 WE, TH ⋮

What does the setting mean for scheduling? ▾

Back

← Number of night shifts per month ⓘ

Select your preferred minimum and maximum number of night shifts in a month.

Number of night shifts (NS) in a month

Maximum unlimited

0NS **13NS**

0 night shifts 20 night shifts

If possible, you will be assigned between 0 and 13 night shifts per month.

Where does the limitation come from? ▾

Back

Scheduling request ⓘ

All priorities ▾ < September | 2025 >

6 Submitted requests

Ferien 1.Prio

31.08.2025 - 01.09.2025
Masseur

Submitted

B Spätdienst 1.Prio

02.09.2025 - 04.09.2025
Physio

Submitted

Ferien 1.Prio

08.09.2025 - 14.09.2025
Physio

Submitted

1 Frühdienst 2.Prio

09.09.2025
Physio

Submitted

Ferien 1.Prio

10.09.2025 - 13.09.2025
Physio

Submitted

Home Time recording Calendar Request Profile

← Agreed shifts

Fixed assigned shifts

Here you can see the agreed shifts that will always be assigned to you if possible.

Shift	Day	Comment
1 Dienst 1	MON	

Unauthorized shifts

Here you can see the agreed shifts that you do not work.

Shift	Day	Comment
2 Dienst 2	TUES	

Why can't I set anything here? ▾

Back

Preferences

Monthly wishes

Agreements
(view-only)

Shift Planner Participation

PP > Akutsomatik > Medizinische Fachbereiche > Pflege > H1-Pflegestation
Log out

Scheduling

Shift preferences

Popular shifts

Unpopular shifts

Regeln

Work and free blocks

work block length

Limitation of shifts per block

Limitation of shifts per month

Free block duration

Night shifts

Number of night shifts per month

Number of night shifts per block

Number of work blocks

Free block duration after a night shift

Weekends

Weekend distribution

Sequence of weekends

Configuration

work block length

Work block length refers to the number of consecutive shifts. The work block length in the schedule is based either on the details provided by the employees or on the presetsings.

General conditions Presetting Importance Employee overview

What can you set here?

Here you can customize the importance of "Work block length" for each individual employee. This is because the default settings are not always suitable for everyone. You will also receive a list with the details and preferences of all employees so that you have a detailed overview.

Employees

<input type="checkbox"/>	Employees	Pw	Category	Preference		General Condition		Importance
				Min	Max	Min	Max	Default: average
<input type="checkbox"/>	Tim Bauer	100%	Mitarbeitende EFZ	Presetting		5 shifts	5 shifts	high
<input type="checkbox"/>	Jonas Becker	90%	Mitarbeitende FH	Presetting		Default		Default
<input type="checkbox"/>	Philipp Berger	90%	Mitarbeitende EFZ	Presetting		Default		Default
<input type="checkbox"/>	Finn Bergmann	100%	Studierende HF	Presetting		Default		Default
<input type="checkbox"/>	Felix Bregi	100%	Pflegehilfskraft	Presetting		2 shifts	6 shifts	Default
<input type="checkbox"/>	Leon Brügger	80%	Mitarbeitende EFZ	Presetting		Default		Default
<input type="checkbox"/>	Max Bärtschi	90%	Mitarbeitende EFZ	Presetting		Default		Default
<input type="checkbox"/>	Ben Fischer	100%	Abteilungsleitung	Presetting		Default		average
<input type="checkbox"/>	Charlotte Fischer	80%	Mitarbeitende EFZ	Presetting		Default		Default

Refined employee preferences

(general conditions, default values, importance)

Shift Planner Participation

PP > Akutsomatik > Medizinische Fachbereiche > Pflege > H1-Pflegestation

Scheduling

Shift preferences

Popular shifts

Unpopular shifts

Regeln

Work and free blocks

Demand profiles

Night shifts

Weekends

Agreements

Shifts allocated on a fixed basis

Unauthorized shifts

Free time

Configuration

Free time

Free time is periods during which employees do not work and which have been firmly agreed and are almost always observed in the plan.

What can you set here?

You can add and edit the free time here. Employees can see these agreed details in the myPOLYPOINT app but cannot edit them.

