Utilization of Algorithms, Dynamic Programming,Optimization

Date	18.11.2022
Team Id	PNT2022TMID34709
Project Name	Personal Assistance For Seniors Who Are Self-Reliant

Utilization of Algorithms:-

Health-care utilization is primarily determined by the need for service (i.e., levels of illness and disability), the availability of services, and the resources available for providing and paying for service.

In countries with fewer freely available services, economic status plays a larger role in determining health-care utilization. Among older adults, the need for health services is greater and often the resources available are fewer.

Many nations have programs in place to provide health services to elderly persons, although these vary dramatically in the generosity of coverage. Nations such as Thailand, Taiwan, and several European countries offer free medical care to older persons. Some countries offer restricted health services.

For example, Singapore provides means-tested subsidies. Many developing nations do not offer health services to the elderly at all. One of the key differences between older and younger people is that older people may need custodial care because of high levels of disability.

This type of care is often not included within the formal health-care system. The growing importance of severe disability with age and the lack of services for the disabled put older persons at risk.

Dynamic Programming:-

Independent scoring of the aligned sections to determine the quality of biological sequence alignments enables recursive definitions of the overall alignment score.

This property is not only biologically meaningful but it also provides the opportunity to find the optimal alignments using dynamic programming-based algorithms. Dynamic programming is an efficient problem solving technique for a class of problems that can be solved by dividing into overlapping subproblems. Pairwise sequence alignment techniques such as Needleman-Wunsch and Smith-Waterman algorithms are applications of dynamic programming on pairwise sequence alignment problems. These algorithms offer polynomial time and space solutions.

In this chapter, we introduce the basic dynamic programming solutions for global, semi-global, and local alignment problems. Algorithmic improvements offering quadratic-time and linear-space programs and approximate solutions with space-reduction and seeding heuristics are discussed.

Optimization:-

1. Patient Flow Optimization

Healthcare providers such as hospitals and clinics might experience any of the following issues due to improper allocation of resources (e.g., exam rooms, nurse practitioner staffing, beds) across units in response to clinically-driven random arrivals of patients:

- Extensive emergency department boarding, including overnight holds •

Crowded surgical units, especially on weekends

- High or low occupancy units
- Hallway placement of inpatients
- Bottleneck units
- High readmission rates to particular units
- The excessively long length of stay, particularly in higher levels of care

Our optimization models can help hospitals improve in the following aspects by adequately allocating the resources like beds across units and optimizing staffing to achieve the desired service:

- Eliminating unnecessary peaks and valleys in their patient flow • Increasing the number of patients that can be treated • Reducing nursing overload, overtime, and turnover
- Achieving maximum compliance with patient-per-nurse ratios without hiring new staff
- Assuring patients are placed in the correct beds
- Improving patient, doctor, and nurse satisfaction
- Improving the quality and safety of patient care
- Reducing patient wait times for services
- Reducing hospital overcrowding
- Lower overall hospital length of stay

2. **Optimization in Healthcare**

The inability to align hospital capacity with patient demand for services results in system stress, widespread waste, and inefficiency. Suboptimal scheduling practices frequently cause hospital overcrowding, readmissions, medical errors, hospital-acquired infections, delays, lack of preferred beds, cancellations, underutilization of existing resources, inflated cost, and nurse and physician burnout. The traditional solutions of adding more physical capacity or increasing staffing are no longer feasible (or advisable) in today's healthcare environment. **2.1. Operating Room Scheduling Optimization**

More than 60% of hospital admissions are surgical operations and operating rooms compete for resources with many other departments. Accordingly, hospitals may experience any of the following issues caused by inefficient

scheduling of their operating rooms:

- Difficulties in accessing the operating rooms for urgent and emergent surgeries
- A significant number of urgent and emergent surgeries done after prime-time hours (facility's business hours)
- Significant moving and delaying of elective surgeries to accommodate urgent and emergent surgeries

2.2. Physician Scheduling Optimization

Physicians are one of the most expensive resources in hospitals and are considered the bottleneck of the care-providing process. Physicians typically have individually negotiated agreements with their employers, which leads to a partial transfer of power from management to physicians and the importance of adhering to the physicians' schedule preferences and contractual agreements for managers.

2.3. Catheterization Laboratory Scheduling Optimization

A catheterization laboratory is an examination room in a hospital or clinic with diagnostic imaging equipment. Different patient streams compete both for catheterization laboratory access and downstream resources, such as telemetry beds. Therefore, catheterization laboratories may experience several problems, such as long waiting times, cancellation of procedures, high overtime, poor utilization, low throughput, high cost per procedure, and poor access to telemetry beds, that affect other services with whom they directly interact (e.g., telemetry units) or with whom they compete for hospital resources (e.g., the emergency department).

2.4. Nurse Scheduling Optimization

Nurses are one of the essential resources in the U.S. healthcare system. They account for approximately 25% of the total hospital operating budget and 44 % of direct care costs. However, healthcare managers face several challenges in managing this vital resource efficiently. For example, unsatisfactory nurse scheduling is a significant reason for nurse resignation, cited by 30.4% as the main reason behind their resignation. More than 50% of full-time nurses work an average of seven hours of overtime each week, which has caused only 25% nurse satisfaction in this country.

2.5. Home Healthcare Routing and Scheduling Optimization

In home healthcare operations, nurses are scheduled and routed to perform various services at clients' homes. Home healthcare planners assign nurses to clients and schedule working times. They do routing and scheduling tasks manually, resulting in high efforts and inefficient plans and schedules. For instance, driving time accounts for between 18% and 26% of working time, which indicates the high potential for optimization in routing and scheduling.

2.6. Radiotherapy Treatment Scheduling Optimization

In oncology departments, the scheduling of radiotherapy for patients plays a crucial role in ensuring the delivery of the proper treatment at the right time. It is well known that a large amount of radiation can be delivered safely to a tumor if it is spread out over several weeks. This procedure saves healthy tissue from unnecessary damage and gives it time to recover

2.7. Patient Multi-appointment Scheduling Optimization

In hospitals, patients need to sequentially visit multiple resource types such as physicians and nurses to receive treatment or be diagnosed. We can consider this process as a multi-appointment scheduling optimization problem