AIPlan4EU

Bringing AI Planning to the European AI On-Demand Platform

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Your scheduling hero

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Document Revision History

Date	Issue	Author/Editor/Contributor	Summary of main change

Executive summary

Healthcare resource allocation loses too much time with ancillary activities such as administration, planning and consultation, while caring for clients is what requires the most attention. This can and must be done more efficiently, according to Taktify. The planning in particular should be something that is automated, so that the needs, availability and wishes of both the client and the healthcare professional are optimally matched. This is currently a very complex, error-prone and time-consuming process. To solve this, Taktify proposes a solution that can automate this process with a Cloud-based Intelligent Health Management Software that can determine the optimal planning using AI based on the wishes or requirements of both the client and the healthcare professional, in order to save time.

1 Context [~1 page]

Please describe the context of the use-case (use pictures if possible/useful to clarify the situation):

- Which is the application domain?
- How are the operations handled currently? Is there an established workflow?
- What are the drawbacks of the current solution (if any)?

Our main goal is to help care organizations connect to domain experts with patients seeking help**.**

We believe that the complexity of the **health care delivery system** within the care organizations requires careful planning and management of human resources. If this is achieved, there will be the equitable provision of health care in terms of numbers, quality, distribution, and an optimal skill mix.

After precise reviews of the available digital solutions in the market, we learned that most existing health management services operate based on simple scheduling methodology and require a domain expert to manually find the most matched caregiver for the patient. Also, current systems worldwide are not benefiting from any kind of automation. So they highlight the need for improvement to more efficient, goal-oriented health services which are more responsive to the growth of in-need populations and rising demands.

So considering the issues care providers face we proposed a solution that will provide them with new, better, and reliable online services that automate the big part of the communications that will reduce the workloads.

2 Planning Application [~2 pages]

Planning is a technology that helps you in automating or optimizing some decisions given a predictive model of a system / situation. Here we need to clearly identify the key decisions that should be automated/optimized in the use-case. Also, a storyboard of how planning is used within the workflow shall be presented.

- What are the key problems that you plan to address with planning technology?
  - Highlight which kind of decisions shall be automated or optimized
- How do you measure the quality of such decisions/automation? Why is the status quo not satisfactory?
- Which kind of data is relevant for taking the decisions to be automated /optimized?
  - Highlight what is “constant” (i.e., it does not change between successive decisions) and what is “contingent” (i.e., non-predictable data that is important to take an informed decision)
- How often is planning invoked? Which actor/software/rule invokes the planning?

- E.g., planning is done once a day to decide the shift activities
- E.g., planning is triggered when a discrepancy is observed w.r.t. the planned course

The United Nations has reported that 12.3 percent of the population were over 60 years of age in 2015, and forecast to be more than 21.3 percent in 2050. Therefore, many countries face an aging population. Providing the required health care services for an aging population is a challenge for health care systems in different countries. Also, pandemic situations, such as what has been observed during the COVID-19 outbreak, significantly increase the demand of home healthcare as many people are asked to stay at home while they still need health and medical services. This has prompted many countries to further invest in their home healthcare services.

Currently each care team approximately spends one hour daily for scheduling and planning that is not refundable by the insurance companies. Decisions related to human resource planning in home health care can be categorized into decisions on staff dimensioning, partitioning the territory into districts (districting), assigning caregivers to patients, and the scheduling and routing of caregivers. An assigning set of patients and caregivers is partitioned into districts based on the costs of the routing and staff dimensioning which demand considering too much attention, rules or exceptions.

We look at human resource planning decisions (districting, staff dimensioning, assignment, and routing) simultaneously and treat travel and service times as uncertain parameters and consider the factors that affect the patients' satisfaction such as continuity of care. Then we proposed a mathematical model for districting, based on staff dimensioning and routing costs. **Districting and staff dimensioning are defined as the first stage decisions (contingent), and assignment, scheduling, and routing are considered as the second stage decisions (constant).**

Districting is the initial phase of designing the system, and has significant effects on improving the efficiency of care delivery. The aim of districting is to partition the basic units (sets of patients and caregivers) into a number of larger clusters so that caregivers are able to deliver care to the patients in their cluster more quickly. This ultimately increases the patients' and the caregivers' satisfaction. Moreover, staff dimensioning is an important tactical decision as it determines the number of caregivers who need to be assigned to each district.

In our proposed model, the set of patients and caregivers is partitioned into districts based on the costs of the routing and staff dimensioning. The goal of the model is to determine the most matched caregivers and patients in each district and the required number of caregivers, while taking into account routing and hiring costs. The caregivers in a district can only be assigned to the patients in that district, and they start their visiting tour from their homes.

Based on our review of real case situations, we found that care centers often try to allocate patients to the caregivers who live in the same residential zone and would like to design the schedule so that the starting and finishing locations for each caregiver are as close as possible. On the other hand caregivers have a predefined maximum number of working hours per day. Similarity between caregivers' skills and continuity of care, which are known to be important points in dimensioning, assignment, scheduling, and routing problems, are considered in the proposed model, to optimize the routing and assignment costs.