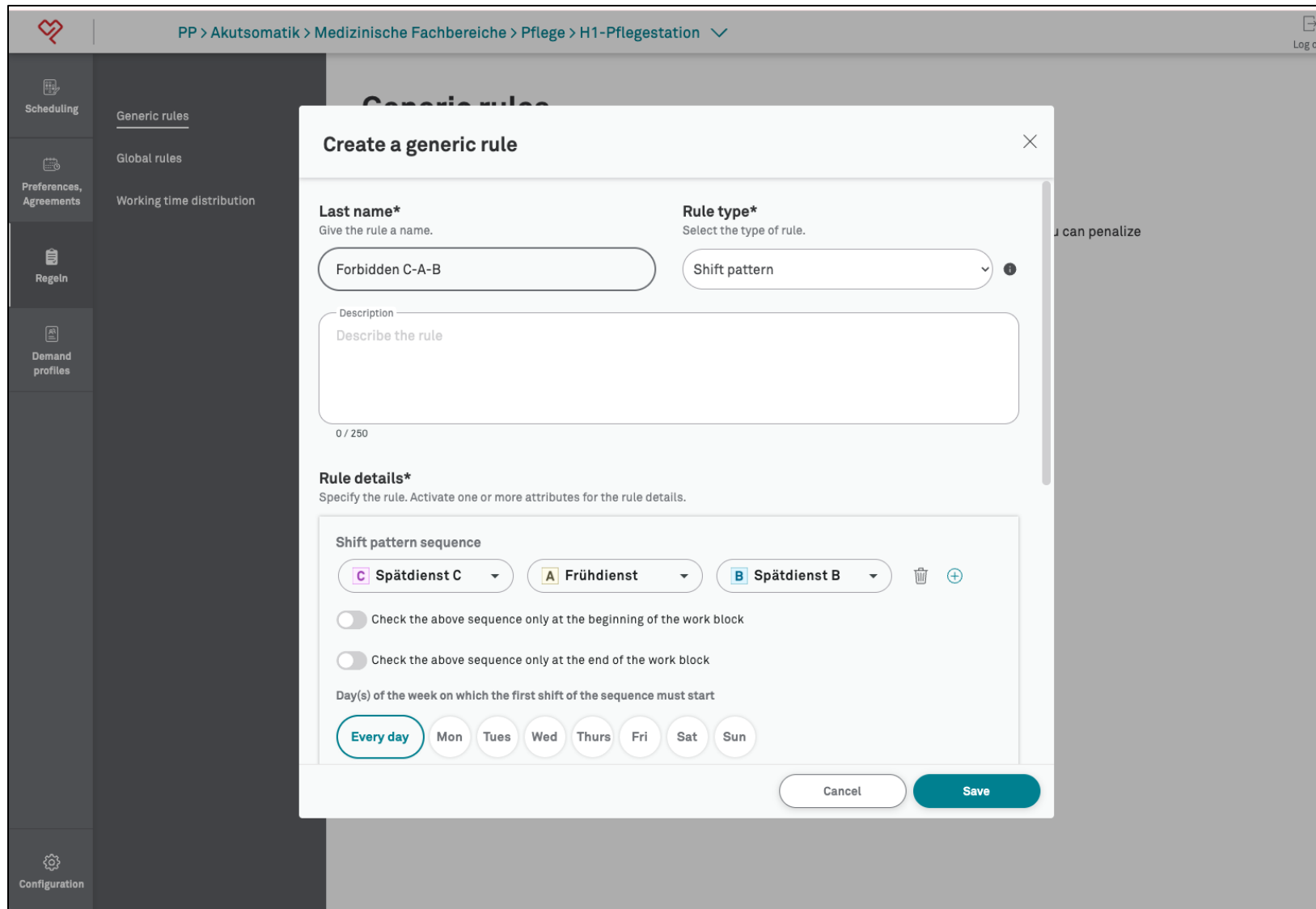
Employees

Employees	Pw	Category	Free Time		Edit
			Days	Time	
Tim Bauer	100%	Mitarbeitende EFZ			+
Jonas Becker	90%	Mitarbeitende FH	Tues	00:00 - 23:59	🗑️ ✎️ +
Philipp Berger	90%	Mitarbeitende EFZ			+
Finn Bergmann	100%	Studierende HF	Sat	00:00 - 23:59	🗑️ ✎️ +
Felix Bregi	100%	Pflegehilfskraft			+
Leon Brügger	80%	Mitarbeitende EFZ	Sat	00:00 - 23:59	🗑️ ✎️
			Sun	00:00 - 23:59	🗑️ ✎️ +
Max Bärtschi	90%	Mitarbeitende EFZ			+
Ben Fischer	100%	Abteilungsleitung	Mon	10:00 - 15:00	🗑️ ✎️ +
Charlotte Fischer	80%	Mitarbeitende EFZ			+
Sarah Fuchs	100%	Pflegehilfskraft			+
Anna Hoffmann	80%	Mitarbeitende FH			+

Shift agreements

(days-off, forbidden shifts, fixed shifts)

Shift Planner Participation



The screenshot shows the 'Create a generic rule' dialog box in the Polypoint Shift Planner. The dialog is titled 'Create a generic rule' and has a close button (X) in the top right corner. It is divided into several sections:

- Last name***: A text input field containing 'Forbidden C-A-B'. Below it is the instruction 'Give the rule a name.'
- Rule type***: A dropdown menu set to 'Shift pattern'. Below it is the instruction 'Select the type of rule.'
- Description**: A text area with the placeholder 'Describe the rule' and a character count '0 / 250'.
- Rule details***: A section with the instruction 'Specify the rule. Activate one or more attributes for the rule details.' It contains:
 - Shift pattern sequence**: A sequence of three shift patterns: 'C Spätdienst C', 'A Frühdienst', and 'B Spätdienst B'. Each pattern is in a dropdown menu. There are trash and add icons to the right.
 - Check the above sequence only at the beginning of the work block
 - Check the above sequence only at the end of the work block
 - Day(s) of the week on which the first shift of the sequence must start**: A row of radio buttons for 'Every day', 'Mon', 'Tues', 'Wed', 'Thurs', 'Fri', 'Sat', and 'Sun'. 'Every day' is selected.

At the bottom of the dialog are 'Cancel' and 'Save' buttons.

Additional preferences
and constraints

(weekends, nights, monthly
shift limits, more complex
rules)

Shift Planner Participation

PP > Akutsomatik > Medizinische Fachbereiche > Pflege > H1-Pflegestation

In this area, you can link the shifts and shift groups with the corresponding personnel categories. Define the minimum and/or optimal number of personnel. In addition, you can link the demand profile with special skills. You can also define here the order of the demand profiles for the smartPEP planning interface.

New demand profile

Display inactive profiles

Profile Active	Demand Profile Designation	Validity	Weekdays						
			Mon	Tues	Wed	Thurs	Fri	Sat	Sun
<input checked="" type="checkbox"/>	Frühdienste	19.08.2025 - unlimited	min. 1 opt. - max. 5	min. 1 opt. - max. 5	min. 1 opt. - max. 5	min. 1 opt. - max. 5	min. 1 opt. - max. 5	min. 1 opt. - max. 5	min. 1 opt. -
		Shift - personnel category combination	Special knowledge				Automatic distribution		Importance
		A Frühdienst - AbtLeit, MA FH, MA EFZ, PHK, Stud HF					<input checked="" type="checkbox"/>		average
<input checked="" type="checkbox"/>	Rad Weekend L4	20.08.2025 - unlimited	min. - opt. - max.	min. - opt. - max.	min. - opt. - max.	min. - opt. - max.	min. - opt. - max.	min. 1 opt. - max. 1	min. 1 opt. -
		Shift - personnel category combination	Special knowledge				Automatic distribution		Importance
		2 H1 Dienst 2 - MA FH, MA EFZ	Radiologie Level 4				<input checked="" type="checkbox"/>		average
<input checked="" type="checkbox"/>	Rad Weeek	20.08.2025 - unlimited	min. 1 opt. - max. 2	min. 1 opt. - max. 2	min. 1 opt. - max. 2	min. 1 opt. - max. 2	min. 1 opt. - max. 2	min. - opt. - max.	min. - opt. -
		Shift - personnel category combination	Special knowledge				Automatic distribution		Importance
		1 H1 Dienst 1 - MA FH, MA EFZ	Radiologie Level 3				<input checked="" type="checkbox"/>		average
		1 H1 Dienst 1 - MA FH, MA EFZ	Radiologie Level 4				<input checked="" type="checkbox"/>		average
		2 H1 Dienst 2 - MA FH, MA EFZ	Radiologie Level 4				<input checked="" type="checkbox"/>		average
		2 H1 Dienst 2 - MA FH, MA EFZ	Radiologie Level 3				<input checked="" type="checkbox"/>		average

Employee demands
(combination of shifts, qualifications, skills)