The quality and accuracy of the proposed automation has been examined through numerical examples. Our instances were generated based on real-world data provided by the Austrian Red Cross (Fikar and Hirsch, 2015). The data was generated based on five instances in an urban region by considering 75 nodes. Patients that are located in close proximity to each other form a basic unit to decrease the size of the problem. Therefore, to generate instances, the k-means algorithm is used to determine the nodes located close to each other and construct the basic units. In this procedure some patients are selected and their corresponding assignment and routing decisions are improved when the first stage decision variables and routing and assignment decisions are fixed for the other patients.

So to make our ideal solution happen we need to have:

- Access to routine and rules of the care organization
- Health data about the care needs, received services, previous transactions (assigned caregiver to care seekers)

3 Introductory Example [~1 page]

Please provide a detailed example case listing the needed data and the expected decision outcome.
E.g. (Logistics scenario) Imagine having 2 shelves A and B with X picking positions and 1 robot that takes pallets from location C …

There is a person in each care organization (at-home care centers that provide services for patients in their own homes) who is responsible for planning and scheduling who is called a planner. There are different care teams with different skill levels, availability, and preferences in each region. So when a patient asks for care services, planners find the most matched caregiver to the patient's needs and inform both parties about their scheduled appointments. Care organizations are already using some management tools for handling the data and recording caregivers' activities and patients' requests but they are not designed for helping planners in making decisions and still the process of assigning a caregiver to a patient is manual and costs a lot of time.

Each care team spends on average one hour daily for scheduling and planning that is not refundable by insurance companies. On the other hand, each caregiver has a direct connection with patients and sets some appointments by themselves orally that mostly causes out of plan appointments, mistakes and unnecessary actions.

Taktify was initially created to address resource allocation, scheduling, and raising care requests for care organization's challenges. The realization was (and still is), that a planner cannot assign all caregivers with keeping the exceptions, preferences, rules, and unexpected requests in her/his mind. This gave rise to the idea of building an intelligent planning system with just simple user-provided recommendations, which is easy to catch. So we summarized the situation like below:

Mind	● The place to keep routine and rules ● The place to keep high priority demands ● The place to keep overall communications ● The place to keep caregivers and patients preferences
Planner	● To assign caregivers to the patients ● To enter the care demands in the system and find the most match caregiver ● To inform caregivers for their assignments ● To ask their availability ● To ask patients satisfaction and their preferences ● To monitor caregivers performance
Taktify	● To do all the above tasks in less than 1 second

4 4 Impact [~ 1 page]

4.1 4.1 Business Impacts

- What are the business impacts of automating/optimizing the decisions?
- How does the quality measure defined in the previous section map to the business? E.g.:
  - by automating the picking from shelves, we can reduce the operational costs by …
  - by optimizing the management of agricultural practices, we can reduce soil compaction that is bad because…)
- How do you define a satisfactory measurement from the business perspective? (e.g., we aim at reducing soil compaction by 10% because…)

4.2 4.2 Other Impacts

- Is there any other impact besides business? E.g. environmental, societal…

The value proposition to this (growing) market is likely to be much more straightforward and the combination of the above components has made our proposed solution far ahead of our competitors. As mentioned, there are a few digital solutions out there that are not benefiting from any kind of automation and still care teams need to spend

approximately one hour daily for planning. Also in a survey on the working time of HHC nurses in two municipalities in Norway, Holm and Angelsen (2014) show that driving time accounts for between 18% and 26% of working time, of which 22% of the driving routes were underestimated. This indicates the high potential of optimization in routing and scheduling to improve operations and lower expenses.

On the other hand by assuming a minimum hourly rate of 20 euros for each caregiver, then a medium sized care organization loses **33 working days or equally a million euros yearly**! And by automating the planning procedure within the care organization, we can allocate a lot of time for patient care instead of throwing away for planning.

5 5 Measures of Success [~1 page]

Describe how, concretely, one can measure the success of a planning integration in this use-case.

- KPIs: what are key indicators and their thresholds?
- Expected performance: computational speed, solution quality…
- How can one make these measures?

Speediness: The proposed algorithm should find near-optimal solutions in about 420.42 seconds and 289.69 seconds depending on the size of the data.

Accuracy rate: The recommended plan is the same as with human planning performance.

Customer satisfaction rate: Users willing to keep using the Taktify system after the pilot end

6 Planning Integration [~ 2 pages]

Please describe how planning will fit in the workflow/pipeline and which consequences/requirements this integration poses. Moreover, if integration with any technology is relevant, please provide the details.
E.g., if we are planning workforce activities, we need ways to avoid alienation and to properly communicate with operators.
E.g., If the flow of goods in a warehouse is governed by a certain WMS system, integrating the planner with such technology is important and requirements for such an integration must be considered.
Please also list any non-functional requirement: e.g., planning needs to be executed on premises, because of data privacy issues.
Also, how and who invokes the planning providing which kind of data?

The system needs some input as mentioned in the previous section which should capture and send to the planning system. So it is necessary to have a user interface to send this information to the planning engine.

Our proposed suggestion to develop an API planning to make the integration phase smoothly.

Non Functional Requirement:

- The system should be flexible, scalable, extensible and easy to configure
- System should support different languages
- Document the usage and workflow
- Reporting capability

Security Requirements:

- Data privacy and GDPR compliance
- API security
- Comply with OWASP API
- Comply with health regulation software

The final product should comply with GDPR and ISO 27001 standards.