Overview



01 POLYPOINT

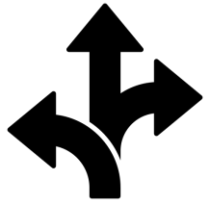
02 SHIFT SCHEDULING

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04 OPTIMIZATION

Mathematical Optimization

Some requirements



Flexibility: Easy to integrate new requirements



Speed: Fast but not instantly - max. one hour comp. time



Consistency: always high-quality solutions

Optimization Methods

State-of-the-art (closely related problems)

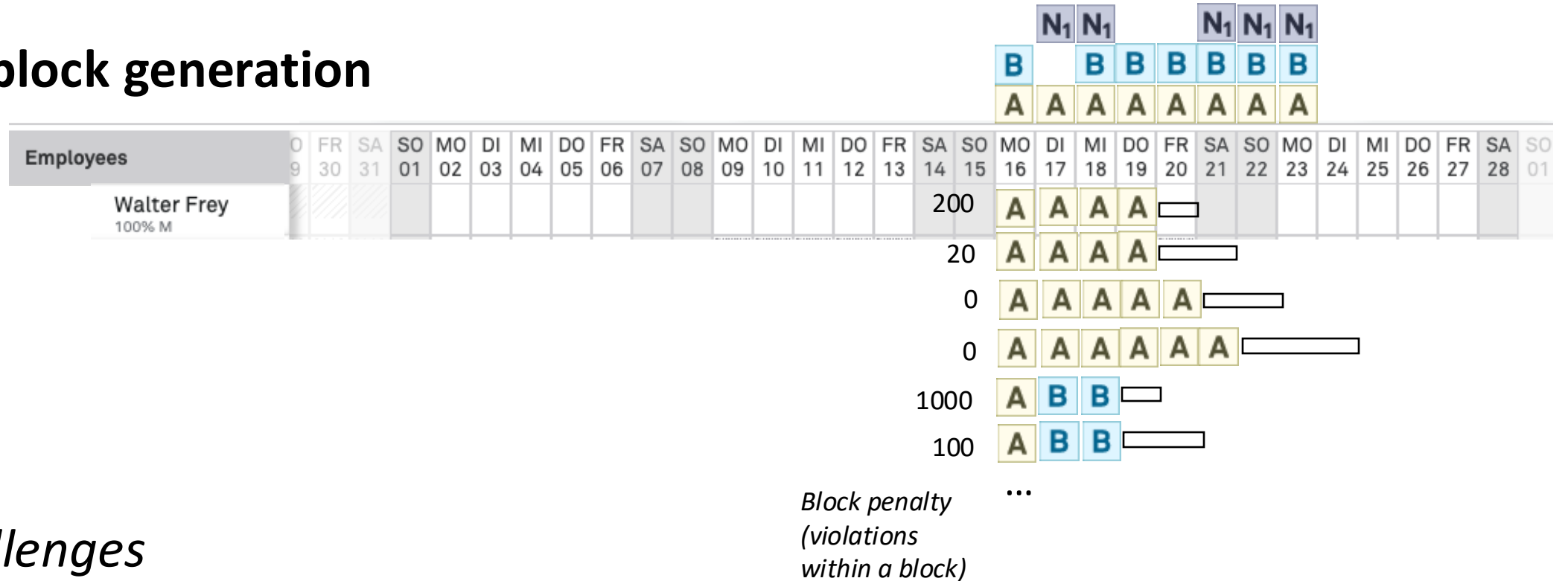
- Constraint programming
- Multi-stage, problem-tailored combinatorial heuristics
- Extended formulations (exact / heuristic column generation)
- No “simple” compact mathematical program

Our method

- Observation: most complex rules within work block
- *Phase 1*: Work block generation
- *Phase 2*: Integer programming
- Like decomposition proposed by Brucker et al. in 2010

Two-Phase Heuristic

1 - Work block generation



Main challenges

- Speed (must be fast)
- Filtering (typically, too many work blocks for the solver)

Two-Phase Heuristic

2 – Integer programming

- Integer program based on work block variables:
 - Many variables (up to 800'000) but „few“ constraints (~ 5'000)
 - No single work block-related constraints
- Hard constraint: non-overlapping work blocks
- Soft constraints for (almost all) violations
- Convex (pwl) cost structures for some violations (e.g. demand)

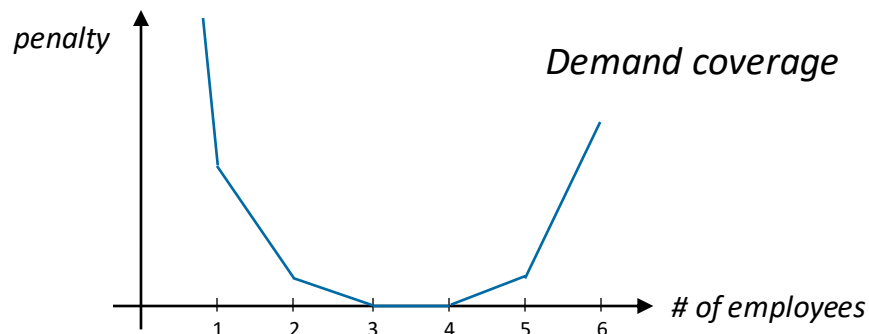
$$\text{Minimize } \sum_{A \in \mathcal{F}} c_A x_A + \sum_{d \in D} f_d^{\text{cov}}(y_d)$$

subject to

$$\sum_{A \in \mathcal{F}} h_{A,d} x_A = y_d \quad \text{for all } d \in D,$$

$$\sum_{A \in \mathcal{F}_e} x_A = 1 \quad \text{for all } e \in E,$$

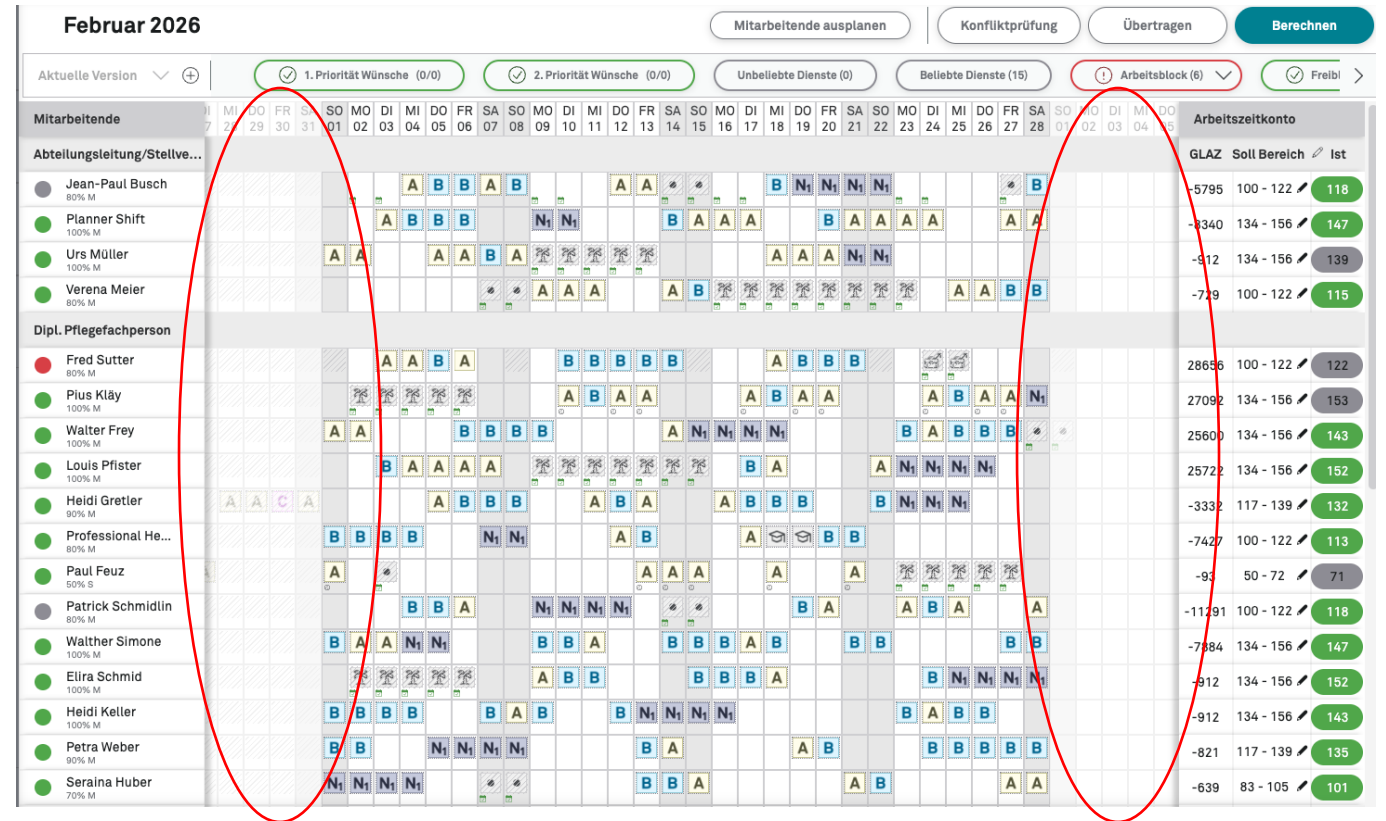
$$x_A \in \{0, 1\} \quad \text{for all } A \in \mathcal{F},$$



Some Challenges

Dynamic planning horizon

- Past and present link
- Impact on future
- Strategic look-ahead



Solution quality

- Weakly-coupled phases, no global optimality
- Local optimality of solutions not guaranteed (due to early stop + filtering)

Some Challenges

Fairness

- Generally difficult with multiple facets, such as:
 - Procedural: voice requests and preferences
 - Distributive: Balance needs and preferences among employees
 - Informational: provide explanations
 - Interpersonal: voice concerns to supervisors
- Two fairness aspects in our mathematical model
 - Wish fulfillment with concave bonus function (1st wish more important than 2nd)
 - Fair distribution of (unpopular) shifts, weekends and holidays
- On-going collaboration with University of Berne (Algorithmic Fairness in Shift Scheduling)

Customer Feedback



Michael Döring-Wermelinger • 2.

CNO LUKS Gruppe bei Luzerner Kantonsspital

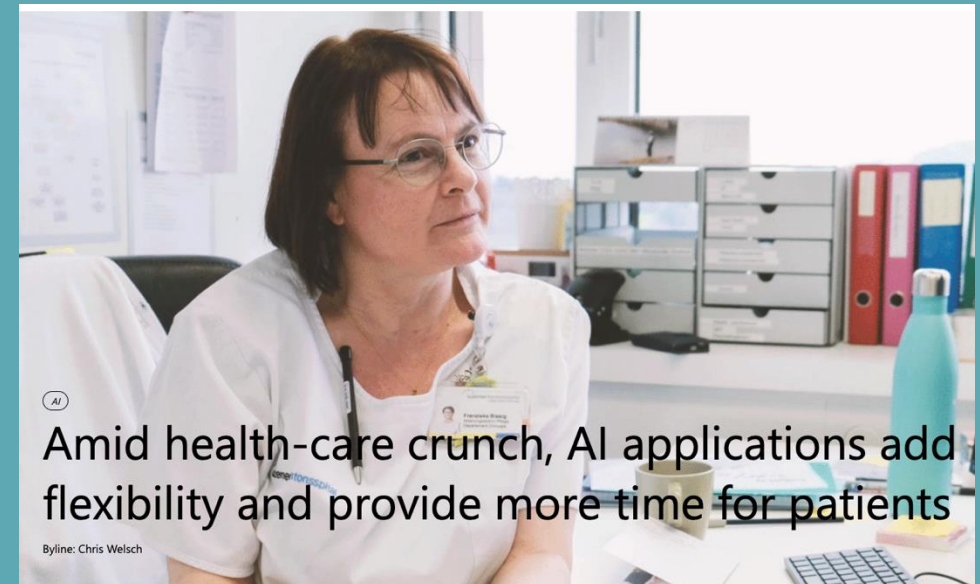
1 Woche • 

...

Inzwischen ist der Pilot erfolgreich abgeschlossen. Mehrere Pläne wurden realisiert und wurden genutzt. Das Team ist mit der Qualität zufrieden, die Umplanungswünsche haben abgenommen. Der Zeitaufwand für die Planerin hat sich bereits jetzt um 2/3 reduziert. Aufgrund des Erfolgs hat das Pflorgeteam

...

Meanwhile, the pilot has been successfully completed. Several plans have been realized and used. The team is satisfied with the quality; the requests for replanning have decreased. The time required for the planner has already been reduced by 2/3. Due to the success, the care team...



AI
Amid health-care crunch, AI applications add flexibility and provide more time for patients

Byline: Chris Welsch

<https://news.microsoft.com/source/emea/features/amid-health-care-crunch-ai-applications-add-flexibility-and-provide-more-time-for-patients/>

Some Reflections

01 Address decision-problems with a significant impact

02 Solve the right problem

03 Combine automatic with manual planning

04 Flexible optimization method

